Draft

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

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Abstract:

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

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ACRONYMS, ABBREVIATIONS, AND SYMBOLS

46 OG/OGMTP	46th Test Wing Precision Strike Division
AAC	Air Armament Center
AAVs	Amphibious Assault Vehicles
ABR	Auditory Brainstem Response
ACC	Air Combat Command
ADC	Acoustic Device Countermeasure
AEGIS	Airborne Early Warning/Ground Environment Integration Segment
AFAST	Atlantic Fleet Active Sonar Training
AFB	Air Force Base
AFSC	Alaska Fisheries Science Center
AFVOSF	Armored Fighting Vehicle Operational Storage Facility
Ag	Silver
ALFS	Airborne Low-Frequency Sonar
AMCM	Airborne Mine Countermeasures
AOR	Area of Responsibility
ARG	Amphibious Ready Group
ARTCC	Air Route Traffic Control Center
ASA	American Sportfishing Association
ASW	Anti-Submarine Warfare
ATCAA	Air Traffic Control Assigned Airspace
AToN	Aid to Navigation
AUTEC	Atlantic Undersea Test & Evaluation Center
AWOIS	Automated Wreck and Obstruction Information System
B.P.	Before Present
BA	Biological Assessment
bbl	Barrel
bbo	Billion Barrels of Oil
BE	Biological Evaluation
BO	Biological Opinion
BRAC	Base Realignment and Closure
BSS	Buoyancy Subsystem
°C	Degrees Celsius
can	Center for Naval Analysis
CCCL	Coastal Construction Control Line
CDC	Centers for Disease Control and Prevention
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
CFMETR	Canadian Forces Maritime Experimental and Test Ranges
CG	Cruiser, Guided Missile
CGS	Connecticut General Statute
CHASN	Charleston
CHPT	Cherry Point
CM	Countermeasure
cm	Centimeters
cm/sec	Centimeters per Second
CMP	Coastal Management Program
CNA	Center for Naval Analysis
CNMI	Commonwealth of Northern Mariana Islands
CNO	Chief of Naval Operations
CO	Carbon Monoxide
COMINEWARCOM	Mine Warfare Command

ACRONYMS, ABBREVIATIONS, AND SYMBOLS, CONT'D

COMPTUEX	Composite Training Unit Exercises
CSB	Cape San Blas
CSG	Carrier Strike Group
CSS	Confederate States Ship
CSTEE	Committee on Toxicity, Ecotoxicity and the Environment
CT	Computerized Tomography
Cu	Copper
CW	Continuous Wave
CY	Calendar Year
CZMA	Coastal Zone Management Act
dB	Decibel(s)
dB re 1 μPa^2 s	dB Referenced to 1 Micropascal Squared Second
dB/μPa	dB Referenced to a Micropascal
dBA	A-Weighted Decibels
DDG	Guided Missile Destroyer
DDT	Dichlorodiphenyltrichloroethane
DEP	Department of Environmental Protection
DICASS	Directional Command-Activated Sonobuoy System
DIFAR	Directional Frequency Analysis and Recording
DOC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
DON	Department of the Navy
DT	Developmental Test
DWRRA	Deep Water Royalty Relief Act
EA	Environmental Assessment
ECM	Electronic Countermeasures
ECSWTR	East Coast Shallow Water Training Range
EEZ	Exclusive Economic Zone
EFD	Energy Flux Density
EFH	Essential Fish Habitat
EGTTR	Eglin Gulf Test and Training Range
EIS	Environmental Impact Statement
EIS/OEIS	Environmental Impact Statement/Overseas Environmental Impact Statement
EL	Energy Flux Density Level
EMATT	Expendable Mobile Acoustic Training Target
ENS	Environment News Service
EO	Executive Order
ER	Ecological Reserve
ERL	Effects Range Low
ERM	Effects Range Median
ESA	Endangered Species Act
ESG	Expeditionary Strike Group
EWTAs	Eglin Water Training Areas
°F	Degrees Fahrenheit
FAA	Federal Aviation Administration
FACSFAC	Fleet Air Control Surveillance Facility
FDA	Food and Drug Administration
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FFG	Fast Frigate
FKNMS	Florida Keys National Marine Sanctuary
FM	Frequency Modulated

ACRONYMS, ABBREVIATIONS, AND SYMBOLS, CONT'D

FMCs	Fishery Management Councils
FMRI	Florida Marine Research Institute
FR	Federal Register
FRP	Fleet Response Plan
FRTP	Fleet Readiness Training Plan
ft	Feet
ft/sec	Foot/feet per Second
ft^2	Square foot/feet
FWC	Florida Fish and Wildlife Conservation Commission
FY	Fiscal Year
g	Grams
g/L	Grams per Liter
GIS	Geographic Information System
GLO	General Land Office
GMFMC	Gulf of Mexico Fishery Management Council
GOMEX	Gulf of Mexico Exercises
GRN	Gulf Restoration Network
HAB	Harmful Algal Bloom
HCN	Hydrogen Cyanide
HLX	Cyclotetramethylenetetranitramine
HNS-IV	Hexanitrostilbene
hr	Hours
HSO_3	Bisulfite
Hz	Hertz
ICUN	International Union for Conservation of Nature and Natural Resources (also known as World Conservation Union)
IEER	Improved Extended Echo Ranging
IFAW	International Fund for Animal Welfare
IHA	Incidental Harassment Authorization
IMPASS	Integrated Maritime Portable Acoustic Scoring and Simulator
in	Inches
in/sec	Inches per Second
$in\text{-}lb/in^2$	Inch Pounds per Square Inch
IUPAC	International Union of Pure and Applied Chemistry
IWC	International Whaling Commission
JASSM	Joint Air-to-Surface Stand-off Missile
JAX	Jacksonville
JAX/CHASN	Jacksonville/Charleston
JAXPORT	Jacksonville Port Authority
JTA	Joint Test Assembly
JTFEX	Joint Task Force Exercises
kg	Kilograms
kHz	Kilohertz
km	Kilometers
km/hr	Kilometers per Hour
km^2	Square Kilometers
kPa	Kilopascal
K_{sp}	Dissociation Constant
L	Liters
lb	Pounds
LCAC	Landing Craft Air Cushion
LCU	Landing Craft Utility
LDEO	Lamont-Doherty Earth Observatory
LFA	Low-Frequency Active (Sonar)

ACRONYMS, ABBREVIATIONS, AND SYMBOLS, CONT'D

LIMPET	Land Installed Marine Powered Energy Transformer
LLC	Limited Liability Company
L_{max}	Maximum Sound Level
LNG	Liquefied Natural Gas
LOA	Letter of Authorization
LOE	Limited Objective Experiment
LWAD	Littoral Warfare Advanced Development
m	Meter(s)
m/sec	Meter(s) per Second
m^2	Square Meter(s)
m^3	Cubic Meters
MAB	Mid-Atlantic Bight
MARAD	Maritime Administration
MBTA	Migratory Bird Treaty Act
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCC	Maine Coastal Current
Mcf	Thousand Cubic Feet
MCM	Mine Countermeasures
MEU	Marine Expeditionary Unit
MF	Midfrequency
MFA	Midfrequency Active
µg	Microgram(s)
µg/L	Microgram(s) per Liter
mg	Milligram(s)
mg/hr	Milligram(s) per Hour
mg/L	Milligram(s) per Liter
mg/m^3	Milligrams per Cubic Meter
mg/sec	Milligram(s) per Second
MHz	Megahertz
mi	Mile(s)
mi^2	Square Miles
min	Minutes
MINEX	Mine Warfare Exercises
MIW	Mine Warfare
mL	Milliliters
MLO	Mine-Like Objects
µm	Micrometers
mm	Millimeter
MMC	Marine Mammal Commission
MMHSRA	Marine Mammal Health and Stranding Response Act
MMHSRP	Marine Mammal Health and Stranding Response Program
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MOA	Military Operations Area
MOU	Memorandum of Understanding
MOUT	Military Operations in Urban Terrain
µPa	Micropascal
µPa-m	Micropascal-meter
MPA	Marine Protected Area
MPRSA	Marine Protection, Research and Sanctuaries Act
MRA	Marine Resource Assessment
µs	Microsecond (one millionth of a second)
MSA	Magnuson-Stevens Fishery Conservation and Management Act

ACRONYMS, ABBREVIATIONS, AND SYMBOLS, CONT'D

MSAT	Marine Species Awareness Training
msec	Milliseconds
MW	Megawatts
N	North
NAAQS	National Ambient Air Quality Standards
NAE NAAQS	Noise Acoustic Emitter National Ambient Air Quality Standards
NAMMCO	North Atlantic Marine Mammal Commission
NAO	Atlantic Ocean Oscillation
NARR	Narranganset
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NATO	Atlantic Ocean Treaty Organization
NATO	North Atlantic Treaty Organization
NAVEDTRA	Naval Education and Training Command Manual
NAVFAC	Naval Facilities Engineering Command
NAVSEAINST	Naval Sea Systems Command Instruction
NDAA	National Defense Authorization Act
NEODS	Naval Explosive Ordnance Disposal School
NEPA	National Environmental Policy Act of 1969
NEW	Net Explosive Weight
NFWF	National Fish and Wildlife Foundation
NM	Nautical Miles
NM/hr	Nautical Miles per Hour
NM^2	Square Nautical Miles
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuaries
NMSA	National Marine Sanctuaries Act
NMMTB	National Marine Mammal Tissue Bank
NMSP	National Marine Sanctuary Program
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOSC	Naval Ocean Systems Center
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NO_x	Nitrogen Oxides
NPAL	North Pacific Acoustic Laboratory
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	National Research Council of the National Academies
NRC	Nuclear Regulatory Commission
NRL	Naval Research Laboratory
NS	Naval Station
NSB	Naval Submarine Base
NSFS	Naval Surface Fire Support
NSWC PCD	Naval Surface Warfare Center Panama City Division
OCGA	Official Code of Georgia
OCS	Outer Continental Shelf
OEA	Overseas Environmental Assessment
OEIS	Overseas Environmental Impact Statement
OF II	Otto Fuel II
ONR	Office of Naval Research
OPAREA	Operating Area
OPCON	Operational Control
OPNAVINST	Chief of Naval Operations Environmental and Natural Resources Program Manual

	Instruction
ORPC	Ocean Renewable Power Company
OT	Operational Test
PADI	Professional Association of Diving Instructors
Pb	Lead
PBR	Potential Biological Removal
PBXN	Plastic Bonded Explosive
PCB	Polychlorinated Biphenyl
PCOLA	Naval Air Station Pensacola
PL	Public Law
PM_{10}	Particulate Matter Less Than 10 Microns in Diameter
PMRF	Pacific Missile Range Facility
PNEC	Probable No Effect Concentration
ppt	Parts per Thousand
PQS	Personal Qualification Standard
PROMAR	Program on the Promotion of Marine Sciences
psi	Pounds per Square Inch
psi-ms	Pounds per Square Inch-Millisecond
psu	Practical Salinity Units
PSW	Precision Strike Weapons
PTS	Permanent Threshold Shift
RDT&E	Research, Development, Test, and Evaluation
RDX	Research Department Explosive
re 1 µPa-m	Reference Pressure of 1 Micropascal at 1 Meter
RIMPAC	Rim of the Pacific
RITE	Roosevelt Island Tidal Energy
rms	Root Mean Square
ROD	Record of Decision
RONEX	Squadron Exercise
s.d.	Standard Deviations
SAB	South Atlantic Bight
SAFMC	South Atlantic Fishery Management Council
SCC	Submarine Command Course
SDB	Small-Diameter Bomb
SEAL	Sea, Air, Land (U.S. Navy special forces team member)
SEASWITI	Southeastern Anti-Submarine Warfare Integrated Training Initiative
sec	Seconds
SEL	Sound Exposure Level
SHAREM	Ship ASW Readiness/Effectiveness Measuring
SHPO	State Historic Preservation Officer
SINKEX	Sinking Exercise of Surface Targets
SO_x	Sulfur Oxides
SPA	Sanctuary Preservation Area
SPAWAR	Space and Naval Warfare Systems Command
SPL	Sound Pressure Level
SRI	Santa Rosa Island
SSBN	Ballistic Nuclear Submarine
SSC	Surveillance Support Center
SSGN	Nuclear Guided Missile Submarine
SSN	Attack Submarine (nuclear powered)
SST	Sea Surface Temperature
SUA	Special Use Airspace
SUS	Signal Underwater Sound
SURTASS	Surveillance Towed Array Sensor System

ACRONYMS, ABBREVIATIONS, AND SYMBOLS, CONT'D

TA	Test Area
T.A.C	Texas Administrative Code
TAP	Tactical Training Theater Assessment and Planning Program
TBD	To Be Determined
TCFG	Trillion Cubic Feet of Gas
TEDs	Turtle Excluder Devices
TGLO	Texas General Land Office
THC	Texas Historic Commission
TL	Transmission Loss
TM	Tympanic-membrane
TORPEX	Torpedo Exercise
TPWD	Texas Parks and Wildlife Department
TS	Threshold Shift
TTS	Temporary Threshold Shift
U.S.	United States
UERR	Undiscovered Economically Recoverable Resources
ULT	Unit Level Training
UME	Unusual Mortality Event
UNDET	Underwater Detonation
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USS	U.S. Ship
USWTR	Undersea Warfare Training Range
UTRR	Undiscovered Technically Recoverable Resources
UUV	Unmanned Underwater Vehicle
VAC	Virginia Capes
VAST/IMPASS	Virtual At-Sea Training/Integrated Maritime Portable Acoustic Scoring and Simulator
VCOA	Virginia Capes
VEMs	Versatile Exercise Mines
VOCs	Volatile Organic Compounds
°W	Degrees West
WA	Warning Area
WDCS	Whale and Dolphin Conservation Society
WHOI	Woods Hole Oceanographic Institution
WMA	Wildlife Management Area
WR	War Reserve
WSEP	Weapons Systems Evaluation Program
WTP	Willingness-To-Pay
XBT	Expendable Bathythermograph
yd	Yards
yr	Year

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) analyzes the potential environmental effects associated with the designation of sonar use areas and use of active sonar technology and the improved extended echo ranging (IEER) system during Atlantic Fleet training exercises. The IEER system consists of an explosive source sonobuoy (AN/SSQ-110A) and an air deployable active receiver (ADAR) sonobuoy (AN/SSQ-101). The proposed action would support and maintain Navy Atlantic Fleet training, as well as maintenance and research, development, test, and evaluation (RDT&E) for mid- and high frequency active sonar that is coincident and substantially similar to Atlantic Fleet training activities. For the purposes of this document, training, maintenance, and RDT&E activities involving active sonar and the explosive source sonobuoy (AN/SSQ-110A) are collectively described as active sonar activities. The activities involving active sonar described in this EIS/OEIS are not new and do not involve significant changes in systems, tempo, or intensity from past activities.

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

In an effort to address the requirements set fourth within NEPA, the AFAST EIS/OEIS discloses all identified significant environmental impacts and informs decision makers and the public of the reasonable alternatives to the proposed action. Impacts to ocean areas of the AFAST Study Area that lie within 22.2 kilometers (km) (12 nautical miles [NM]) of land (territorial seas) are subject to analysis under NEPA. This is based on Presidential Proclamation 5928, issued December 27, 1988, in which the United States extended its exercise of sovereignty and jurisdiction under international law to 22.2 km (12 NM) from land, although the Proclamation expressly provides that it does not extend or otherwise alter existing federal law or any associated jurisdiction, rights, legal interests, or obligations.

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

The Proposed Action requires an assessment of potential effects occurring within and outside U.S. territory; therefore, the document was prepared as an EIS/OEIS under the authorities of both NEPA and EO 12114. In Chapter 4 of this EIS/OEIS, italicized text describes the effects that occur in areas located within the U.S. territory, while non-italicized text describes the effects that occur in areas located outside the U.S. territory. In addition to NEPA and EO 12114, this document complies with a variety of other environmental regulations. Refer to Section 1.3 for additional information.

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

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

The AFAST Study Area associated with the proposed Atlantic Fleet training activities encompasses the waters and their associated substrates within and adjacent to existing Operating Areas (OPAREAs), located along the East Coast and within the Gulf of Mexico as depicted in Figure ES-1. These Navy OPAREAs include designated ocean areas near fleet concentration areas (i.e., homeports) where the majority of routine Navy training and RDT&E occur. Navy training exercises are not confined to the OPAREAs; some active sonar activities or portions of these activities are conducted seaward of the OPAREAs, and a limited amount of active sonar use is conducted shoreward of the OPAREAs.

ES.2 PURPOSE AND NEED

The purpose of the Proposed Action is to provide active sonar training for U.S. Navy Atlantic Fleet ship, submarine, and aircraft crews, and to conduct RDT&E activities to support the requirements of the Fleet Readiness Training Plan (FRTP) and stay proficient in Anti-Submarine

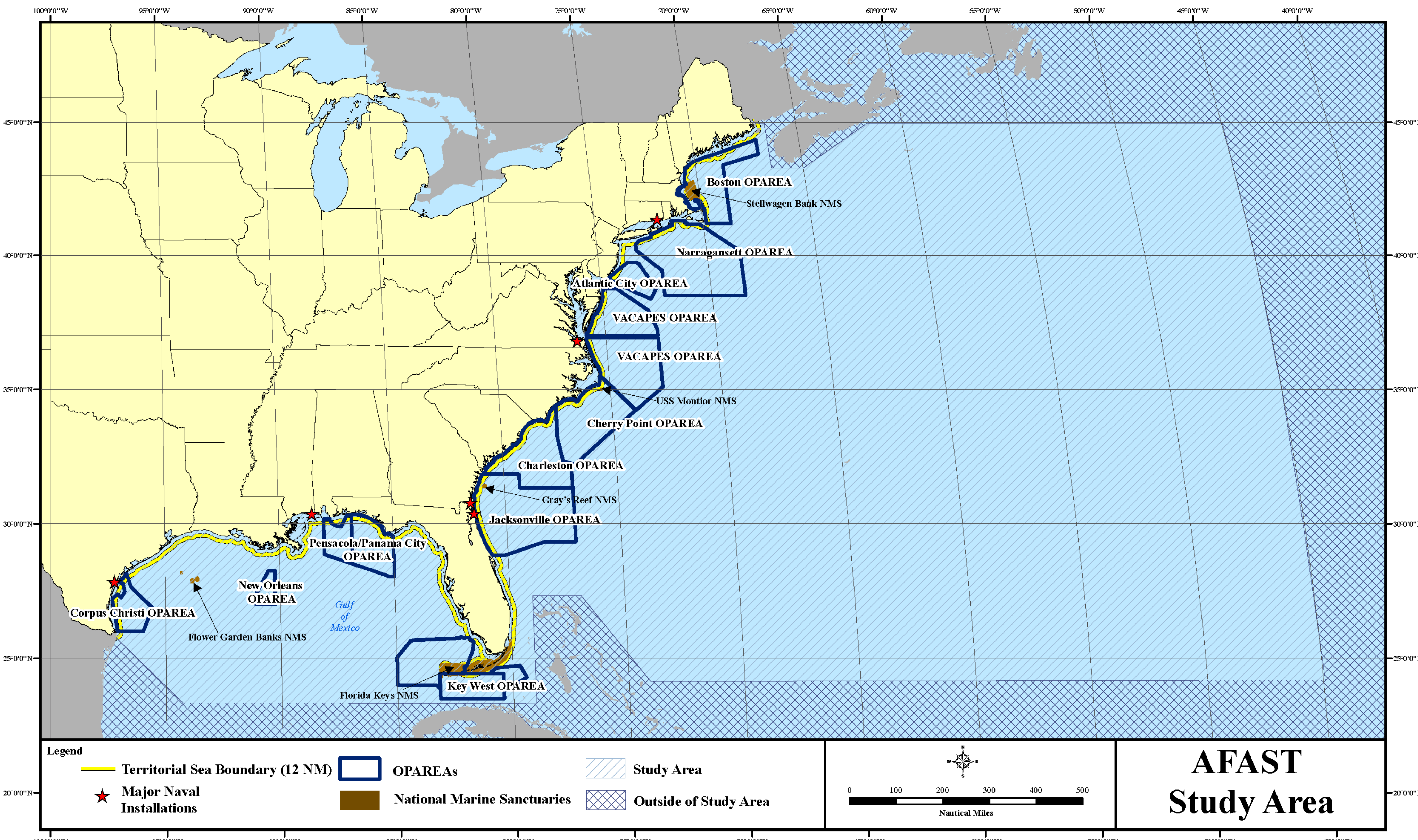

Figure ES-1. Overall Atlantic Fleet Study Area

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Warfare (ASW) and Mine Warfare (MIW) skills. The FRTP is the Navy's training cycle that requires naval forces to build up in preparation for operational deployment and to maintain a high level of proficiency and readiness while deployed.

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

ES.3 PUBLIC INVOLVEMENT

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

Table ES-1. Scoping Meeting Locations and Dates

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

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

A notice of availability was published in the *Federal Register* announcing the availability of the Draft EIS/OEIS. The Draft EIS/OEIS is now available for general review and is being circulated for review and comment. Public meetings will be advertised and held to receive public comments on the Draft EIS/OEIS. A Final EIS/OEIS will be prepared that responds to all public comments received on the Draft EIS/OEIS. Responses to public comments may take various forms as necessary, including correction of data, clarifications of and modifications to analytical approaches, and inclusion of additional data or analyses. The Final EIS/OEIS will then be made available for public review.

ES.4 PROPOSED ACTION AND ALTERNATIVES

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

Section 2.5 describes the process for developing alternatives and Section 2.6 describes the operational requirements associated with the active sonar activities. Specifically, the Navy used the following process in developing the criteria to be used during alternatives identification:

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

(2) Use the requirements defined in Step 1 (e.g. the size of the area, the water depth, or the bottom type needed for a particular training event) to identify the feasible active sonar locations (Section 2-6).

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

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

The operational requirements discussed in Section 2.6 were used as the screening criteria. If a reasonable alternative did not meet one or more of the selection criteria, the alternative was not considered feasible and was not further analyzed. Four feasible alternatives, including the No Action Alternative, are analyzed in this EIS/OEIS. Under all four alternatives, only active sonar systems with an operating frequency less than 200 kilohertz (kHz) were analyzed. Active sonar systems with an operating frequency greater than 200 kHz were not analyzed, as these signals attenuate rapidly during propagation (30 decibels per kilometer [dB/km] or more signal spreading losses), resulting in very short propagation distances. In addition, such frequencies are outside the known hearing range of most marine mammals. Although there are no direct data on auditory thresholds for any mysticete species, anatomical evidence strongly suggests that their inner ears are well adapted for low frequency hearing (Richardson et al., 1995; Ketten, 1998).

Under Alternative 1, Designated Active Sonar Areas (Figure ES-2), fixed active sonar areas would be designated using an environmental analysis to determine locations that would minimize environmental effects to biological resources while still meeting operational requirements. These areas would be available for use year-round. Under Alternative 2, Designated Seasonal Active Sonar Areas (Figures ES-3 through ES-6), active sonar training areas would be designated using the same environmental analysis conducted under Alternative 1. The areas would be adjusted seasonally to minimize effects to marine resources while still meeting minimum operational requirements. Under Alternative 3, Designate Areas of Increased Awareness (Figure ES-7), the results of the environmental analysis conducted for Alternative 1 and 2 were utilized in conjunction with a qualitative environmental analysis of sensitive habitats to identify areas of increased awareness. Active sonar would not be conducted within these areas of increased awareness. The No Action Alternative can be regarded as continuing with the present course of action. Under the No Action Alternative (Figure ES-8), the Navy would continue conducting active sonar activities within and adjacent to existing OPAREAs rather than designate active sonar areas or areas of increased awareness.

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

As the biological science continues to evolve, the areas identified in this Draft EIS/OEIS could evolve and change as well, again potentially restricting access to areas that would be critical to training. Not only would Alternatives 1 and 2 severely limit the necessity to train in areas similar to where potential threats operate, it would require the relocation of approximately 30 percent of Navy's current training. Furthermore, independent of the geographic limitations that would be imposed by Alternative 3; there is not a significant difference in the analytical results between Alternative 3 and the No Action Alternative. Due to the relatively insignificant difference between Alternative 3 and the No Action Alternative and the importance of the geographic flexibility required to conduct realistic training, the No Action Alternative was selected as the operationally preferred option.

ES.5 ALTERNATIVES ANALYSIS

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

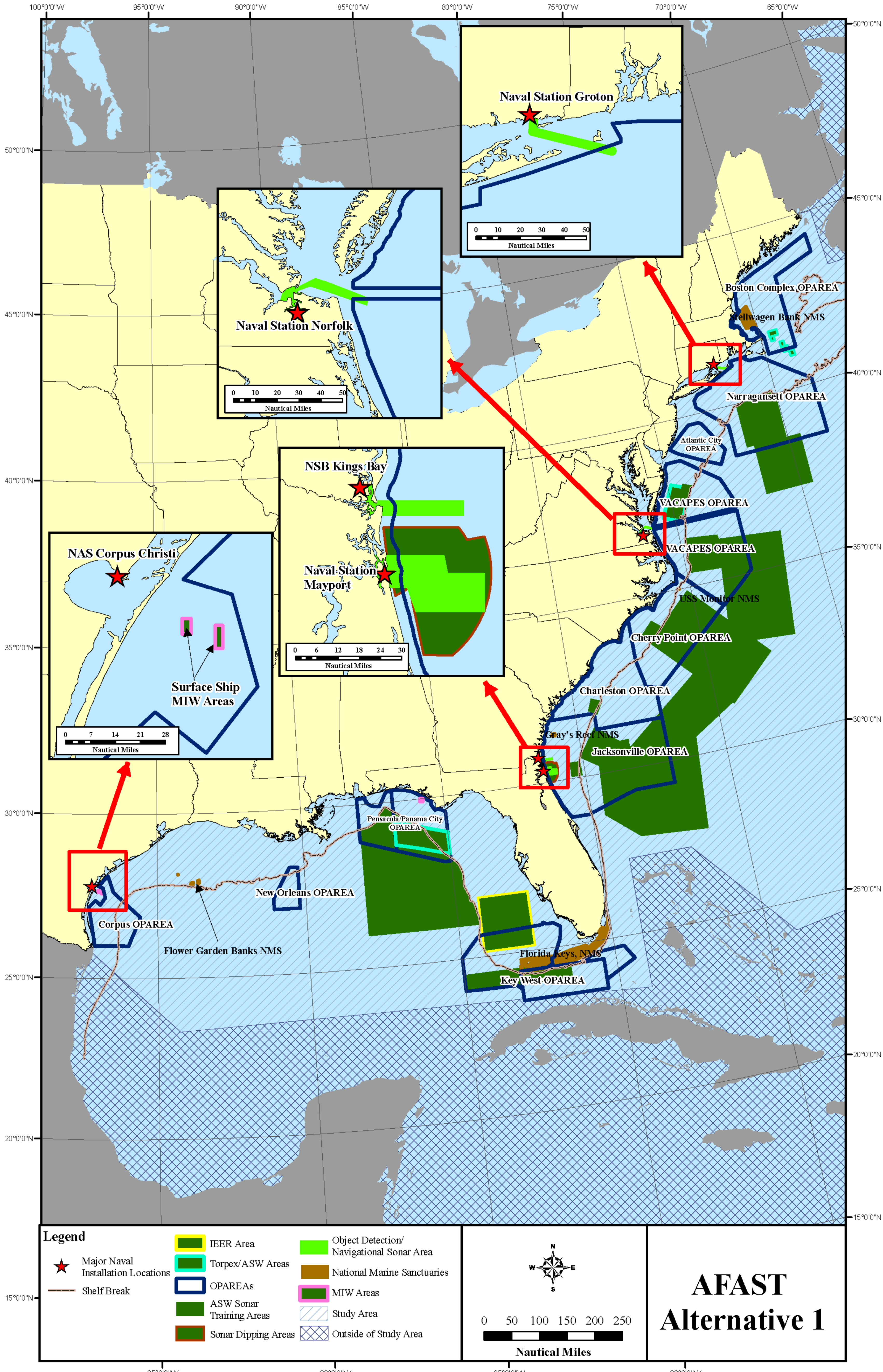


Figure ES-2. Alternative 1 – Active Sonar Activities would occur in Designated Areas (Overall)

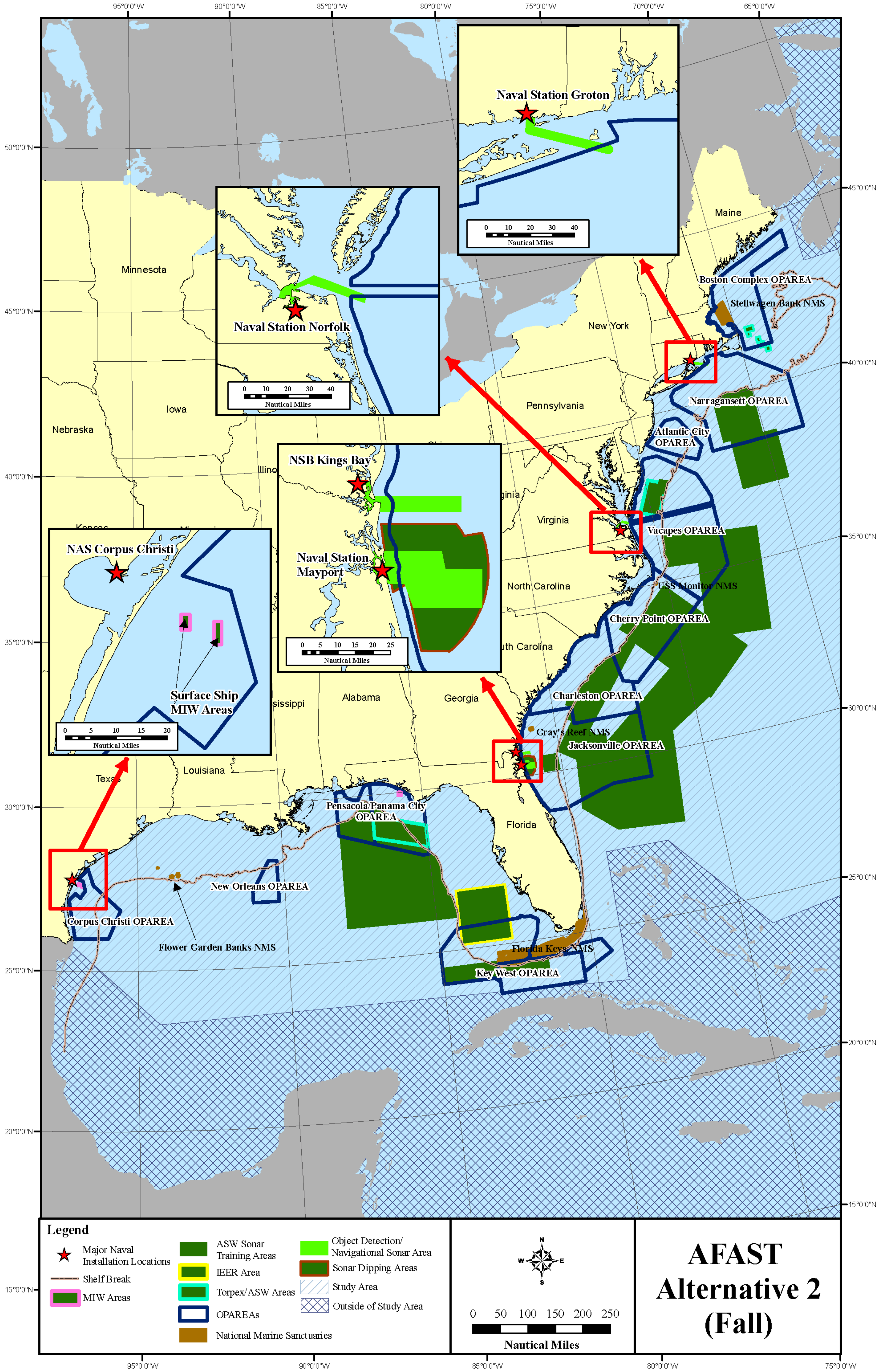


Figure ES-3. Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall–Fall)

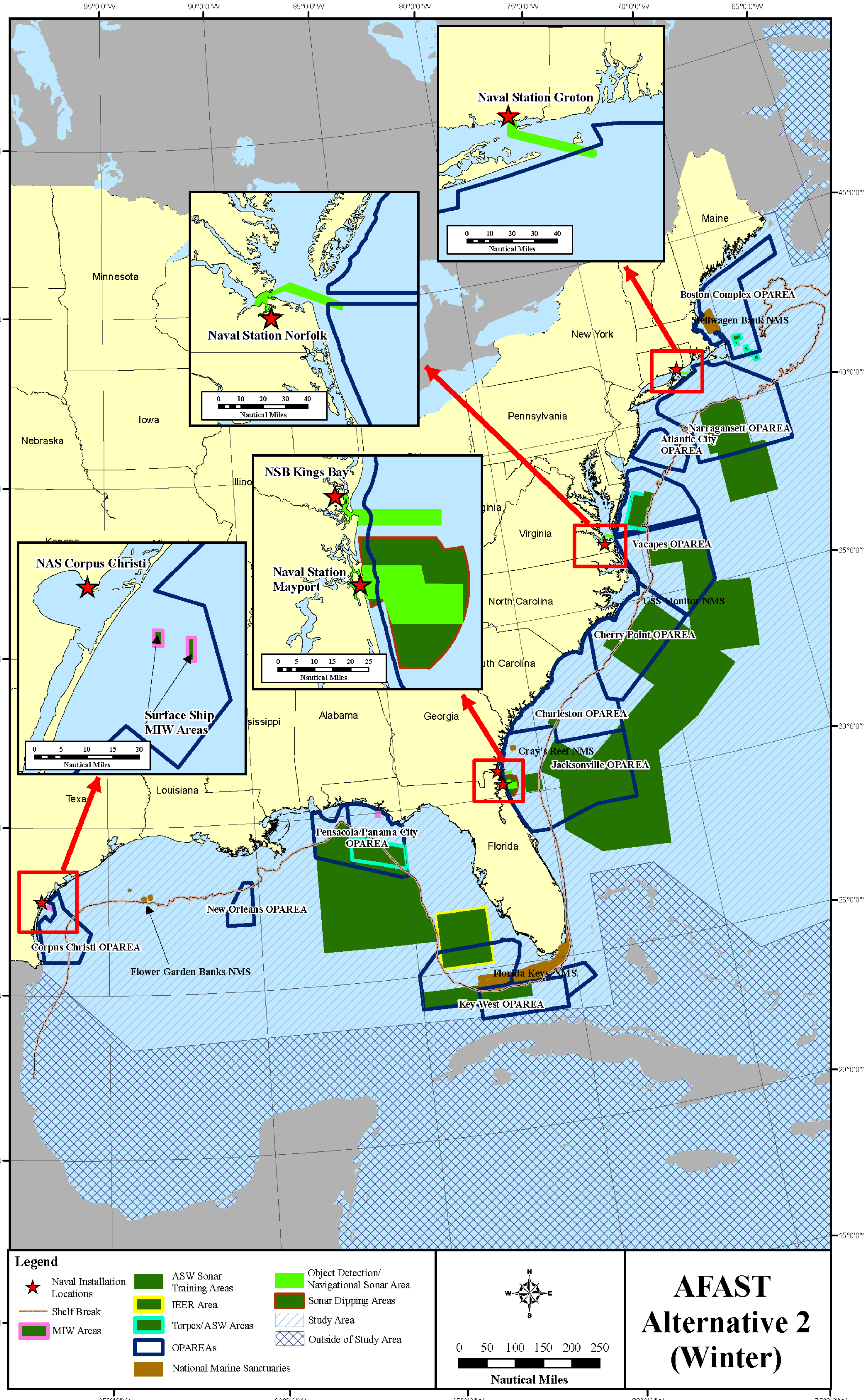


Figure ES-4. Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall–Winter)

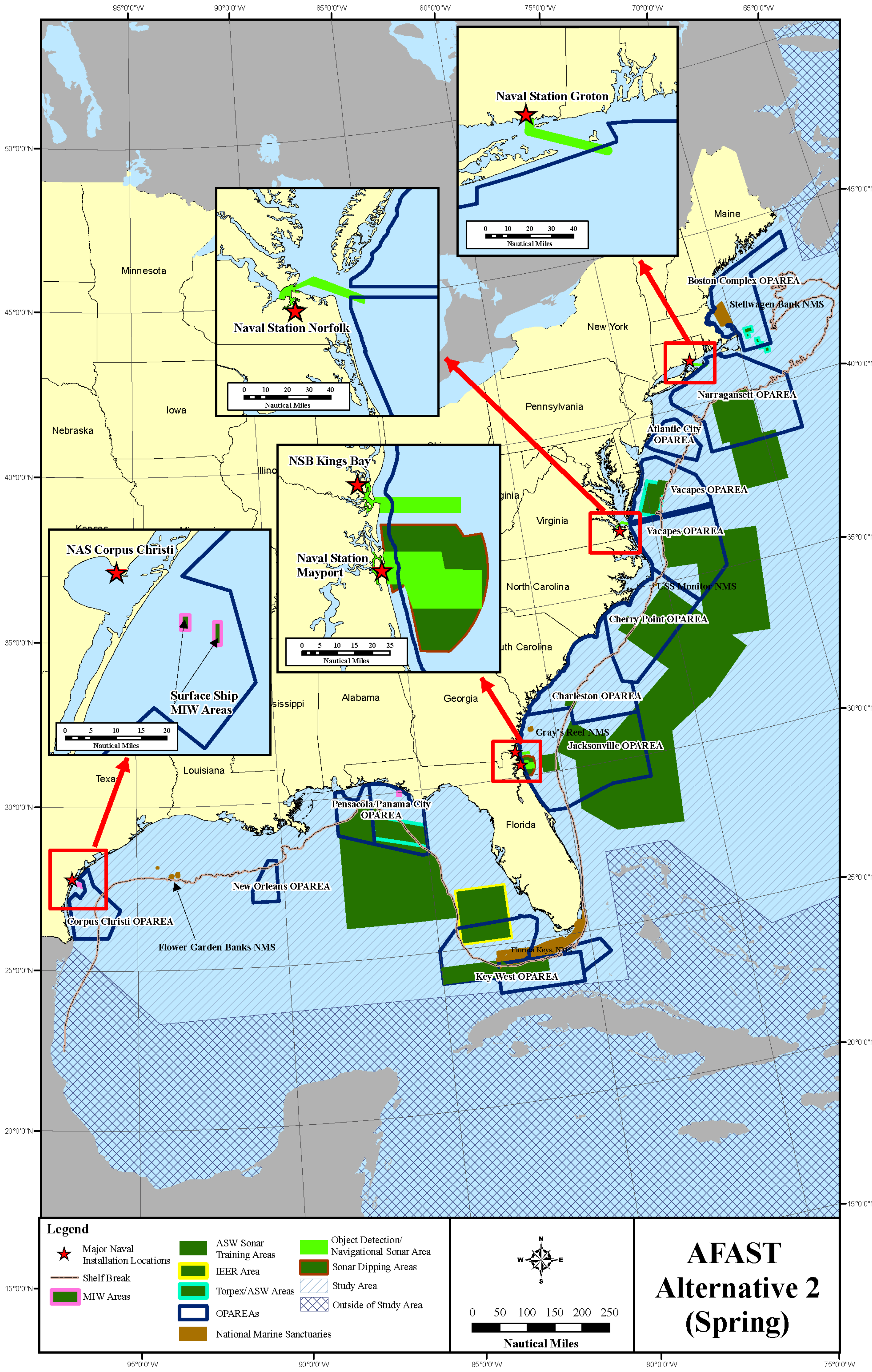


Figure ES-5. Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall–Spring)

1

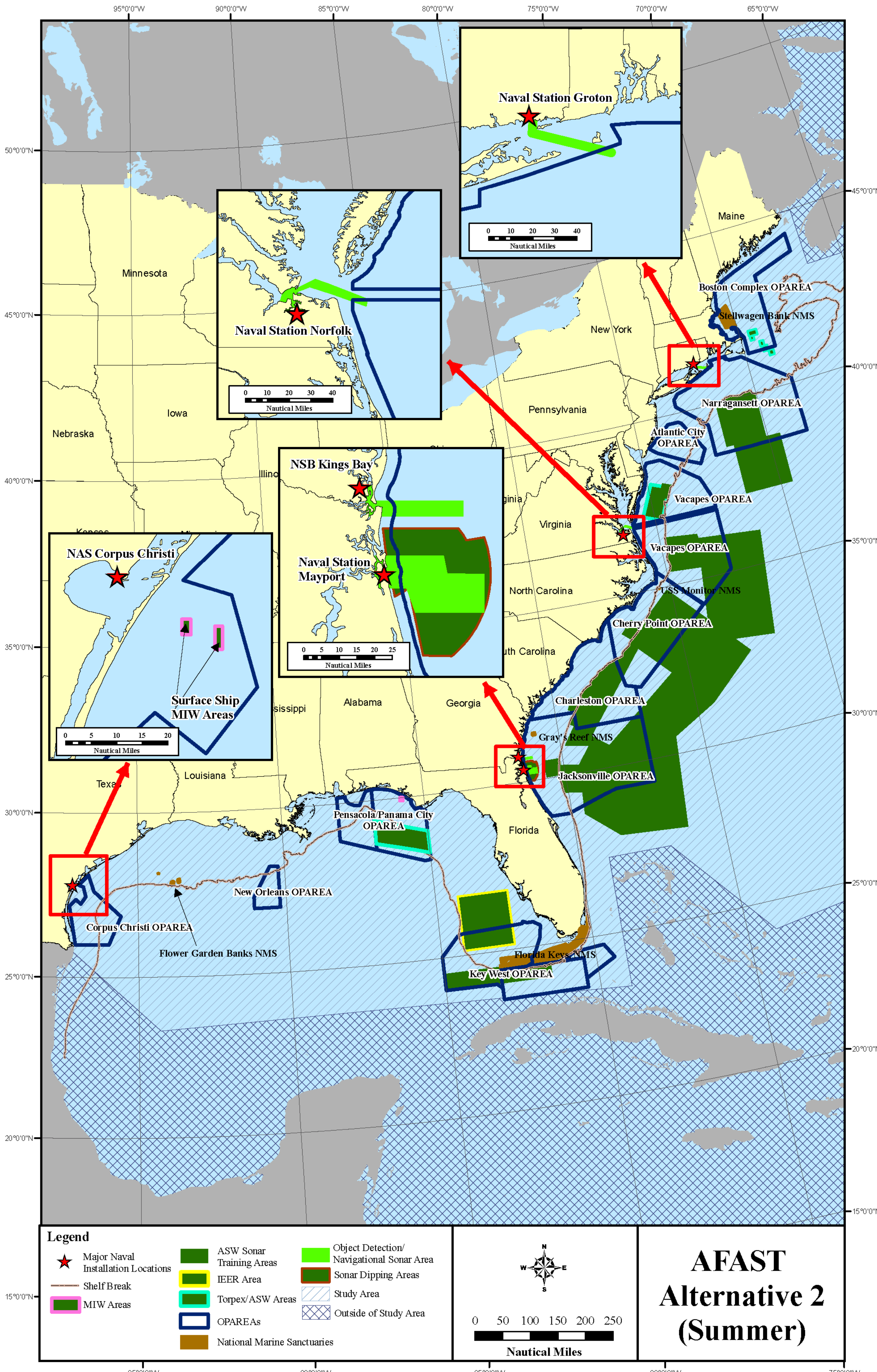
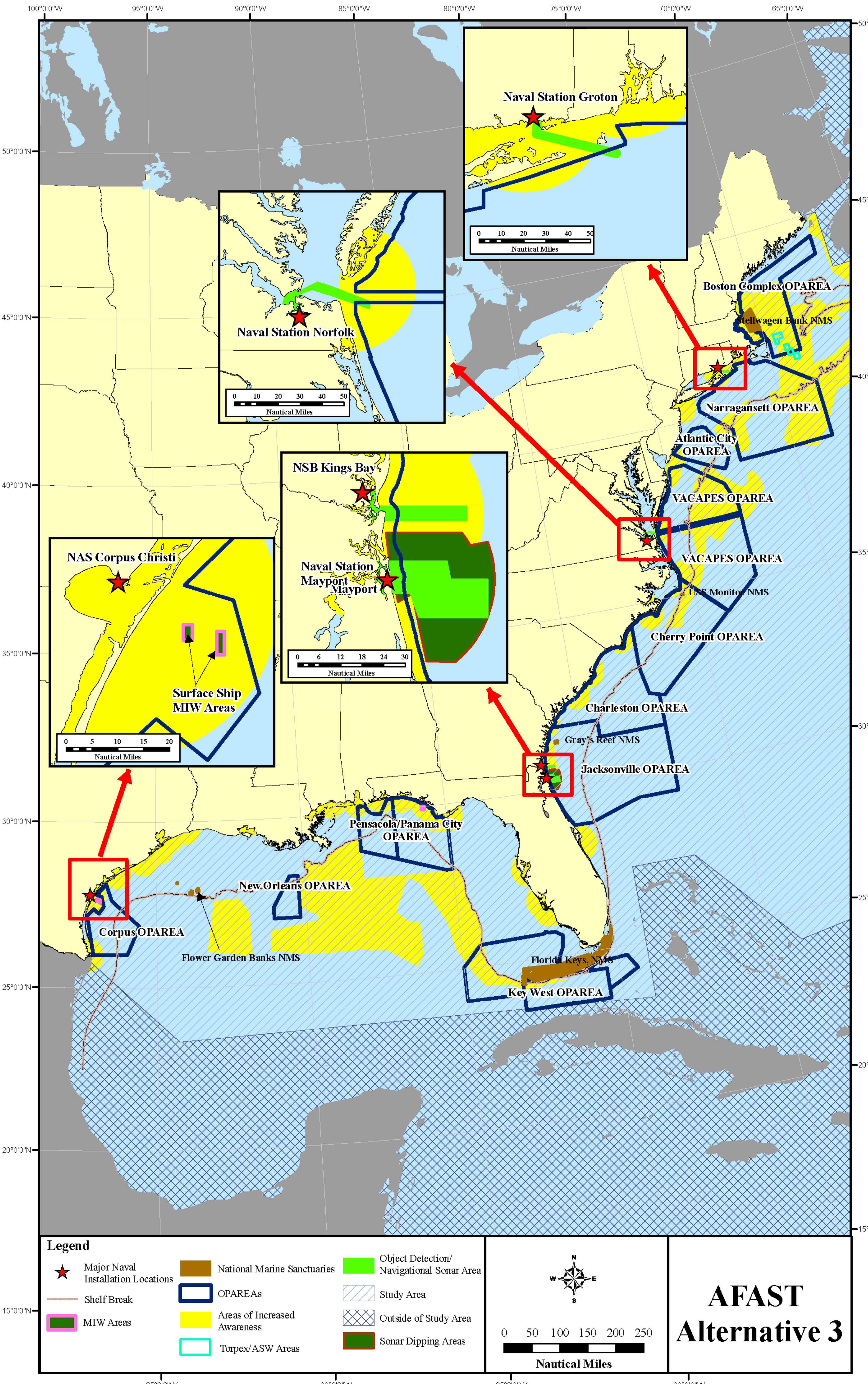


Figure ES-6. Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall–Summer)



1
2 **Figure ES-7. Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (Overall)**

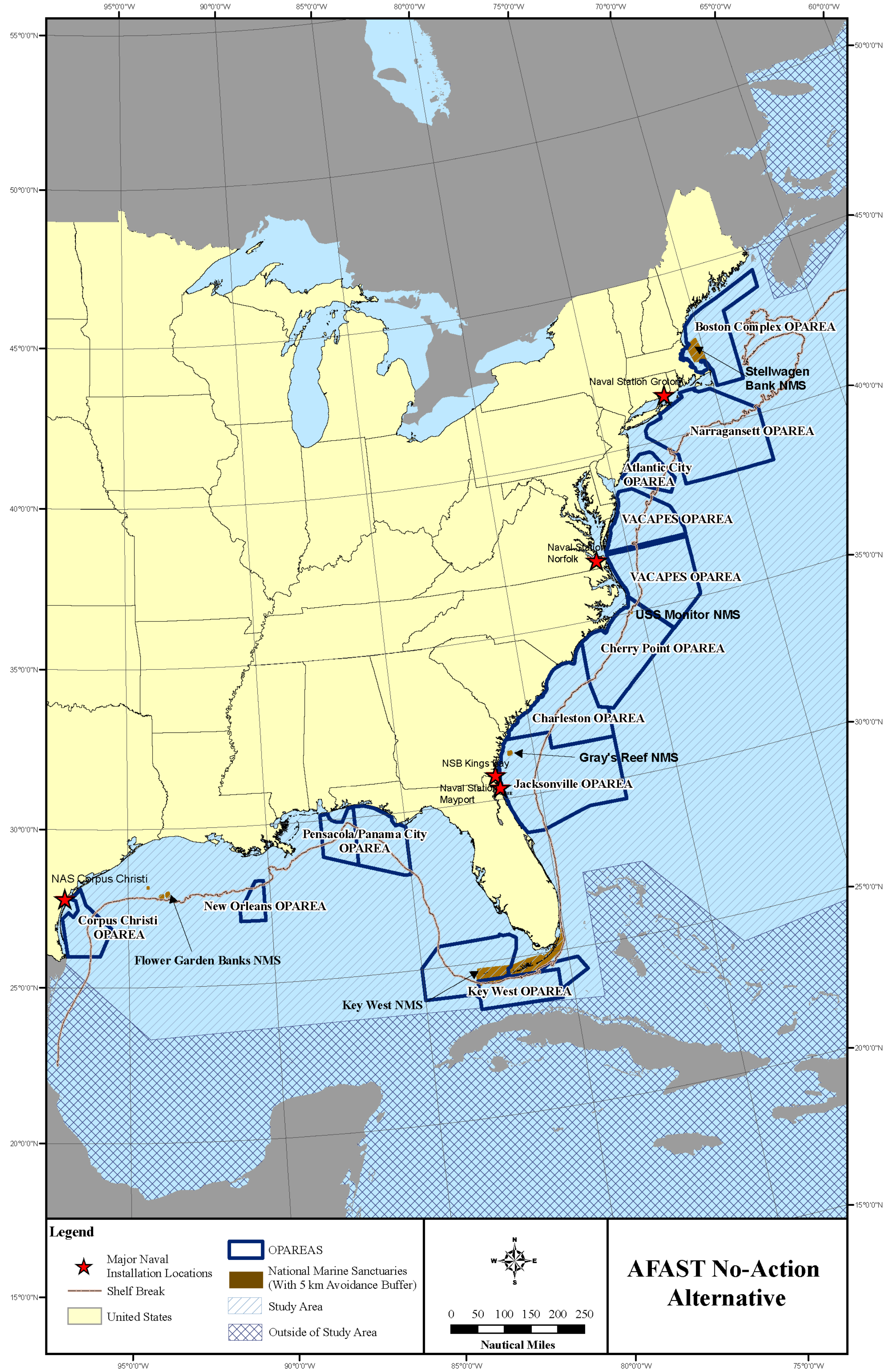


Figure ES-8. No Action Alternative – Active Sonar could occur Anywhere in the Study Area

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Table ES-2. Summary of Effects by Alternative

Environmental Resource	Alternative			
	No Action Alternative	Alternative 1	Alternative 2	Alternative 3
Sediment Quality	There would be no significant impact and no significant harm to sediment quality from expended components.	There would be no significant impact and no significant harm to sediment quality from expended components.	There would be no significant impact and no significant harm to sediment quality from expended components.	There would be no significant impact and no significant harm to sediment quality from expended components.
Marine Habitat	There would be no significant impact and no significant harm to marine habitat from expended components.	There would be no significant impact and no significant harm to marine habitat from expended components.	There would be no significant impact and no significant harm to marine habitat from expended components.	There would be no significant impact and no significant harm to marine habitat from expended components.
Water Quality	There would be no significant impact and no significant harm to water quality from expended components.	There would be no significant impact and no significant harm to water quality from expended components.	There would be no significant impact and no significant harm to water quality from expended components.	There would be no significant impact and no significant harm to water quality from expended components.
Marine Mammals	There would be no significant impact and no significant harm to marine mammals from expended components or vessel strikes. Refer to Table ES-3 for potential exposures to marine mammals from active sonar and explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to marine mammals from expended components or vessel strikes. Refer to Table ES-3 for potential exposures to marine mammals from active sonar and explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to marine mammals from expended components or vessel strikes. Refer to Table ES-3 for potential exposures to marine mammals from active sonar and explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to marine mammals from expended components or vessel strikes. Refer to Table ES-3 for potential exposures to marine mammals from active sonar and explosive source sonobuoys (AN/SSQ-110A).

Table ES-2. Summary of Effects by Alternative

Environmental Resource	Alternative			
	No Action Alternative	Alternative 1	Alternative 2	Alternative 3
Sea Turtles	There would be no significant impact and no significant harm to sea turtles from expended components. There would be no significant impact and no significant harm to sea turtles from active sonar. Refer to Table ES-3 for potential exposures to impulsive sound from explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to sea turtles from expended components. There would be no significant impact and no significant harm to sea turtles from active sonar. Refer to Table ES-3 for potential exposures to impulsive sound from explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to sea turtles from expended components. There would be no significant impact and no significant harm to sea turtles from active sonar. Refer to Table ES-3 for potential exposures to impulsive sound from explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to sea turtles from expended components. There would be no significant impact and no significant harm to sea turtles from active sonar. Refer to Table ES-3 for potential exposures to impulsive sound from explosive source sonobuoys (AN/SSQ-110A).
Marine Fish	There would be no significant impact and no significant harm to fish from active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to fish from active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to fish from active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to fish from active sonar or explosive source sonobuoys (AN/SSQ-110A).
Essential Fish Habitat	There would be no effect to essential fish habitat from active sonar. There would be no significant impact and no significant harm to essential fish habitat from explosive source sonobuoys (AN/SSQ-110A).	There would be no effect to essential fish habitat from active sonar. There would be no significant impact and no significant harm to essential fish habitat from explosive source sonobuoys (AN/SSQ-110A).	There would be no effect to essential fish habitat from active sonar. There would be no significant impact and no significant harm to essential fish habitat from explosive source sonobuoys (AN/SSQ-110A).	There would be no effect to essential fish habitat from active sonar. There would be no significant impact and no significant harm to essential fish habitat from explosive source sonobuoys (AN/SSQ-110A).
Seabirds	There would be no significant impact and no significant harm to seabirds from active sonar, explosive source sonobuoys (AN/SSQ-110A), or entanglement associated with expended materials.	There would be no significant impact and no significant harm to seabirds from active sonar, explosive source sonobuoys (AN/SSQ-110A), or entanglement associated with expended materials.	There would be no significant impact and no significant harm to seabirds from active sonar, explosive source sonobuoys (AN/SSQ-110A), or entanglement associated with expended materials.	There would be no significant impact and no significant harm to seabirds from active sonar, explosive source sonobuoys (AN/SSQ-110A), or entanglement associated with expended materials.

Table ES-2. Summary of Effects by Alternative

Environmental Resource	Alternative			
	No Action Alternative	Alternative 1	Alternative 2	Alternative 3
Marine Invertebrates	There would be no effect to marine invertebrates from active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no effect to marine invertebrates from active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no effect to marine invertebrates from active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no effect to marine invertebrates from active sonar or explosive source sonobuoys (AN/SSQ-110A).
Marine Plants and Algae	There would be no significant impact and no significant harm to marine plants and algae from active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to marine plants and algae from active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to marine plants and algae from active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to marine plants and algae from active sonar or explosive source sonobuoys (AN/SSQ-110A).
National Marine Sanctuaries	There would be no effect to the Monitor, Gray's Reef, Florida Keys, Flower Garden, or Stellwagen Bank NMS.	There would be no effect to the Monitor, Gray's Reef, Florida Keys, Flower Garden, or Stellwagen Bank NMS.	There would be no effect to the Monitor, Gray's Reef, Florida Keys, Flower Garden, or Stellwagen Bank NMS.	There would be no effect to the Monitor, Gray's Reef, Florida Keys, Flower Garden, or Stellwagen Bank NMS.
Airspace Management	There would be no effect to airspace management from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no effect to airspace management from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no effect to airspace management from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no effect to airspace management from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Energy (Water, Wind, Oil, and Gas)	There would be no significant impact and no significant harm to energy exploration from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to energy exploration from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to energy exploration from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to energy exploration from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).

Table ES-2. Summary of Effects by Alternative

Environmental Resource	Alternative			
	No Action Alternative	Alternative 1	Alternative 2	Alternative 3
Recreational Boating	There would be no significant impact and no significant harm to recreational boating from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to recreational boating from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to recreational boating from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to recreational boating from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Commercial and Recreational Fishing	There would be no significant impact and no significant harm to commercial and recreational fishing from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to commercial and recreational fishing from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to commercial and recreational fishing from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to commercial and recreational fishing from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Commercial Shipping	There would be no significant impact and no significant harm to commercial shipping from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to commercial shipping from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to commercial shipping from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to commercial shipping from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Scuba Diving	There would be no significant impact and no significant harm to scuba diving from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to scuba diving from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to scuba diving from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to scuba diving from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).

Table ES-2. Summary of Effects by Alternative

Environmental Resource	Alternative			
	No Action Alternative	**Alternative 1**	**Alternative 2**	**Alternative 3**
Marine Mammal Watching	There would be no significant impact and no significant harm to marine mammal watching from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to marine mammal watching from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to marine mammal watching from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to marine mammal watching from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Cultural Resources	There would be no significant impact and no significant harm to cultural resources from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to cultural resources from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to cultural resources from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).	There would be no significant impact and no significant harm to cultural resources from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Coastal Zone Consistency	Consistency Determinations have been submitted to the states of Connecticut, Florida, Georgia, Texas, and Virginia pursuant to 15 CFR Section 930.39.	Consistency Determinations have been submitted to the states of Connecticut, Florida, Georgia, Texas, and Virginia pursuant to 15 CFR Section 930.39.	Consistency Determinations have been submitted to the states of Connecticut, Florida, Georgia, Texas, and Virginia pursuant to 15 CFR Section 930.39.	Consistency Determinations have been submitted to the states of Connecticut, Florida, Georgia, Texas, and Virginia pursuant to 15 CFR Section 930.39.
Environmental Justice and Risks to Children	There would be no disproportionate effects to minority or low-income populations, and no environmental health risks or safety risks to children.	There would be no disproportionate effects to minority or low-income populations, and no environmental health risks or safety risks to children.	There would be no disproportionate effects to minority or low-income populations, and no environmental health risks or safety risks to children.	There would be no disproportionate effects to minority or low-income populations, and no environmental health risks or safety risks to children.

CFR = Code of Federal Regulations

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

Species	No Action Alternative				Alternative 1				Alternative 2				Alternative 3			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	6	548	0	0	1	195	0	0	1	196	0	0	6	489
Humpback whale**	0	0*	34	5911	0	0*	27	6160	0	0*	27	6256	0	0*	33	5821
Minke whale	0	0	2	630	0	0	2	327	0	0	2	334	0	0	2	761
Bryde's whale	0	0	0	26	0	0	0	26	0	0	0	26	0	0	0	26
Sei whale**	0	0	0*	2078	0	0	0*	1644	0	0	0*	1644	0	0	0*	1428
Fin whale**	0	0	1	1362	0	0	1	671	0	0	1	671	0	0	1	1024
Sperm whale**	0	1	62	14845	0	0*	45	10513	0	0*	44	10348	0	0*	45	12262
Kogia spp.	0	0	52	6043	0	0	42	6621	0	0	43	6740	0	0	51	6078
Beaked whale	0	0	35	3645	0	0	17	1730	0	0	16	1611	0	0	31	2859
Rough-toothed dolphin	0	0	33	3698	0	0	29	4047	0	0	30	4103	0	0	24	3132
Bottlenose dolphin	0	46	7613	754347	0	25	3162	486638	0	28	3585	538457	0	40	5919	673784
Pantropical spotted dolphin	0	12	1738	176890	0	12	1559	191738	0	12	1581	194344	0	12	1639	171575
Atlantic spotted dolphin	0	24	6174	382823	0	17	2640	348154	0	17	2681	353806	0	20	5269	325355
Spinner dolphin	0	2	291	21447	0	1	145	11002	0	1	145	11002	0	2	290	21402
Clymene dolphin	0	4	612	68368	0	4	501	74023	0	4	511	75268	0	4	594	68240
Striped dolphin	0	9	916	367628	0	3	194	428912	0	3	198	429566	0	5	461	261068
Common dolphin	0	5	986	167339	0	8	1288	320852	0	7	1196	307182	0	2	416	145127
Fraser's dolphin	0	0	5	354	0	0	5	348	0	0	5	348	0	0	5	349
Risso's dolphin	0	7	881	143883	0	5	524	108680	0	5	646	126917	0	7	875	138868
Atlantic white-sided dolphin	0	0	2	34288	0	0	0	110	0	0	0	110	0	0	2	45052
Melon-headed whale	0	0	23	1685	0	0	23	1654	0	0	23	1654	0	0	23	1657
Pygmy killer whale	0	0	3	242	0	0	3	238	0	0	3	238	0	0	3	238
False killer whale	0	0	7	507	0	0	7	498	0	0	7	498	0	0	7	498
Killer whale	0	0	1	65	0	0	1	64	0	0	1	64	0	0	1	64
Pilot whales	0	10	1105	188392	0	8	829	146817	0	8	903	156587	0	10	1024	178153
Short-finned pilot whale	0	0	16	1166	0	0	16	1145	0	0	16	1145	0	0	16	1147
Harbor porpoise	0	0	0	286132	0	0	0	28	0	0	0	28	0	0	1	459060
Gray Seal	0	0	3	37670	0	1	11	177715	0	1	11	177715	0	0	3	38008
Harbor Seal	0	0	4	69569	0	0	1	20	0	0	1	20	0	0	4	84999
Loggerhead sea turtle**	0	0	2	N/A	0	1	4	N/A	0	1	3	N/A	0	0	1	N/A
Kemp's ridley sea turtle*[1*]	0	0	0	N/A	0	0	0	N/A	0	0	0	N/A	0	0	0	N/A
Leatherback sea turtle**	0	0	0	N/A	0	1	3	N/A	0	0	2	N/A	0	0	0	N/A
Hardshell sea turtles[2]**	0	0	1	N/A	0	1	2	N/A	0	0	2	N/A	0	0	1	N/A

* Indicates an exposure greater than or equal to 0.05, therefore is considered a "may affect" for ESA-listed species ** Endangered or threatened species; N/A – Not applicable (criteria applies to active sonar only).
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.
2. This category includes green, hawksbill, and unidentified hardshell species for all regions. It also includes Kemp's ridley sea turtles in the Gulf of Mexico, and may include extralimital occurrences of olive ridley turtles along the Atlantic coast.

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The Marine Mammal Protection Act (MMPA) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction (MMPA, 1972). The act further regulates "takes" of marine mammals in the global commons (i.e., the high seas) by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 of the MMPA (16 U.S.C. 1362), means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment, Level A (potential injury) and Level B (potential disturbance). In support of the Proposed Action, the Navy is requesting a Letter of Authorization (LOA) pursuant to Section 101(a)(5)(A) of the MMPA. After the application is reviewed by NMFS, a Notice of Receipt of Application will be published in the *Federal Register*. Publication of the Notice of Receipt of Application will initiate the 30-day public comment period, during which time anyone can obtain a copy of the application by contacting NMFS. In addition, the MMPA requires NMFS to develop regulations governing the issuance of a LOA and to publish these regulations in the *Federal Register*. Specifically, the regulations for each allowed activity establish (1) permissible methods of taking, and other means of affecting the least practicable adverse impact on such species or stock and its habitat, and on the availability of such species or stock for subsistence, and (2) requirements for monitoring and reporting of such taking. For military readiness activities (as described in the National Defense Authorization Act), a determination of "least practicable adverse impacts" on a species or stock that includes consideration, in consultation with the DoD, of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

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

ES.6 MITIGATION MEASURES

NEPA regulations require an EIS to include appropriate mitigation measures not already included in the Proposed Action or alternatives (40 CFR 1502.12[f]). Each of the alternatives, including the Proposed Action considered in this EIS/OEIS, include mitigation measures intended to reduce environmental effects from Navy activities. These measures are detailed in Chapter 5, Mitigation Measures.

ES.7 CUMULATIVE IMPACTS

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

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

1. PURPOSE AND NEED FOR THE PROPOSED ACTION

The Department of the Navy (DON) has prepared this Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) to analyze the potential environmental effects associated with the use of mid- and high-frequency active sonar technology and the improved extended echo ranging (IEER) system during Atlantic Fleet training exercises. The IEER system consists of an explosive source sonobuoy (AN/SSQ-110A) and an air deployable active receiver (ADAR) sonobuoy (AN/SSQ-101). In addition, this document incorporates research, development, test, and evaluation (RDT&E) active sonar activities similar, and coincident with, Atlantic Fleet training that have not been previously evaluated in other environmental planning documents. For the purposes of this document, "active sonar activities" refers to training, maintenance, and RDT&E activities involving mid- and high-frequency active sonar and explosive source sonobuoy (AN/SSQ-110A). Refer to Figure 1-1 for terminology used throughout this document.

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

Figure 1-1. Select Sound Terminology

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

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

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

1.1 PURPOSE

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

1.2 NEED

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

Basic combat skills are learned and practiced during basic Independent ULT activities. Basic skills are then refined during Coordinated ULT. Strike Group Training is integrated training using progressively more difficult, complex, and large-scale exercises conducted at an increasing tempo. This training provides the warfighter with the skills necessary to function as part of a coordinated fighting force in a hostile environment with the capacity to accomplish multiple missions. By conducting this training, the Navy achieves its legal requirement to maintain, train, and equip combat-ready naval forces that are capable of winning wars, deterring aggression, and maintaining freedom of the seas.

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

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

1.2.1 ASW Training

Potential adversary nations are investing heavily in submarine technology, including designs for nuclear attack submarines, strategic ballistic missile submarines, and modern diesel electric submarines.

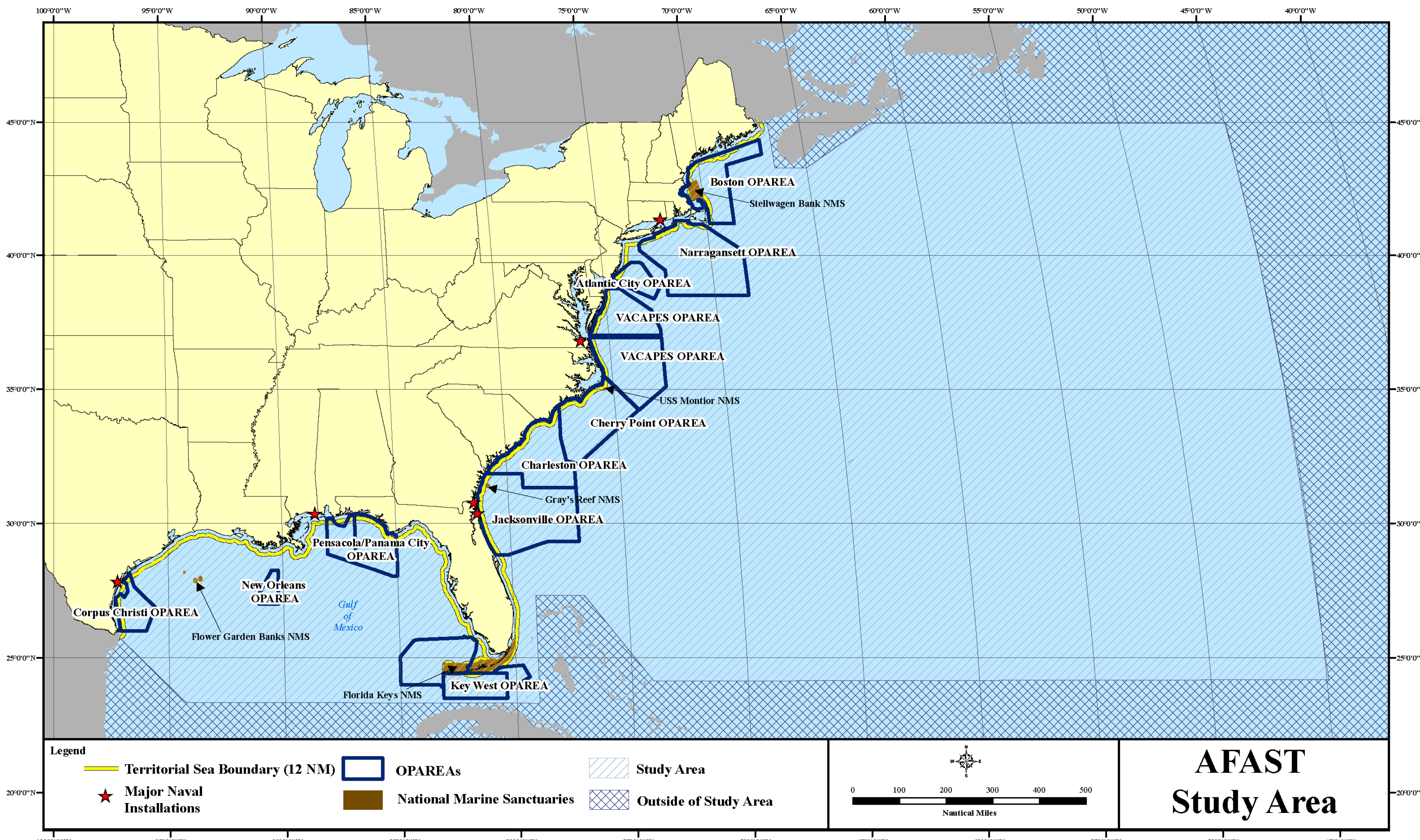

Figure 1-2. Overall Atlantic Fleet Study Area

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

Since Navy personnel ultimately fight as trained, a training environment that matches the conditions of actual combat is necessary. Sailors must also train using the combat tools that would be used during a conflict. A complicating factor facing the Navy today is the nature of the littoral waters where submarines can operate. These littoral regions are frequently confined, congested water and air space, which makes identification of allies, adversaries, and neutral parties more challenging than in deeper waters.

When searching for submarines, U.S. naval forces use many sensors. The two broad categories of sensors in use today are acoustic (sound) and non-acoustic. Acoustic tools are currently more effective for searching for submarines because sound travels through water more easily than non-acoustic emissions like light and radio waves (Figure 1-3). Two types of acoustic devices, passive and active sonar, can be used to detect submarines. Passive sonar devices only receive sound energy. As submarine technology evolves and submarines become significantly quieter, the usefulness of passive sonar continues to diminish. Active sonar devices emit sound energy into the water and receive it after it bounces off the hulls of threat submarines. Modern, quiet submarines can be better detected using active sonar devices, which can detect threat submarines at distances outside the firing range of many modern-day torpedoes (Figure 1-4). Therefore, active sonar is more useful than passive sonar to search for submarines in littoral waters or to search for modern, quiet submarines. Detection of submarines using sound is very difficult, and training is needed to build and hone these skills to be prepared in a real threat environment.

Since an adversary equipped with modern, quiet submarines has the potential to deny all Department of Defense (DoD) forces access to strategic areas of the world, the value of active sonar training has broad effects for all DoD forces.

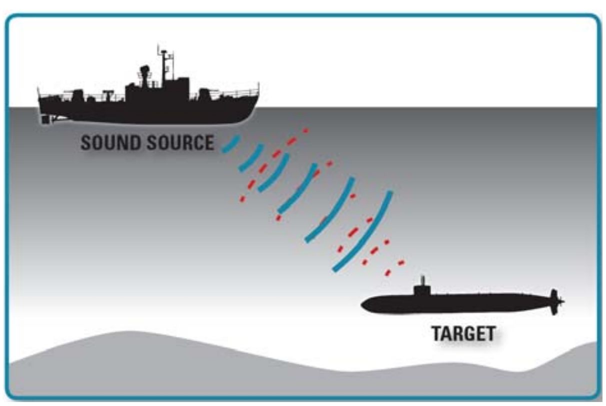

Figure 1-3. Depiction of Surface Ship Using Active Sonar

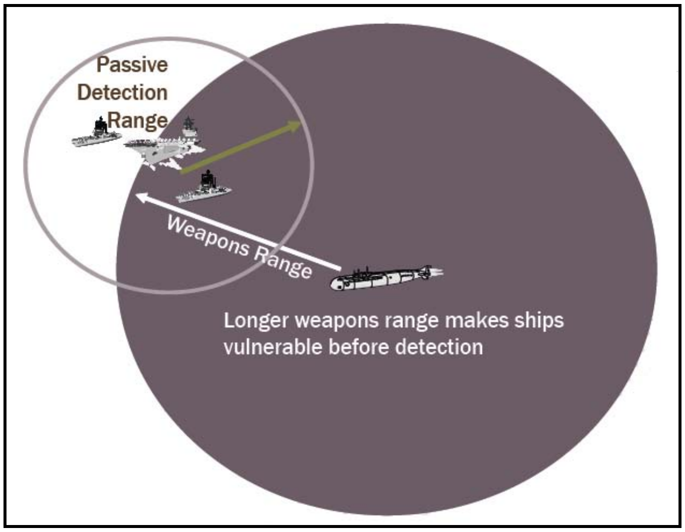

Figure 1-4. Depiction of Passive Detection Range and Submarine Weapons Range

1.2.2 MIW Training

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

Figure 1-5. Depiction of Ship with Mine Damage

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

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

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

1.3 REGULATORY COMPLIANCE

The Proposed Action requires an assessment of effects within and outside U.S. territory; therefore, the document is being prepared as an EIS/OEIS under the authorities of NEPA and Presidential Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. In Chapter 4 of this EIS/OEIS, italicized text describes the effects that occur in areas located within the U.S. territory, while non-italicized text describes the effects that occur in areas located outside the U.S. territory.

In addition to NEPA and EO 12114, this document complies with a variety of other environmental regulations. The following sections summarize the environmental requirements most relevant to this EIS/OEIS.

1.3.1 NEPA

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

1.3.2 EO 12114

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

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

1.3.3 Marine Mammal Protection Act

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

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

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

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

In support of the Proposed Action, the Navy is applying for an authorization pursuant to Section 101(a)(5)(A) of the MMPA. After the application is reviewed by NMFS, a Notice of Receipt of Application will be published in the *Federal Register*. Publication of the Notice of Receipt of Application will initiate the 30-day public comment period, during which time anyone can obtain a copy of the application by contacting NMFS. In addition, the MMPA requires NMFS to develop regulations governing the issuance of a Letter of Authorization (LOA) and to publish these regulations in the *Federal Register*. Specifically, the regulations for each allowed activity establish:

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

1.3.4 Endangered Species Act

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

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

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

1.3.5 Magnuson-Stevens Fishery Conservation and Management Act

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

1.3.6 Coastal Zone Management Act

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

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

1.3.7 Migratory Bird Treaty Act

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

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

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

1.3.8 National Marine Sanctuaries Act

The National Marine Sanctuaries Act (NMSA) prohibits the destruction of, loss of, or injury to any sanctuary resource managed under law or regulations, and any violation of the act, any regulations, or permits issued thereunder (16 U.S.C. 436). In addition, Section 304(d) of the NMSA (16 U.S.C. 1434[d]) requires federal agencies to consult with the Secretary of Commerce, through NOAA, on federal agency actions, internal or external, to any national marine sanctuary that are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is “may” destroy, cause the loss of, or injure). Under Section 304(d), if NOAA determines that the action is likely to destroy, cause the loss of, or injure sanctuary resources, NOAA shall recommend reasonable and prudent alternatives that can be taken by a federal agency to protect sanctuary resources. The federal agency may choose not to follow these alternatives provided the reasons are submitted in writing. However, if the head of a federal agency takes an action other than an alternative recommended by NOAA and such action results in the destruction of, loss of, or injury to a sanctuary resource, the head of the agency shall promptly prevent and mitigate further damage and restore or replace the sanctuary resource in a manner approved by NOAA. Regulations for each designated national marine sanctuary specifically address military and defense activities.

1.3.8.1 Executive Order 13158, Marine Protected Areas

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

1.3.8.2 Executive Order 13089, Coral Reef Protection

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

1.3.9 Cooperating Agencies

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

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

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

1.4 PUBLIC INVOLVEMENT

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

1.4.1 Notice of Intent

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

1.4.2 Public Scoping Meetings

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

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

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

Table 1-1. Scoping Meeting Locations and Dates

Location	Date	Facility
Chesapeake, Virginia	23 October 2006	Chesapeake Conference Center, 900 Greenbrier Circle
Corpus Christi, Texas	26 October 2006	American Bank Center, 1901 North Shoreline Boulevard
New London, Connecticut	02 November 2006	Radisson Hotel, 35 Governor Winthrop Boulevard
Jacksonville, Florida	07 November 2006	Ramada Inn Mandarin, 3130 Hartley Road
Panama City, Florida	09 November 2006	Marriot Bay Point Resort, 4200 Marriot Drive
Morehead City, North Carolina	14 November 2006	National Guard Armory, 3609 Bridge Street
Charleston, South Carolina	16 November 2006	Town and Country Inn (Conference Center), 2008 Savannah Highway
New London, Connecticut	29 November 2006	Radisson Hotel, 35 Governor Winthrop Boulevard

1.4.2.1 Issues Raised During Scoping that Are Within the Scope of this EIS/OEIS

The public scoping process resulted in receiving general comments, the majority of which are within the scope of this EIS/OEIS and will be incorporated as such. An overview of comments received is provided in this section with an emphasis placed on comments received from regulatory agencies. For organizational purposes, the comments are presented in the manner they are addressed in this document.

1.4.2.1.1 Purpose and Need

Comments received on the overall need of the Proposed Action included substituting “synthetic” training for real-life training and using alternative technologies such as a lab setting. The use of “synthetic” training is discussed in Section 2.7.

Once comment was received regarding the development of a clear purpose and need that identifies a core requirement. The purpose is provided in Section 1.1, and the need is provided in Section 1.2.

A comment was received from the North Carolina Department of Administration asking that the Navy justify the purpose and need, which is provided in Sections 1.1 and 1.2, respectively.

1.4.2.1.2 Alternative Development

Comments were received regarding developing reasonable alternative locations and actions, adequately describing noise producing activities (e.g., source levels, frequency ranges, duty cycles), and thoroughly describing the Proposed Action. Reasonable alternatives considered in the development of this document are included in Sections 2.7 and 2.8. Some comments received were in regards to the Navy relocating training activities to areas away from vulnerable and endangered species concentrations. Suggestions included locating sonar training to areas where marine life is less abundant and away from the areas and the migratory corridors related to breeding, feeding, and calving areas, as well as using seasonal restrictions. These comments were used in developing reasonable alternatives described in Sections 2.7 and 2.8.

The Louisiana Department of Wildlife and Fisheries advised that the Navy avoid green, hawksbill, Kemp's ridley, and loggerhead sea turtles; finback and humpback whales; manatees; and the Gulf sturgeon. The Virginia Department of Conservation and Recreation recommended the Navy implement the avoidance of high areas of marine mammal activities and use seasonal training at times of inactivity or lower activity. The agency highlighted the existence of the loggerhead sea turtle and the presence of state and federally listed marine mammals within the project vicinity. Additionally, the Marine Mammal Commission asked the Navy to include an approach based on a mixture of species-specific geographical and seasonal adjustments. Species density and habitat was taken into consideration when developing all reasonable alternatives.

A comment was received from the North Carolina Department of Administration regarding the potential use of onshore facilities, such as harbors. Although not directly included, the use of onshore facilities is similar to alternative training methods discussed in Section 2.7.

1.4.2.1.3 Affected Resources

Many comments received were related to the use of active sonar and peer-reviewed science. Letters also included information about the presence of specific species and past mass stranding activities. In response to these comments, Chapter 3 includes available scientific information on marine species hearing, and Appendix E provides an in-depth review of marine mammal strandings.

The Virginia Department of Environmental Quality noted the affected environment should include aquatic spawning, nursery, and feeding grounds, significant wildlife habitat areas, and underwater historic sites. These applicable affected environmental resources are included in Chapter 3.

1.4.2.1.4 Environmental Consequences

Physical Environment

One commenter and several regulatory agencies noted that the Navy should perform CZMA consistency determinations for the AFAST activities. In accordance, the Navy will determine whether active sonar activities will have reasonably foreseeable effects to coastal uses and resources and, if so, whether they are consistent with the enforceable policies of approved state coastal programs. The Navy will submit a CZMA consistency determination to appropriate state agencies as necessary.

Comments received from the North Carolina Department of Administration pertained to effects to marine habitats from debris and measures to retrieve equipment and other materials. Potential effects to bottom sediments are discussed in Section 4.3.

Another comment received from the North Carolina Department of Administration was in regards to analyzing potential effects to the water column, and analyzing for toxins to be released into the water column. A toxicological analysis was conducted for batteries and is presented in Section 4.3.

Biological Environment

Several comments received were in regards to appropriately evaluating the potential effects of active sonar, entanglement, ingestion of debris, and ship strikes to marine species. Chapter 4 provides an analysis of potential effects related to active sonar, including items expended during exercises, potential for masking, and information related to ship strikes. Chapter 4 provides a quantitative analysis on the number of marine mammals (Section 4.4) and sea turtles (Section 4.5) that may be exposed to sound sources during AFAST activities, as well as a qualitative analysis for EFH (Section 4.6), marine fish (Section 4.7), seabirds (Section 4.8), marine invertebrates (Section 4.9), and marine plants and algae (Section 4.10). During the analysis, individual species ecological habitat, distribution, and abundance were considered, as well as the best scientific information available regarding species sensitivity to sound, when determining overall effect to the respective species. A few comments were received requesting that information on marine stress be added to the document. The dose-function acoustic methodology presented in this EIS/OEIS makes use of definitions provided in the MMPA and was developed by NMFS in consideration of potential effects of sound on marine mammals. The conceptual framework presented in Section 4.4 includes a discussion of stress.

The North Carolina Department of Administration requested that data sources and methods used be identified, conclusion statements be written clearly, and a worst-case analysis be conducted if insufficient information exists. In addition, the environmental analysis should include potential effects from active sonar to fish, reef fish, and their habitats, as well as seabirds. These comments are addressed in Chapter 4.

The Mid-Atlantic Fisheries Management Council requested the Navy research available literature and incorporate this information on the effect of sound on fish behavior, with particular emphasis on the effect of exposure to mid-range sonar. Known scientific information on the potential effects of sound and active sonar to fish behavior is presented in Section 4.7.

The Connecticut Department of Environmental Protection requested the analysis include whether the proposed sonar systems and training exercises could affect the sea turtles, harbor porpoises, harbor seals, or the many fish species migrating into and out of the Long Island Sound. Potential effects to these species are included in Sections 4.4, Marine Mammals; 4.5, Sea Turtles; 4.6, EFH; and 4.7, Marine Fish.

The Florida Fish and Wildlife Conservation Commission recommended the Navy identify and evaluate the potential effects to protected and sensitive habitats, as well as protected species that would be affected by the training activities throughout the project boundary. Refer to Chapter 4 for analytical results for these aspects.

The Marine Mammal Commission asked the Navy incorporate the potential range of effects to a species-by-species basis for marine mammals and to consider species especially vulnerable to human activities and mid-frequency sonar. Potential effects to marine mammals are presented in Section 4.4.

Anthropogenic (Man-Made) Environment

A public commenter requested analysis of potential effects active sonar might have to whale-watching and dolphin-watching boat tours from Virginia Beach, Virginia. Section 4.18 analyzes potential effects from the Proposed Action to marine mammal watching.

In addition, one commenter expressed concern about the potential safety risks to human divers from use of active sonar during AFAST training. Section 4.17 addresses potential effects to scuba divers from implementation of the Proposed Action.

Comments were received from the North Carolina Department of Administration regarding potential effects to shipwrecks, closure of public accessible areas during training activities, and oil and gas leasing. Potential effects to shipwrecks is included in Section 4.19 and potential effects to the public as a result of AFAST activities is discussed in Sections 4.14, Recreational Boating; 4.15, Commercial and Recreational Fishing; 4.16, Commercial Shipping; 4.17, Scuba Diving; and 4.18, Marine Mammal Watching. Furthermore, potential effects related to energy (water, wind, oil, and gas) exploration activities are presented in Section 4.13.

The Alabama Historical Commission requested potential effects to cultural resources be included in the document. Potential effects to shipwrecks are included in Section 4.19.

The Massachusetts Department of Public Health requested the EIS/OEIS include information on potential effects from sonar use to marine activities such as swimming, boating, fishing, shell-fishing, and/or changes in fish stock that could potentially change human consumption patterns. Potential effects to these aspects are provided in Sections 4.6, EFH; 47, Marine Fish; 4.14, Recreational Boating; 4.15, Commercial and Recreational Fishing; and 4.17, Scuba Diving.

1.4.2.1.5 Mitigation Measures

Comments received recommended developing more meaningful mitigation measures, short- and long-term monitoring plans, use of third party observers, and standoff distances. The mitigation measures presented in Chapter 5 outline the Navy's commitment to protect marine animals during active sonar activities and include requirements for naval watchstanders (e.g., marine mammal observers), standoff distances, and development of a monitoring plan.

Comments received from the North Carolina Department of Administration pertained to incorporating a marine animal monitoring program and providing a summary of mitigations that will be implemented. Chapter 5 discusses a monitoring program.

The North Carolina Division of Coastal Management recommended AFAST activities be posted in advance to facilitate collection of public observations on the occurrence of marine mammals before the activity. Although the Navy notifies the public regarding activities that can affect public safety (e.g., Torpedo Exercises [TORPEX]), advance notification of specific unit locations is classified.

The Connecticut Department of Environmental Protection requested the document include proposed mitigations for these potential effects to marine animals to the greatest extent practicable. Chapter 5 provides mitigation measures for active sonar activities.

1.4.2.1.6 Cumulative Impacts

One commenter recommended that the cumulative impacts analysis include AFAST-related sound along with other man-made sources. This analysis is included in Chapter 6.

The North Carolina Department of Administration asked that the cumulative impacts analysis include the Undersea Warfare Training Range (USWTR), the Outlying Landing Field, and oil and gas leasing. USWTR, as well as oil and gas leasing are incorporated into Chapter 6. The Outlying Landing Field has no potential to affect the resources analyzed in this AFAST EIS/OEIS; therefore, it is not addressed in Chapter 6.

A comment was received from the Marine Mammal Commission that pertained to including information on the multiple training ranges and training activities under way in the action area and the means for coordinating the activities to avoid or minimize cumulative impacts. This information is provided in Chapter 6.

The North Carolina Department of Administration noted the cumulative impacts analysis should address all existing, proposed, and reasonably foreseeable activity in the area, including military actions (e.g., sonar training range and integrated anti-swimmer systems) and additional effects from routine training, special training, joint training, international training exercises, land-based training facilities, and designated military air space, as appropriate. Information addressing this comment can be found in Chapter 6

1.4.2.1.7 NEPA Process/Public Involvement

Some comments received pertained to the layout and advertising of the Public Scoping Meetings, recommending the Navy reduce jargon in the EIS/OEIS, making acoustic models used during the analysis available to the public and scientific community, and disclosing more details about proposed activities. The Navy will advertise the AFAST EIS/OEIS Public Hearing location and dates in the *Federal Register* and in area local newspapers prior to the activity. Wherever possible, the Navy provided details on each AFAST activity; however, certain information regarding sonar systems cannot be made available to the public. The methodology used in the acoustic analysis has been summarized in Chapter 4. In addition, Appendix H contains detailed information on the modeling conducted to determine the acoustic footprints for each of the systems analyzed.

1.4.2.1.8 General Comments

One commenter requested the Navy disclose information on each sonar system. A description of each sonar system used during active sonar activities is provided in Appendix C, Exercise and Sonar Type Descriptions.

The public provided suggestions on permits and other general considerations. Consultations and permits that the public identified as requirements are those in accordance with the MMPA, ESA, MSA for EFH, MBTA, and Marine Protection, Research, and Sanctuaries Act. Permit requirements are addressed in Section 1.3, Regulatory Compliance.

The North Carolina Department of Administration recommended tables and figures be included to reduce technical complexity. When appropriate to the discussion, tables and figures have been inserted into the document.

In addition, the North Carolina Department of Administration and North Carolina Division of Coastal Management recommended that the Navy conduct studies in support of the EIS/OEIS for improved effects analyses. Where applicable, results from Navy-funded research are included in the document, in addition to results of other scientific research projects.

1.4.2.2 Issues Raised During Scoping that are Outside the Scope of this EIS/OEIS

The public scoping process resulted in some general comments that are outside the scope of this EIS/OEIS. These comments consisted of the following:

- Breeding program. Two comments were received regarding whether the Navy would consider funding a marine mammal breeding program. A breeding program itself is outside the scope of this EIS/OEIS.
- USWTR and Rim of the Pacific (RIMPAC) Exercises. Many general comments focused on the USWTR and RIMPAC environmental planning documents. Included in the comments were copies of letters submitted to the Navy following the release of these two documents. The content of these comments generally discussed the two respective documents and requested the Navy take a different approach for the preparation of the AFAST EIS/OEIS. This EIS/OEIS will discuss USWTR in terms of potential cumulative

impacts (refer to Chapter 6), but the potential environmental effects associated with the construction and operation of an underwater range will be documented in a USWTR EIS/OEIS (refer to Section 1.5.2 for more information). In addition, this EIS/OEIS does not discuss RIMPAC exercises since the OPAREAs are geographically separate.

- Fisheries and sonar ranges. An article on North Carolina's fishing industry and the proposed naval sonar range was received. The Proposed Action described in this EIS/OEIS does not involve construction of a sonar range. However, potential effects to fish, as well as commercial and recreational fishing, were included for analyses and are presented in Chapter 4.
- Construction of infrastructure. A comment was received from the Alabama Department of Environmental Management stating that the construction of infrastructure would affect tourism due to visual effects of activities occurring offshore and within federal waters. No construction of infrastructure will occur under the Proposed Action described in this EIS/OEIS; however, socioeconomics issues relative to AFAST activities were included in the analysis provided in Chapter 4.

1.4.3 Notice of Availability of Draft EIS/OEIS

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

Upon release of the Draft EIS/OEIS, the U.S. Environmental Protection Agency (EPA) will place a notice of availability in the *Federal Register*. The document will then be to federal and state agencies and to those members of the public that may be interested or affected circulated for review and comment for a period of at least 45 days. The EIS/OEIS distribution list is presented in Appendix B. The EIS/OEIS will also be made available for general review in public libraries listed in Appendix B, as well as on the AFAST EIS/OEIS website. Public hearings will be held following the release of the Draft EIS/OEIS to seek additional public comment on a variety of issues, including the range of alternatives considered and their associated effects; accuracy and completeness of data; and analytical conclusions. The dates and locations of the public hearings will be included in the notice of public hearing.

Comments on this Draft EIS/OEIS can be sent via U.S. mail or fax, as well as through the AFAST website as follows:

Naval Facilities Engineering Command, Atlantic Division
Attention: Code EV22 (Atlantic Fleet Sonar Project Manager)
6506 Hampton Boulevard
Norfolk, VA 23508-1278
Fax: (888) 875-6781
Website: http://afasteis.gcsaic.com

1.4.4 Preparation of Final EIS/OEIS

The Final EIS/OEIS will incorporate and formally respond to all public comments received on the Draft EIS/OEIS. Possible responses in the Final EIS/OEIS include modifying the alternatives including the Proposed Action; developing and evaluating alternatives not previously given serious consideration; supplementing, improving, or modifying the analysis; making factual corrections; and explaining why some comments do not warrant further response. The notice of availability of the Final EIS/OEIS will be published in the *Federal Register* accompanied by a 30-day public review.

1.4.5 Decision Document

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

1.5 RELATED ENVIRONMENTAL DOCUMENTS

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

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

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

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

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

(2) Expanding warfare missions supported by the range complexes, and

(3) Upgrading and modernizing existing range capabilities to enhance and sustain Navy training and RDT&E activities.

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

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

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

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

1.5.2 USWTR EIS/OEIS

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

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

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

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

This December 2006 Final Supplemental Overseas Environmental Assessment (OEA) (DON, 2006d) documented a quantitative acoustic exposure effects analysis on marine mammals and sea turtles (Naval Surface Fire Support [NSFS] activities only) related to the proposed use of mid-frequency active sonar sources during 2007 Atlantic Fleet major training (Strike Group) exercises and from NSFS Integrated Maritime Portable Acoustic Scoring and Simulator (IMPASS) training that is ancillary to training exercises in accordance with EO 12114. Threshold criteria were used in the quantitative acoustic exposure effects analysis for both mid-frequency active sonar sources and for small ordnance used during NSFS (IMPASS) activities. Level B harassment was analyzed at 173 decibels (dB) based on the findings of Finneran and Schlundt (2004) after exposures were estimated at the 190 dB level. In addition to sonar, the Navy modeled NSFS explosive 5-inch rounds at 23 pounds per square inch (psi), the criteria for Level B harassment.

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

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

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

The Navy concluded that the USS Truman 07-1 Combined CSG COMPTUEX/JTFEX would not affect any of the ESA-listed fish or sea turtle species with exception of the loggerhead sea turtle.

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

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

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

1.5.7 Northeast Torpedo Exercise Endangered Species Act Consultations

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

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

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

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

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

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

2. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

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

2.1 WHY THE NAVY TRAINS

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

President Theodore Roosevelt, 1902

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

2.1.1 Our Navy Mission

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

2.1.2 How We Fight

We demonstrate our Nation's military capabilities today through our forward-deployed forces strategically positioned in key regions of the world that are vital to our nation's trade, communications, and political interests: the Mediterranean Sea, the Arabian Gulf, and the Western Pacific.

2.1.3 Train As We Fight - The Requirement For Realistic Training

The key to combat effectiveness is realistic training in the air, on land, and at sea – the single greatest tool the military has in preparing and protecting our naval forces. "Train As We Fight" is not just a phrase, but rather a statement of the absolute necessity to realistically train our sailors for the conditions in which they may find themselves while protecting the nation.

Realistic training supplements limited combat experience. Combat is a time of intense chaos where panic and fear can easily overcome self-discipline and focus. Military commanders throughout the ages have relied on intensive and repetitive training to counter this problem. They understand that when confronted with danger, humans will respond in the way most familiar to them. In this post-Cold War era, naval professionals may never experience combat. Training "as we intend to fight" means realistic exercises which replicate the stress, discomfort, and physical conditions of combat. A realistic training program is the best means, short of combat, of preparing our forces and generating confidence in, and knowledge of, our plans, tactics, and procedures. Large-scale free-play exercises, including training exercises at sea, involve all elements of naval forces and connect sailors to their missions before they are actually employed. We train as if full-scale armed conflict were imminent. Whether conducting training or combat, the same organizational structure, procedures, command and control, equipment, and thinking apply.

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

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

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

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

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

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

No amount of technology, hardware, or classroom education can achieve the required level of combat readiness without access to quality range complexes and operating areas that afford our naval forces the realistic training needed to execute their missions. Simulation and models can help, but there is no way to simulate the feeling of riding through the surf on a landing craft, experience just what the recoil of the main gun on an Abrams tank is like, or the intensity of searching for an elusive, ultra-quiet submarine. Before this nation sends the precious resource of our youth into harm's way we owe it to them to provide every measure of safety possible -- and that starts with realistic and comprehensive training.

2.1.5 Why We Train With Active Sonar

Sea control is the foundation for the United States' global power projection. If the United States cannot command the seas and airspace above them, we cannot project power to command or influence events ashore and we cannot shape the security environment. For the last century, submarines have been the weapon of choice for weaker naval powers intending on contesting a dominant power's control of the seas. Today, there are more than 300 modern, quiet diesel submarines around the world, operated by more than 40 nations, including Iran and North Korea. Our Nation cannot in good conscience ask our young Sailors and Marines to serve on ships at sea without the ability to defend themselves against this threat. The key to maintaining the Navy's ability to defend against adversary submarines is a comprehensive "at-sea" training regime to prepare our Sailors for this contingency. This training requires the use of active sonar. The skills developed during this training are perishable and require periodic refreshing, which can't be regenerated easily. If training is not as realistic as possible, we will quickly lose our edge in this critical dimension of the battlefield. Submarines have been and are likely to remain the weapon system with the highest leverage in the maritime domain.

The ability to locate and track a submarine is a mission skill that must be possessed by every deploying strike group and individual surface combatant. There are three fundamental truths about ASW. First, it is critically important to our strategies of sea control, power projection, and direct support to land campaigns. The Chinese military strategist Sun Tzu recognized some 2,400 years ago that the best way to defeat an enemy is to attack his strategy directly. As the United States looks to maintain its forward presence and power projection from the sea, the submarine threat that denies, frustrates, or delays sea-based operations clearly embodies Sun Tzu's dictum and attacks our strategy directly. We must retain the capability to defend against this enemy strategy.

Second, ASW requires a highly competent team of air, surface and sub-surface platforms to be effective in a complex and a highly variable three-dimensional environment. Each of our assets brings different strengths to the fight. We will need this full spectrum of undersea, surface, airborne, and space-based systems to ensure that we fully exploit the operating area. The undersea environment – ranging from the shallows of the littoral to the vast deeps of the great ocean basins and polar regions under ice – demand a multi-disciplinary approach: reliable intelligence: oceanography: surveillance and cueing of multiple sensors, platforms and undersea weapons. Most importantly, it takes highly skilled and motivated people. Our Strike Group training areas are designed to provide the most realistic training in the most relevant environments, replicating to the best of our ability the stresses we expect to endure. The integration of undersea ranges, with land-based bombing ranges, safety landing fields and amphibious landing sites are critical to this realism, allowing real-time exercise play in complex scenarios.

Finally, ASW is extremely difficult. During the 1982 Falklands conflict, the Argentine submarine SAN LUIS operated in the vicinity of the British task force for more than a month and was a constant concern to Royal Navy commanders. Despite the deployment of five nuclearattack submarines, 24-hour per day airborne ASW operations, and expenditures of precious time, energy, and ordinance, the British never once detected the Argentine submarine. The United States must effectively employ all its capabilities to find modern diesel, air-independent, and nuclear submarines in the noisy, contact-dense environments typical of the littoral and be ready as well to detect, neutralize, and engage submarines in deep water and arctic environments. Today, this complex and challenging mission taxes our forces to their very limits and we have no excess capacity in this area. We must continue to improve or our performance compared to other world actors will most certainly decline.

As modern submarines have become significantly quieter, passive sonar is not effective enough in making sure that we can track and take action against all enemy submarines. Mid-frequency active sonar has become a major piece of the Navy's ASW program. Without mid-frequency active sonar, the U.S. Navy would be severely limited in their ability to combat the threat posed by modern, quiet submarines. Training with mid-frequency active sonar is, therefore, critical to national security.

Since our men and women will fight as they have been trained, they must receive the most demanding and comprehensive training possible. As noted earlier, we expect a potential fight to occur in a complicated three-dimensional environment of varying depths of water, temperature, salinity and bottom contours. In order to effectively detect, track and neutralize an adversary's submarines, our air, surface and submarine assets must work together to share and exploit limited location and intelligence data. Each of our assets must train and work together with a broad array of tools, including mid-frequency active sonar, to effectively neutralize the adversary.

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

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

2.2 ASW AND MIW TRAINING ACTIVITIES

ASW and MIW training is conducted to meet deployment certification requirements as directed in the FRTP. The U.S. Navy Atlantic Fleet meets these requirements by conducting training activities prior to deployment of forces. The FRTP requires Basic ULT, Intermediate ULT, and Sustainment Training. The Navy meets these requirements during Independent ULT, Coordinated ULT, and Strike Group Training. At the beginning of the cycle, basic combat skills are learned and practiced during basic Independent ULT activities. Basic skills are then refined during Coordinated ULT. Strike Group Training is integrated training using progressively more difficult, complex, and large-scale exercises conducted at an increasing tempo. This training provides the warfighter with the skills necessary to function as part of a coordinated fighting force in a hostile environment with the capacity to accomplish multiple missions.

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

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

2.2.1 Independent Unit Level Training Activities

Independent ULT activities include training and sonar maintenance activities that each individual unit is required to accomplish in order to become certified prior to deploying or to maintain proficiency. Independent ULT activities can include the use of the IEER system, which consists of an explosive source sonobuoy (AN/SSQ-110A) and an air deployable active receiver (ADAR) sonobuoy (AN/SSQ-101). The training requirement is based on the successful completion of the training on a per-unit basis. (See Appendix C, Exercise and Sonar Type Descriptions, for a description of current Independent ULT activities involving active sonar.)

The majority of Independent ULT activities involving active sonar components are conducted to meet MIW and ASW training requirements. These activities can be conducted with one or more ships at the same time. ASW Independent ULT activities focus on training sonar operators on the detection, classification, and tracking of underwater targets. Activities include both near shore and open-ocean ASW training activities.

MIW Independent ULT activities focus on training sonar operators to detect, locate, and characterize mine-like objects under various environmental conditions, including those suspended in the water (i.e., moored mines), mines on the ocean floor (i.e., proud mines), and mines buried under the ocean floor. Some guided missile destroyers (DDGs), cruisers (CGs), fast frigates (FFGs), and submarines can operate their hull-mounted sonars, normally used for ASW, in an object detection/navigational mode. This mode allows ships to detect mines and other objects in the water, as well as to navigate through the area.

2.2.2 Coordinated Unit Level Training Activities

Coordinated ULT activities concentrate on warfare team training and initial multiunit operations. During this phase, vessels and aircraft begin to develop warfare skills in coordination with other units while continuing to maintain unit proficiency. Coordinated ULT activities involve one or more combined exercises, such as Southeastern ASW Integrated Training Initiative (SEASWITI). In addition, specialty training operations such as Submarine Command Course

(SCC) Operations and Integrated ASW Course (IAC) have also been included in this category. (See Appendix C, Exercise and Sonar Type Descriptions, for a description of current Coordinated ULT activities involving active sonar.)

2.2.3 Strike Group Training Activities

Strike Group training activities continue to develop and refine integrated Strike Group warfare skills and command and control procedures. The objective of this phase is to ensure that all units in the strike group are prepared to support the group commander's specific mission requirements. Strike Group training activities include exercises such as Carrier Strike Group Composite Training Unit Exercises (CSG COMPTUEXs), Joint Task Force Exercises (JTFEXs), and Expeditionary Strike Group Composite Training Unit Exercises (ESG COMPTUEXs). These training exercises provide realistic training opportunities for the Atlantic Fleet with opposing forces in a battlefield environment that mimics the types of challenges the Navy could face during deployment. (See Appendix C, Exercise and Sonar Type Descriptions, for a description of current Strike Group Training activities involving active sonar.)

2.2.4 RDT&E

RDT&E activities are typically conducted to ensure that the ASW and MIW active sonar and IEER systems being developed function properly and meet the operational requirements set forth in the test plan. The sensors tested in conjunction with RDT&E activities are either existing systems or new systems with similar operating parameters. RDT&E activities addressed in this EIS/OEIS are substantially similar to AFAST activities. For RDT&E activities included in this analysis, active sonar activities occur in similar locations as representative ULT events. A separate environmental analysis would be conducted for new sensors that do not have operating parameters similar to the existing systems addressed in this AFAST EIS/OEIS.

2.2.5 Active Sonar Maintenance

Active sonar maintenance includes both pier side and at-sea activities. These activities are required before deployment, after major sonar array maintenance, and when the systems are suspected of not operating at optimal levels.

2.3 SONAR SYSTEMS

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

- ***Passive sonars*** are only used to listen to incoming sounds. Passive sonars do not emit sound energy into the water and cannot acoustically affect the environment. Therefore, although passive sonars are used, they are not acoustically analyzed in this AFAST EIS/OEIS.
- ***Active sonars*** emit acoustic energy to obtain information concerning a distant object from the reflected sound energy. Active sonars are the most effective detection systems against modern ultra-quiet submarines and sea mines in shallow water. High frequency sonars in excess of 200 kilohertz (kHz) dissipate rapidly; accordingly, scientific studies indicate they do not affect marine resources.

2.3.1 Sonars Modeled for Acoustic Effects Analysis

Table 2-1 identifies all of the acoustic systems used during Atlantic Fleet active sonar activities. The acoustic systems presented in Table 2-1 have been separated out into systems that were analyzed and systems that were not analyzed in the effects analysis. The systems that were not analyzed included systems that are typically operated at frequencies greater than 200 kHz.

It is important to note that, as a group, marine mammals have functional hearing ranging from 10 hertz (Hz) to 200 kHz; however, their best hearing sensitivities are well below that level. Since active sonar sources operating at 200 kHz or higher attenuate rapidly and are at or outside the upper frequency limit of even the ultrasonic species of marine mammals, further consideration and modeling of these higher frequency acoustic sources are not warranted. As such, high-frequency active sonar systems in excess of 200 kHz are not analyzed in this EIS/OEIS.

Table 2-1. Acoustic Systems Analyzed and Not Analyzed

Systems That Were Analyzed			
System	***Frequency***	***Associated Platform***	***System Description***
AN/SQS-53	MF	DDG and CG hull-mounted sonar	Utilized 70% in search mode and 30% track mode
AN/AQS-13 or AN/AQS-22[*]	MF	Helicopter dipping sonar	AN/AQS-22: 10 pings/dip, 30 seconds between pings)- also used to represent AN/AQS-13
Explosive source sonobuoy (AN/SSQ-110A)	Impulsive	Helicopter and MPA deployed	Contains two 4.1 lb charges
AN/SQQ-32	HF	MCM over the side system	Used during MIW training events detect, classify, and localize bottom and moored mines
AN/BQS-15	HF	Submarine navigational sonar	Only used when entering and leaving port
AN/SQS-56	MF	FFG hull-mounted sonar	Utilized 70% in search mode and 30% track mode
MK-48 Torpedo	HF	Submarine fired exercise torpedo	Active for 15 min per torpedo run
MK-46 Torpedo	HF	Surface ship and aircraft fired exercise torpedo	(15 min per torpedo run), modeling also used to represent MK-54
AN/SLQ-25 (NIXIE)	MF	DDG, CG, and FFG towed array	20 mins per use
AN/SQS-53 and AN/SQS-56 (Kingfisher)	MF	DDG, CG, and FFG hull-mounted sonar (object detection)	only modeled 53 Kingfisher, used to represent 56
AN/BQQ-10	MF	Submarine hull-mounted sonar	2 pings per hour
Tonal sonobuoy (DICASS) (AN/SSQ-62)	MF	Helicopter and MPA deployed	12 pings, 30 secs between pings
ADC MK-3 and MK-2[**]	MF	Submarine fired countermeasure	20 mins
Submarine fired countermeasure	MF	Submarine fired countermeasure	20 mins per use

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

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

*AN/AQS-22 modeling is representative of all helicopter dipping sonar
**MK-3 modeling is representative of all ADCs

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

In addition, systems that were found to have similar acoustic output parameters (i.e. frequency, power, deflection angles) were compared. The system with the largest acoustic footprint was modeled as representative of those similar systems that have a smaller footprint. An example of this representative modeling is the AN/AQS-22 for the AN/AQS-13. Based on individual sonar parameters and the acoustic modeling, the AN/SQS-53 hull-mounted sonar was noted as being the most powerful of all the sonar systems analyzed. The AN/SQS-53 has a nominal source level of 235 decibels with a reference pressure of 1 micro-Pascal at 1 meter (dB re 1 μPa-m) and transmits at center frequency range of 3.5 kHz. As a result, this sonar system has the largest acoustic footprint.

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

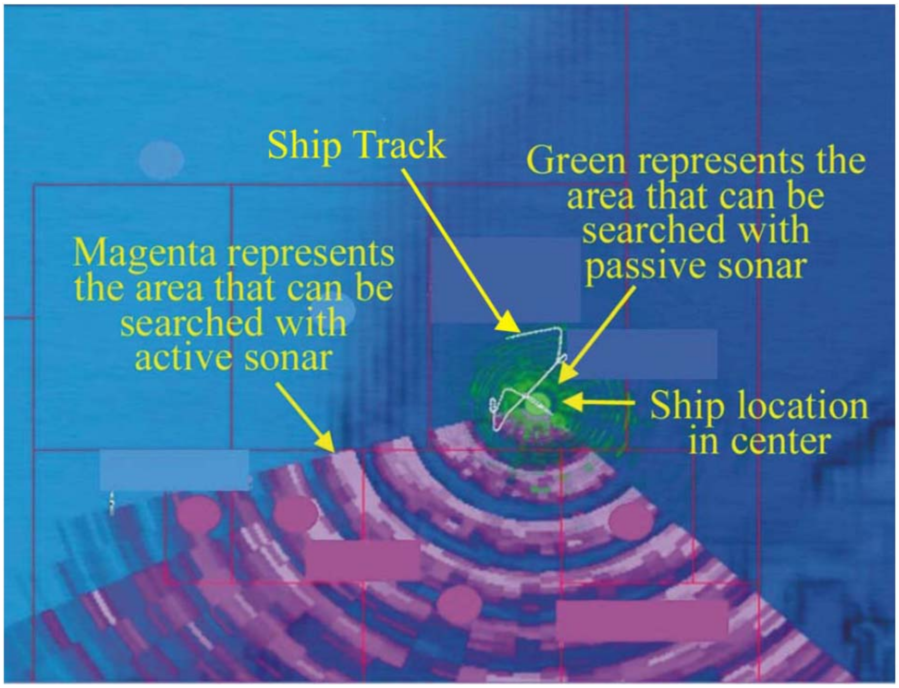

Figure 2-1. Comparative Detection Capability of Active and Passive Sonar

2.3.2 ASW Sonar Systems

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

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

- **Surface Ship Sonars.** A variety of surface ships operate the AN/SQS-53 and AN/SQS-56 hull-mounted mid-frequency active sonar (Figure 2-2) during ASW sonar training exercises, including 11 CGs, 26 DDGs (AN/SQS-53), and 17 FFGs (AN/SQS-56). About half of the U.S. Navy ships do not have any onboard tactical sonar systems.

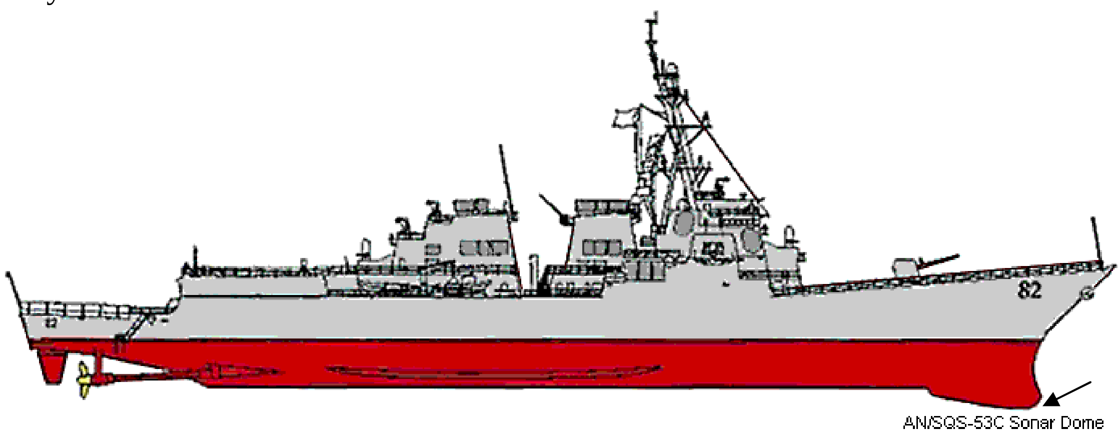

Figure 2-2. Guided Missile Destroyer with a AN/SQS-53 Sonar

- **Submarine Sonars.** Tactical military submarines (i.e. 25 SSNs and 6 SSBNs) equipped with hull-mounted mid-frequency active sonars (Figure 2-3) are used to detect and target enemy submarines and surface ships. A submarine's mission revolves around its stealth; therefore, mid-frequency active sonars are used very infrequently since the pinging of the mid-frequency active sonar also gives away the location of the submarine. Note that the AN/BQQ-10 is the more predominant system, and that the system is identified throughout the remainder of this document with the understanding that the AN/BQQ-5, AN/BSY-1/2, and AN/BQQ-10 are similar in those operational parameters with potential to affect marine mammals. In addition, Seawolf Class attack submarines, Virginia Class attack submarines, Los Angeles Class attack submarines, and Ohio Class nuclear guided missile submarines also have the AN/BQS-15, a sonar that uses both mid- and high-frequency for under-ice navigation and mine-hunting.

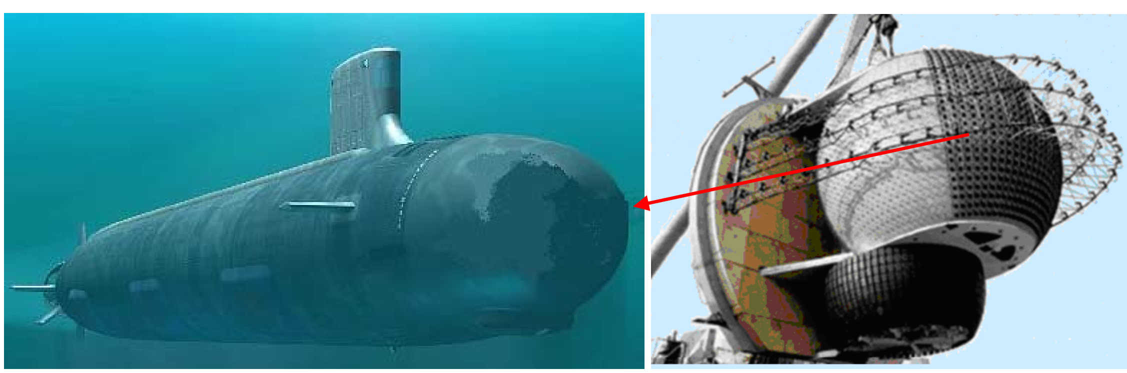

Figure 2-3. Submarine AN/BQQ-10 Active Sonar Array

- **Aircraft Sonar Systems.** Aircraft sonar systems that operate during ASW sonar activities include sonobuoys and dipping sonars.

- **Sonobuoys.** Sonobuoys (Figure 2-4), deployed by both helicopter and fixed-wing MPA, are expendable devices that are either tonal (active), impulsive (explosive), or listening (passive). The Navy uses a tonal sonobuoy called a Directional Command-Activated sonobuoy System (DICASS) and a sonobuoy system called an IEER system, which consists of an explosive source sonobuoy (AN/SSQ-110A) and an air deployable active receiver (ADAR) sonobuoy (AN/SSQ-101). The Navy also uses a passive sonobuoy called a Directional Frequency Analysis and Recording (DIFAR). Passive listening buoys such as DIFAR (AN/SSQ-53) are deployed from helicopters or maritime patrol aircraft and do not emit active sonar. These systems are used for the detection and tracking of submarine threats.

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

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

MH-60R preparing to dip AN/AQS-22 (ALFS)

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

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

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

- **Acoustic Device Countermeasures.** Several types of countermeasure devices could be deployed during Fleet training exercises, including the Acoustic Device Countermeasure MK-1, MK-2, MK- 3, MK-4 and the AN/SLQ-25A (NIXIE). Countermeasure devices are submarine simulators and act as decoys to avert localization and torpedo attacks (Figure 2-7). Countermeasures may be towed or free floating sources.

MK 30 Recoverable Sub Simulator Target

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

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

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

2.3.3 MIW Sonar Systems

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

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

- **Submarine Sonars.** Submarines use a sail-mounted sonar, the AN/BQS-15, to detect mines and objects.

2.4 REPRESENTATIVE ACTIVE SONAR USE AND ACOUSTIC SOURCES

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

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Table 2-2. Summary of Active Sonar Activities

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

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

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

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

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

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

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

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

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

* Number of events and total hours modeled for acoustic effects analysis.
** The source frequency is greater than 200 kHz, which is above the known hearing range of marine mammals. These sources, therefore, were not modeled for the acoustic effects analysis.
*** OPAREAs also include area seaward of each OPAREA unless otherwise noted.

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

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Table 2-3. Events per Year by Operating Area

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

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

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

2.4.1 Independent Unit Level Training Scenarios

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

2.4.1.1 Surface Ship ASW ULT

One or two surface ships (CG, DDG, or FFG) conduct ASW localization and tracking training using the AN/SQS-53 and/or AN/SQS-56. The AN/SLQ-25 NIXIE may be employed. Additionally, one MK-39 EMATT or MK-30 target per scenario may be employed as a target. In some Surface Ship ASW ULT events a MK-1, MK-2, MK-3, MK-4, MK-46 torpedo, and a Noise Acoustic Emitter (NAE) could be used. Under the No Action Alternative, Surface Ship

ASW ULT would be occurring in both deep and shallow water areas throughout the eastern and southeastern coast of the United States.

2.4.1.2 Surface Ship Object Detection/Navigational Training ULT

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

2.4.1.3 Helicopter ASW ULT

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

2.4.1.4 Submarine ASW ULT

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

2.4.1.5 Submarine Object Detection/Navigational Training ULT

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

2.4.1.6 Maritime Patrol Aircraft ASW ULT

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

2.4.1.7 Surface Ship MIW ULT

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

2.4.2 Coordinated Unit Level Training

2.4.2.1 Southeastern Anti-Submarine Warfare Integrated Training Initiative

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

2.4.2.2 Group Sail

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

2.4.2.3 Integrated ASW Course

IAC is a tailored course of instruction designed to improve SCC and Strike Group integrated ASW warfighting skill sets. Key components for this course of instruction include coordinated ASW training for the SCC or ASW Commander and staff, key shipboard decision makers, and ASW watch teams. IAC consists of two phases, IAC Phase I and IAC Phase II. IAC Phase I is an approved Navy course of instruction consisting of five days of basic and intermediate level classroom training. IAC Phase II is intended to leverage the knowledge gained during IAC Phase I and build the basic ASW coordination and integration skills of the Strike Group ASW Team. IAC Phase II is a coordinated training scenario that typically involves three DDG's, one CG and one FFG, two to three embarked helicopters, one submarine, and one MPA aircraft searching for, locating, and attacking one submarine. The scenario consists of two 12-hour events that occur five times per year. While the ships are searching for the submarine, the submarine may practice simulated attacks against the ships. The ships and their embarked helicopters conduct ASW localization training using the AN/SQS-53, AN/SQS-56, and AN/AQS-13 or AN/AQS 22 dipping sonar. The submarines also periodically operate the AN/BQQ-10 sonar. Approximately 18 tonal sonobuoys may also be used per scenario. Multiple acoustic sources may be active at one time. These events would occur within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs or within and adjacent to the GOMEX OPAREA. During these exercises, some activities may occur in more than one OPAREA.

2.4.2.4 Submarine Command Course Operations

This scenario is conducted as training for submarine Executive Officers, and involves two submarines conducting ASW training. The AN/BQQ-10 sonar is used, as well as four ADCs per scenario. In addition, up to 36 MK-48 torpedoes could be fired during the duration of an exercise. The SCC Operations scenario occurs two times per year and lasts from 3 to 5 days. This training exercise would be occurring in the JAX/CHASN and Northeast OPAREAs in deep ocean areas. Since MK-39 EMATTs or MK-30 targets may be employed as a target, a support vessel may be required. This limits the western edge of the exercise boundary to within 148 km (80 NM) of a support facility.

2.4.2.5 Squadron Exercise and Gulf of Mexico Exercise

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

2.4.3 Strike Group Training

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

2.4.3.1 Composite Training Unit Exercise

The COMPTUEX is a training scenario designed to provide coordinated training to the entire ESG and CSG. An ESG COMPTUEX consists of a U.S. Navy ESG and U.S. Marine Corps units conducting integrated maritime and amphibious operations. ESG COMPTUEXs include the insertion of amphibious forces onto a beach, movement of vehicles and troops over land, delivery of troops and equipment from ship to shore via helicopters and fixed-wing MPA, the use of live-fire and blank munitions from ground-based troops and aircraft, and ship operations. In addition, Navy ships provide indirect Naval Surface Fire Support in support of the landing amphibious forces utilizing non-explosive ordnance. A CSG COMPTUEX is a major at-sea training event that represents the first time before deployment that an aircraft carrier and its carrier air wing integrate operations with surface and submarine units in an at-sea environment. The ESG and CSG consist of multiple ships, aircraft and submarines operating as an integrated force. A typical ESG or CSG consists of six surface ships, one to five aircraft, and three submarines, approximately half of which are not equipped with active sonar sensors.

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

2.4.3.2 Joint Task Force Exercise

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

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

2.4.4 Maintenance

2.4.4.1 Surface Ship Sonar Maintenance

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

2.4.4.2 Submarine Sonar Maintenance

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

2.4.5 RDT&E

For the purposes of analyzing RDT&E activities, active sonar usage has been rolled into representative ULT events.

2.4.6 Torpedo Exercise Areas

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

2.5 PROCESS FOR DEVELOPING ALTERNATIVES

Based on public and regulatory concern regarding the potential effects of sonar to marine mammals, the Navy focused on the potential for acoustic exposure of marine mammals when developing a reasonable range of alternatives. In developing the criteria to be used during alternatives identification, the Navy used the following process:

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

(2) Use the requirements defined in Step 1 (e.g. the size of the area, the water depth, or the bottom type needed for a particular training event) to identify the feasible active sonar locations (Section 2-6).

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

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

Refer to Appendix D, Description of Alternative Development, for more information.

2.6 OPERATIONAL REQUIREMENTS

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

The Navy's operational requirements include the following:

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

2.6.1 Universal Operational Requirements

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

2.6.1.1 Realistic Training Environmental Requirements

Realistic training is the single greatest asset the military has in preparing and protecting its sailors. To successfully defend against submarine and underwater mine threats, sailors must train in a similar environment with the same tools they would use in actual combat.

In order for Navy personnel to ultimately fight as trained, a training environment that matches the conditions of actual combat is necessary. Thus, the cornerstones of effective training are conditions that mirror realistic combat scenarios for participating units. Sailors must also train using the combat tools that would be used during a conflict. A complicating factor facing the Navy today is the nature of the littoral (shallow) waters where submarines can operate. These littoral regions are frequently confined, congested water and air space, which makes identification of allies, adversaries, and neutral parties more challenging than in deeper waters.

2.6.1.2 Year-Round Training

The ability to train year-round is required if the Navy is to meet the requirements and schedules associated with the FRTP and the potential for surge situations (i.e., immediate deployment of forces). In order to meet potential surge situations, the Navy is required under the FRTP to have five or six CSGs ready to deploy within 30 days of notification and an additional one or two CSGs ready to go within 90 days. In order to meet this requirement, the Navy must have year-round access to training areas to ensure that a sufficient number of certified surface units are ready to be deployed at any given time. In general, the effects analyses assume that active sonar activities occur during all seasons.

2.6.1.3 Proximity to Homeports/Air Stations

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

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

Helicopter airspeed and maximum flight duration necessitate that the training area entry point be located within 7 km (4 NM) of the airfield for dipping sonar training activities and within 30 km (16 NM) for Airborne Mine Countermeasures (AMCM) tow missions. This equates to an on-station flight time of approximately one hour, with a reserve flight time of an additional one hour. ASW helicopters participating in training are stationed in Mayport, Florida and Norfolk, Virginia.

MPA have the capability of transiting faster and have much longer flight durations than helicopters. Maritime patrol aircraft are stationed at Brunswick, Maine; Patuxent River, Maryland; and Jacksonville, Florida. Crews stationed at each of these bases would use the proposed ASW training areas, as well.

In addition, TORPEX activities are required to be conducted within an acceptable distance (i.e., 28 to 37 km [15 to 20 NM]) from a support facility equipped to assist in the recovery of fired exercise torpedoes. RDT&E activities are also typically conducted within close proximity to a shore side support facility equipped with the personnel and equipment required to deploy and recover test systems and targets.

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

2.6.1.4 Coordinated Sea and Air Space

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

2.6.2 Operational Requirements According to each Active Sonar Activity

The remaining five operational requirements listed in the introductory paragraph are discussed in subsequent sections as they apply for each active sonar activity. Specific operational requirements for active sonar activities are summarized in sub-sections 2.5.2.1 through 2.5.2.8.

2.6.2.1 Littoral ASW Independent ULT

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

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

2.6.2.2 Open-Ocean ASW Independent ULT

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

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

2.6.2.3 MIW Independent ULT

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

MIW Independent ULT activities require water depths from 5 to 40 m (16 to 131 ft). The required training area for these MIW Independent ULT activities is a 111 km x 148 km (60 NM x 80 NM) rectangular area. The overall training area may need to be larger to ensure sufficient space is available under the environmental conditions of the day to replicate a realistic training environment, thus ensuring the necessary operational flexibility during all training conditions that may be encountered.

2.6.2.4 Object Detection/Navigational Sonar Independent ULT

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

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

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

Submarine navigational sonar training areas require the submarine lanes used for entering and departing Groton, Connecticut, Norfolk, Virginia, and Kings Bay, Georgia submarine bases. The required training area for submarine navigational sonar was determined to be a 7 km (4 NM) wide swath of water beginning in port and following the submarine transit lanes out to open water. The overall training area may need to be larger to ensure sufficient space is available under the environmental conditions of the day to replicate a realistic training environment, thus ensuring the necessary operational flexibility during all training conditions that may be encountered.

2.6.2.5 Coordinated MIW and ASW ULT

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

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

Coordinated MIW ULT training requires up to five surface ships, one helicopter, and various UUV packages. Two of the MIW Coordinated ULT activities, GOMEX exercises and RONEX, require a 37 km × 37 km (20 NM × 20 NM) training area. The overall training area may need to be larger to ensure sufficient space is available under the environmental conditions of the day to replicate a realistic training environment, thus ensuring the necessary operational flexibility during all training conditions that may be encountered.

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

2.6.2.6 Strike Group Training Exercises

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

Strike Group training requires up to two strike groups along the East Coast and within the eastern Gulf of Mexico. The Strike Group training activities require a 148 km x 222 km (80 NM × 120 NM) training area to accommodate unscripted freeplay scenarios. These unscripted scenarios attempt to eliminate artificial rules that might provide one side or the other an uneven advantage. The overall training area may need to be larger to ensure sufficient space is available under the environmental conditions of the day to replicate a realistic training environment, ensuring the necessary operational flexibility during all training conditions that may be encountered.

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

2.6.2.7 RDT&E Activities

RDT&E activities require close proximity to a shore side support facility equipped with the personnel and equipment required to deploy and recover test systems and targets. Specifically, the majority of the MIW RDT&E activities would be conducted on the shelf within the northern portion of the GOMEX OPAREA, offshore of Naval Surface Warfare Center, Panama City Division (NSWC PCD). In addition, the majority of the ASW RDT&E would occur within the VACAPES and NE OPAREAs adjacent to Naval Air Station Patuxent River and the Naval Undersea Warfare Center, Newport facilities. The water depth and environmental conditions required is dependent on the test system undergoing developmental tests (DTs) or operational tests (OTs). RDT&E water depth requirements can vary depending on the system being tested and typically range from 2 to 610 m (7 to 2,001 ft) in depth.

The area required for RDT&E activities can vary depending on the system being tested and the overall objective of the given test. For example, some MIW RDT&E activities only require a minimum 6 km x 9 km (3 NM x 5 NM) area, while some RDT&E activities involving sonobuoys require up to a 185 km x 185 km (100 NM x 100 NM) area.

2.6.2.8 Active Sonar Maintenance

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

2.7 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER ANALYSIS

The operational requirements discussed in Section 2.6 are used as the screening criteria. The alternatives discussed in subsequent sections were considered but were not feasible because they did not meet one or more of the screening criteria.

2.7.1 Conduct No Active Sonar Activities

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

2.7.2 Utilization of U.S. West Coast Training Areas

West Coast training areas would not be practical for training Atlantic Fleet units because of the extreme transit distance, excessive costs, and time constraints that would be involved (i.e., proximity to homeport/air base is too far). Crew training needs to be conducted on the specific ship to which they are assigned. It is important that the crew being trained become familiar with the ship they operate. Therefore, if training were to be conducted on the West Coast, the entire crew and ship would need to make the trip over in order to maintain the same level of ASW and MIW proficiency for the ship and its crew. Lastly, units need to be stationed on both coasts to respond to contingency and be available to combat commanders world-wide.

2.7.3 All Active Sonar Activities Conducted through Simulation

Conducting all activities through simulation does not meet the operational requirements of realistic training (Section 2.6.1.1). Initial training of sonar technicians can and does occur using simulators, and simulators are usually the first method used for the initial training of new sonar technicians in the basics of sonar system operations. However, simulators will not replace real-world training in the foreseeable future since simulators cannot provide the dynamic and vastly challenging scenarios that are encountered in the ocean environment. Specifically, computer modeling simulations cannot adequately mimic the bathymetry, sound propagation properties, or oceanography to the degree necessary to serve as a substitute for actual at-sea sonar operations.

Furthermore, computer simulation cannot replicate the complexities of conducting ASW in at-sea combat when a ship is expected to integrate its ASW operations with other ships operating mid-frequency active sonar, defend the air space in its operating area from aircraft firing missiles targeted at an aircraft carrier or amphibious ships, or defend itself against other surface ships. For instance, Coordinated ULT and Strike Group Training activities require multiple crews to interact in a variety of acoustic environments that cannot be simulated. In addition, the majority of RDT&E activities cannot be reliably modeled or researched using computer simulation, and must be conducted in a variety of acoustic environments to ensure the safe and effective use of the active sonar system. The sole reliance on simulators would deny Navy strike groups the training benefit and opportunity to derive critical lessons learned in the employment of active sonar in the following specific areas:

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

Currently, these factors cannot be adequately simulated to provide the fidelity and level of training necessary in the employment of active sonar. Another significant factor is that many of the East Coast OPAREAs have been surveyed and are similar to the prospective operating environments in many of the world's "hot spots" where U.S. Navy forces may be required to fight. Conducting live training with active sonar in our own littoral waters is necessary in replicating the conditions expected in many overseas areas in which U.S. Navy forces could operate in harm's way. As with any combat skill, employment of active sonar is a perishable talent that must be exercised in a realistic and integrated manner in order to maintain proficiency. Eliminating the use of active sonar during the training cycle would rapidly cause ASW skills to deteriorate and thus put U.S. Navy forces at risk during real-world operations or combat.

Realistic training is the single greatest asset the military has in preparing and protecting its sailors. To successfully defend against submarine and underwater mine threats, sailors must train in a similar environment using the tools they would employ during actual combat. Therefore, the Navy must train in a variety of environments using all of its sonar platforms, including noisy coastal areas where threat detection is difficult.

2.7.4 Restricting Active Sonar Use by Season or Large Geographic Region during Specific Time Periods over Large Regions

Multiple active sonar activities that involve vessels and helicopters stationed out of multiple homeports can occur simultaneously. Since the training schedule is driven by the deployment schedule, activities must be conducted year-round. In addition, given that activities must be conducted in a realistic environment and available activity areas are limited by proximity to homeports, water depth, and acoustic environments, no one OPAREA can be avoided. Restricting active sonar use during certain seasons over large geographic regions would not provide realistic, year-round, active sonar training opportunities. The Navy would not comply with the FRTP, and world-wide presence requirements would not be met. Furthermore, this alternative could not meet another crucial requirement, which is proximity to homeports/air stations, as well as support facilities.

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

Based on extensive discussion within the operational community, the Atlantic Fleet does not presently anticipate that an increase in active sonar activities is needed to fulfill mission requirements described in this document nor that a decrease in the intensity of operations would fulfill those same operational requirements. Therefore, a variation of alternatives considering a change in the tempo of operations is not considered reasonable at this time, as they do not meet the purpose and need. Likewise, Atlantic Fleet Tactical Training Theater Assessment and Planning (TAP) EIS/OEIS alternatives are not expected to propose any change in the tempo of operations for warfare missions that require active sonar activities.

2.8 ALTERNATIVES INCLUDED FOR ANALYSIS

The following alternatives described in this section represent a full range of options that meet all of the screening criteria. Under Alternative 1, Designated Active Sonar Areas, fixed active sonar areas would be designated using an environmental analysis to determine locations that would minimize environmental effects to biological resources while still meeting operational requirements. These areas would be available for use year-round. Under Alternative 2, Designated Seasonal Active Sonar Areas, active sonar training areas would be designated using the same environmental analysis conducted under Alternative 1. The areas would be adjusted seasonally to minimize effects to marine resources while still meeting minimum operational requirements. Under Alternative 3, Designated Areas of Increased Awareness, the results of the environmental analysis conducted for Alternative 1 and 2 were utilized in conjunction with a qualitative environmental analysis of sensitive habitats to identify areas of increased awareness. Active sonar would not be conducted within these areas of increased awareness. Under the No Action Alternative, the Navy would continue conducting active sonar activities within and adjacent to existing OPAREAs rather than designate active sonar areas or areas of increased awareness.

2.8.1 No Action Alternative

The No Action Alternative (Figure 2-8) is to continue conducting active sonar activities within and adjacent to existing OPAREAs rather than designate active sonar areas or areas of increased awareness. The No Action alternative can be regarded as continuing with the present course of action. Under the No Action Alternative, active sonar activities occur in locations that maximize active sonar opportunities and meet applicable operational requirements associated with a specific active sonar activity. Currently active sonar training does not occur in North Atlantic right whale critical habitat with the exception of object detection and navigation off shore Mayport, Florida and Kings Bay, Georgia; helicopter ASW offshore Mayport, Florida; and TORPEXs in the northeast during August, September, and October. Additionally, active sonar training does not currently occur in National Marine Sanctuaries along the East coast and Gulf of Mexico.

2.8.1.1 ASW Training Areas

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

2.8.1.1.1 Helicopter ASW ULT Areas

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

2.8.1.1.2 SEASWITI Areas

This training exercise generally occurs in deep water off the coast of Jacksonville, Florida.

2.8.1.1.3 Group Sail Areas

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

2.8.1.1.4 Integrated ASW Course

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

2.8.1.1.5 Submarine Command Course Operations Areas

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

2.8.1.1.6 Torpedo Exercise Areas

TORPEX can occur anywhere within and adjacent to East Coast and GOMEX OPAREAs. The exception is in the Northeast OPAREA where the North Atlantic right whale critical habitat is located. TORPEX areas that meet current operational requirements for proximity to torpedo and target recovery support facilities were established during previous consultations. Therefore, TORPEX activities in the northeast North Atlantic right whale critical habitat are limited to these established areas.

2.8.1.2 MIW Training Areas

MIW Training could occur in territorial or non-territorial waters. Independent and Coordinated MIW ULT activities would be conducted within and adjacent to the Pensacola and Panama City

OPAREAs in the northern Gulf of Mexico and off the east coast of Texas in the Corpus Christi OPAREA.

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

2.8.1.3 Object Detection/Navigational Training Areas

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

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

2.8.1.4 Maintenance Areas

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

2.8.1.4.1 Surface Ship Sonar Maintenance Areas

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

2.8.1.4.2 Submarine Sonar Maintenance Areas

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

2.8.2 RDT&E Areas

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

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

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2.8.3 Process for Development of Action Alternatives

Following identification of operational requirements associated with Step 1 of the alternative development process (previously discussed in Section 2.6), candidate active sonar activity areas were delineated for specific types of active sonar activities (i.e. Step 2). The Navy then refined its candidate areas by avoiding sensitive areas where feasible, while still meeting optimal operational requirements (i.e. Step 3 and 4). Using a surrogate analysis, the Navy defined these sensitive areas as having relatively greater potential for marine mammal exposure to sonar as discussed in the following paragraphs. The Navy further assumed that all active sonar activities conducted within the designated areas would utilize the mitigation measures detailed in Chapter 5.

Throughout the AFAST Study Area, marine mammal densities and the acoustic environment characteristics were combined in a series of maps (Appendix D, Description of Alternatives Development) to show projected marine mammal exposures to AN/SQS-53. Maps for the following marine mammals were generated using seasonal densities:

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

The acoustic environment determines how sound travels through the water and depends on a variety of factors including temperature [seasonal variations], depth, geologic features, etc. (refer to Appendix D, Description of Alternatives Development, for additional information). The maps were generated using 100 hours (hrs) of AN/SQS-53 using the following formula (depicted in Figure 2-9):

acoustic environment + marine mammal density = projected exposures

The 100 hrs is purely relative, as any time frame could have been used and would have generated identical results for areas having a high potential for exposure. The use of 100 hrs provided a clear distinction between areas of high, medium, and low exposure potential. The Navy used these maps for the purpose of identifying areas of low marine mammal exposures that meet the optimal operational requirements. Based on habitat preferences and species behavioral patterns, beaked whale, North Atlantic right whale, and sperm whale densities were specifically considered during the environmental analysis. However, due to the well-published sensitivities that beaked whales exhibit to mid-frequency active sonar, beaked whale seasonal density graphics and exposure grids served as the primary data used to limit the placement of the training areas locations. Overall, the active sonar areas were placed to avoid or minimize effects to marine species within the larger, operationally feasible areas.

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

2.8.4 Alternative 1 – Designate Active Sonar Areas

Alternative 1 designates fixed active sonar areas based on operational requirements and environmental analysis. Training fidelity would be accomplished by identifying optimal locations (Figures 2-10 through 2-13) based on replication of threat environments, proximity for multiple assets, safety of personnel, adequacy of training spaces, and availability of multiple training locations to support FRTP and surge. In addition, the trans-Atlantic routes associated with vessel movements in and out of port would not change or be altered based on the development of this alternative.

2.8.4.1 Independent ULT

2.8.4.1.1 Surface Ship ASW ULT

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

2.8.4.1.2 Surface Ship Object Detection/Navigational Sonar ULT

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

2.8.4.1.3 Helicopter ASW ULT

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

2.8.4.1.4 Submarine ASW ULT

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

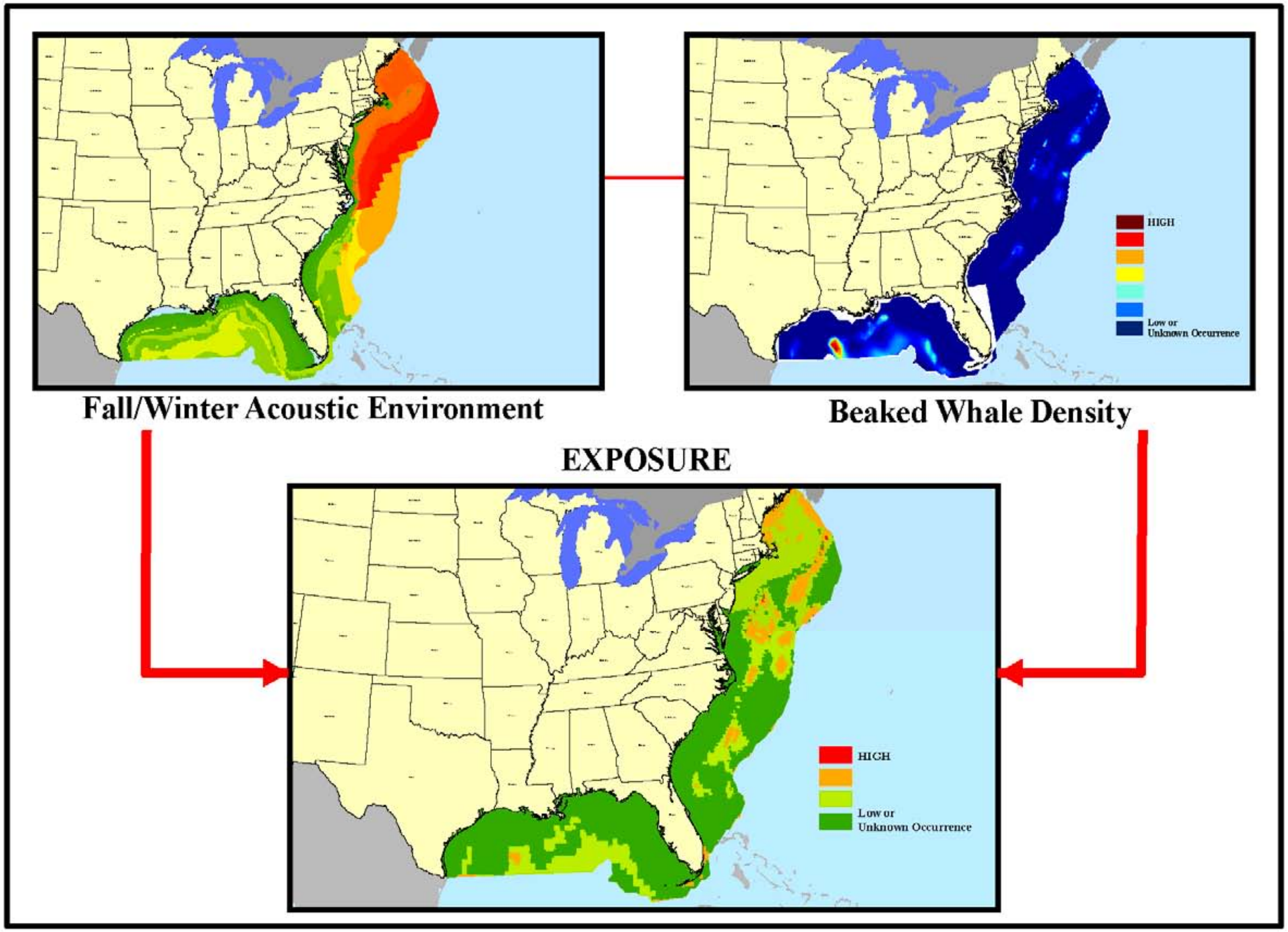

Figure 2-9. Flow Diagram Depicting How Maps Were Generated for Beaked Whale Exposures (Fall/Winter)

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2.8.4.1.5 Submarine Object Detection/Navigational Sonar ULT

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

2.8.4.1.6 Maritime Patrol Aircraft ASW ULT

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

2.8.4.1.7 Surface Ship MIW ULT

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

2.8.4.2 Coordinated ULT

2.8.4.2.1 SEASWITI

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

2.8.4.2.2 Torpedo Exercise

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

2.8.4.2.3 Group Sail

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

2.8.4.2.4 Integrated ASW Course

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

2.8.4.2.5 Submarine Commander's Course Operations

SCC Operations occur in the designated ASW training areas within and seaward of the JAX/CHASN and Northeast OPAREAs. Support vessels may be required for this training activity since it would be conducted in deep ocean areas and MK-39 EMATTs may be employed as targets. As such, the western edge of the exercise boundary must be within 148 km (80 NM) of a support facility.

2.8.4.2.6 Squadron Exercise and Gulf of Mexico Exercise

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

2.8.4.3 Strike Group Training

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

2.8.4.3.1 Composite Unit Training Exercise

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

2.8.4.3.2 Joint Task Force Exercise

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

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2.8.4.4 Maintenance Activities

2.8.4.4.1 Surface Ship Sonar Maintenance

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

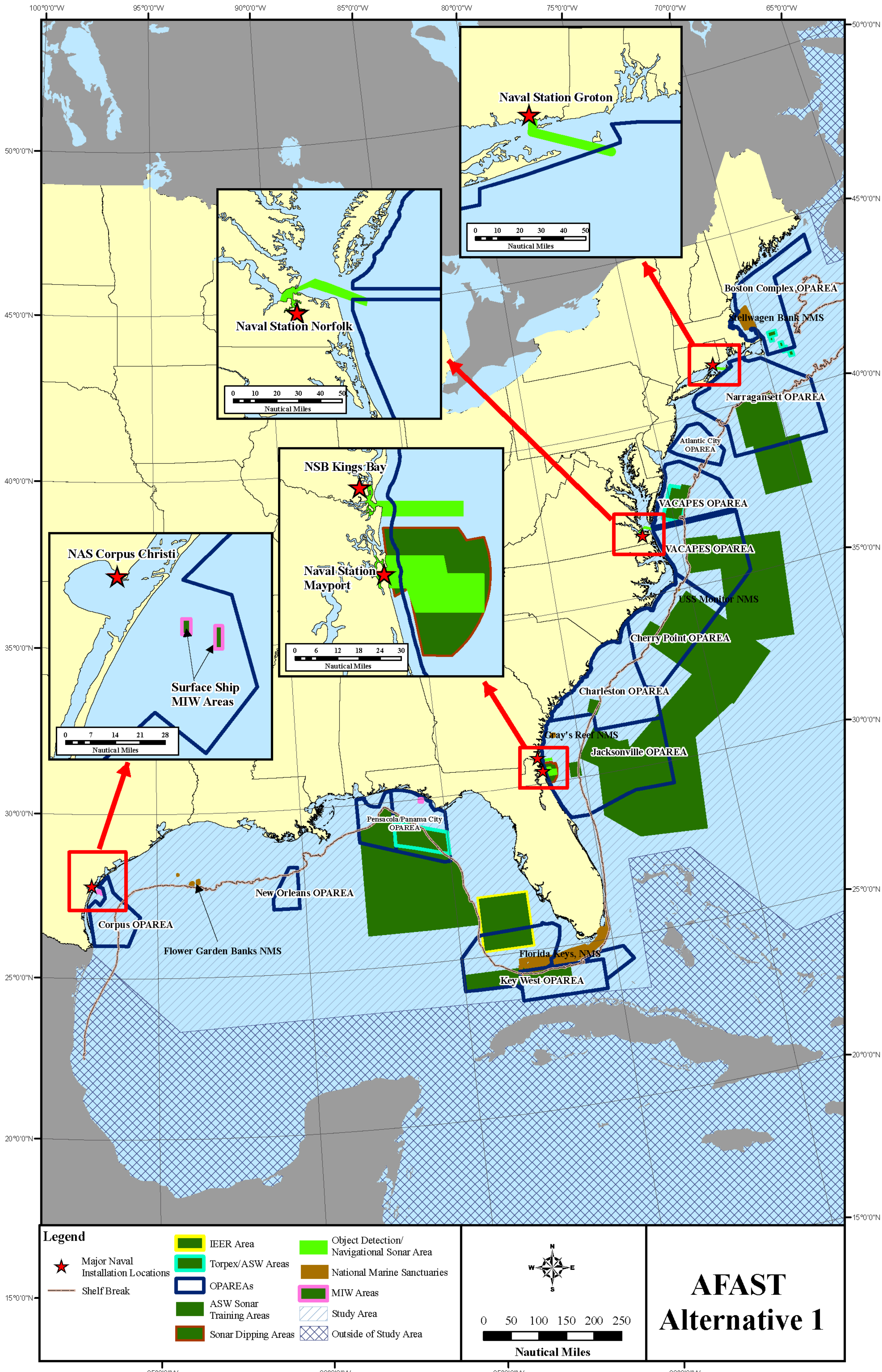

Figure 2-10. AFAST Alternative 1 – Active Sonar Activities would occur in Designated Areas (Overall)

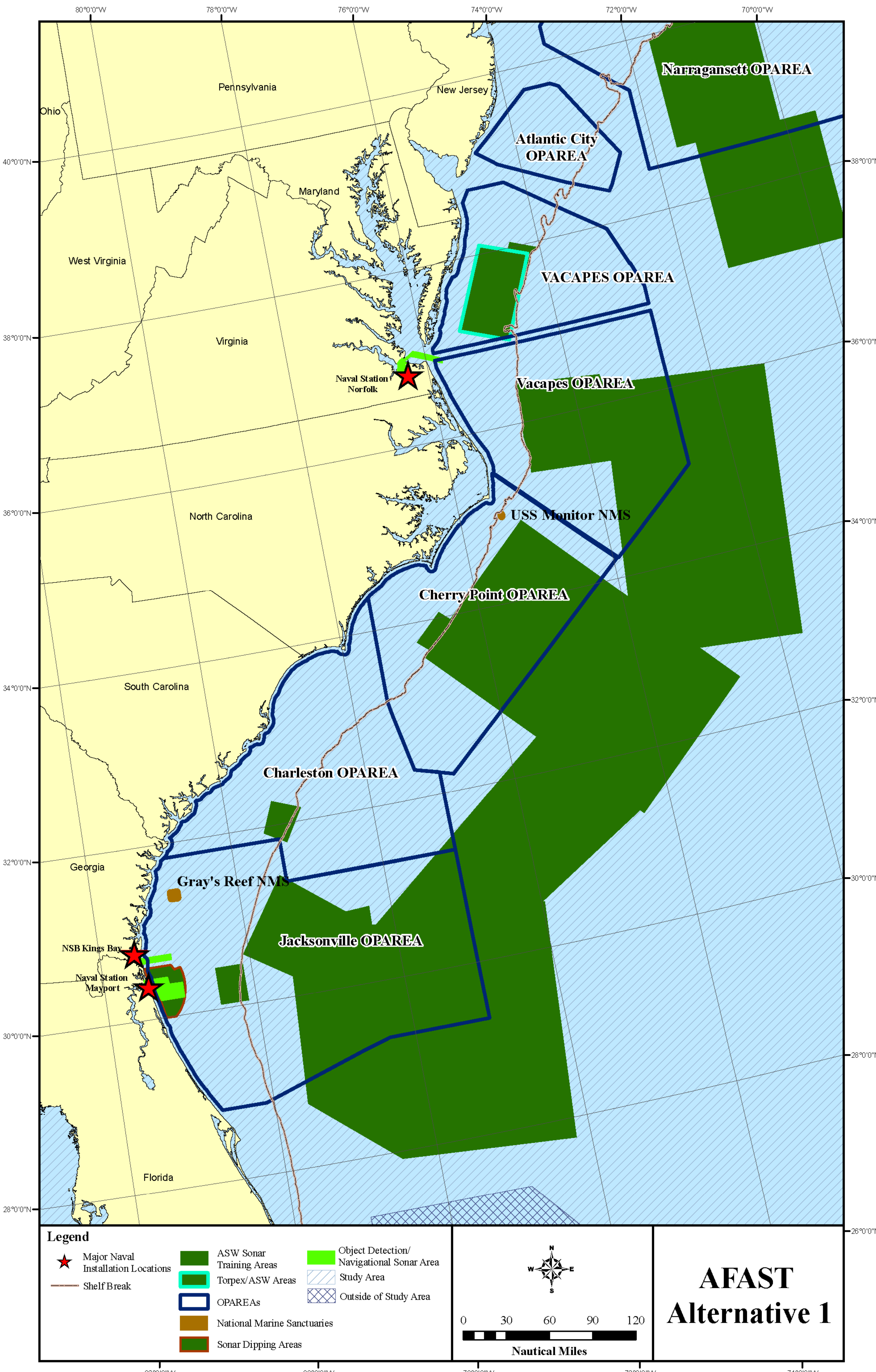

Figure 2-11. AFAST Alternative 1 – Active Sonar Activities would occur in Designated Areas (Southeast)

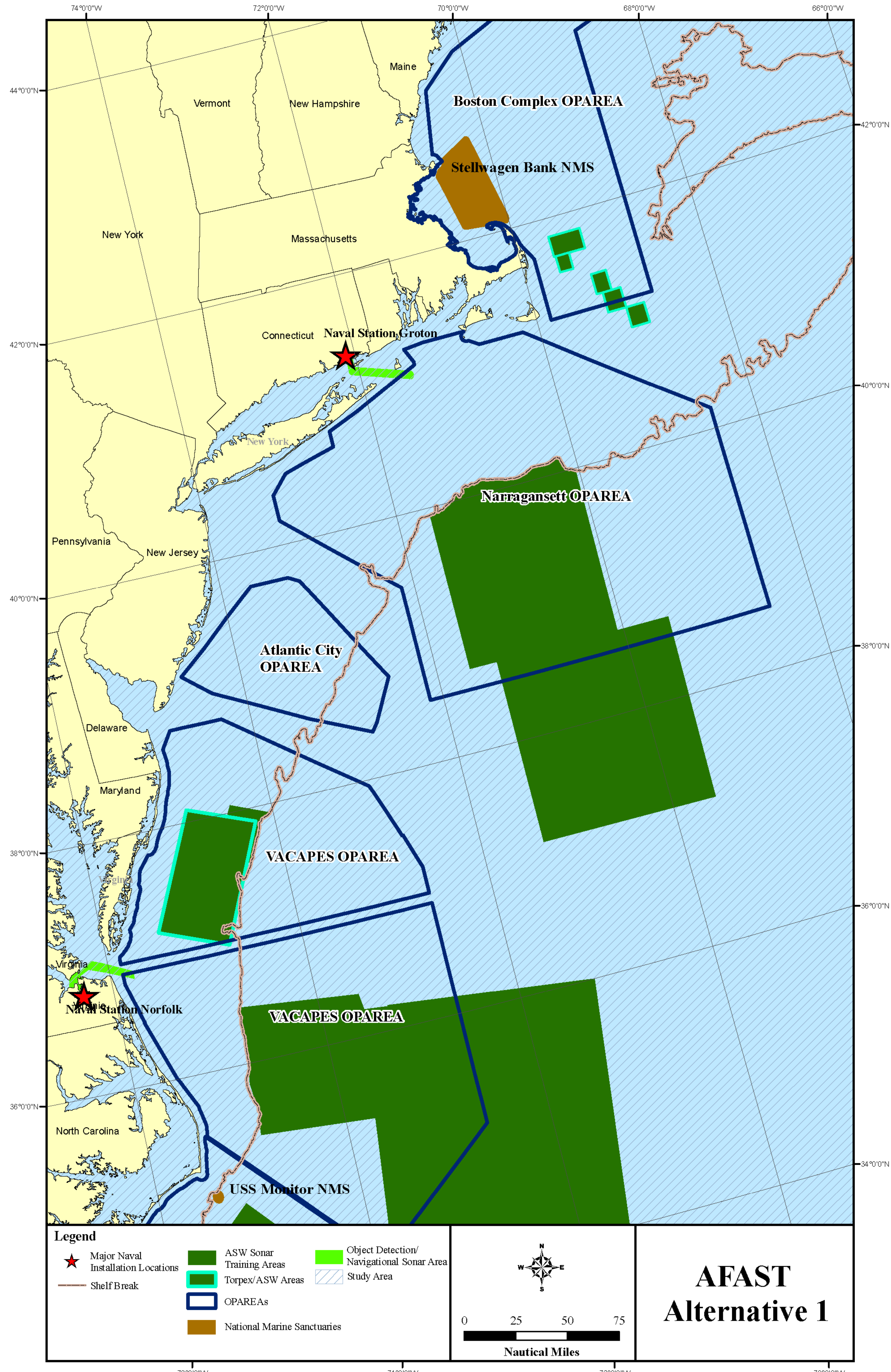

Figure 2-12. AFAST Alternative 1 – Active Sonar Activities would occur in Designated Areas (Northeast)

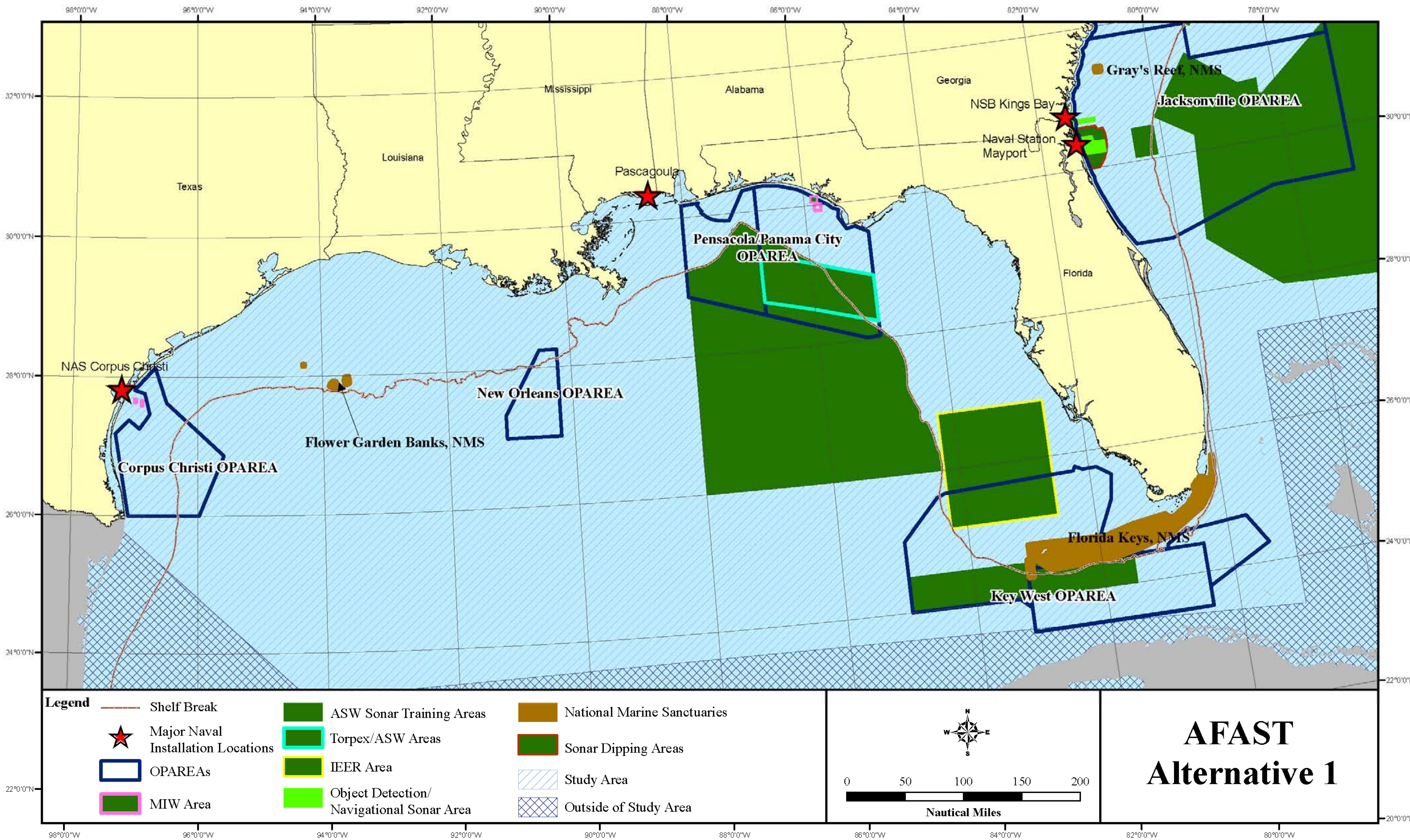

Figure 2-13. AFAST Alternative 1 – Active Sonar Activities would occur in Designated Areas (GOMEX)

2.8.4.4.2 Submarine Sonar Maintenance

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

2.8.5 Alternative 2 – Designate Seasonal Active Sonar Areas

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

Utilizing the approach discussed in Section 2.8.3, maps were generated for each season (spring, summer, fall, and winter) showing the projected exposures for identified seven marine species categories. Table 2-4 depicts the seasonal breakout used to define the seasons by specific calendar date beginning each season and ending each season.

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

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

The Navy used these maps for the purpose of identifying areas of higher marine mammal exposures within the Alternative 1 active sonar training areas. The seasonal exposure data was compared to the Alternative 1 active sonar training areas, resulting in the reduction in specific training areas during the spring and winter and the addition of available training areas during the fall and summer. The Alternative 2 training areas remained consistent with the Alternative 1 active sonar training areas during the spring season. The seasonal changes to active sonar training areas are depicted in Figures 2-14 through 2-25. There were no seasonal changes in the GOMEX OPAREA (Figure 2-26). In addition the trans-Atlantic routes associated with vessel movements in and out of port would not change or be altered based on the development of this alternative.

Based on habitat preferences and species behavioral patterns, densities of beaked whales, North Atlantic right whales, and sperm whales were specifically considered during the environmental analysis. However, due to the well-published sensitivities that beaked whales exhibit to mid-frequency active sonar, it was determined that their seasonal densities and exposure grids should serve as the primary data used to seasonally adjust the active sonar training area locations.

2.8.5.1 Independent ULT

2.8.5.1.1 Surface Ship ASW ULT

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

2.8.5.1.2 Surface Ship Object Detection/Navigational Sonar ULT

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

2.8.5.1.3 Helicopter ASW ULT

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

2.8.5.1.4 Submarine ASW ULT

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

2.8.5.1.5 Submarine Object Detection/Navigational Sonar ULT

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

2.8.5.1.6 Maritime Patrol Aircraft ULT

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

2.8.5.1.7 Surface Ship MIW ULT

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

2.8.5.2 Coordinated ULT

2.8.5.2.1 SEASWITI

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

2.8.5.2.2 Torpedo Exercise

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

2.8.5.2.3 Group Sail

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

2.8.5.2.4 Integrated ASW Course

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

2.8.5.2.5 Submarine Commander's Course Operations

Similar to Alternative 1, SCC Operations would be conducted in the designated ASW training areas within and seaward of the JAX/CHASN OPAREA. Support vessels may be required for this training activity, since it is conducted in deep ocean areas and MK-39 EMATTs may be employed as a target. As such, the western edge of the exercise boundary must be within 148 km (80 NM) of a support facility. Seasonally, the JAX/CHASN OPAREA training area expands slightly in the summer and fall.

2.8.5.2.6 Squadron Exercise and Gulf of Mexico Exercise

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

2.8.5.3 Strike Group ULT

2.8.5.3.1 Composite Unit Training Exercise

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

2.8.5.3.2 Joint Task Force Exercise

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

2.8.5.4 Maintenance Activities

2.8.5.4.1 Surface Ship Sonar Maintenance

As with the Alternative 1, naval surface ships would operate their active sonar systems for maintenance while pier side at their homeport, located in either Norfolk, Virginia or Mayport, Florida. Additionally, maintenance could occur in the open ocean in any of the designated ASW training areas.

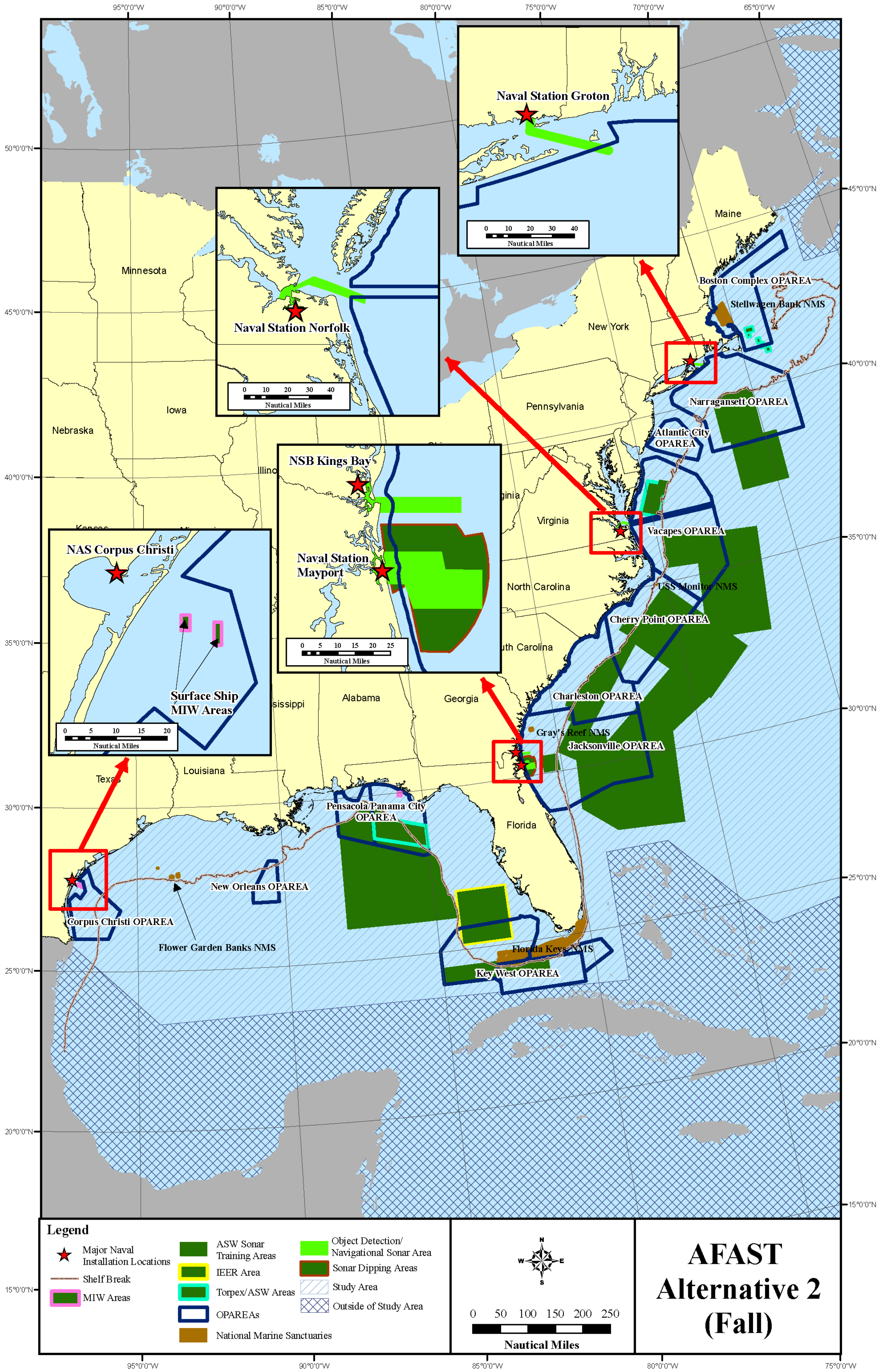

Figure 2-14. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall—Fall Season)

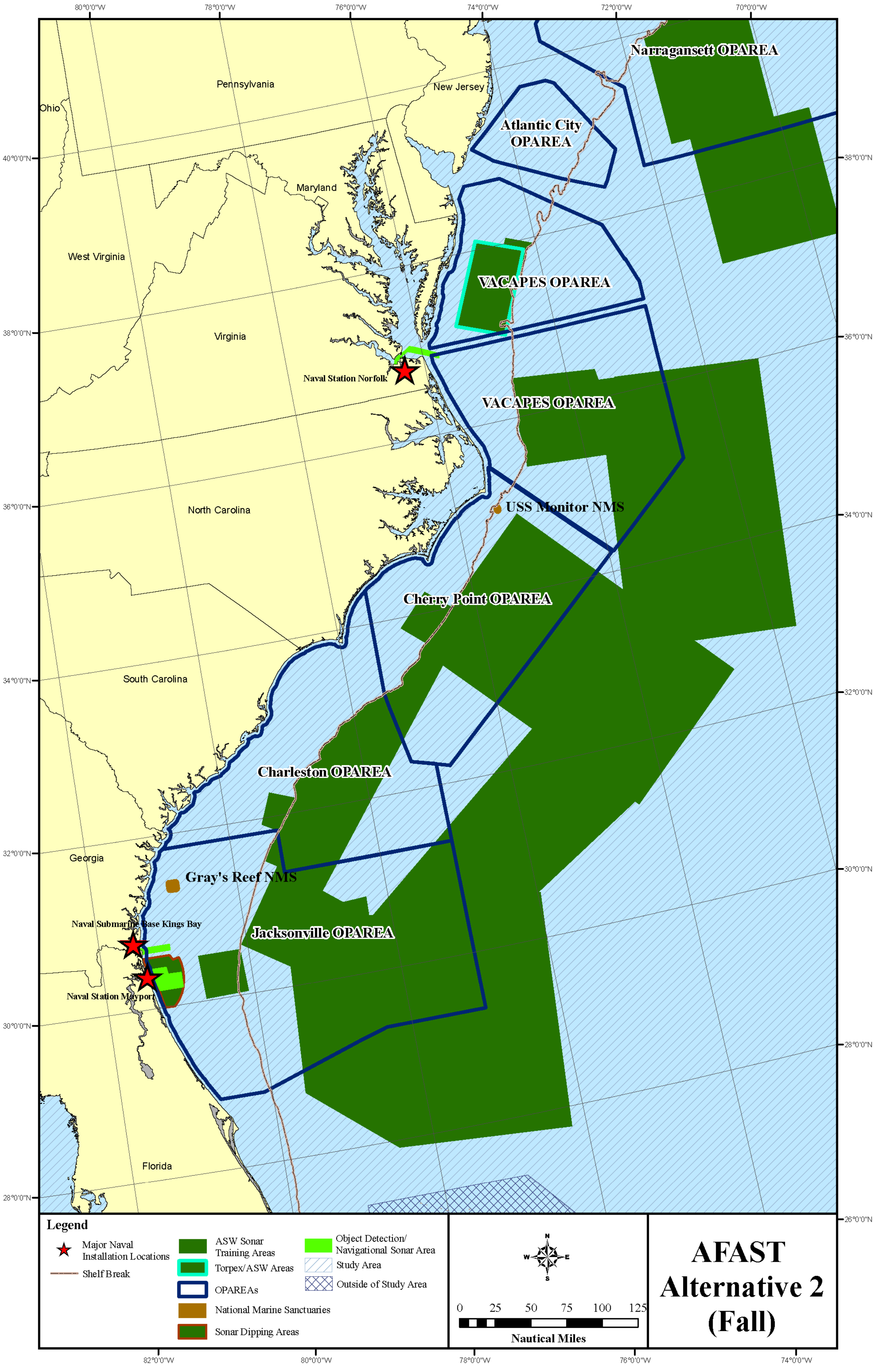

Figure 2-15. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Southeast—Fall Season)

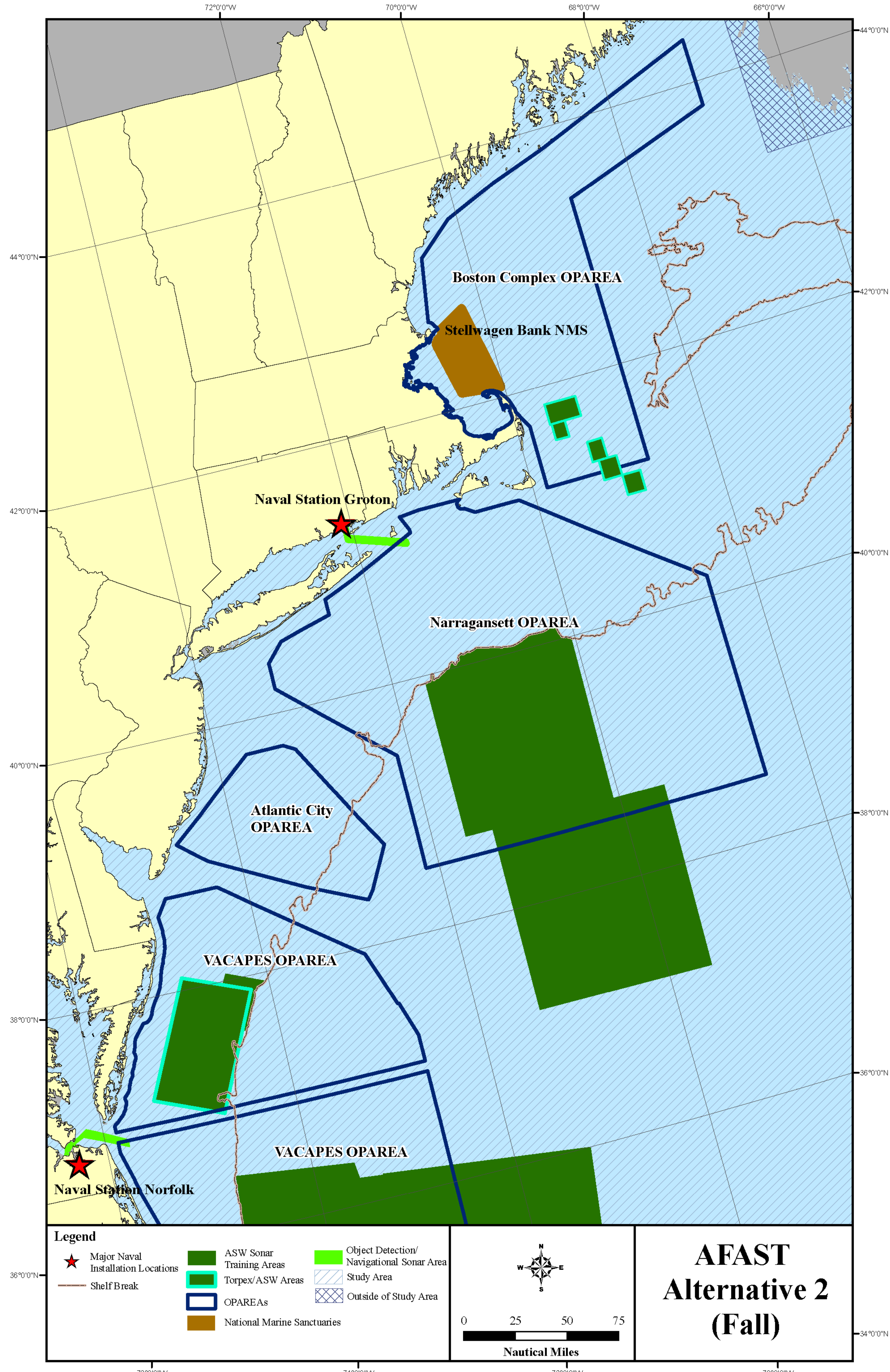

Figure 2-16. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Northeast—Fall Season)

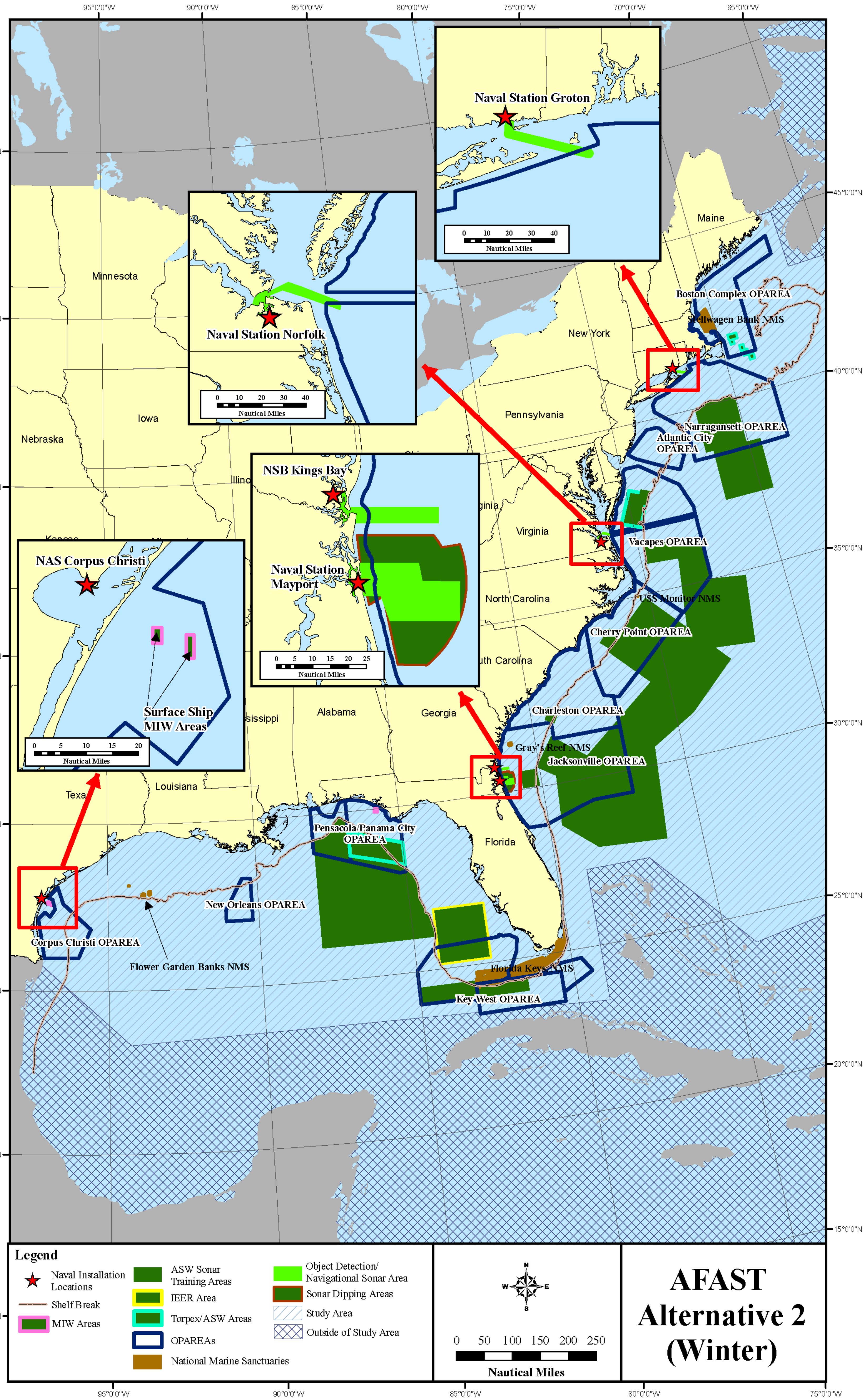

Figure 2-17. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall—Winter Season)

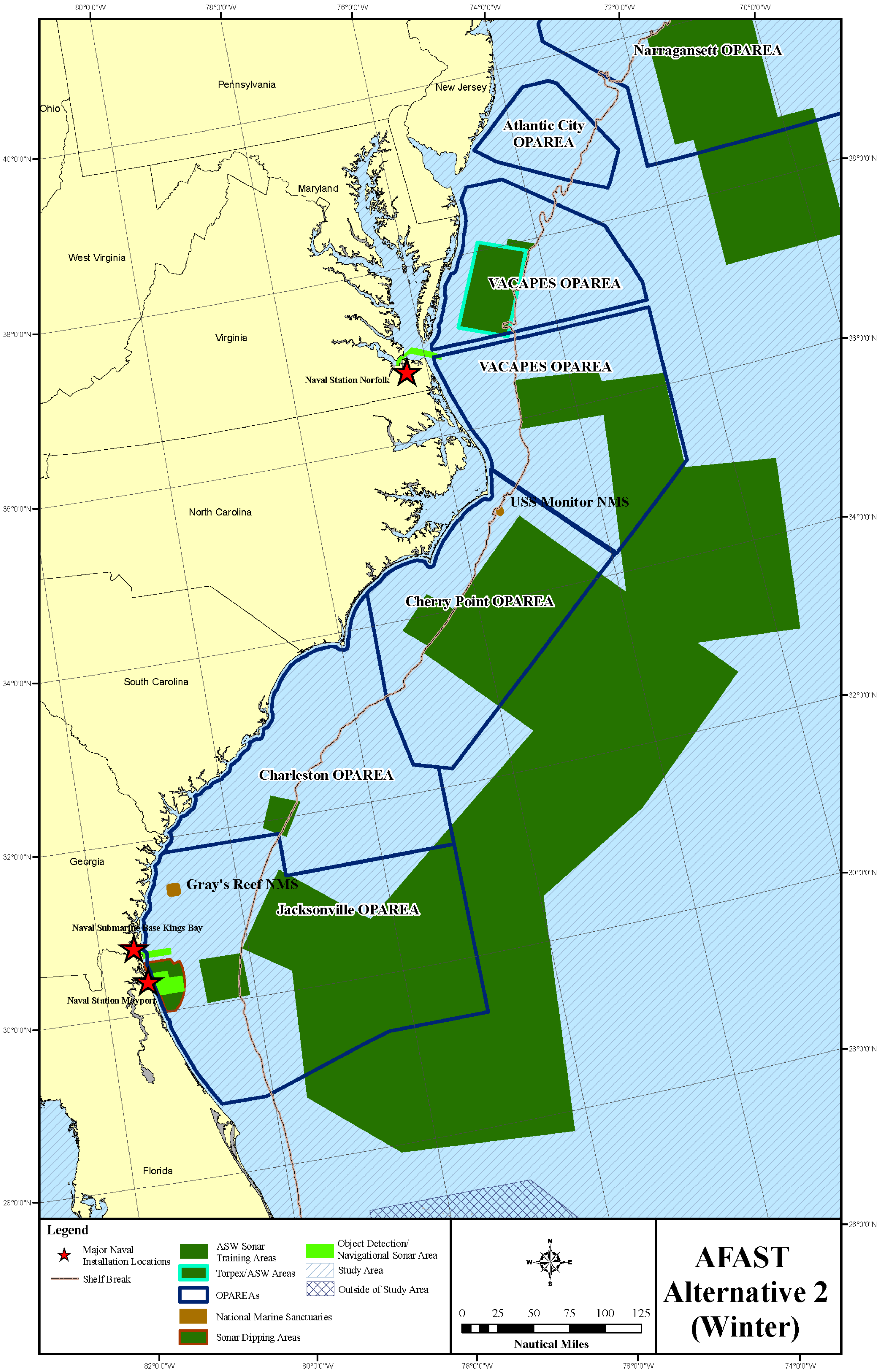

Figure 2-18. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Southeast—Winter Season)

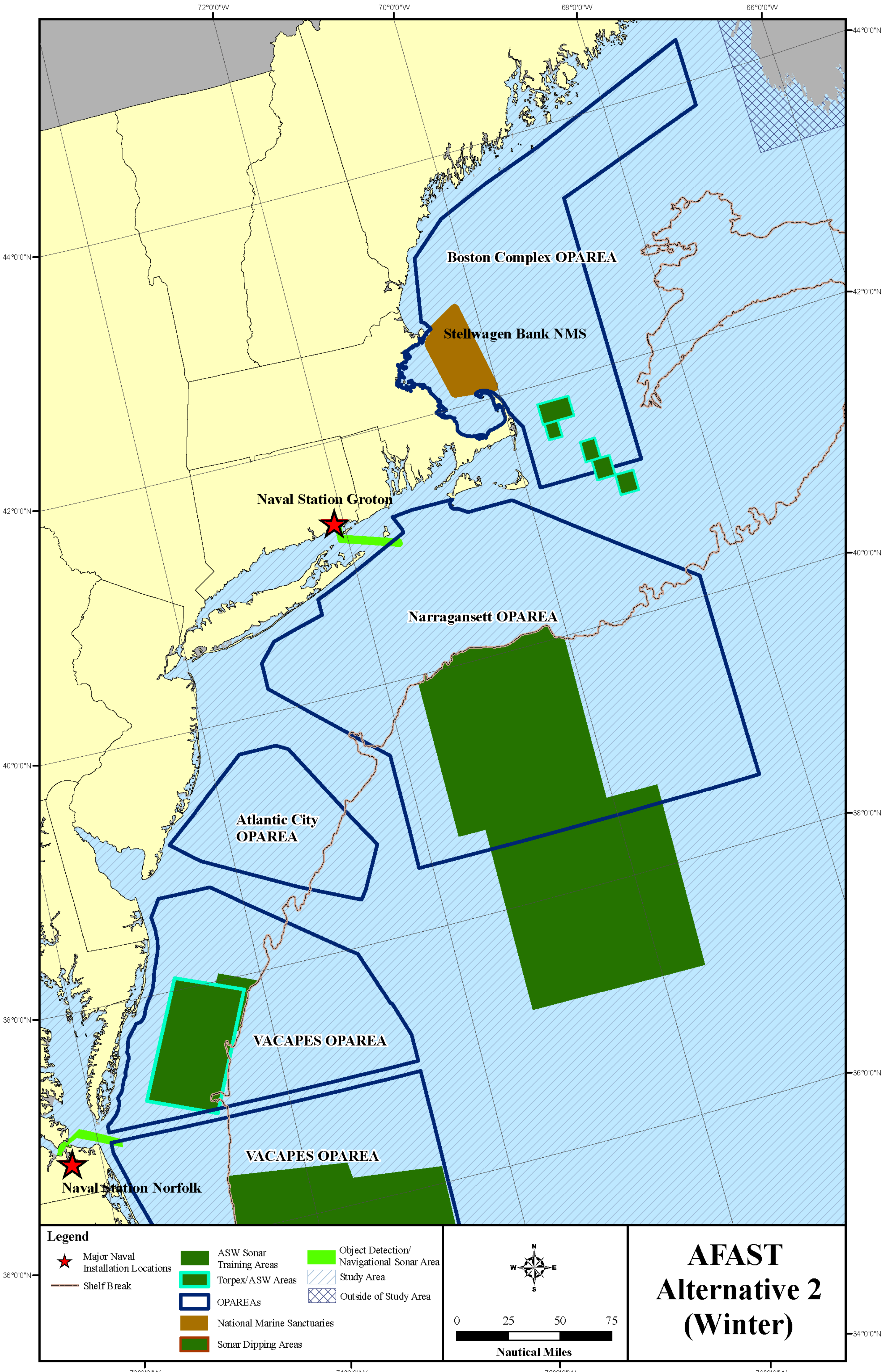

Figure 2-19. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Northeast—Winter Season)

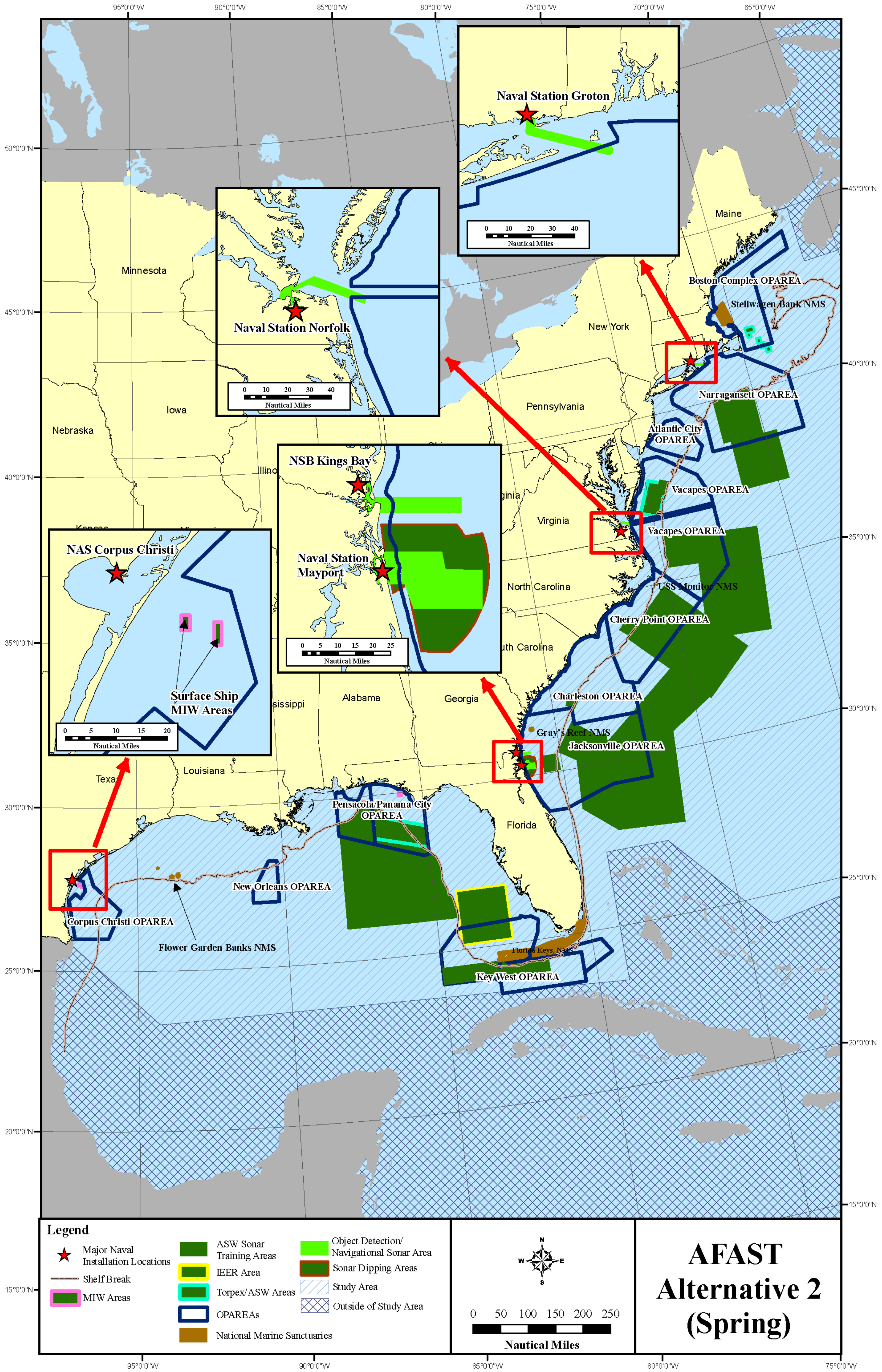

Figure 2-20. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall—Spring Season)

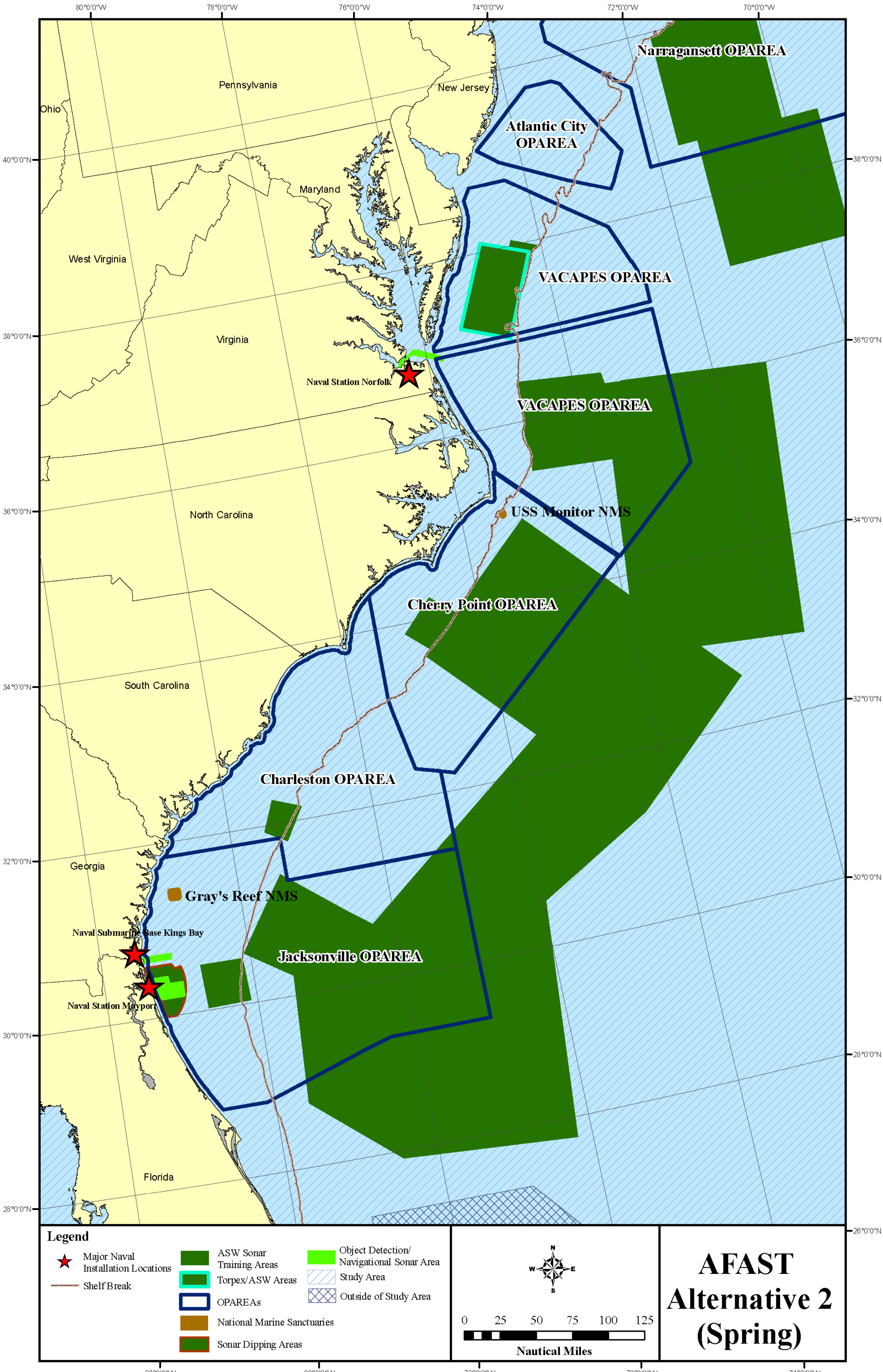

Figure 2-21. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Southeast—Spring Season)

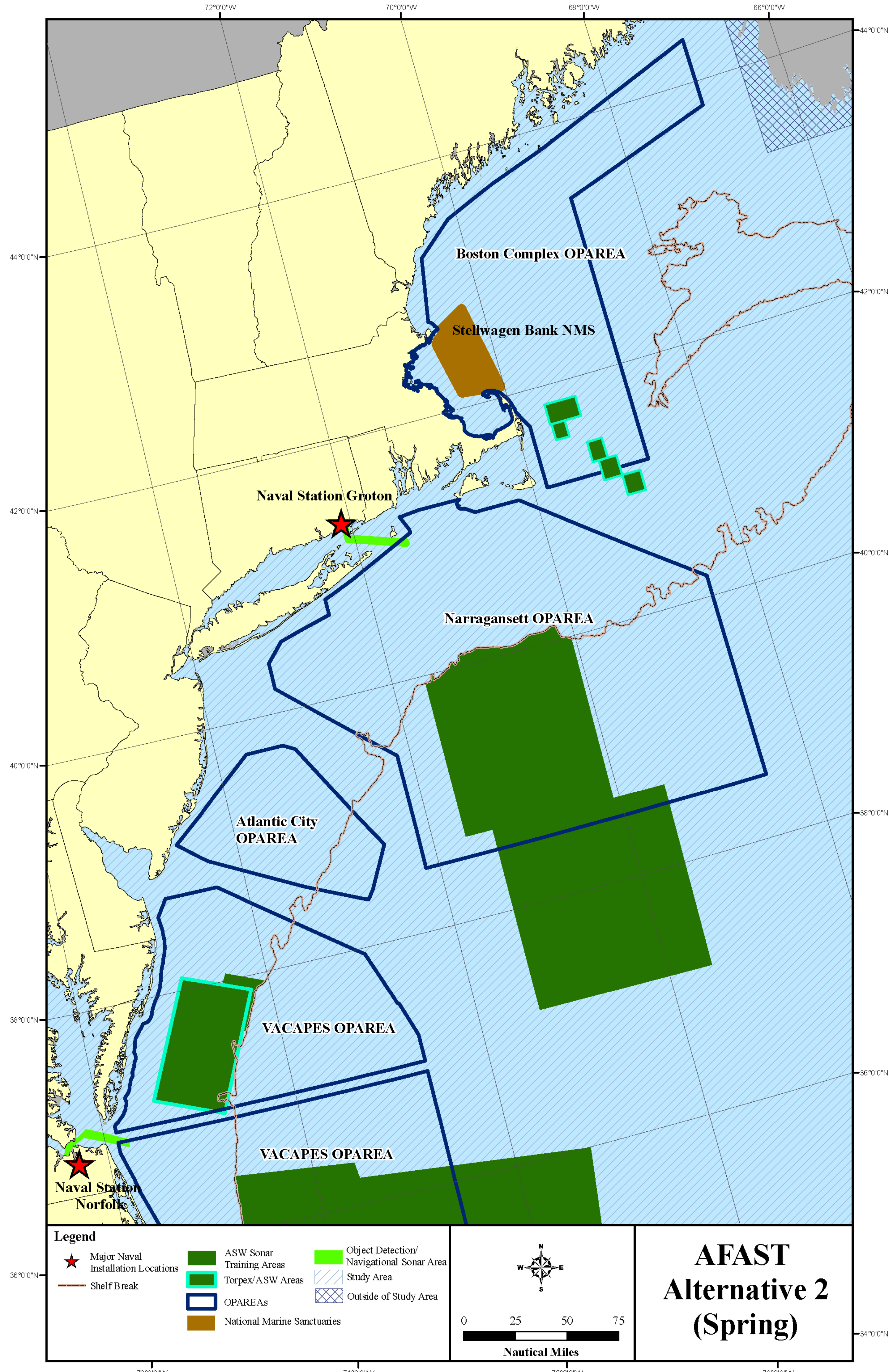

Figure 2-22. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Northeast—Spring Season)

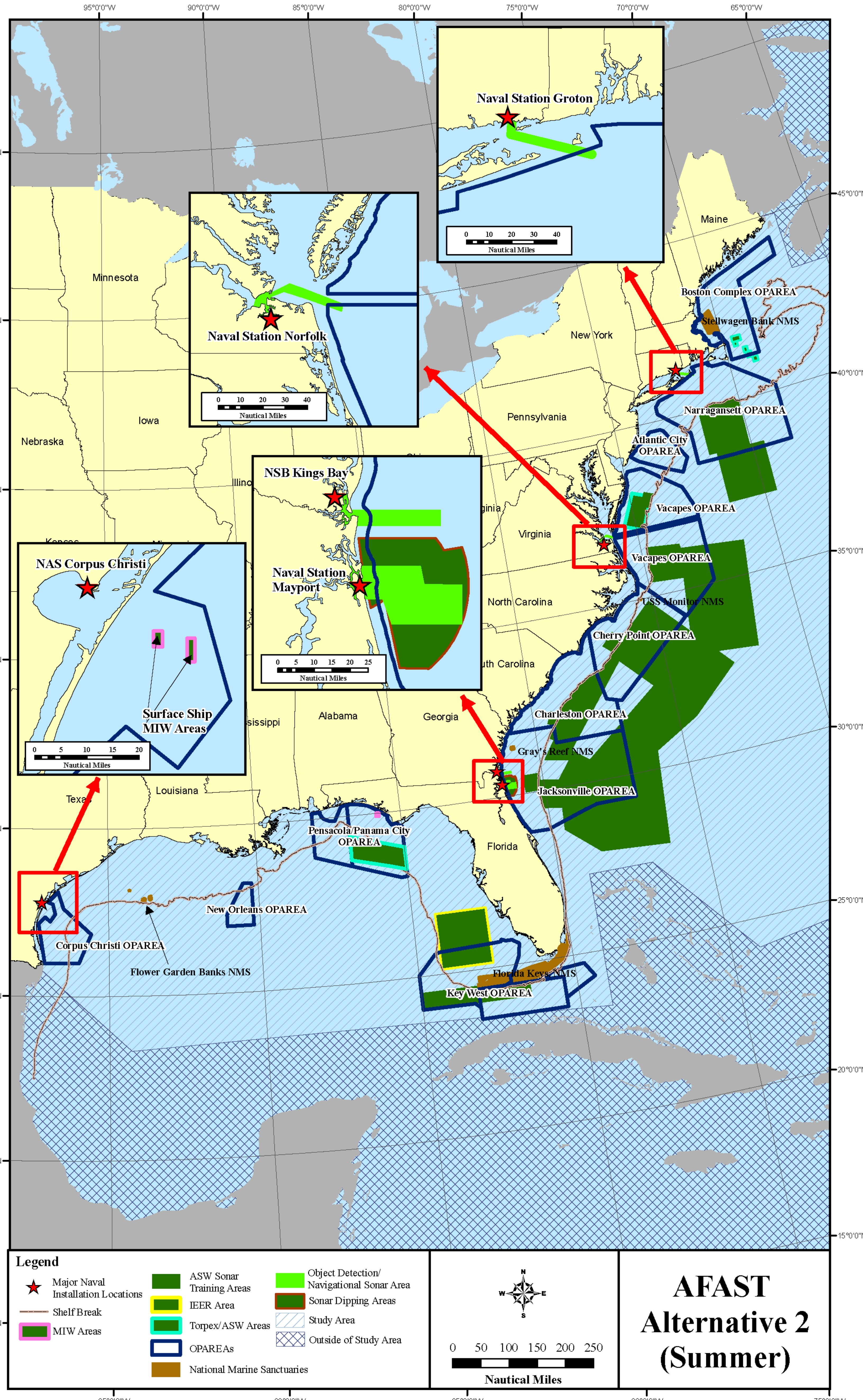

Figure 2-23. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall—Summer Season)

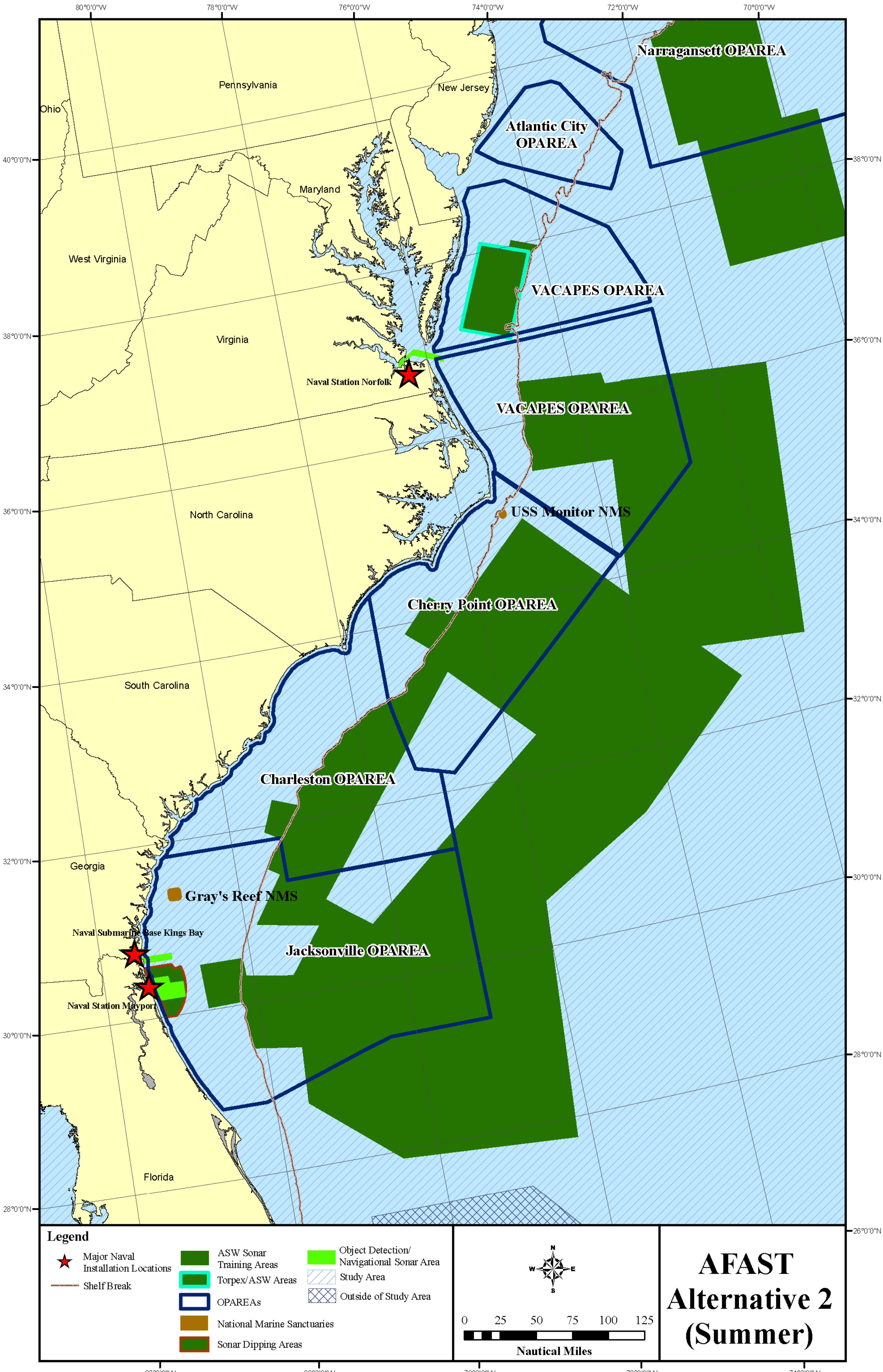

Figure 2-24. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Southeast—Summer Season)

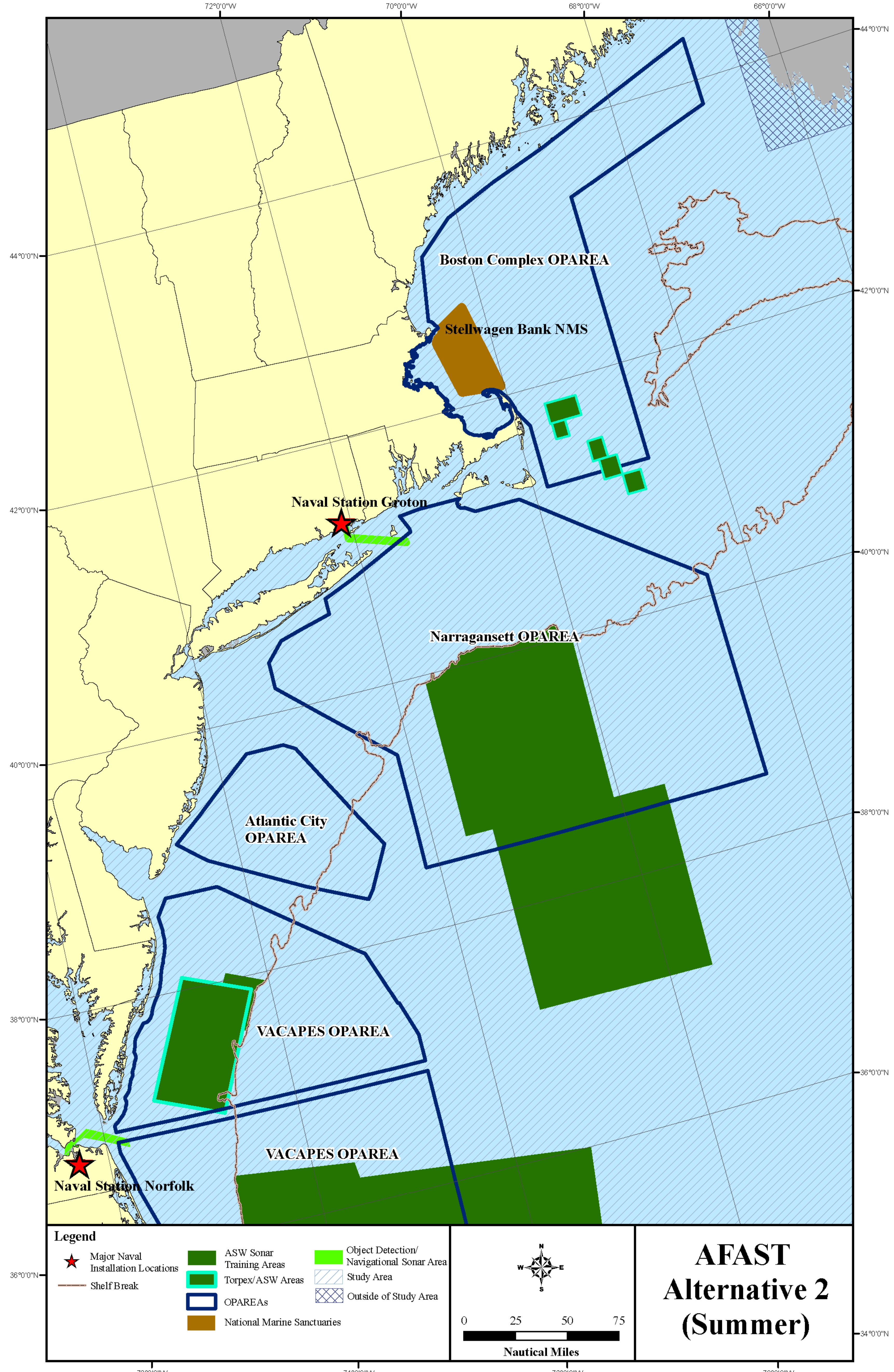

Figure 2-25. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Northeast—Summer Season)

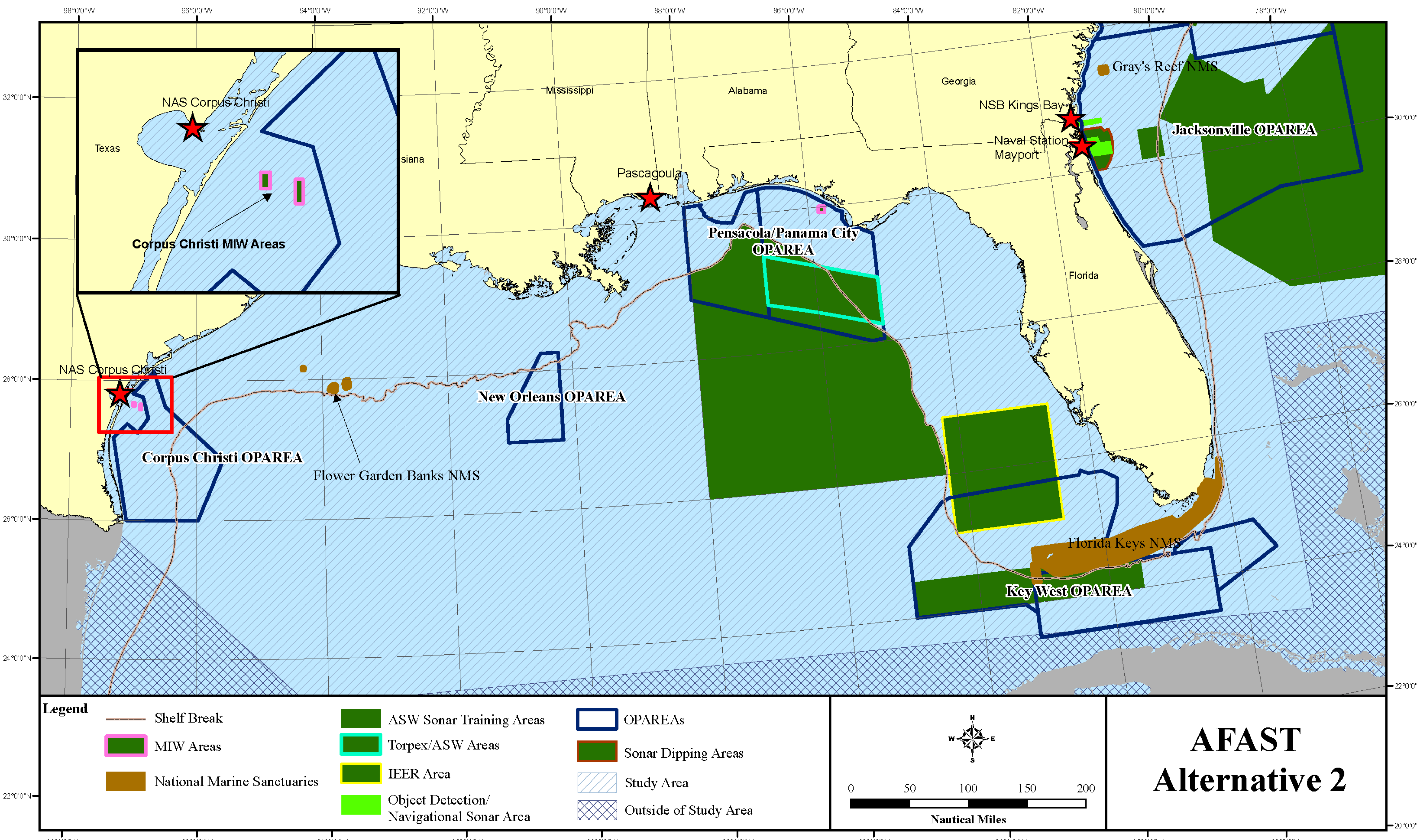

Figure 2-26. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (GOMEX—All Seasons)

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2.8.5.4.2 Submarine Sonar Maintenance

As with the Alternative 1, submarines would conduct maintenance activities pier side at their homeport, located in either Groton, Connecticut, Norfolk, Virginia, or Kings Bay, Georgia. Additionally, sonar maintenance could occur in open water within any of the designated active sonar areas as the system's performance may warrant.

2.8.6 Alternative 3 – Designated Areas of Increased Awareness

While updated marine mammal densities were developed and used for the surrogate analysis, the differences in marine mammal exposures across Alternatives 1 and 2 did not vary as much as expected prior to the surrogate analysis. Therefore, in addition to considering the surrogate marine mammal acoustic exposure analysis to develop a reasonable range of alternatives, a number of other habitat types were considered and included in the development of Alternative 3. Under Alternative 3, active sonar activities would not be conducted in designated environmental sensitive areas offshore of the U.S. East Coast and within the Gulf of Mexico to the extent allowable while meeting operational requirements. However, the trans-Atlantic routes associated with vessel movements in and out of port would not change or be altered based on the development of this alternative. These environmentally sensitive areas typically indicate higher concentrations of marine species and include the following features:

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

All marine waters within the Study Area but outside the environmentally sensitive areas identified in Figures 2-27 through 2-30 would be open to active sonar activities. Due to operational requirements there are several types of active sonar areas that do cross areas of increased awareness, but these are limited and described below in the following sections.

2.8.6.1 Independent ULT Areas

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

2.8.6.1.1 Surface Ship ASW

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

2.8.6.1.2 Surface Ship Object Detection/Navigational Sonar ULT

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

2.8.6.1.3 Helicopter ASW ULT

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

2.8.6.1.4 Submarine ASW ULT

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

2.8.6.1.5 Submarine Object Detection/Navigational Sonar ULT

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

2.8.6.1.6 Maritime Patrol Aircraft ASW ULT

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

2.8.6.1.7 Surface Ship MIW ULT

Navy MIW ships would operate their active sonars for mine detection training primarily in shallow water OPAREAs in the Gulf of Mexico. Similar to the No Action Alternative, this training would be conducted in OPAREAs in the northern Gulf of Mexico in the GOMEX OPAREA, and off the east coast of Texas, in the Corpus Christi OPAREA. Designated MIW

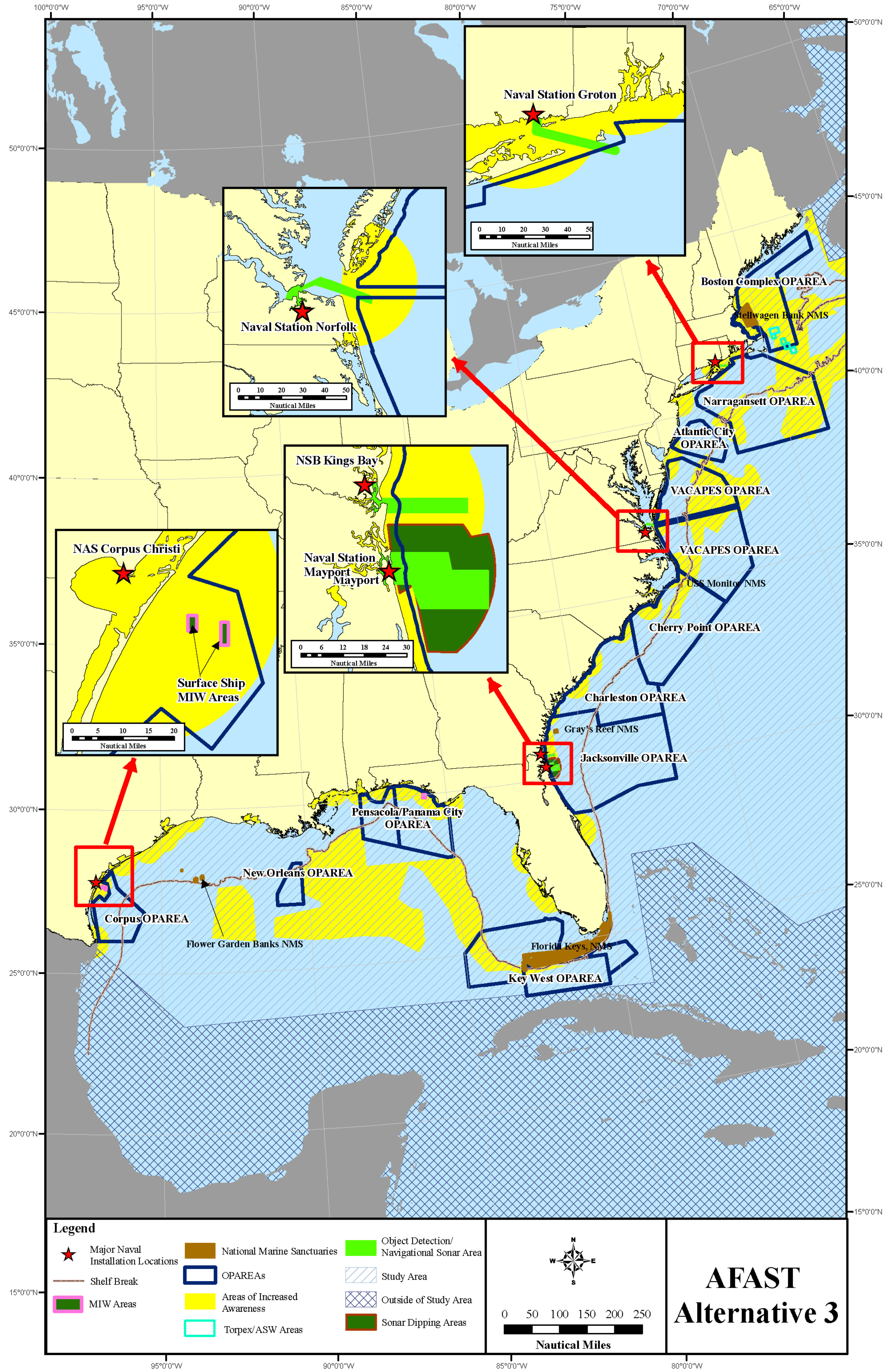

Figure 2-27. AFAST Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (Overall)

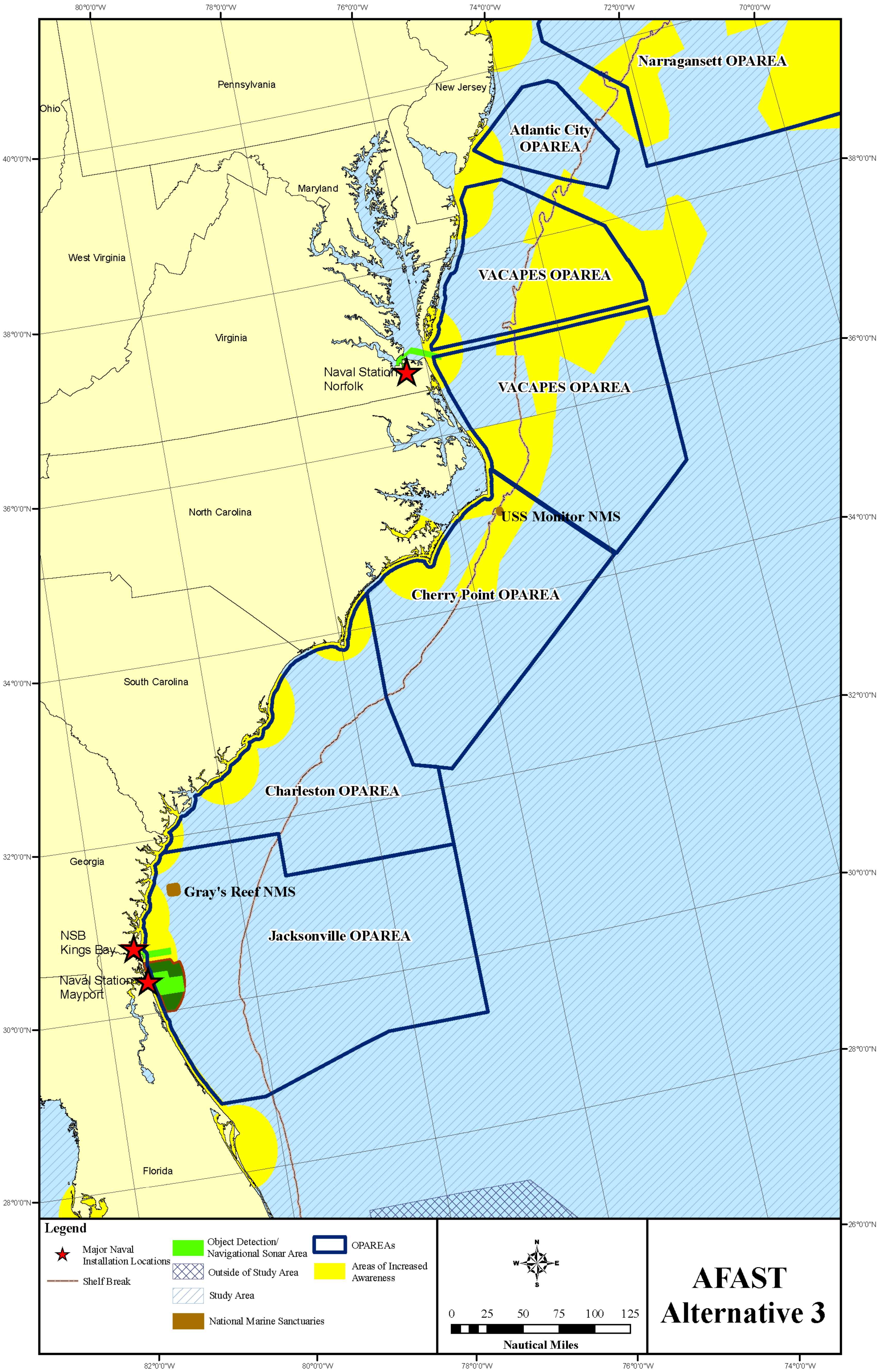

Figure 2-28. AFAST Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (Southeast)

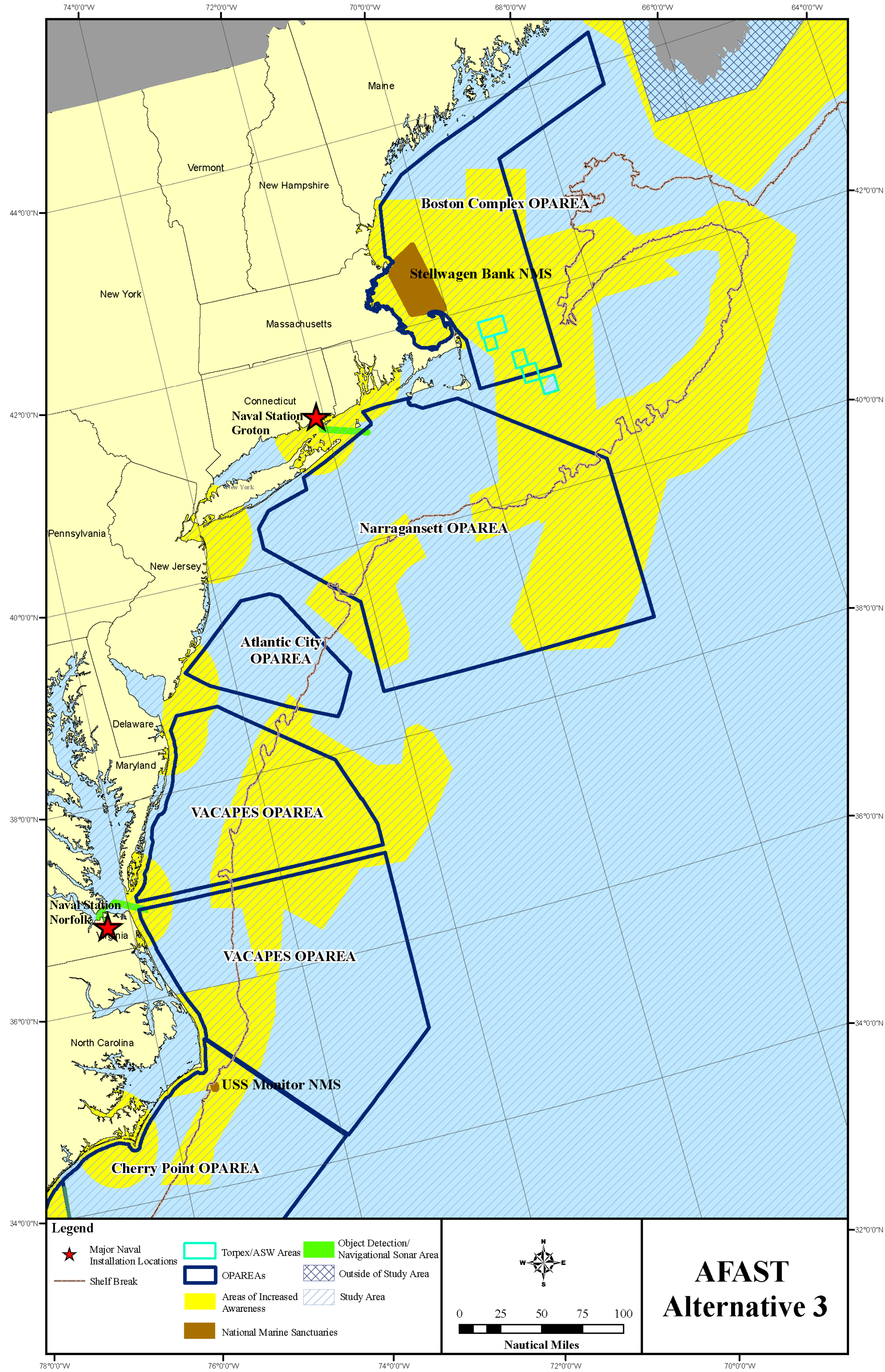

Figure 2-29. AFAST Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (Northeast)

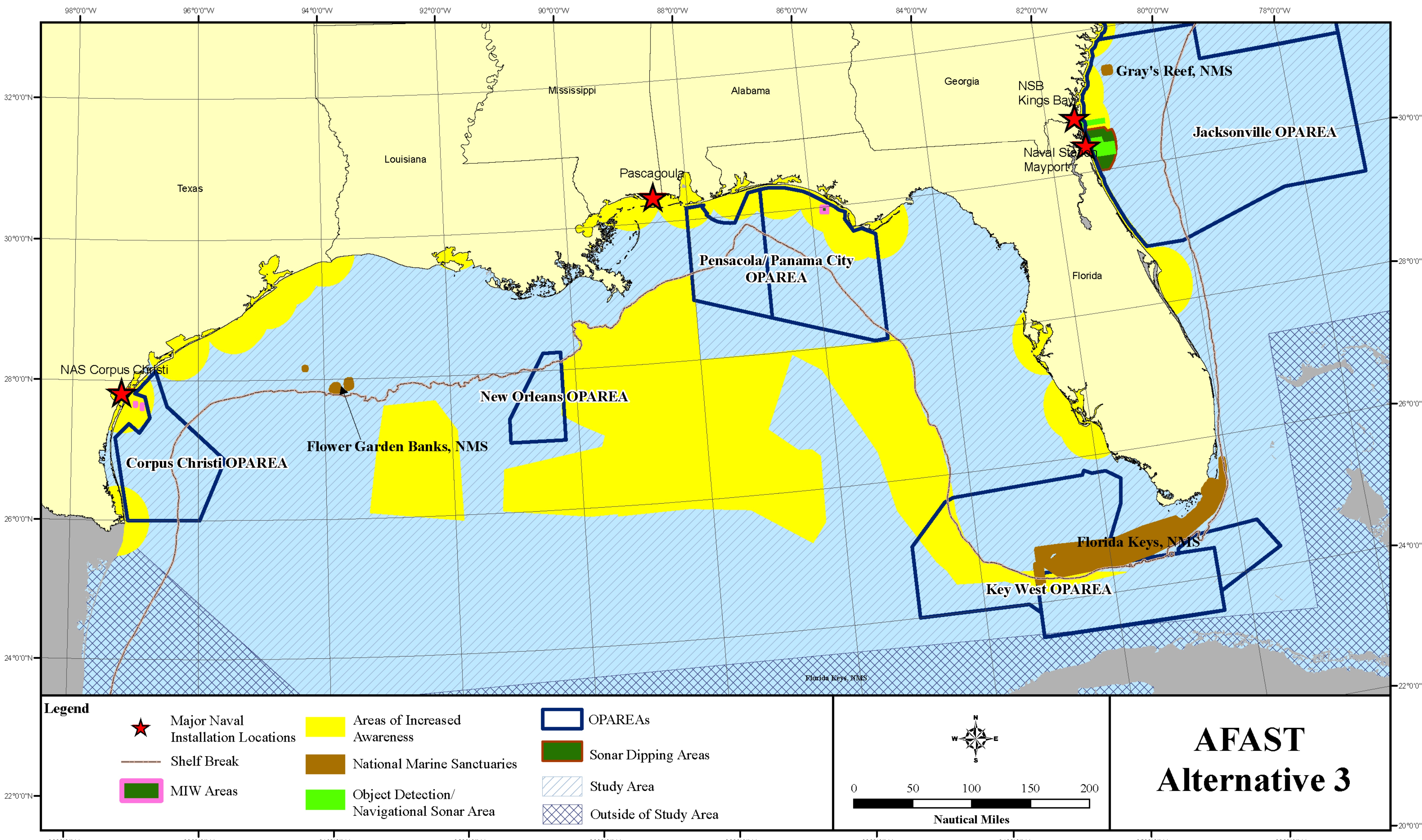

Figure 2-30. AFAST Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (GOMEX)

ranges are very small, on the order of a few square miles, but are within areas of increased awareness offshore Florida and Texas.

2.8.6.2 Coordinated ULT Areas

2.8.6.2.1 SEASWITI

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

2.8.6.2.2 Torpedo Exercise

ASW training involving torpedo firing would occur within the VACAPES and GOMEX OPAREAs outside of areas of increased awareness, however designated TORPEX boxes within and adjacent to the Northeast OPAREA would reside within areas of increased awareness that are based on North Atlantic right whale critical habitat. These training areas were established during prior consultations with NMFS.

2.8.6.2.3 Group Sail

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

2.8.6.2.4 Integrated ASW Course

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

2.8.6.2.5 Submarine Commander's Course Operations

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

2.8.6.2.6 Squadron Exercise and Gulf of Mexico Exercise

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

2.8.6.3 Strike Group Training Areas

2.8.6.3.1 Composite Training Unit Exercise

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

2.8.6.3.2 Joint Task Force Exercise

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

2.8.6.4 Sonar Maintenance Activities

2.8.6.4.1 Surface Ship Sonar Maintenance

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

2.8.6.4.2 Submarine Sonar Maintenance

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

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

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

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

2.8.6.6 Areas of Persistent Oceanographic Features

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

2.8.6.7 North Atlantic Right Whale Critical Habitat Areas

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

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

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

(3) Cape Cod and Massachusetts Bays

In order to reduce potential exposures of endangered right whales during their critical calving and feeding activities, the three designated critical habitat would be considered as areas of increased awareness. However, based on operational requirements associated with object detection/navigational sonar training for surface ships and submarines, a 4 km (2 NM) break in the area was included off Mayport, Florida, and Kings Bay, Georgia. In addition, based on operational and safety requirements, the area off Mayport, Florida will be used for helicopter dipping sonar. Furthermore, a small portion of the TORPEX activity area is located within an area of increased awareness in the Northeast OPAREA that is designated due to the presence of North Atlantic right whale critical habitat. However, TORPEX activities would not occur 5 km (3 NM) of the Stellwagen Bank National Marine Sanctuary. This area cannot be relocated due to operational requirements, specifically, proximity to support facilities for recovery operations.

2.8.6.8 River and Bay Mouths

Bay and river mouths are areas where low-salinity waters meet with high-salinity ocean waters. These areas are called mixing zones or the convergence zone (Figure 2-31). Mixing zones occur when the front of the salt wedge meets lower salinity waters flowing out of a bay or river. Mixing zones are typically characterized as areas containing increased levels of suspended particles (i.e., turbidity). The characteristic of increased suspended particles plays a significant role in retaining planktonic organisms, thus creating productive larval fish nursery areas (Chesapeake Biological Laboratory [CBL], 2006). This increased production of larval and juvenile fish provides a natural feeding ground for predatory fish. Thus, the increase in predator fish attracts marine mammals that feed on these large species of fish.

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

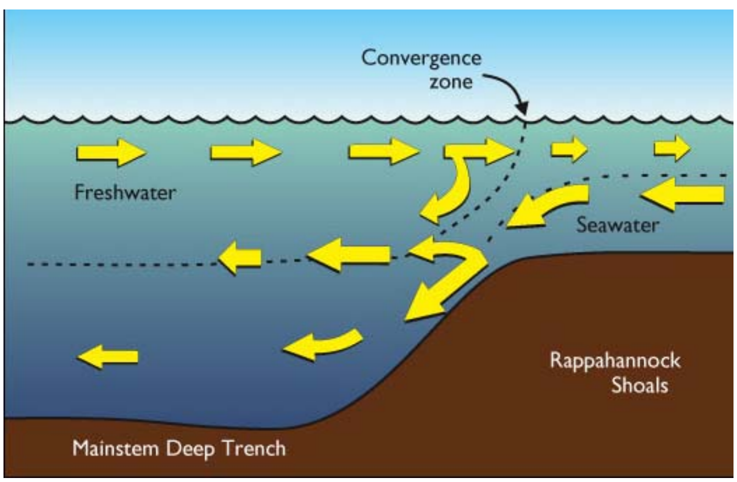

Figure 2-31. Chesapeake Bay Convergence Zone
Source: Boicourt, 2004

2.8.6.9 Areas of High Marine Mammal Density

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

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

2.8.6.10 Designated National Marine Sanctuaries

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

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

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

Gray's Reef National Marine Sanctuary was established to protect one of the largest live hardbottom (Figure 2-32) areas in the southeastern United States. The live bottom areas of the sanctuary support "an unusual assemblage of temperate and tropical marine flora and fauna." Loggerhead sea turtles use the reef year-round. In addition, North Atlantic right whales use part of the sanctuary as a winter calving area, which is the only known calving area of its kind for this highly endangered species (NOAA, 2007a).

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

Figure 2-32. Example of Hardbottom Area

The Florida Keys National Marine Sanctuary was established to protect important natural and cultural resources. In addition to a colorful diversity of marine life associated with expanses of coral reefs (Figure 2-33), a trail of historic shipwrecks lines the southern boundary of this sanctuary. Mangrove forests occur throughout the land-water interfaces of the numerous islands or keys in the sanctuary, providing habitat, shelter, food, and nursery areas for birds, fish, and invertebrates. Five species of sea turtles, as well as the endangered manatee inhabit the waters of this sanctuary (NOAA, 2007b).

Figure 2-33. Example of Coral Reef

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

Though each of these five sanctuaries have established boundaries, to further protect these sensitive areas, the Navy would observe a 5 km (3 NM) buffer around each sanctuary.

2.9 PREFERRED ALTERNATIVE

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

As the biological science continues to evolve, the areas identified in this Draft EIS/OEIS could evolve and change as well, again potentially restricting access to areas that would be critical to training. Not only would Alternatives 1 and 2 severely limit the necessity to train in areas similar to where potential threats operate, it would require the relocation of approximately 30 percent of Navy's current training. Furthermore, independent of the geographic limitations that would be imposed by Alternative 3, there is not a significant difference in the analytical results between Alternative 3 and the No Action Alternative. Due to the relatively insignificant difference between Alternative 3 and the No Action Alternative and the importance of the geographic flexibility required to conduct realistic training, the No Action Alternative was selected as the operationally preferred option.

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

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

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

2.11 ISSUES ELIMINATED FROM FURTHER CONSIDERATION

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

Table 2-5. Environmental Issues Eliminated from Further Analysis

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

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

2.12 POTENTIAL EFFECTS TO RESOURCE AREAS

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

Table 2-6. Summary of Effects – Marine Habitat

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

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

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

Table 2-7. Summary of Potential for Response – Biological Resources

Stressor	Biological Resource							
	Marine Mammals	**Sea Turtles**	**EFH**	**Marine Fish**	**Sea Birds**	**Marine Invertebrates**	**Marine Plants and Algae**	**National Marine Sanctuaries**
Acoustical								
Surface Ship Sonar	Potential for exposure to underwater sound (Section 4.4.11).	Potential for exposure, but no anticipated response (Section 4.5.1).	No anticipated effects (Section 4.8).	Potential for exposure to underwater sound (Section 4.9.1).	Potential for exposure, but no anticipated response (Section 4.10.1).	Potential for exposure to underwater sound (Section 4.11.1).	Potential for exposure to underwater sound (Section 4.12.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.13).
Mine Warfare Sonar	Potential for exposure to underwater sound (Section 4.4.11).	Potential for exposure, but no anticipated response (Section 4.51).	No anticipated effects (Section 4.8).	Potential for exposure to underwater sound (Section 4.9.1).	Potential for exposure, but no anticipated response (Section 4.10.1).	Potential for exposure to underwater sound (Section 4.11.1).	Potential for exposure to underwater sound (Section 4.12.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.13).
Aircraft Dipping Sonar	Potential for exposure to underwater sound (Section 4.4.11).	Potential for exposure, but no anticipated response (Section 4.5.1).	No anticipated effects (Section 4.8).	Potential for exposure to underwater sound (Section 4.9.1).	Potential for exposure, but no anticipated response (Section 410.1).	Potential for exposure to underwater sound (Section 4.11.1).	Potential for exposure to underwater sound (Section 4.12.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.13).
Submarine Sonar	Potential for exposure to underwater sound (Section 4.4.11).	Potential for exposure, but no anticipated response (Section 4.5.1).	No anticipated effects (Section 4.8).	Potential for exposure to underwater sound (Section 4.9.1).	Potential for exposure, but no anticipated response (Section 4.10.1).	Potential for exposure, but no anticipated response .	Potential for exposure to underwater sound (Section 4.12.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.13).
Sonobuoys								
Tonal (AN/SSQ-62)	Potential for exposure to underwater sound (Section 4.4.11).	Potential for exposure, but no anticipated response (Section 4.5.1).	No anticipated effects (Section 4.8).	Potential for exposure to underwater sound (Section 4.9.1).	Potential for exposure, but no anticipated response (Section 4.10.1).	Potential for exposure to underwater sound (Section 4.11.1).	Potential for exposure to underwater sound (Section 4.12.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.13).

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

Stressor	Biological Resource							
	Marine Mammals	**Sea Turtles**	**EFH**	**Marine Fish**	**Sea Birds**	**Marine Invertebrates**	**Marine Plants and Algae**	**National Marine Sanctuaries**
Explosive source sonobuoy (AN/SSQ-110A)	Potential for exposure to impulsive sound (Section 4.4.11).	Potential for exposure to impulsive sound (Section 4.5.2).	Potential for exposure to impulsive sound (Section 4.6).	Potential for exposure to impulsive sound (Section 4.7).	Potential for exposure, but no anticipated response (Section 4.8).	Potential for exposure to impulsive sound (Section 4.9).	Potential for exposure to impulsive sound (Section 4.10) , but no anticipated response.	Potential for exposure to impulsive sound (Section 4.11).
Listening (AN/SSQ-53 and AN/SSQ-101)	No potential exposure to sound.	No potential exposure to sound.	No anticipated effects (Section 4.6).	No potential exposure to sound.	No potential exposure to sound.	No potential exposure to sound.	No potential exposure to sound.	No potential exposure to sound.
Aircraft generated sound	Potential for exposure to underwater sound (Section 4.4.12).	Potential for exposure, but no anticipated response.	No anticipated effects (Section 4.6).	Potential for exposure, but no anticipated response.	Potential for exposure, but no anticipated response.	Potential for exposure, but no anticipated response.	Potential for exposure, but no anticipated response.	Potential for exposure, but no anticipated response.
Non-Acoustical								
Vessel Strikes	Potential for injury from vessel interaction (Section 4.4.13).	Potential for injury from vessel interaction (Section 4.5.3).	Potential for injury from vessel interaction	No anticipated injury from vessel interaction.	No anticipated injury from vessel interaction.	No anticipated injury from vessel interaction.	No anticipated injury from vessel interaction.	Potential for species injury from vessel interaction (Section 4.11).
Expended Materials								
Sonobuoy Parachutes	Potential for entanglement or ingestion (Section 4.4.13).	Potential for entanglement (Section 4.5.3).	Potential for injury from expended material.	No anticipated entanglement.	Potential for entanglement (Section 4.9.4).	No anticipated entanglement.	No anticipated entanglement.	Potential for species entanglement (Section 4.11).

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

Stressor	Biological Resource							
	Marine Mammals	**Sea Turtles**	**EFH**	**Marine Fish**	**Sea Birds**	**Marine Invertebrates**	**Marine Plants and Algae**	**National Marine Sanctuaries**
Torpedoes	Potential for direct contact (Section 4.4.13).	Potential for direct contact (Section 4.5.3).	Potential for injury from expended material.	No anticipated contact.	No anticipated contact.	No anticipated contact.	No anticipated contact.	Potential for direct contact (Section 4.11).
Torpedo Guidance Wire	Potential for entanglement (Section 4.4.13).	Potential for entanglement (Section 4.5.3).	Potential for injury from expended material.	No anticipated entanglement.	No anticipated entanglement.	No anticipated entanglement.	No anticipated entanglement.	Potential for species entanglement (Section 4.11).
Torpedo Flex Hoses	Potential for entanglement (Section 4.4.13).	Potential for entanglement (Section 4.5.3).	Potential for injury from expended material.	No anticipated entanglement	No anticipated entanglement.	No anticipated entanglement.	No anticipated entanglement.	Potential for species entanglement (Section 4.11).
Acoustical Device Countermeasures	Potential for direct contact (Section 4.4.13).	Potential for direct contact (Section 4.5.3).	Potential for injury from expended material.	No anticipated contact.	No anticipated contact.	No anticipated contact.	No anticipated contact.	Potential for species direct contact (Section 4.11).
Expendable Mobile Acoustic Training Targets	Potential for direct contact (Section 4.4.13).	Potential for direct contact (Section 4.5.3).	Potential for injury from expended material.	No anticipated contact.	No anticipated contact.	No anticipated contact.	No anticipated contact.	Potential for species direct contact (Section 4.11).

Table 2-8. Summary of Effects – Anthropogenic

Stressor	Anthropogenic Resource							
	Airspace Management	**Energy**	**Recreational Boating**	**Commercial and Recreational Fishing**	**Commercial Shipping**	**SCUBA Diving**	**Marine Mammal Watching**	**Cultural Resources**
Availability of Ocean and Airspace	No effect.	Potential for conflict with energy development (Section 4.13).	Potential for interaction with non-military vessels (Section 4.14).	Potential for area closures (Section 4.15).	Potential for interaction with non-military vessels (Section 4.16).	Potential for interaction and diver exposure to active sonar (Section 4.17).	Potential for interaction with non-military vessels (Section 4.18).	No potential exposure.
Expended Materials	No effect.	No potential exposure.	No potential exposure.	No potential exposure.	No potential exposure.	No potential exposure.	No potential exposure.	Potential for disturbance to cultural resources (Section 4.20).

3. AFFECTED ENVIRONMENT

3.1 INTRODUCTION

As stated previously, the Department of the Navy (DON) seeks to designate areas where mid- and high-frequency active sonar and improved extended echo ranging (IEER) system training, maintenance, and research, development, test, and evaluation (RDT&E) activities will occur within and adjacent to existing operating areas (OPAREAs) and to conduct those activities. The IEER system consists of an explosive source sonobuoy (AN/SSQ-110A) and an air deployable active receiver (ADAR) sonobuoy (AN/SSQ-101). This chapter describes the physical, biological, and human resources that could be affected by the Proposed Action. The resources addressed in this chapter include the following:

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

The environmental parameters provided in this chapter serve as the baseline from which to compare the potential effects of the proposed actions considered in this Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). The environmental parameters presented in this chapter correspond to the resource discussions contained in Chapter 4, Environmental Consequences.

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

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

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

3.2 BEST AVAILABLE DATA

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

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

3.2.1 Navy Marine Resource Assessment Program

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

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

3.2.2 Marine Species Density Determinations

The density estimates that were used in previous Navy environmental documents have been recently updated to provide a compilation of the most recent data and information on the occurrence, distribution, and density of marine mammals and sea turtles in the southeast

OPAREAs. The updated density estimates presented in this EIS/OEIS are derived from the *Navy OPAREA Density Estimates (NODE) for the Northeast OPAREAS* report (DON, 2007h*)*, the *NODE for the Southeast OPAREAS* report (DON, 2007i), and the *NODE for the GOMEX OPAREA* report (DON, 2007j).

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

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

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

For each region, a list of each species and how their density was derived is shown in Tables 3-1 through 3-3. For a more detailed description of the methodology involved in calculating the density estimates provided in this EIS/OEIS, please refer to each of the NODE reports (DON, 2007h, 2007p, 2007q).

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

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

Source: DON, 2007h

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

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

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

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

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

Source: DON, 2007j

3.2.3 Primary Literature

The preparers of this EIS/OEIS conducted a number of literature searches using *Science Direct*®, *High Wire Press*®, *Directory of Open Access Journals,* and the *Journal of the Acoustical Society of America-Online (JASA-O). Science Direct*® databases provide access to more than 8 million articles in over 2,000 journals focused on the physical sciences and engineering; life sciences; health sciences; and social sciences and humanities. *High Wire Press*® offers access to nearly 4.3 million articles published by approximately 1,040 journals. Topics for journals in these databases include biological, social, medical, physical sciences, and the humanities. The *Directory of Open Access Journals* includes peer-reviewed scientific and scholarly publications that are available to the public free of charge. The searches of each database included general queries in the resource areas of and potential effects to marine species (marine mammals, sea turtles, fish, and birds), socioeconomics (fisheries, tourism, boating, and diving), natural resources (oil and gas), artificial reefs, whale and dolphin watching, and cultural resources. Finally, *JASA-O* offers search capabilities for and access to articles as early as 1929. Searches for articles available from this journal included focused information on hearing capabilities and potential effects to marine species such as marine mammals, sea turtles, fish, and diving birds.

3.2.4 Government Publications

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

3.2.5 Other Data Sources

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

3.3 OCEANOGRAPHY

3.3.1 Currents

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

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

3.3.1.1 Atlantic Ocean, Offshore of the Southeastern United States

3.3.1.1.1 Currents

The Gulf Stream exerts a considerable influence on the oceanographic conditions in the VACAPES OPAREA. After the Gulf Stream separates from the East Coast in North Carolina, the current passes through the southeastern portion of the VACAPES OPAREA. In this area, the Gulf Stream is approximately 50 km (27 NM) wide and 1,000 m (3,280 ft) deep. Surface velocity ranges from 3.7 to 9.3 kilometers per hour (km/hr) (2 to 5 nautical miles per hour [NM/hr]), and temperature ranges from 25 to 28^{o}C (77 to 82^{o}F).

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

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

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

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

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

3.3.1.2 Atlantic Ocean, Offshore of the Northeastern United States

3.3.1.2.1 Currents

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

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

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

The Scotian Shelf water that enters the Gulf of Maine can vary in temperature and salinity depending upon the extent that the Labrador Slope Water (Labrador Intermediate Water) intrudes onto the shelf. During negative Atlantic Ocean Oscillation (NAO) phases, this colder, fresher slope water has spread through the basins of the Gulf of Maine and even onto Georges Bank.

The anticyclonic (clockwise) waters on and around Georges Bank as well as those flowing out of the Gulf of Maine through the Great South Channel, are part of a generally southwesterly flowing coastal current system that extends from Newfoundland to Cape Hatteras.

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

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

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

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

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

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

3.3.1.3 Eastern Gulf of Mexico

3.3.1.3.1 Currents

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

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

3.3.1.4 Western Gulf of Mexico

3.3.1.4.1 Currents

Loop current eddies are major current mechanisms in the deeper waters of the western Gulf of Mexico. Loop current eddies are rings of counterclockwise circulation that randomly break off from the main body of the Loop Current and drift slowly westward. Typically, the eddies range from 200 to 300 km (108 to 162 NM) across, with a vertical depth of 1,000 m (3,281 ft). They slowly rotate approximately 2.9 to 7.2 km/hr (1.6 to 3.9 NM/hr) and drift westward at a rate of 2 to 5 km (1 to 3 NM) per day (Oey et al., 2005). Also known as warm-core rings, the period of separation from the Loop Current ranges from 5 to 19 months, with the average period of a ring separating every 11 months (Vukovich, 2005). The rings dissipate after a few months to a year (Oey et al., 2005)

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

3.3.2 Water Characteristics

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

3.3.2.1 Atlantic Ocean, Offshore of the Southeastern United States

3.3.2.1.1 Water Characteristics

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

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

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

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

3.3.2.2 Atlantic Ocean, Offshore of the Northeastern United States

3.3.2.2.1 Water Characteristics

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

An annual phenomenon particularly important to the MAB is the formation of the “cold pool.” This mass of cooler water is found on the continental shelf in summer and stretches from the

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

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

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

3.3.2.3 Eastern Gulf of Mexico

3.3.2.3.1 Water Characteristics

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

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

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

3.3.2.4 Western Gulf of Mexico

3.3.2.4.1 Water Characteristics

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

3.3.3 Bathymetry

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

3.3.3.1 Atlantic Ocean, Offshore of the Southeastern United States

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

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

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

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

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

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

3.3.3.2 Atlantic Ocean, Offshore of the Northeastern United States

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

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

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

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

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

3.3.3.3 Eastern Gulf of Mexico

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

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

3.3.3.4 Western Gulf of Mexico

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

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

3.3.4 Bottom Types

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

3.3.4.1 Atlantic Ocean, Offshore of the Southeastern United States

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

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

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

3.3.4.2 Atlantic Ocean, Offshore of the Northeastern United States

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

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

3.3.4.3 Eastern Gulf of Mexico

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

3.3.4.4 Western Gulf of Mexico

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3.4 MARINE HABITAT

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

3.4.1 Contaminated Sediment

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

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

1. Bulk organics from sewage treatment plants, oil and grease, and other organic wastes.
2. Halogenated hydrocarbons, such as DDT and PCBs.
3. Polycyclic aromatic hydrocarbons (PAHs), usually associated with crude oil, fossil fuel burning, municipal and industrial effluents, and river discharges.
4. Heavy metals, such as iron, zinc, copper, lead, and mercury, as well as metalloids including arsenic and selenium typically from consumer products, such as batteries,

medical applications, electronics, and chemical industries. Heavy metal enrichment increases with decreasing sediment particle size.

5. Nutrients, through unwanted algal growth, oxygen depletion in overlying waters, and altered food chains or species succession (Hameedi et al., 2002).

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

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

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

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

Even though the sources of contamination may be difficult to determine, it is still important to know the possible effects of these contaminants, as they are presently in the environment.

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

3.4.2 Marine Debris

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

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

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

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

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

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

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

3.4.3 Water Quality

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

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

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

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

- Persistent organic pollutants such as PCBs, Polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polycyclic aromatic hydrocarbons (PAHs), DDT, chlordanes, halogenated cyclic hydrocarbons (HCHS), and other pesticides.
- Flame retardants: polybrominated diphenyl ethers (PBDEs) and other brominated flame retardants.
- Plasticizers: Phthalate esters.
- Surfactants: Alkyphenol ethoxylates (e.g., nonylphenoletoxylates [NPEO]).
- New-era pesticides and herbicides.

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

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

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

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

3.4.4 U.S. Military Activities

3.4.4.1 Debris

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

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

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

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

3.4.4.2 Expended Materials Used for Training

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

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

Each Sinking Exercise (SINKEX) uses as a target an excess vessel hulk that is eventually sunk during the course of the exercise. The target is an empty, cleaned, and environmentally remediated target vessel that is towed to a designated location where various ships, submarines, or aircraft use multiple types of weapons to fire shots at the target vessel. The EPA granted the DON a general permit through the Marine Protection, Research, and Sanctuaries Act to transport vessels "for the purpose of sinking such vessels in ocean waters…" (40 Code of Federal Regulations [CFR] Part 229.2). Subparagraph (a)(3) of this regulation states "all such vessel sinkings shall be conducted in water at least 12 1,000 fathoms (6,000 ft) deep and at least 93 km (50 NM) from land." According to Naval Sea Systems Command (NAVSEA), the Navy has conducted an average of 10 sink exercises per year since 1997 (NAVSEA, 2007).

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

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

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

3.5 SOUND IN THE ENVIRONMENT

This section describes the ambient sound environment comprising physical, biological, and anthropogenic sources. Figure 3-1 illustrates the frequencies of each sound source. Table 3-4 provides example intensities (source level) of various underwater sound producers.

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

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

ATOC = Acoustic Thermometry of Ocean Climate

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

ATOC = Acoustic Thermometry of Ocean Climate

3.5.1 Physical Sources of Sound

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

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

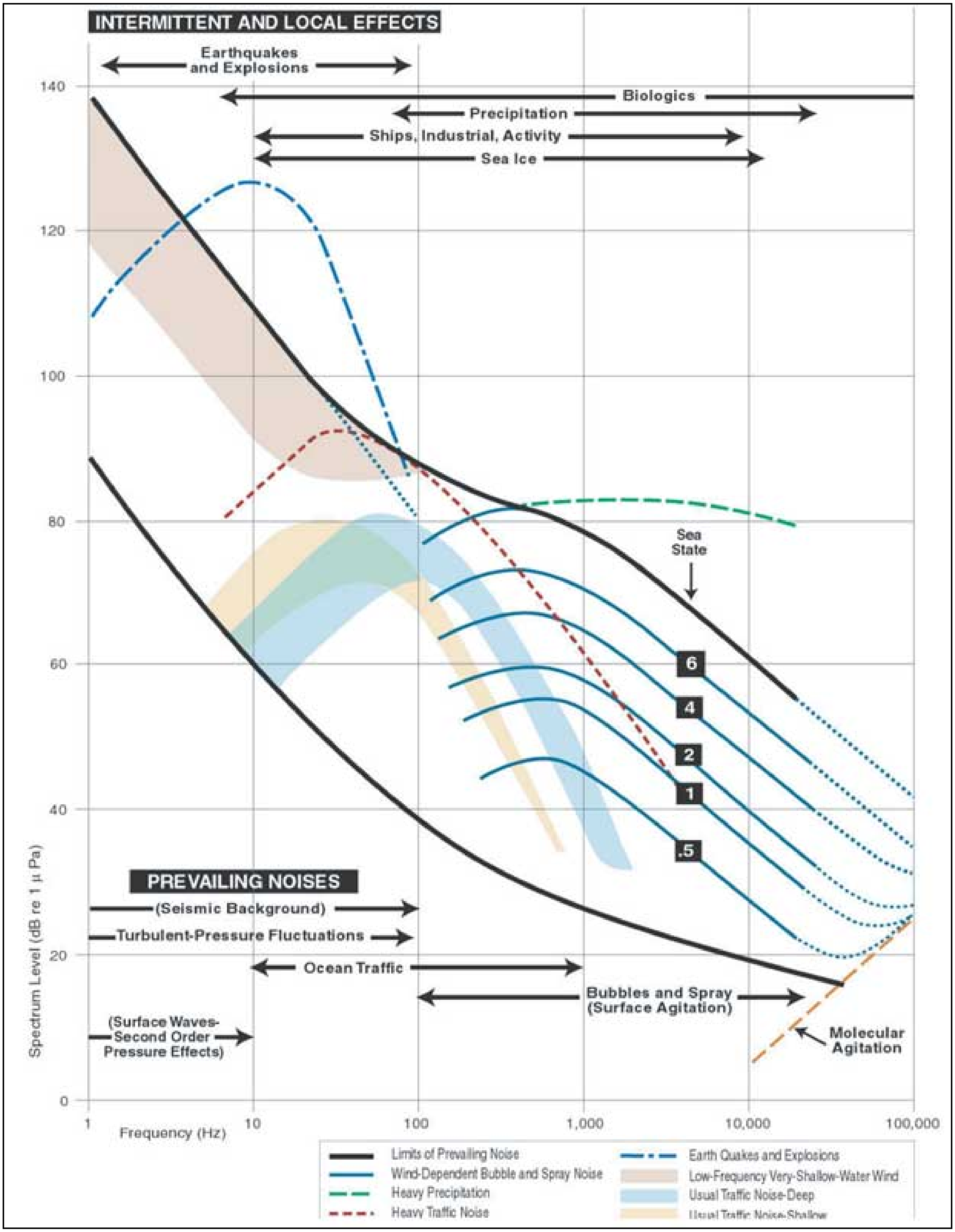

Figure 3-1. Ambient Sound Levels
(adapted from Wenz, 1962)

3.5.2 Biological Sources of Sound

Marine animals use sound to navigate, communicate, locate food, reproduce, and protect themselves underwater (Scowcroft et al., 2006). For example, reproductive activity, including courtship and spawning, accounts for the majority of sounds produced by fish. During the spawning season, croakers vocalize for many hours and often dominate the acoustic environment (Scowcroft et al., 2006). In addition, toothed whales and dolphins (odontocetes) produce a wide variety of sounds including clicks, whistles, and pulsed sounds. Marine life of various types can raise sound levels near 20 dB (e.g., dolphin whistles), in the range of a few kHz (e.g., crustaceans and fish), and in the tens to hundreds of kHz (e.g., dolphin clicks). For instance, bottlenose dolphin clicks and whistles have a dominant frequency range of 110 to 130 kHz and 3.5 to 14.5 kHz, respectively. In addition, sperm whale clicks range in frequency from 0.1 kHz to 30 kHz, with dominant energy in two bands (2 to 4 kHz and 10 to 16 kHz). Figure 3-1 illustrates the variability from all of these potential sound sources.

3.5.3 Anthropogenic Sources of Sound

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

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

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

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

3.6 MARINE MAMMALS

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

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

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

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

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

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

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

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

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

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

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

Common Name	Scientific Name	ESA Status	Possible Location
Family Phocoenidae			
Harbor porpoise	*Phocoena phocoena*		East Coast
Order Carnivora			
Suborder Pinnipedia			
Family Phocidae (true seals)			
Hooded seal	*Cystophora cristata*		East Coast
Harp seal	*Pagophilus groenlandica*		East Coast
Gray seal	*Halichoerus grypus*		East Coast
Harbor seal	*Phoca vitulina*		East Coast
Ringed seal	*Pusa hispida*		East Coast
Walrus	*Odobenus rosmarus*		East Coast
Order Sirenia			
Family Trichechidae (manatees)			
West Indian manatee	*Trichechus manatus*	Endangered	East Coast and Gulf of Mexico

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

The following sections describe marine mammal occurrence in the OPAREAs located along the north and south Atlantic coasts and east and west Gulf of Mexico.

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

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

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

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

Cetacean movements are often a reflection of the distribution and abundance of prey, and changes in cetacean distributions have been correlated with shifts in the distribution and abundance of prey. Cetacean movements have also been linked to indirect indicators of prey, such as temperature variations, sea-surface chlorophyll concentrations, and features such as bottom depth. Movements in many areas may also be related to the presence of oceanographic features, such as upwelling events or warm-core rings. The increased nutrient concentrations associated with upwelling results in areas of high primary productivity. Marine mammals have also been associated with warm-core rings that have pinched off the Gulf Stream Current. Many species, including sperm whales (*Physeter macrocephalus*), were associated with the periphery of Gulf Stream warm-core rings, probably due to the increased productivity and presence of prey species around the rings. Habitat prediction models were recently developed for 13 cetacean species of the Midwestern North Atlantic Ocean, from Cape Hatteras to Nova Scotia.

Pinnipeds do not normally range as far south as the VACAPES OPAREA. It is speculated that pinnipeds move south because the collapsed fish stocks no longer support current high populations. In addition, California sea lions may exist in the mid-Atlantic United States as feral individuals that escaped or were released from marine parks. The West Indian manatee may move into the area during warm months but would be limited primarily to nearshore waters.

3.6.1.1 Mysticetes

3.6.1.1.1 North Atlantic Right Whale (*Eubalaena glacialis*)

Description – Until recently, right whales in the North Atlantic and North Pacific were classified together as a single species referred to as the "northern right whale." Genetic data indicate that these two populations represent separate species: the North Atlantic right whale (*Eubalaena glacialis*) and the North Pacific right whale (*Eubalaena japonica*) (Rosenbaum et al., 2000). In this report, the naming convention matches that used in the NOAA stock assessment reports; therefore, "northern right whale" refers to the North Atlantic right whale species.

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

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

Approximately 350 individuals, including about 70 mature females, are thought to occur in the western North Atlantic (Kraus et al., 2005). The most recent NOAA Stock Assessment Report states that in a review of the photo-identified recapture database for October 2005, 306 individually recognized whales were known to be alive during 2001 (Waring et al., 2007). This represents a minimum population size, and no estimate of abundance with an associated coefficient of variation has been calculated for this population (Waring et al., 2007).

This species is presently declining in number (Caswell et al., 1999; Kraus et al., 2005) and is considered to be reproductively dysfunctional, which means even if human induced mortality is eliminated, the species still likely faces extinction (Reeves et al., 2001). Kraus et al. (2005) noted that the recent increases in birth rate are too small to overcome this decline.

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

Acoustics and Hearing **–** Northern right whales produce a variety of sounds, including moans, screams, gunshots, blows, upcalls, downcalls, and warbles that are often linked to specific behaviors (Matthews et al., 2001; Laurinolli et al., 2003; Vanderlaan et al., 2003; Parks et al., 2005; Parks and Tyack, 2005). Sounds can be divided into three main categories: (1) blow sounds; (2) broadband impulsive sounds; and (3) tonal call types (Parks and Clark, 2007). Blow sounds are those coinciding with an exhalation; it is not known whether these are intentional communication signals or just produced incidentally (Parks and Clark, 2007). Broadband sounds include non-vocal slaps (when the whale strikes the surface of the water with parts of its body) and the "gunshot" sound; data suggests that the latter serves a communicative purpose (Parks and Clark, 2007). Tonal calls can be divided into simple, low-frequency, stereo-typed calls and more complex, frequency-modulated, higher-frequency calls (Parks and Clark, 2007). Most of these sounds range in frequency from 0.02 to 15 kHz (dominant frequency range from 0.02 to less than 2 kHz; durations typically range from 0.01 to multiple seconds) with some sounds having multiple harmonics (Parks and Tyack, 2005). Source levels for some of these sounds have been measured as ranging from 137 to 192 dB root-mean-square (rms) re 1 μPa-m (decibels at the reference level of one micro Pascal at one meter) (Parks et al., 2005; Parks and Tyack, 2005). In certain regions (i.e., northeast Atlantic), preliminary results indicate that right whales vocalize more from dusk to dawn than during the daytime (Leaper and Gillespie, 2006).

Recent morphometric analyses of northern right whale inner ears estimates a hearing range of approximately 0.01 to 22 kHz based on established marine mammal models (Parks et al., 2004; Parks and Tyack, 2005; Parks et al., 2007). In addition, Parks et al. (2007) estimated the functional hearing range for right whales to be 15 Hz to 18 kHz. Nowacek et al. (2004) observed that exposure to short tones and down sweeps, ranging in frequency from 0.5 to 4.5 kHz, induced an alteration in behavior (received levels of 133 to 148 dB re 1 μPa-m), but exposure to sounds produced by vessels (dominant frequency range of 0.05 to 0.5 kHz) did not produce any behavioral response (received levels of 132 to 142 dB re 1 μPa-m).

Distribution – Right whales occur in sub-polar to temperate waters. The northern right whale was historically widely distributed, ranging from latitudes of 60°N to 20°N, prior to serious declines in abundance due to intensive whaling (e.g., NMFS, 2006c; Reeves et al., 2007). Northern right whales are found primarily in continental shelf waters between Florida and Nova Scotia (Winn et al., 1986). Most sightings are concentrated within five high-use areas: coastal waters of the southeastern United States. (Georgia and Florida), Cape Cod and Massachusetts bays, the Great South Channel, the Bay of Fundy, and the Nova Scotian Shelf (Winn et al., 1986; Silber and Clapham, 2001). There are documented records for this species in the Gulf of Mexico; mother/calf pairs have been sighted as far west as Texas (Zoodsma, 2006).

Most northern right whale sightings follow a well-defined seasonal migratory pattern through several consistently utilized habitats (Winn et al., 1986). It should be noted, however, that some individuals may be sighted in these habitats outside the typical time of year and that migration routes are poorly known (there may be a regular offshore component). The population migrates as two separate components, although some whales may remain in the feeding grounds throughout the winter (Winn et al., 1986; Kenney et al., 2001). Pregnant females and some juveniles migrate from the feeding grounds to the calving grounds off the southeastern United States in late fall to winter. The cow-calf pairs return northward in late winter to early spring. The majority of the right whale population leaves the feeding grounds for unknown habitats in the winter but returns to the feeding grounds coinciding with the return of the cow-calf pairs. Some individuals as well as cow-calf pairs can be seen through the fall and winter on the feeding grounds with feeding observed (e.g., Sardi et al., 2005).

During the spring through early summer, northern right whales are found on feeding grounds off the northeastern United States and Canada. Individuals may be found in Cape Cod Bay in February through April (Winn et al., 1986; Hamilton and Mayo, 1990) and in the Great South Channel east of Cape Cod in April through June (Winn et al., 1986; Kenney et al., 1995). Right whales are found throughout the remainder of summer and into fall (June through November) on two feeding grounds in Canadian waters (Gaskin, 1987 and 1991). The peak abundance is in August, September, and early October. The majority of summer/fall sightings of mother/calf pairs occur east of Grand Manan Island (Bay of Fundy), although some pairs might move to other unknown locations (Schaeff et al., 1993). Jeffreys Ledge appears to be important habitat for right whales, with extended whale residences; this area appears to be an important fall feeding area for right whales and an important nursery area during summer (Weinrich et al., 2000). The second feeding area is off the southern tip of Nova Scotia in the Roseway Basin between Browns, Baccaro, and Roseway banks (Mitchell et al., 1986; Gaskin, 1987; Stone et al., 1988; Gaskin, 1991). The Cape Cod Bay and Great South Channel feeding grounds are formally designated as critical habitats under the ESA (Silber and Clapham, 2001).

During the winter (as early as November and through March), northern right whales may be found in coastal waters off North Carolina, Georgia, and northern Florida (Winn et al., 1986). The waters off Georgia and northern Florida are the only known calving ground for western northern right whales; it is formally designated as a critical habitat under the ESA (Figure 4-1). Calving occurs from December through March (Silber and Clapham, 2001). On January 1, 2005, the first observed birth on the calving grounds was reported (Zani et al., 2005). The majority of the population is not accounted for on the calving grounds, and not all reproductively active females return to this area each year (Kraus et al., 1986a).

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

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

Critical habitat for the north Atlantic population of the North Atlantic right whale exists in portions of the JAX/CHASN and Northeast OPAREAs (Figures 3-2 and 3-3). The following three areas occur in U.S. waters and were designated by NMFS as critical habitat in June 1994 (NMFS, 2005b):

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

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

(3) Cape Cod and Massachusetts Bays.

The northern critical habitat areas serve as feeding and nursery grounds, while the southern area from the mid-Georgia coast extending southward along the Florida serves as calving grounds. The waters off Georgia and northern Florida are the only known calving ground for western North Atlantic right whales. A large portion of this habitat lies within the coastal waters of the

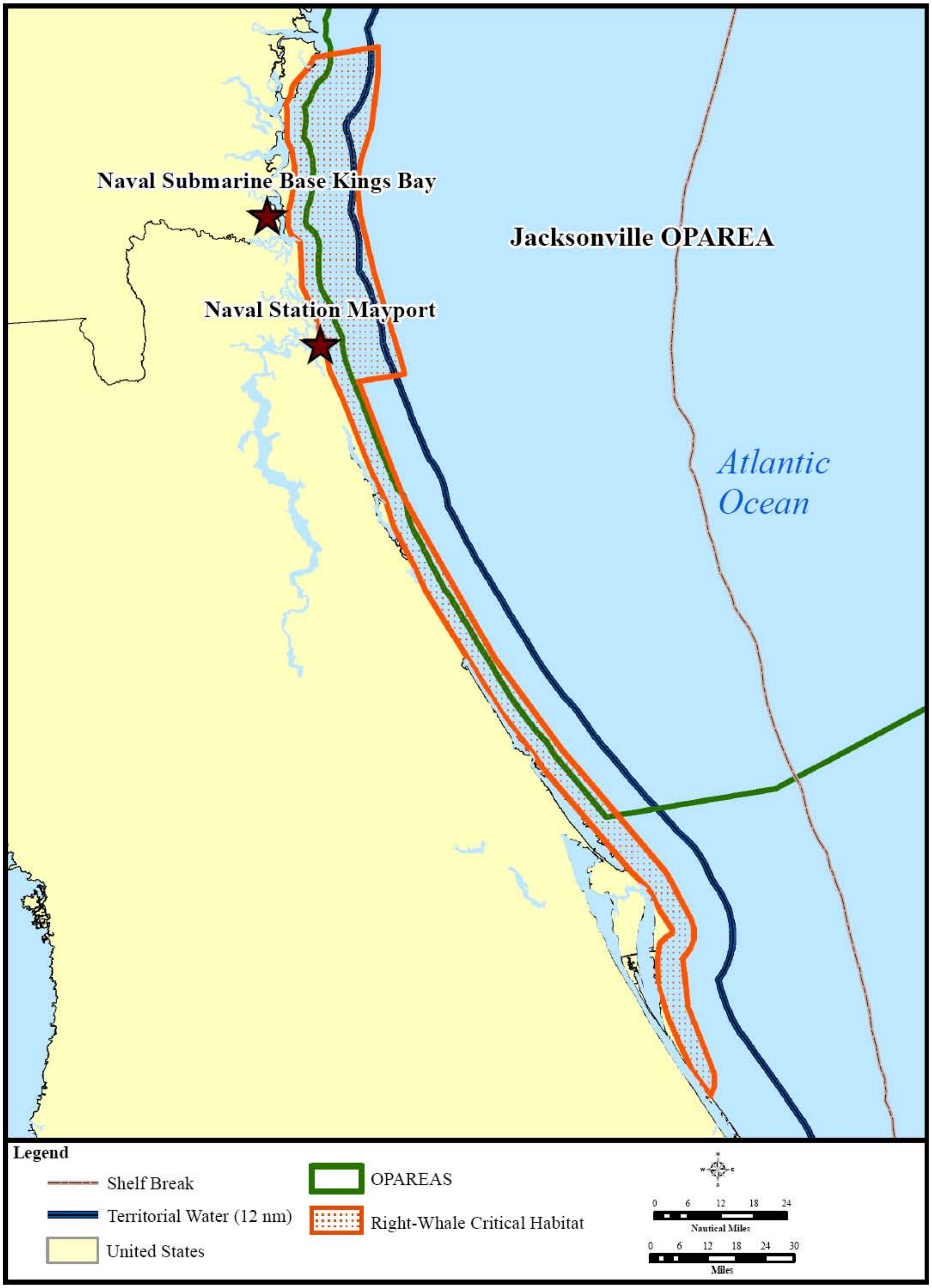

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Figure 3-2. Southeast North Atlantic Right Whale Critical Habitat

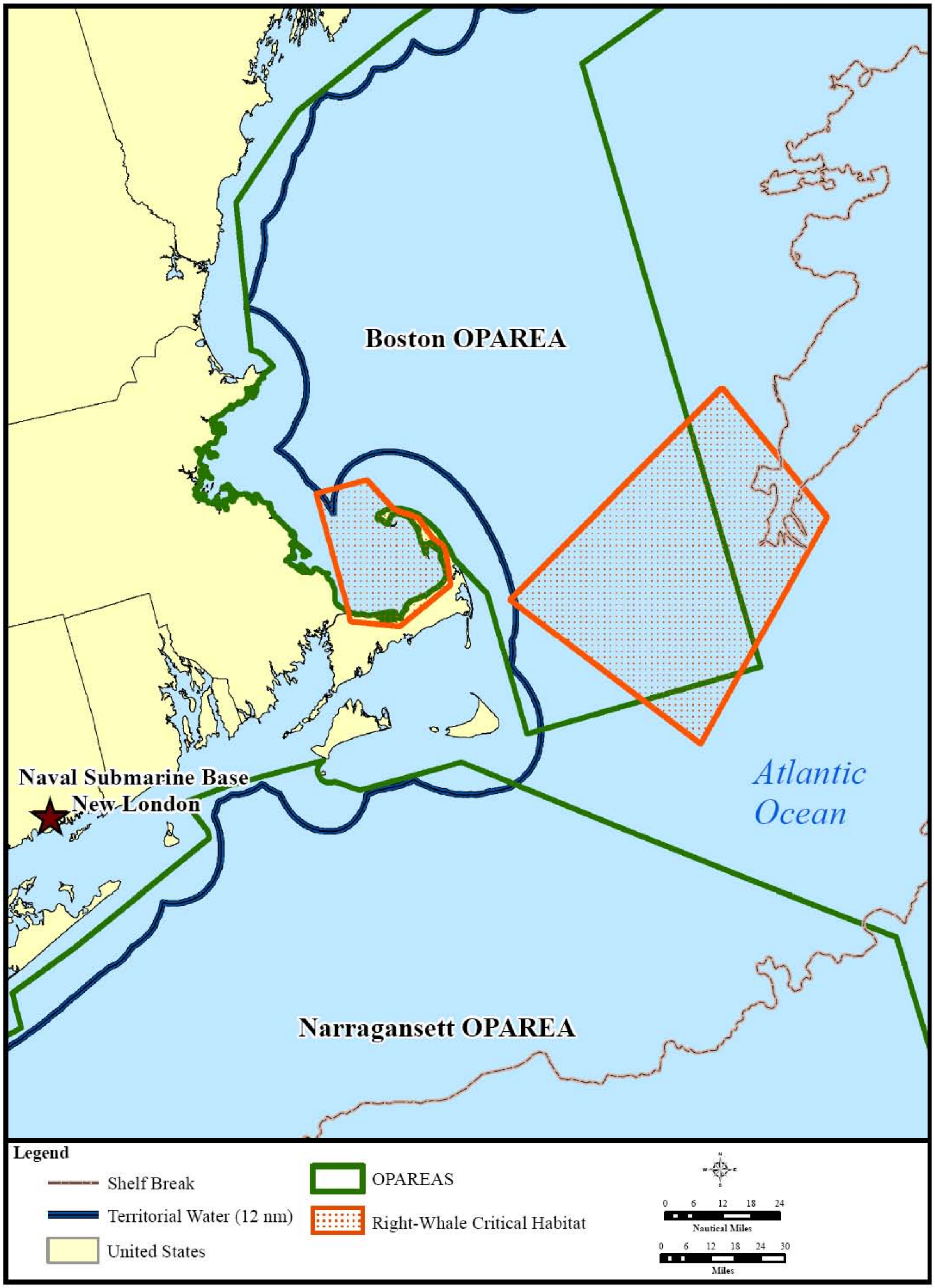

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Figure 3-3. Northeast North Atlantic Right Whale Critical Habitat

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

Atlantic Ocean, Offshore of the Southeastern United States

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

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

Atlantic Ocean, Offshore of the Northeastern United States

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

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

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

In the summertime, right whales generally occur in the continental shelf waters from the Bay of Fundy and the Scotian Shelf to the southern tip of New Jersey. The highest occurrences of right whales are found in the Bay of Fundy. Known high abundance areas are in the Grand Manan Basin (east of Grand Manan Island in the lower Bay of Fundy) and in the Roseway Basin.

In the fall, right whales are generally found in the continental shelf waters from the Bay of Fundy and Roseway Basin to Maryland. Right whales are present through at least mid-October on their feeding grounds located in Northeast.

In 1999, a Mandatory Ship Reporting System was implemented by the U.S. Coast Guard, which requires specified vessels (DON ships are exempt) to report their location, course, speed, and destination upon entering the nursery and feeding areas of the right whale. At the same time, ships receive information on locations of right whale sightings, in order to avoid collisions with the animals. In the 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.

Gulf of Mexico

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

3.6.1.1.2 Humpback Whale (Megaptera novaeangliae).

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

Status **–** Humpback whales are classified as endangered under the ESA (NMFS, 1991). An estimated 11,570 humpback whales occur in the entire North Atlantic (Stevick et al., 2003a). The International Whaling Commission (IWC) considers the "feeding stock" to be the appropriate unit for management of humpback whales in the North Atlantic (COSEWIC, 2003). Humpback whales in the North Atlantic are thought to belong to five different feeding stocks: Gulf of Maine, Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, and Iceland. There appears to be very little exchange between these separate feeding stocks (Katona and Beard, 1990). The best estimate of abundance for the Gulf of Maine Stock is 902 individuals (Waring et al., 2007); this number is based on line-transect surveys conducted in 1999 (Clapham et al., 2003). There is no designated critical habitat for this species.

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

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

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

Social calls are from 50 Hz to over 10 kHz, with dominant frequencies below 3 kHz (Silber, 1986). Female vocalizations appear to be simple; Simão and Moreira (2005) noted little complexity. The male song, however, is complex and changes between seasons. Components of the song range from under 20 Hz to 4 kHz and occasionally 8 kHz, with source levels measured between 151 and 189 dB re 1 μPa-m and high-frequency harmonics extending beyond 24 kHz (Au et al., 2001; Au et al., 2006). Songs have also been recorded on feeding grounds (Mattila et al., 1987; Clark and Clapham, 2004). The main energy lies between 0.2 and 3.0 kHz, with frequency peaks at 4.7 kHz. "Feeding" calls, unlike song and social sounds, are highly stereotyped series of narrow-band trumpeting calls. They are 20 Hz to 2 kHz, less than 1 sec in duration, and have source levels of 162 to 192 dB re 1 μPa-m. The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al., 1985; Thompson et al., 1986).

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

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

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

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

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

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

The routes taken during the southbound and northbound migrations are not known. Examination of whaling catches revealed that both northward and southward migrations are characterized by a staggering of sexual and maturational classes; lactating females are among the first to leave summer feeding grounds in the fall, followed by subadult males, mature males, non-pregnant females, and pregnant females (Clapham, 1996). On the northward migration, this order is broadly reversed, with newly pregnant females among the first to begin the return migration to high latitudes. Stevick et al. (2003b) reported sighting males 6.63 days earlier in the West Indies than females. Individuals identified on feeding grounds in the Gulf of Maine and eastern Canada arrived significantly earlier (9.97 days) than those animals identified in Greenland, Iceland, and Norway (Stevick et al., 2003b). During the northward migration, the whales are not believed to separate into discrete feeding groups until north of Bermuda (Katona and Beard, 1990).

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

Atlantic Ocean, Offshore of the Southeastern United States

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

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

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

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

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

Atlantic Ocean, Offshore of the Northeastern United States

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

In the winter, humpback whales generally occur in continental shelf waters from the southern region of the Gulf of Maine to Virginia. There occurrences of humpback whales have been recorded primarily over the continental shelf in the Gulf of Maine, in Cape Cod and Massachusetts Bays, Great South Channel, over Stellwagen Bank, Jeffreys Ledge, and Georges Bank (CETAP, 1982; Clapham et al., 1993). The occurrences south of the Gulf of Maine may represent whales in transit.

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

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

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

Gulf of Mexico

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

3.6.1.1.3 Minke Whale (*Balaenoptera acutorostrata*)

Description – Minke whales are small rorquals; adults reach lengths of just over 9 m (30 ft) (Jefferson et al., 1993). The head is pointed, and the median head ridge is prominent. The dorsal fin is tall (for a baleen whale), falcate, and located about two-thirds of the way back from the snout tip (Jefferson et al., 1993). The minke whale is dark gray dorsally, white beneath, with streaks of intermediate shades on the sides (Stewart and Leatherwood, 1985). The most distinctive light marking is a brilliant white band across each flipper of Northern Hemisphere minke whales (Stewart and Leatherwood, 1985).

Status – There are four recognized populations in the North Atlantic Ocean: Canadian East Coast, West Greenland, Central North Atlantic, and Northeastern North Atlantic (Donovan, 1991; Waring et al., 2007). Minke whales off the eastern United States are considered to be part of the Canadian East Coast stock which inhabits the area from the eastern half of the Davis Strait to 45ºW and south to the Gulf of Mexico (Waring et al., 2007). The best estimate of abundance for the Canadian East Coast stock is 2,998 individuals (Waring et al., 2007).

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

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

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

Distribution **–** Minke whales are distributed in polar, temperate, and tropical waters (Jefferson et al., 1993); they are less common in the tropics than in cooler waters. This species is more abundant in New England waters rather than the mid-Atlantic (Hamazaki, 2002; Waring et al., 2006). The southernmost sighting in recent NMFS shipboard surveys was of one individual offshore of the mouth of Chesapeake Bay, in waters with a bottom depth of 3,475 m (11,401 ft) (Mullin and Fulling, 2003).

There appears to be a strong seasonal component to minke whale distribution (Horwood, 1990). Spring and summer are periods of relatively widespread distribution, and when they are most abundant off the northeastern United States. During fall in New England waters, there are fewer minke whales, and during early winter (January and February), the species appears to be largely absent from this area (Waring et al., 2006). Minke whales off the U.S. Atlantic Coast apparently migrate offshore and southward in winter (Mitchell, 1991; Mellinger et al., 2000). Clark and Gagnon (2004) reported that based on acoustics data, minke whales move clockwise through the Caribbean from winter into spring. Minke whales are known to occur during the winter months (November through March) in the western North Atlantic from Bermuda to the West Indies (Winn and Perkins, 1976; Mitchell, 1991; Mellinger et al., 2000).

Atlantic Ocean, Offshore of the Southeastern United States

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

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

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

Atlantic Ocean, Offshore of the Northeastern United States

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

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

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

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

Gulf of Mexico

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

(Jefferson, 2006). Given the recent lack of records, the former hypothesis may be more accurate (Jefferson, 2006).

3.6.1.1.4 Bryde's Whale (*Balaenoptera edeni*)

Description – Bryde's whales can be easily confused with sei whales. Bryde's whales usually have three prominent ridges on the rostrum (other rorquals generally have only one) (Jefferson et al., 1993). The Bryde's whale's dorsal fin is tall and falcate and generally rises abruptly out of the back. Adults can be up to 16 m (51 ft) in length (Jefferson et al., 1993), but there is a smaller "dwarf" species that rarely reaches over 10 m (33 ft) in length (Jefferson, 2006).

It is not clear how many species of Bryde's whales exist but genetic analyses suggest at least two species (Rice, 1998; Kato, 2002). The taxonomy of the baleen whale group formerly known as sei and Bryde's whales is currently confused and highly controversial (see Reeves et al., 2004 for a recent review). It is clear that there are at least three species in this group, the antitropically distributed sei whale, the tropically distributed standard form Bryde's whale (probably referable to *Balaenoptera brydei*), and the "dwarf Bryde's whale" (probably referable to *Balaenoptera edeni*), which inhabits tropical waters of the Indo-Pacific (Yoshida and Kato, 1999). However, the nomenclature is still not resolved due to questions about the affinities of the type specimens of *Balaenoptera brydei* and *Balaenoptera edeni*.

Status – No abundance information is currently available for Bryde's whales in the western North Atlantic. The best estimate of abundance for the Bryde's whale in the northern GOMEX is 40 individuals (Mullin and Fulling, 2004; Waring et al., 2006). It has been suggested that the Bryde's whales found in the GOMEX may represent a resident stock (Schmidly, 1981), but there is no information on stock differentiation (Waring et al., 2006). The NOAA Stock Assessment Report provisionally considers the GOMEX population a separate stock from the Atlantic Ocean stock(s) (Waring et al., 2006).

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

Acoustics and Hearing – Bryde's whales produce low frequency tonal and swept calls similar to those of other rorquals (Oleson et al., 2003). Calls vary regionally, yet all but one of the call types have a fundamental frequency below 60 Hz. They last from one-quarter of a second to several seconds and are produced in extended sequences (Oleson et al., 2003). Heimlich et al. (2005) recently described five tone types. While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Distribution – Bryde's whales are found in subtropical and tropical waters and generally do not range north of 40° in the northern hemisphere or south of 40° in the southern hemisphere (Jefferson et al., 1993). In the Atlantic, Bryde's whales are distributed in the Gulf of Mexico and Caribbean Sea south to Cabo Frio, Brazil (Cummings, 1985; Mullin et al., 1994b). Most sightings in the GOMEX have been made in the DeSoto Canyon region and off western Florida (Davis et al., 2000b). Mead (1977) speculated that the GOMEX represents at least a portion of the range of a dispersed, resident population of Bryde's whale. There is a known concentration of this species in Venezuelan waters (Notarbartolo di Sciara, 1982). There are occasional reported sightings of this species in the rest of the Caribbean (Erdman, 1970; Mignucci-Giannoni, 1989 and 1996). Long migrations are not typical of Bryde's whales although limited shifts in distribution toward and away from the equator in winter and summer, respectively, have been observed (Cummings, 1985).

Atlantic Ocean, Offshore of the Southeastern United States

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

Atlantic Ocean, Offshore of the Northeastern United States

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

Gulf of Mexico

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

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

3.6.1.1.5 Sei Whale (*Balaenoptera borealis*)

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

***Status* –** Sei whales are listed as endangered under the ESA. The International Whaling Commission recognizes three sei whale stocks in the North Atlantic: Nova Scotia, Iceland-Denmark Strait, and Northeast Atlantic (Perry et al., 1999). The Nova Scotia Stock occurs in U.S. Atlantic waters (Waring et al., 2007). There are no recent abundance estimates for the Nova Scotia stock (Waring et al., 2007). There is no designated critical habitat for this species.

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

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

***Acoustics and Hearing* –** Sei whale vocalizations have been recorded only on a few occasions. Recordings from the North Atlantic consisted of paired sequences (0.5 to 0.8 sec, separated by 0.4 to 1.0 sec) of 10 to 20 short (4 milliseconds [msec]) frequency-modulated (FM) sweeps between 1.5 and 3.5 kHz; source level was not known (Thomson and Richardson, 1995). These mid-frequency calls are distinctly different from low-frequency tonal and frequency swept calls recently recorded in the Antarctic; the average duration of the tonal calls was 0.45 ± 0.3 sec, with an average frequency of 433 ± 192 Hz and a maximum source level of 156 ± 3.6 dB re 1 μPa-m (McDonald et al., 2005). While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

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

Sei whales spend the summer months feeding in the subpolar higher latitudes and return to the lower latitudes to calve in the winter. There is some evidence from whaling catch data of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males (Horwood, 1987; Perry et al., 1999; Gregr et al., 2000). For the most part, the location of winter breeding areas remains a mystery (Rice, 1998; Perry et al., 1999), but the winter range of most rorquals is hypothesized to be in offshore waters (Kellogg, 1928; Gaskin, 1982) and acoustic data support this hypothesis of an offshore wintering habitat (Clark, 1995).

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

Newfoundland and the Grand Banks in late summer, then back to the Scotian Shelf in fall, and offshore and south in winter (Mitchell and Chapman, 1977).

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

Atlantic Ocean, Offshore of the Southeastern United States

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

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

There are several sei whale records for the North Carolina area. This species is probably a relatively common migrant there (Lee and Socci, 1989). This whale is difficult to distinguish from Bryde's whale at sea and is frequently grouped with Bryde's whale in the sighting data. There is only one recorded sighting of a sei whale in the CHPT OPAREA. Two other individuals were recorded during the Oregon II marine mammal survey near the Onslow Bay area in January 1992, but they were not positively identified as either sei or Bryde's whales. January through April is the time of year when this species is most likely to be present in the OPAREA.

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

Atlantic Ocean, Offshore of the Northeastern United States

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

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

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

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

Gulf of Mexico

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

3.6.1.1.6 Fin Whale (*Balaenoptera physalus*)

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

Status – Fin whales are classified as endangered under the ESA (NMFS, 2006n). The NOAA Stock Assessment Report estimates that there are 2,814 individual fin whales in the U.S. Atlantic waters (Waring et al., 2007); this is probably an underestimate, however, as the data were not corrected for animals missed while diving. Incorporation of a dive correction factor brings the estimate to 5,000 to 6,000 fin whales in the waters of the U.S. Atlantic (CETAP, 1982; Kenney et al., 1997). No critical habitat is designated for this species.

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

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

Distribution **–** Fin whales are broadly distributed throughout the world's oceans, usually in temperate to polar latitudes and less commonly in the tropics (Reeves et al., 2002a). In general, fin whales are more common north of about 30ºN than they are in tropical zones (NMFS, 1998a). The overall range of fin whales in the North Atlantic extends from the Gulf of Mexico/Caribbean and Mediterranean north to Greenland, Iceland, and Norway (Gambell, 1985; NMFS, 1998a). In the western North Atlantic, the fin whale is the most commonly sighted large whale in continental shelf waters from the mid-Atlantic coast of the United States to eastern Canada (CETAP, 1982; Hain et al., 1992; Waring et al., 2004). Fin whales are the dominant large cetacean species in all seasons in the North Atlantic and have the largest standing stock and food requirements (Hain et al., 1992; Kenney et al., 1997). The fin whale is also the most common whale species acoustically detected with Navy deepwater hydrophone arrays in the North Atlantic (Clark, 1995).

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

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

Atlantic Ocean, Offshore of the Southeastern United States

Fin whales follow the typical baleen whale migratory pattern of feeding at the high latitudes in summer and fasting at low latitudes in winter. It is thought that fin whales migrate north nearshore along the coast during spring and south offshore during winter. They are common in waters of the U. S. Atlantic, principally from Cape Hatteras northward (Waring et al., 2007).

Fin whales may occur in the VACAPES OPAREA year-round. Sighting data show that these whales are distributed over the continental shelf and into waters over the continental slope, although the majority of sightings occurred on the continental shelf. Acoustic data indicate there is a substantial deep-ocean component to fin whale distribution (Clark, 1995; Waring et al., 2007).

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

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

Atlantic Ocean, Offshore of the Northeastern United States

Fin whales occur year round throughout the study area in continental shelf and rise waters. During winter, the general distribution of whales seems to shift towards the southern region of the NE OPAREAs.

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

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

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

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

Gulf of Mexico

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

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

3.6.1.1.7 Blue Whale (*Balaenoptera musculus*)

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

Status **–** Blue whales are classified as endangered under the ESA. The blue whale was severely depleted by commercial whaling in the twentieth century (NMFS, 1998b). At least two discrete populations are found in the North Atlantic. One ranges from West Greenland to New England and is centered in eastern Canadian waters; the other is centered in Icelandic waters and extends south to northwest Africa (Sears et al., 2005). There are no current estimates of abundance for the North Atlantic blue whale. However, the photo-identified individuals from the Gulf of St. Lawrence area are considered to be a minimum population estimate for the western North Atlantic stock (Waring et al., 2007); there are nearly 400 individuals based on research efforts by Sears et al. (2005). There is no designated critical habitat for this species in the North Atlantic.

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

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

Distribution – Blue whales are distributed from the ice edge to the tropics and subtropics in both hemispheres (Jefferson et al., 1993). The longest documented migration for this species is between Iceland and Mauritania at an estimated 5,200 km (2,806 NM) (Sears et al., 2005). Stranding and sighting data suggest that the blue whale's original range in the Atlantic extended south to Florida, the Gulf of Mexico, the Cape Verde Islands, and the Caribbean Sea (Yochem and Leatherwood, 1985). Blue whales rarely occur in the U.S. Atlantic Exclusive Economic Zone (EEZ) and the Gulf of Maine from August to October, which may represent the limits of their feeding range (CETAP, 1982; Wenzel et al., 1988). Sightings in the Gulf of Maine and U.S. EEZ have been made in late summer and early fall (August and October) (CETAP, 1982; Wenzel et al., 1988). Researchers using the Navy-integrated undersea surveillance system (IUSS) resources detected blue whales throughout the open Atlantic south to at least the Bahamas (Clark, 1995), suggesting that all North Atlantic blue whales may comprise a single stock (NMFS, 1998b).

Atlantic Ocean, Offshore of the Southeastern United States

There is only one record of a blue whale in the VACAPES OPAREA, a sighting made between the 3,000 m (9,840 ft) and 4,000 m (13,120 ft) isobaths during the Cetacean and Turtle Assessment Program (CETAP) surveys in April 1969. There are no records of the blue whale in the CHPT or CHAS/JAX OPAREAs.

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

Atlantic Ocean, Offshore of the Northeastern United States

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

Gulf of Mexico

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

3.6.1.2 Odontocetes

The following odontocetes have possible or confirmed occurrence along the East Coast and in the Gulf of Mexico.

3.6.1.2.1 Sperm Whale (*Physeter macrocephalus*)

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

Status – Sperm whales are classified as endangered under the ESA (NMFS, 2006e), although they are globally not in any immediate danger of extinction. The current best estimate of sperm whale abundance in the western North Atlantic Ocean is 4,804 individuals (Waring et al., 2007). The current best estimate of abundance for sperm whales in the northern GOMEX is 1,349 individuals (Mullin and Fulling, 2004). Based on mark-recapture analyses of photo-identified individuals, 398 individuals are suggested to utilize the region south of the Mississippi River Delta between the Mississippi Canyon and DeSoto Canyon along and about the 1,000 m (3,281 ft) isobath (Jochens et al., 2006). NMFS provisionally considers the sperm whale population in the northern GOMEX as a stock distinct from the U.S. Atlantic stock (Waring et al., 2006). Genetic analyses, coda vocalizations, and population structure support this (Jochens et al., 2006). Stock structure for sperm whales in the North Atlantic is not known (Dufault et al., 1999). There is no designated critical habitat for this species.

Diving Behavior – Sperm whales forage during deep dives that routinely exceed a depth of 400 m (1,312 ft) and a duration of 30 min (Watkins et al., 2002). They are capable of diving to depths of over 2,000 m (6,562 ft) with durations of over 60 min (Watkins et al., 1993). Sperm whales spend up to 83 percent of daylight hours underwater (Jaquet et al., 2000; Amano and Yoshioka, 2003). Males do not spend extensive periods of time at the surface (Jaquet et al., 2000). In contrast, females spend prolonged periods of time at the surface (1 to 5 hrs daily) without foraging (Whitehead and Weilgart, 1991; Amano and Yoshioka, 2003). An average dive cycle consists of about a 45 min dive with a 9 min surface interval (Watwood et al., 2006). The average swimming speed is estimated to be 2.5 km/hr (1.3 NM/hr) (Watkins et al., 2002). Dive descents for tagged individuals average 11 min at a rate of 1.52 m/sec (2.95 kn), and ascents average 11.8 min at a rate of 5.5 km/hr (3 NM/hr) (Watkins et al., 2002).

Acoustics and Hearing **–** Sperm whales typically produce short-duration (less than 30 ms), repetitive broadband clicks used for communication and echolocation. These clicks range in frequency from 0.1 to 30 kHz, with dominant frequencies between the 2 to 4 kHz and 10 to 16 kHz ranges (Thomson and Richardson, 1995). When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill, 1977). Codas are shared between individuals of a social unit and are considered to be primarily for intragroup communication (Weilgart and Whitehead, 1997; Rendell and Whitehead, 2004). Recent research in the South Pacific suggests that in breeding areas the majority of codas are produced by mature females (Marcoux et al., 2006). Coda repertoires have also been found to vary geographically and are categorized as dialects, similar to those of killer whales (Weilgart and Whitehead, 1997; Pavan et al., 2000). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean and those in the Pacific (Weilgart and Whitehead, 1997). Furthermore, the clicks of neonatal sperm whales are very different from those of adults. Neonatal clicks are of low-directionality, long-duration (2 to 12 ms), low-frequency (dominant frequencies around 0.5 kHz) with estimated source levels between 140 and 162 dB re 1 μPa-m rms, and are hypothesized to function in communication with adults (Madsen et al., 2003). Source levels from adult sperm whales' highly directional (possible echolocation), short (100 μs) clicks have been estimated up to 236 dB re 1 μPa-m rms (Møhl et al., 2003). Creaks (rapid sets of clicks) are heard most-frequently when sperm whales are engaged in foraging behavior in the deepest portion of their dives with intervals between clicks and source levels being altered during these behaviors (Miller et al., 2004; Laplanche et al., 2005). It has been shown that sperm whales may produce clicks during 81 percent of their dive period, specifically 64 percent of the time during their descent phases (Watwood et al., 2006). In addition to producing clicks, sperm whales in some regions like Sri Lanka and the Mediterranean Sea have been recorded making what are called trumpets at the beginning of dives just before commencing click production (Teloni, 2005). The estimated source level of one of these low intensity sounds (trumpets) was estimated to be 172 dB_{pp} re 1 μPa-m (Teloni et al., 2005).

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

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

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

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

Atlantic Ocean, Offshore of the Southeastern United States.

In the VACAPES OPAREA, sperm whales are distributed along the continental shelf edge and over the continental slope. There have also been occasional sightings on the continental shelf. During the winter, spring, and fall, their occurrence in the VACAPES OPAREA is expected in the area of the continental shelf edge between the 200 m (656 ft) and the 4,000 m (13,120 ft) isobaths. In the summer, the highest likelihood of encountering this species, begins at the 200m (656 ft) isobath and extends past the eastern boundary of the VACAPES OPAREA (DON, 2001a; 2007a).

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

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

Atlantic Ocean, Offshore of the Northeastern United States

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

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

Gulf of Mexico

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

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

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

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

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

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

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

Pygmy sperm whales have a shark-like head with a narrow, underslung lower jaw (Jefferson et al., 1993). The flippers are set high on the sides near the head. The small falcate dorsal fin of the pygmy sperm whale is usually set well behind the midpoint of the back (Jefferson et al., 1993). The dwarf sperm whale is similar in appearance to the pygmy sperm whale, but it has a larger dorsal fin that is generally set nearer the middle of the back (Jefferson et al., 1993). The dwarf sperm whale also has a shark-like profile but with a more pointed snout than the pygmy sperm whale. Pygmy and dwarf sperm whales reach body lengths of around 3 and 2.5 m (10 to 8 ft), respectively (Plön and Bernard, 1999).

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

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

There is currently no information to differentiate the Northern GOMEX stock from the Atlantic stock(s) (Waring et al., 2006). The best estimate of abundance for *Kogia* spp. in the GOMEX is 742 individuals (Mullin and Fulling, 2004; Waring et al., 2006). A separate estimate of abundance for the pygmy sperm whale or the dwarf sperm whale cannot be calculated due to uncertainty of species identification at sea (Waring et al., 2006).

Diving Behavior – Willis and Baird (1998) reported that whales of the genus *Kogia* make dives of up to 25 min. Dive times ranging from 15 to 30 min (with 2 min surface intervals) have been recorded for a dwarf sperm whale in the Gulf of California (Breese and Tershy, 1993). Median dive times of around 11 min are documented for *Kogia* (Barlow, 1999). A satellite-tagged pygmy sperm whale released off Florida was found to make long nighttime dives, presumably indicating foraging on squid in the deep scattering layer (DSL) (Scott et al., 2001). Most sightings of *Kogia* are brief; these whales are often difficult to approach and they sometimes actively avoid aircraft and vessels (Würsig et al., 1998).

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

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

Distribution – *Kogia* species apparently have a worldwide distribution in tropical and temperate waters (Jefferson et al., 1993). In the western Atlantic Ocean, *Kogia* spp. (specifically, the pygmy sperm whale) are documented as far north as the northern Gulf of St. Lawrence (Measures et al., 2004) and as far south as Colombia (dwarf sperm whale) (Muñoz-Hincapié et al., 1998). *Kogia* spp. generally occur along the continental shelf break and over the continental slope in the GOMEX (Baumgartner et al., 2001; Fulling and Fertl, 2003).

Atlantic Ocean, Offshore of the Southeastern United States

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

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

Atlantic Ocean, Offshore of the Northeastern United States

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

Gulf of Mexico

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

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

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

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

3.6.1.2.3 Beluga Whale (*Delphinapterus leucas*)

Description – The beluga or white whale, is a medium-sized whale, robust in body shape. Sexual dimorphism is apparent, with females attaining a maximum body length of 4.1 m (13.5 ft), while most adult males are less than 5.5 m (18.0 ft) and weigh upwards of 1,500 kg (3,307 lb) (Jefferson et al., 1993). The beluga has a small bulbous head and a very short beak. Instead of a dorsal fin, this species has a prominent dorsal ridge (1 to 3 cm in height) that runs along the midline of the back. The beluga has more head and neck flexibility than other cetaceans since the cervical (neck) vertebrae are not fused. At birth, the calf is a dark slate gray to brownish gray, whitening as they age, reaching the pure white stage between 5 and 12 years of age (Brodie, 1989). Belugas could be confused with narwhals (*Monodon monoceros*), which overlap with their range, and adult Risso's dolphins, which are superficially similar in appearance (Reeves and Katona, 1980).

Status – There are well over 100,000 belugas in the circumpolar Arctic. Stocks are defined primarily on the basis of summering grounds, most of which are centered on estuaries where animals molt (Reeves et al., 2002b). There are approximately 12 North American beluga management units (Brown Gladden et al., 1999). In stock assessment reports, NMFS does not include beluga whales among those species having populations or stocks in the Western North Atlantic Ocean or in the Gulf of Mexico.

Diving Behavior – Belugas are not generally thought of as deep-diving marine mammals, with typical dives to approximately 20 m (66 ft). However, they are capable of diving to extreme depths; free-ranging belugas have been documented to dive to maximum depths of 350 m (1,148 ft) (Martin and Smith, 1992). Under experimental conditions, a trained beluga repeatedly dove to 400 m (1,312 ft) with ease, and even dove to a depth of 647 m (2,123 ft) (Ridgway, 1986). The maximum dive duration recorded for the beluga is 25 min (Martin et al., 1998).

Acoustics and Hearing – Belugas make such an array of sounds that nineteenth century sailors and explorers of the high Arctic named them "sea canaries." Scientists have documented as many as 50 call types (O'Corry-Crowe, 2002). Whistle and pulsed calls are typically made at frequencies between 0.4 and 20 kHz (Thomson and Richardson, 1995). Belugas have demonstrated echolocation abilities with frequencies of 40 to 60 kHz, but has been known to go up to 100 to 120 kHz (Au et al., 1985); the source level is 206 to 225 dB re 1 µPa-m, peak-to-peak (Thomson and Richardson, 1995).

This species has good high-frequency hearing, with high sensitivities from 32 kHz to 108 kHz (Klishin et al., 2000). Hearing extends at least as low as 40 to 75 Hz, however, sensitivity at these low frequencies appears to be poor (Awbrey et al., 1988; Klishin et al., 2000). Ridgway et al. (2001) determined that beluga hearing is not attenuated at depth (which means that zones of audibility occur throughout the depths to which these whales dive). Temporary threshold shifts (TTS) of 6 to 7 dB were observed in the beluga after exposure to single impulses with peak pressure of 160 kilopascal (kPa) (23 psi) and total energy flux of 186 dB re 1 µPa-m (Finneran et al., 2002). After exposures to intense tones (0.4, 3, 10, 20, and 75 kHz), belugas exhibited altered behavior at 180 to 196 dB re 1 µPa-m; TTS was induced at source levels generally between 192 and 201 dB re 1 µPa-m (Schlundt et al., 2000).

Distribution – The beluga has a nearly circumpolar distribution, being found in arctic and subarctic waters along the northern coasts of Canada, Alaska, Russia, Norway, and Greenland (Gurevich, 1980). Distribution is centered mainly between 50ºN and 80ºN (Reeves et al., 2002b). The St. Lawrence estuary is at the southern limit of the distribution of this species (Lesage and Kingsley, 1998). Long migrations (thousands of kilometers) are a normal part of beluga behavior in some locales (Reeves, 1990). These movements are probably a response to a combination of coastal ice formations, offshore feeding opportunities, and the affinity for estuarine conditions during the summer calving period (Brodie, 1989).

Atlantic Ocean, Offshore of the Southeastern United States

The beluga whale is not expected to occur within the western North Atlantic Ocean offshore of the southeastern United States.

Atlantic Ocean, Offshore of the Northeastern United States

The beluga is extralimital in the Northeast OPAREAs at all times of the year. The southernmost record is from Cape May, NJ (Reeves and Katona, 1980; CETAP, 1982; Reeves, 1990). Overstrom et al. (1991) documented the occurrence and activities of a solitary beluga that inhabited Long Island Sound from February 1985 until its death in May 1986. Most of the individuals found off the northeastern United States probably originate from the St. Lawrence River population, which winters in the Gulf of St. Lawrence or along the open coasts of Labrador and Newfoundland (Reeves and Katona, 1980). There is no direct evidence, however, to support this assumption regarding the origination of these stray individuals (Reeves, 1990; Lesage and Kingsley, 1998).

Gulf of Mexico

The beluga whale is not expected to occur within the Gulf of Mexico.

3.6.1.2.4 Beaked Whales (various species)

Description – Based upon available data, six beaked whales are known to occur in the western North Atlantic Ocean: Cuvier's beaked whales, northern bottlenose whales, and four members of the genus *Mesoplodon* (True's, Gervais', Blainville's, and Sowerby's beaked whales), which, with the exception of *Ziphius* and *Hyperoodon*, are nearly indistinguishable at sea (Coles, 2001). Four have documented occurrence in the GOMEX, including Cuvier's beaked whale and three members of the genus *Mesoplodon* (Gervais', Blainville's, and Sowerby's beaked whales). The Smithsonian Institution is currently developing an online system to facilitate species-level identification of stranded individuals (Allen et al., 2005). They are presented in one summary due to the paucity of biological information available for each species and the difficulty of species-level identifications for *Mesoplodon* species. *Mesoplodon* spp. are also often termed 'mesoplodonts.'

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

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

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

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

Gervais' beaked whale males reach lengths of at least 4.5 m, while females reach at least 5 m (17 ft) (Jefferson et al., 1993). These beaked whales are dark gray dorsally with a light-gray belly.

Adult males have one tooth evident per side, one-third of the distance from the snout tip to the corner of the mouth (Jefferson et al., 1993).

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

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

***Status* –** The best estimate of mesoplodont and Cuvier's beaked whale abundance combined in the western North Atlantic is 3,513 individuals (Waring et al., 2007). A recent study of global phylogeographic structure of Cuvier's beaked whales suggested that some regions show a high level of differentiation (Dalebout et al., 2005). However, it was not possible for this study to discern finer-scale population differences within the North Atlantic (Dalebout et al., 2005). Using mark-recapture techniques, 133 northern bottlenose whales have been estimated to utilize the Gully (Nova Scotia) (Gowans et al., 2000). It is not possible to obtain any additional species-specific estimates due to the difficulty of individual identification at sea.

The best estimate of abundance for the Cuvier's beaked whale in the northern GOMEX is 95 individuals (Mullin and Fulling, 2004; Waring et al., 2006). The best estimate of abundance for *Mesoplodon* spp. in the northern GOMEX is 106 individuals (Mullin and Fulling, 2004; Waring et al., 2006). It is not possible to obtain species-specific estimates due to the difficulty of identifying specimens at sea. The GOMEX Cuvier's beaked whale and *Mesoplodon* spp. populations are provisionally being considered as separate stocks for management purposes although there is currently no information to differentiate these stocks from the Atlantic Ocean stock(s) (Waring et al., 2006).

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

(164 ft) of the water column. Both species make a series of shallow dives after a deep foraging dive to recover from oxygen debt; average intervals between foraging dives have been recorded as 63 min for Cuvier's beaked whales and 92 min for Blainville's beaked whales (Tyack et al., 2006).

Acoustics and Hearing – Sounds recorded from beaked whales are divided into two categories: whistles and pulsed sounds (clicks); whistles likely serve a communicative function and pulsed sounds are important in foraging and/or navigation (Johnson et al., 2004; Madsen et al., 2005b) (MacLeod and D'Amico, 2006; Tyack et al., 2006). Whistle frequencies are about 2 to 12 kHz, while pulsed sounds range in frequency from 300 Hz to 135 kHz; however, as noted by MacLeod and D'Amico (2006), higher frequencies may not be recorded due to equipment limitations. Whistles recorded from free-ranging Cuvier's beaked whales off Greece ranged in frequency from 8 to 12 kHz, with an upsweep of about 1 sec (Manghi et al., 1999), while pulsed sounds had a narrow peak frequency of 13 to 17 kHz, lasting 15 to 44 sec in duration (Frantzis et al., 2002). Short whistles and chirps from a stranded subadult Blainville's beaked whale ranged in frequency from slightly less than 1 to almost 6 kHz (Caldwell and Caldwell, 1971a).

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

Recent studies incorporating DTAGs (miniature sound and orientation recording tag) attached to Blainville's beaked whales in the Canary Islands and Cuvier's beaked whales in the Ligurian Sea recorded high-frequency echolocation clicks (duration: 175 μs for Blainville's and 200 to 250 μs for Cuvier's) with dominant frequency ranges from about 20 to over 40 kHz (limit of recording system was 48 kHz) and only at depths greater than 200 m (656 ft) (Johnson et al., 2004; Madsen et al., 2005b; Zimmer et al., 2005; Tyack et al., 2006). The source level of the Blainville's beaked whales' clicks were estimated to range from 200 to 220 dB re 1 μPa-m peak-to-peak (Johnson et al., 2004), while they were 214 dB re 1 μPa-m peak-to-peak for the Cuvier's beaked whale (Zimmer et al., 2005).

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

Distribution – Cuvier's beaked whales are the most widely distributed of the beaked whales and are present in most regions of all major oceans (Heyning, 1989; MacLeod et al., 2006). This species occupies almost all temperate, subtropical, and tropical waters, as well as subpolar and even polar waters in some areas (MacLeod et al., 2006).

Northern bottlenose whales are restricted to northern latitudes of the North Atlantic. This species is routinely found in the Gully, a submarine canyon off the coast of Nova Scotia, near the southern and western limits of the species' range (Gowans et al., 2000).

The ranges of most mesoplodonts are poorly known. In the western North Atlantic and Gulf of Mexico, these animals are known mostly from strandings (Mead, 1989a; MacLeod, 2000a; MacLeod et al., 2006). Blainville's beaked whales are thought to have a continuous distribution throughout tropical, subtropical, and warm-temperate waters of the world's oceans; they occasionally occur in cold-temperate areas (MacLeod et al., 2006). The Gervais' beaked whale is restricted to warm-temperate and tropical Atlantic waters with records throughout the Caribbean Sea (MacLeod et al., 2006). The Gervais' beaked whale is the most frequently stranded beaked whale in the Gulf of Mexico (Würsig et al., 2000). The Sowerby's beaked whale is endemic to the North Atlantic; this is considered to be more of a temperate species (MacLeod et al., 2006). The stranding on the Gulf coast of Florida is considered to be extralimital (Jefferson and Schiro, 1997; MacLeod et al., 2006). In the western North Atlantic, confirmed strandings of True's beaked whales are recorded from Nova Scotia to Florida and also in Bermuda (MacLeod et al., 2006). There is also a sighting made southeast of Hatteras Inlet, North Carolina (note that the latitude provided by Tove is incorrect) (Tove, 1995).

The continental shelf margins from Cape Hatteras to southern Nova Scotia were recently identified as known key areas for beaked whales in a global review by MacLeod and Mitchell (2006). Macleod and Mitchell (2006) described the northern GOMEX continental shelf margin as "a key area" for beaked whales.

Atlantic Ocean, Offshore of the Southeastern United States

Five species of beaked whales may occur in the waters off the southeastern United States including Cuvier's beaked, Gervais' beaked, Blainville's beaked, and True's beaked. The Sowerby's beaked whale is endemic to the North Atlantic and is considered to be more of a temperate species (MacLeod et al., 2006). The single stranding record from the Gulf coast of Florida is considered to be extralimital (Jefferson and Schiro, 1997; MacLeod et al., 2006). In the VACAPES, CHPT, and JAX/CHASN OPAREAs, beaked whale occurrence is assumed to be the same for all seasons and to primarily occur from the shelf break to the deeper offshore waters.

Atlantic Ocean, Offshore of the Northeastern United States

To determine beaked whale occurrence for the NE OPAREAs, information regarding unidentified beaked whales, Blainville's beaked whale, Cuvier's beaked whale, Sowerby's beaked whale, and northern bottlenose whale was pooled. Insufficient data are available for Gervais' beaked whale and True's beaked whale. In general, beaked whales occur in deeper waters off the continental slope. Overall, summer has the highest occurrences of beaked whales. During the wintertime, beaked whales may sporadically occur, extending from the continental slope to those deeper waters over the continental rise, from the southern flank of Georges Bank south to the VACAPES OPAREA. Stranding data suggest that beaked whales may occur as far north as southern Maine.

In the springtime, beaked whales may occur over the continental slope, in waters from the Scotian Shelf, through the southern regions of Narragansett Bay and Atlantic City OPAREAS.

In the summer, the general occurrence of beaked whales extends from waters over the continental slope to those deeper waters over the continental rise, from Browns Bank south to the VACAPES OPAREA. During this season beaked whales may occur in greater concentrations outside the Northeast Channel, along the southern flank of Georges Bank, southeastern region of Narragansett Bay OPAREA, and in the southwestern region of the NE OPAREAs.

Lastly, in the fall, beaked whales may sporadically occur, extending from the continental slope to those deeper waters over the continental rise, from outside the Northeast Channel to the southern map extent, and the western region of the Narragansett Bay OPAREA, just north of the Hudson Canyon.

Gulf of Mexico

Beaked whales are considered to be a deep water species. There are a handful of beaked whale sightings on the continental shelf off Mississippi and Alabama made during the Esher et al. (1992) surveys. Many surveys have taken place on the continental shelf in this region, yet this is the only survey program that recorded beaked whales. Two of the beaked whale sightings reported during the fall in the near vicinity of the shelf break are suspect with group sizes of 6 and 10 individuals, respectively. These are much larger group sizes than are typically reported. There is also one beaked whale sighting off Mobile Bay, Alabama, in waters with a bottom depth of approximately 30 m (98 ft). This could be a sighting of an individual which may have later stranded.

In the winter, sightings are in waters seaward of the shelf break, particularly over the continental slope. This is a time of year with both decreased survey effort and high sea states that can make sighting cetaceans (especially beaked whales) difficult. Occurrence should be expected in deep waters throughout the entire northern GOMEX.

The spring is the season with the most survey effort; sightings are throughout the deep waters of the northern GOMEX. Beaked whales are anticipated to occur throughout deep waters of the Gulf. The area of greatest concentration may occur over the abyssal plain at the southern edge of the GOMEX. Other patches of high concentrations may occur in waters over the Florida Escarpment and in the region influenced by the Tortugas Gyre.

In the summer, sightings are throughout most of the deep waters of the northern GOMEX. There may be patchy occurrence primarily in the central and eastern GOMEX, particularly in the Mississippi Canyon region and around parts of the Florida Escarpment. The areas of greatest concentration are in waters over the continental slope and abyssal plain south of Louisiana.

Fall is a season with a lesser amount of recorded sightings, likely due to decreased survey effort and high Beaufort sea states that can make sighting cetaceans difficult during this time of year. Occurrence should be expected in deep waters throughout the entire northern GOMEX.

3.6.1.2.5 Rough-toothed Dolphin (*Steno bredanensis*)

Description – This is a relatively robust dolphin with a cone-shaped head; it is the only one with no demarcation between the melon and beak (Jefferson et al., 1993). The "forehead" slopes smoothly from the blowhole onto the long, narrow beak (Reeves et al., 2002b). The rough-toothed dolphin has large flippers that are set far back on the sides and a prominent falcate dorsal fin (Jefferson et al., 1993). The body is dark gray with a prominent narrow dorsal cape that dips slightly down onto the side below the dorsal fin. The lips and much of the lower jaw are white, and many individuals have white scratches and spots on the body from cookie-cutter sharks and other rough-toothed dolphins. The rough-toothed dolphin reaches 2.8 m (9.2 ft) in length (Jefferson et al., 1993).

Status – No abundance estimate is available for rough-toothed dolphins in the western North Atlantic. The best estimate of abundance for rough-toothed dolphins in the northern GOMEX is 2,223 individuals (Fulling et al., 2003; Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior –Rough-toothed dolphins may stay submerged for up to 15 min (Miyazaki and Perrin, 1994) and are known to dive as deep as 150 m (492 ft) (Manire and Wells, 2005).

Acoustics and Hearing – The rough-toothed dolphin produces a variety of sounds, including broadband echolocation clicks and whistles. Echolocation clicks (duration less than 250 microseconds [µsec]) typically have a frequency range of 0.1 to 200 kHz, with a dominant frequency of 25 kHz (Miyazaki and Perrin, 1994; Yu et al., 2003; Chou, 2005). Whistles (duration less than 1 sec) have a wide frequency range of 0.3 to greater than 24 kHz but dominate in the 2 to 14 kHz range (Miyazaki and Perrin, 1994; Yu et al., 2003).

Auditory evoked potential (AEP) measurements were performed on six individuals involved in a mass stranding event on Hutchinson Island, Florida in August 2004 (Cook et al., 2005). The rough-toothed dolphin can detect sounds between 5 and 80 kHz and is most likely capable of detecting frequencies much higher than 80 kHz (Cook et al., 2005).

Distribution – Rough-toothed dolphins are found in tropical to warm-temperate waters globally, rarely ranging north of 40°N or south of 35°S (Miyazaki and Perrin, 1994). Rough-toothed dolphins occur in low densities throughout the eastern tropical Pacific where surface water temperatures are generally above 25°C (77°F) (Perrin and Walker, 1975). This species is not a commonly encountered species in the areas where it is known to occur (Jefferson, 2002c). Not many records for this species exist from the western North Atlantic, but they indicate that this species occurs from Virginia south to Florida, the Gulf of Mexico, the West Indies, and along the northeastern coast of South America (Leatherwood et al., 1976; Würsig et al., 2000). Two separate mass strandings of rough-toothed dolphins occurred in the Florida Panhandle during December 1997 and 1998 (Rhinehart et al., 1999). Additionally, a mass stranding of a minimum of 70 individuals occurred off the Florida Keys March 2, 2005 (Banick and Borger, 2005).

Atlantic Ocean, Offshore of the Southeastern United States

Rough-toothed dolphins may occur in waters off the shelf break in the VACAPES, CHPT, and JAX/CHASN OPAREA based on their preference for deep-waters. A few strandings and two sightings of rough-toothed dolphins have been recorded in or near the VACAPES OPAREA. It is assumed that rough-toothed dolphin could occur year round. During the winter, the rough-toothed dolphin's is generally expected in warmer waters, so their occurrence may follow the western edge of the standard deviation of the Gulf Stream.

Atlantic Ocean, Offshore of the Northeastern United States

The rough-toothed dolphin is extralimital at all times of the year in the NE OPAREAs based on the warm-water preference of this species. There are only two confirmed sighting of this species, which occurred in June and September 1979.

Gulf of Mexico

Rough-toothed dolphins occur in both oceanic and continental shelf waters in the northern Gulf of Mexico (Fulling et al., 2003; Mullin and Fulling, 2004). Rough-toothed dolphins were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico between 1992 and 1998 (Hansen et al., 1994; Mullin and Hoggard, 2000).

In the winter, there is only one sighting record available for this species during this season. Two stranded and rehabilitated individuals were released with tags in late March 1998 off Sarasota, Florida and remained in the northeastern GOMEX (Wells et al., 1999). This is a time of year that is typically data deficient for deep water cetaceans in the Gulf because there is little survey effort. It is also the time when Beaufort sea states are highest which makes detection of species much more difficult (Mullin et al., 2004).

In the spring, rough-toothed dolphins occur in the deeper waters seaward of the shelf break, including over the abyssal plain. Sighting concentrations are predicted to be inshore of the Florida Escarpment and over the continental slope south of Louisiana.

In the summer, the greatest concentration of this species is suggested to be over the abyssal plain near the central edge of the study area. Other concentrations are predicted on the west Florida Shelf and in the Mississippi Canyon region. This is the only time of the year that occurrence is also anticipated in continental shelf waters off southern Texas. The occurrence patterns for this season likely reflect the most realistic picture for the species since both oceanic and shelf occurrences are predicted.

In the fall, two sighting records are available for rough-toothed dolphins during this season. The predicted occurrence is in the Mississippi Canyon region. It should be noted that this is a time of year when Beaufort sea states are high which makes detection of species much more difficult (Mullin et al., 2004).

3.6.1.2.6 Bottlenose Dolphin (*Tursiops truncatus*)

Description – Bottlenose dolphins are large and robust, varying in color from light gray to charcoal. The genus *Tursiops* is named for its short, stocky snout that is distinct from the melon (Jefferson et al., 1993). The dorsal fin is tall and falcate. There are striking regional variations in body size, with adult lengths from 1.9 to 3.8 m (6.2 to 12.5 ft) (Jefferson et al., 1993).

The taxonomy of the genus *Tursiops* has been debated for decades and continues to be contested. Two *Tursiops* species are currently recognized: the bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) (Rice, 1998; IWC, 2005). It is likely that additional species-level taxonomy will be recognized based on future genetic and morphometric analyses (Natoli et al., 2004). Indo-Pacific bottlenose dolphins are found in coastal Indo-Pacific tropics (Curry and Smith, 1997), while all other forms are considered to be bottlenose dolphins.

Scientists currently recognize several nearshore (coastal) and an offshore morphotype or form of bottlenose dolphins, which are distinguished by external and cranial morphology, hematology, diet, and parasite load (Duffield et al., 1983; Hersh and Duffield, 1990; Mead and Potter, 1995; Curry and Smith, 1997). There is also a clear genetic distinction between nearshore and offshore bottlenose dolphins worldwide (Curry and Smith, 1997; Hoelzel et al., 1998). It has been suggested that the two forms should be considered different species (Curry and Smith, 1997; Kingston and Rosel, 2004), but no official taxonomic revisions have yet been made.

Status – Two forms of bottlenose dolphins are recognized in the western North Atlantic Ocean: nearshore (coastal) and offshore morphotypes. Each morphotype is referred to as a stock by NMFS. There is a complex mosaic that comprises the coastal stock (NMFS-SEFSC, 2001; Waring et al., 2007). NMFS recognizes the mosaic to be seven discrete management units (MU) that have distinct spatial and temporal components: Northern Migratory MU, Northern North Carolina MU, Southern North Carolina MU, South Carolina MU, Georgia, Northern Florida MU, and Central Florida MU (Waring et al., 2007). Three MUs occur during the summer (May through October) in the CHPT OPAREA: Northern Migratory, Northern North Carolina, and Southern North Carolina. During the winter (November through April), the Northern Migratory, Northern North Carolina, and Southern North Carolina MUs overlap along the coast of North Carolina and are referred to as the Winter Mixed MU (Waring et al., 2007).

NMFS provides abundance estimates for each MU by season. During the summer, the best estimates of abundance for the Northern Migratory, Northern North Carolina, and Southern North Carolina MUs are 17,466, 7,079, and 3,786 individuals, respectively (Waring et al., 2007). During the winter, an estimated 16,913 individuals make up the Winter Mixed MU (Waring et al., 2007). The MUs making up the coastal stock are considered depleted under the MMPA (Waring et al., 2007).

From 1987 to 1988, the annual number of bottlenose dolphins stranded along the eastern United States increased tenfold relative to previous years (MMC, 2002). This die-off started in the mid-Atlantic region, moved northward and then southward to encompass nearly the entire eastern seaboard from New Jersey to central Florida (MMC, 2002). The pattern of strandings was considered evidence for a single coastal migratory stock along the eastern United States. Analysis of the event suggested that more than half of this stock may have died during the event (MMC, 2002). In April 2006, NMFS published a draft Bottlenose Dolphin Take Reduction Plan, to reduce the incidental mortality and serious injury to the Atlantic coastal stocks of bottlenose dolphins in commercial fisheries to below PBR (NMFS, 2006f).

Currently, a single western North Atlantic offshore stock is recognized seaward of 34 km (18 NM) from the U.S. coastline (Waring et al., 2007). The minimum population estimate for this stock is 70,775 individuals (Waring et al., 2007).

There is a need for information to accurately identify stocks of bottlenose dolphins in the GOMEX (Hubard and Swartz, 2002; MMC, 2002; Sellas et al., 2005). As noted earlier, offshore and coastal forms are recognized. In the northern GOMEX, there are coastal stocks; a continental shelf stock; an oceanic stock; and bay, sound, and estuarine stocks (Waring et al., 2006). Sellas et al. (2005) reported the first evidence that the coastal stock off west central Florida is genetically separated from the adjacent inshore areas, while Fazioli et al. (2006) recently demonstrated that dolphins found inshore within bays, sounds, and estuaries on the west central Florida coast move into the nearby Gulf waters used by the coastal stocks. Genetic, photo-identification, and tagging data support the concept of relatively discrete bay, sound, and estuarine stocks; these 33 stocks recognized by the NOAA Stock Assessment Report are all thought to occur inshore of the GOMEX study area and are not discussed further here.

There are three coastal stocks in the northern GOMEX that occupy waters from the shore to the 20 m (66 ft) isobath: Eastern Coastal, Northern Coastal, and Western Coastal (Waring et al., 2006). The Western Coastal stock inhabits the nearshore waters from the Texas/Mexico border to the Mississippi River mouth; the best estimate for this stock is 3,449 individuals (Waring et al., 2006). The Northern Coastal stock is defined from the Mississippi River mouth to approximately 84°W; the best estimate is 4,191 dolphins (Waring et al., 2006). The Eastern Coastal stock is defined from 84°W to Key West, Florida; the best estimate is 9,912 individuals (Waring et al., 2006).

The Continental Shelf stock is defined as dolphins inhabiting the waters from the Texas/Mexico border to Key West, Florida between the 20 and 200 m (66 and 656 ft) isobaths (Waring et al., 2006). The best estimate of abundance for this stock is 25,320 bottlenose dolphins (Fulling et al., 2003; Waring et al., 2006). The continental shelf stock probably consists of a mixture of both the coastal and offshore ecotypes.

The Oceanic stock is provisionally defined as bottlenose dolphins inhabiting waters from the 200 m (656 ft) isobath to the seaward extent of the EEZ (Waring et al., 2006). The best estimate of abundance for the bottlenose dolphin in oceanic waters of the northern GOMEX is 2,239 individuals (Mullin and Fulling, 2004; Waring et al., 2006). This stock is believed to consist of the offshore form of bottlenose dolphins described by Hersh and Duffield (1990). Both inshore/coastal stocks and the oceanic stock are separate from the continental shelf stock; however, the continental shelf stock may overlap with coastal stocks and the oceanic stock in some areas and may be genetically indistinguishable from those other stocks (Waring et al., 2006).

In the last few decades, there have been five unusual mortality events involving bottlenose dolphins in the GOMEX (NOAA and FFWCC, 2004). The most recent occurred between March 10, 2004 and April 13, 2004, in which 107 bottlenose dolphins dead stranded along the Florida Panhandle (NOAA and FFWCC, 2004). Analyses indicated that breve toxins and low levels of domoic acid were present in the stranded animals, possibly leading to the stranding event (NOAA and FFWCC, 2004; Flewelling et al., 2005). NOAA contracted Mote Marine Laboratory to assess the health of bottlenose dolphins (including live captures and tracking) in St. Joseph Bay in the Florida Panhandle during April thru July 2005 (Balmer and Wells, 2006).

Diving Behavior – Dive durations as long as 15 min are recorded for trained individuals (Ridgway et al., 1969). Typical dives, however, are more shallow and of a much shorter duration. Mean dive durations of Atlantic bottlenose dolphins typically range from 20 to 40 sec at shallow depths (Mate et al., 1995) and can last longer than 5 min during deep offshore dives (Klatsky et al., 2005). Offshore bottlenose dolphins regularly dive to 450 m (1,476 ft) and possibly as deep as 700 m (2,297 ft) (Klatsky et al., 2005). Bottlenose dolphin dive behavior may correlate with diel cycles (Mate et al., 1995; Klatsky et al., 2005); this may be especially true for offshore stocks, which have dive deeper and more frequently at night to feed upon the deep scattering layer (Klatsky et al., 2005).

Acoustics and Hearing – Sounds emitted by bottlenose dolphins have been classified into two broad categories: pulsed sounds (including clicks and burst-pulses) and narrow-band continuous sounds (whistles), which usually are frequency modulated. Clicks and whistles have a dominant frequency range of 110 to 130 kHz and a source level of 218 to 228 dB re 1 μPa-m peak-to-peak (Au, 1993) and 3.4 to 14.5 kHz and 125 to 173 dB re 1 μPa-m peak-to-peak, respectively (Ketten, 1998). Whistles are primarily associated with communication and can serve to identify specific individuals (i.e., signature whistles) (Caldwell and Caldwell, 1965; Janik et al., 2006). Up to 52 percent of whistles produced by bottlenose dolphin groups with mother-calf pairs can be classified as signature whistles (Cook et al., 2004). Sound production is also influenced by group type (single or multiple individuals), habitat, and behavior (Nowacek, 2005). Bray calls (low-frequency vocalizations; majority of energy below 4 kHz), for example, are used when capturing fishes, specifically sea trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*), in some regions (i.e., Moray Firth, Scotland) (Janik, 2000). Additionally, whistle production has been observed to increase while feeding (Acevedo-Gutiérrez and Stienessen, 2004; Cook et al., 2004). Furthermore, both whistles and clicks have been demonstrated to vary geographically in terms of overall vocal activity, group size, and specific context (e.g., feeding, milling, traveling, and socializing) (Jones and Sayigh, 2002; Zaretsky et al., 2005; Baron, 2006). For example, preliminary research indicates that characteristics of whistles from populations in the northern Gulf of Mexico significantly differ (i.e., in frequency and duration) from those in the western north Atlantic (Zaretsky et al., 2005; Baron, 2006).

Bottlenose dolphins can typically hear within a broad frequency range of 0.04 to 160 kHz (Au, 1993; Turl, 1993). Electrophysiological experiments suggest that the bottlenose dolphin brain has a dual analysis system: one specialized for ultrasonic clicks and another for lower-frequency sounds, such as whistles (Ridgway, 2000). Scientists have reported a range of highest sensitivity between 25 and 70 kHz, with peaks in sensitivity at 25 and 50 kHz (Nachtigall et al., 2000). Recent research on the same individuals indicates that auditory thresholds obtained by electrophysiological methods correlate well with those obtained in behavior studies, except at the some lower (10 kHz) and higher (80 and 100 kHz) frequencies (Finneran and Houser, 2006).

Temporary threshold shifts (TTS) in hearing have been experimentally induced in captive bottlenose dolphins using a variety of noises (i.e., broad-band, pulses) (Ridgway et al., 1997; Schlundt et al., 2000; Nachtigall et al., 2003; Finneran et al., 2005; Mooney et al., 2005; Mooney, 2006). For example, TTS has been induced with exposure to a 3 kHz, one-second pulse with sound exposure level (SEL) of 195 dB re 1 μPa^2-s (Finneran et al., 2005), one-second pulses from 3 to 20 kHz at 192 to 201 dB re 1μPa-m (Schlundt et al., 2000), and octave band noise (4 to 11 kHz) for 50 minutes at 179 dB re 1 μPa-m (Nachtigall et al., 2003). Preliminary research indicates that TTS and recovery after noise exposure are frequency dependent and that an inverse relationship exists between exposure time and sound pressure level associated with exposure (Mooney et al., 2005; Mooney, 2006). Observed changes in behavior were induced with an exposure to a 75 kHz one-second pulse at 178 dB re 1 μPa-m (Ridgway et al., 1997; Schlundt et al., 2000). Finneran et al. (2005) concluded that a SEL of 195 dB re 1 μPa^2 s is a reasonable threshold for the onset of TTS in bottlenose dolphins exposed to mid-frequency tones.

Distribution **–** The overall range of the bottlenose dolphin is worldwide in tropical and temperate waters. This species occurs in all three major oceans and many seas. Dolphins of the genus *Tursiops* generally do not range poleward of 45º, except around the United Kingdom and northern Europe (Jefferson et al., 1993). Climate changes can contribute to range extensions as witnessed in association with the 1982/83 El Niño event when the range of some bottlenose dolphins known to the San Diego, California area was extended 600 km (324 NM) northward to Monterey Bay (Wells et al., 1990). Bottlenose dolphins continue to occur in Monterey Bay to this day.

In the western North Atlantic, bottlenose dolphins occur as far north as Nova Scotia but are most common in coastal waters from New England to Florida, the Gulf of Mexico, the Caribbean, and southward to Venezuela and Brazil (Würsig et al., 2000). Bottlenose dolphins occur seasonally in estuaries and coastal embayments as far north as Delaware Bay (Kenney, 1990) and in waters over the outer continental shelf and inner slope, as far north as Georges Bank (CETAP, 1982; Kenney, 1990).

Genetic analyses and spatial patterns observed from aerial surveys indicate regional and seasonal distribution differences between the coastal and offshore stocks. North of Cape Hatteras, the coastal stock is thought to be restricted to waters less than 25 m (82 ft) in depth, while offshore dolphins generally range beyond the 50 m (164 ft) isobath (CETAP, 1982; Kenney, 1990; Waring et al., 2007). Mitochondrial DNA and spatial analyses from dolphins south of Cape Hatteras suggest individuals sighted within 7.5 km (4 NM) of shore are of the coastal form and those beyond 34 km (18 NM) from shore and in waters with a bottom depth greater than 34 m (112 ft) are of the offshore form (Torres et al., 2003). However, Torres et al. (2003) also found an extensive region of overlap between the coastal and offshore stocks between 7.5 (4.0 NM) and 34 km (18 NM) from shore.

In North Carolina, there is significant overlap between distributions of coastal and offshore dolphins during the summer. North of Cape Lookout, there is a separation of the two stocks by bottom depth; the coastal form occurs in nearshore waters (less than 20 m [66 ft] deep) while the offshore form is in deeper waters (greater than 40 m [131 ft] deep) (Waring et al., 2007).

However, south of Cape Lookout to northern Florida, there is significant spatial overlap between the two stocks. In this region, coastal dolphins may be found in waters as deep as 31 m (102 ft) and 75 km (40 NM) from shore while offshore dolphins may occur in waters as shallow as 13 m (43 ft) (Garrison et al., 2003). Additional aerial surveys and genetic sampling are required to better understand the distribution of the two stocks throughout the year.

Discrete MUs exhibit seasonal migrations regulated by temperature and prey availability (Torres et al., 2005; Waring et al., 2007), traveling as far north as New Jersey in summer and as far south as central Florida in winter (Waring et al., 2007). During the summer, the Northern Migratory MU occurs from the New York/New Jersey border to the Virginia/North Carolina border. The Northern North Carolina MU ranges from the Virginia/North Carolina border to Cape Lookout, North Carolina during the summer months, and the Southern North Carolina MU ranges from Cape Lookout, North Carolina to Murrell's Inlet, South Carolina at this time of year. In the winter months, these three MUs overlap along the coast of North Carolina and southern Virginia. Coastal bottlenose dolphins along the western Atlantic coast may exhibit either resident or migratory patterns (Waring et al., 2007). Photo-identification studies support evidence of year-round resident bottlenose dolphin populations in Beaufort and Wilmington, North Carolina (Koster et al., 2000; Waring et al., 2007); these are the northernmost documented sites of year-round residency for bottlenose dolphins in the western North Atlantic (Koster et al., 2000). A high rate of exchange occurs between the Beaufort and Wilmington sites as well (Waring et al., 2007). Individuals from the Northern Migratory MU may enter these areas seasonally as well, as evidenced by a bottlenose dolphin tagged in 2001 in Virginia Beach who overwintered in waters between Cape Hatteras and Cape Lookout (NMFS-SEFSC, 2001).

The offshore stock is expected to remain in the Gulf Stream during the winter months (Mead and Potter, 1990); this theory is supported by recent stable isotope analysis in teeth collected from coastal and offshore individuals, indicating significant differences in distributions between the two stocks. Despite small sample sizes, such evidence suggests offshore dolphins may not undergo seasonal migrations (Cortese, 2000).

The bottlenose dolphin is by far the most widespread and common cetacean in coastal waters of the GOMEX (Würsig et al., 2000). Bottlenose dolphins are frequently sighted near the Mississippi River Delta (Baumgartner et al., 2001) and have even been known to travel several kilometers up the Mississippi River.

Atlantic Ocean, Offshore of the Southeastern United States

In the U.S. Atlantic, the bottlenose dolphin is distributed along the coast from Long Island, New York, to the Florida Keys and up through the Gulf of Mexico. Aerial surveys conducted between 1978 and 1982 (CETAP, 1982) north of Cape Hatteras, North Carolina identified two concentrations of bottlenose dolphins, one inshore of the 25 m (82 ft) isobath and the other offshore of the 50 m (164 ft) isobath. The lowest density of bottlenose dolphins was observed over the continental shelf, with higher densities along the coast and near the continental shelf edge. It was suggested, therefore, that the coastal morphotype is restricted to waters less than 25 m (82 ft) deep north of Cape Hatteras (Kenney, 1990). Similar patterns were observed during summer months north of Cape Lookout, NC in more recent aerial surveys (Garrison and Yeung, 2001; Garrison et al., 2003). However, south of Cape Lookout during both winter and summer months, there was no clear longitudinal discontinuity in bottlenose dolphin sightings (Garrison and Yeung, 2001; Garrison et al., 2003).

Bottlenose dolphins occur in the VACAPES, CHPT and JAX/CHASN OPAREAs year-round. The bottlenose dolphin is among the most numerous marine mammal species in the coastal waters.

Atlantic Ocean, Offshore of the Northeastern United States.

Bottlenose dolphins occur year-round in waters over the continental shelf extending to deeper waters over the abyssal plain, from the Scotian Shelf south to the VACAPES OPAREA. Most of the sightings seem to occur in the vicinity of the continental slope.

In the wintertime, bottlenose dolphins may occur over the continental shelf and slope waters, from Cape Cod Bay and the tip of Georges Bank to the southern map extent. During this season, the greatest number of bottlenose dolphins occurs outside the NE OPAREAs south towards the VACAPES OPAREA.

In the springtime, bottlenose dolphins occur primarily over the continental self and slope, in waters from Jeffreys Bank and south towards the VACAPES OPAREA. Few occurrences may be found in the deeper waters of the southern region of the NE OPAREAs. During the spring months, this species may occur in greater concentrations in the vicinity of the continental slope, near the tip of Georges Bank, in the center and southern regions of Narragansett Bay and Atlantic City OPAREAs respectively, and just south of the NE OPAREAs. Bottlenose dolphin sightings in the northeast region increase during spring, as individuals move north into the NE OPAREAs as water temperatures increase (NMFS-SEFSC, 2001; Waring et al., 2004).

In the summer, the general occurrence of bottlenose dolphins extends from waters over the continental shelf to those deeper waters over the southern region of the NE OPAREAs. During this season, bottlenose dolphins may occur in greater concentrations in the vicinity of the continental slope, along the southern flank of Georges Bank (eastern region of Narragansett Bay OPAREA) and the southern region of the Atlantic City OPAREA, and in the waters over the New England Sea Mount Chain. In the fall, bottlenose dolphins may occur from Jeffreys Bank to the southern map extent, in waters over the continental shelf extending to those deeper waters over the continental rise. During this season, bottlenose dolphins may be found in greater concentrations in waters over Gilbert Canyon, just east of Narragansett Bay OPAREA.

Gulf of Mexico

Bottlenose dolphins are abundant in continental shelf waters throughout the northern GOMEX (Fulling et al., 2003; Waring et al., 2006). Mullin and Fulling (2004) noted that in oceanic waters, bottlenose dolphins are encountered primarily in upper continental slope waters (less than 1,000 m [3,281 ft] in bottom depth) and that highest densities are in the northeastern Gulf.

In the winter, bottlenose dolphins may occur on the outer continental shelf and upper slope of the western Gulf and nearshore waters in the north-central and north-eastern Gulf, as well as the DeSoto Canyon region and Florida Escarpment. The large number of sightings in shelf waters off Mississippi, Alabama, and the Florida Panhandle are a result of aerial surveys conducted here during this season. It is well-known that the bottlenose dolphin occurs in nearshore waters west of the Mississippi River or over most of the Florida Shelf throughout these areas year-round; the apparent absence of occurrence in these areas is biased by the lack of survey effort during this time of year.

In the spring, bottlenose dolphins occur on the outer continental shelf and upper slope of the western Gulf and nearshore waters in the north-central and north-eastern Gulf, as well as the DeSoto Canyon region and Florida Escarpment. The large number of sightings in shelf waters off Mississippi, Alabama, and the Florida Panhandle are a result of aerial surveys conducted here during this season.

In summer, occurrence is predicted throughout the vast majority of shelf waters, as well as over the continental slope. There may be increased occurrence in shelf waters off Matagorda, Corpus Christi, and Galveston bays in Texas; on the shelf just to the west of the Mississippi Canyon; on the shelf off the Mississippi River Delta; and in an area on the Florida Shelf. Significant occurrences are anticipated near all bays in the northern Gulf.

As with the summer, occurrence is predicted throughout the vast majority of shelf waters, as well as the continental slope waters. There may be pockets of increased occurrence in shelf waters off Matagorda and Corpus Christi bays in Texas and on the Florida Shelf off Sarasota and Tampa bays; these are all well-known areas of bottlenose dolphin occurrence. Other areas of increased occurrence are over the Florida Escarpment and in an area off the Mississippi River Delta.

3.6.1.2.7 Pantropical and Atlantic Spotted Dolphins (*Stenella attenuata*)

Description – The pantropical spotted dolphin is a rather slender dolphin. This species has a dark dorsal cape, while the lower sides and belly of adults are gray. The beak is long and thin; the lips and beak tip tend to be bright white. A dark gray band encircles each eye and continues forward to the apex of the melon; there is also a dark gape-to-flipper stripe (Jefferson et al., 1993). Pantropical spotted dolphins are born spotless and develop spots as they age although the degree of spotting varies geographically (Perrin and Hohn, 1994). Some populations may be virtually unspotted (Jefferson, 2006). Adults may reach 2.6 m (8.5 ft) in length (Jefferson et al., 1993).

Status – The best estimate of abundance of the western North Atlantic stock of pantropical spotted dolphins is 4,439 individuals (Waring et al., 2007). There is no information on stock differentiation for pantropical spotted dolphins in the U.S. Atlantic (Waring et al., 2007). The best estimate of abundance for the pantropical spotted dolphin in the northern GOMEX is 91,321 individuals (Mullin and Fulling, 2004; Waring et al., 2006). The pantropical spotted dolphin is the most abundant and commonly seen cetacean in deep waters of the northern GOMEX (Davis and Fargion, 1996a; Jefferson, 1996a; Mullin and Hansen, 1999; Davis et al., 2000b; Würsig et al., 2000; Mullin et al., 2004).

Diving Behavior – Dives during the day generally are shorter and shallower than dives at night; rates of descent and ascent are higher at night than during the day (Baird et al., 2001). Similar mean dive durations and depths have been obtained for tagged pantropical spotted dolphins in the eastern tropical Pacific and off Hawaii (Baird et al., 2001).

Acoustics and Hearing **–** Pantropical spotted dolphin whistles have a frequency range of 3.1 to 21.4 kHz (Thomson and Richardson, 1995). Clicks typically have two frequency peaks (bimodal) at 40 to 60 kHz and 120 to 140 kHz with estimated source levels up to 220 dB re 1 μPa peak-to-peak (Schotten et al., 2004). No direct measures of hearing ability are available for pantropical spotted dolphins, but ear anatomy has been studied and indicates that this species should be adapted to hear the lower range of ultrasonic frequencies (less than 100 kHz) (Ketten, 1992 and 1997).

Distribution **–** Pantropical spotted dolphins occur in subtropical and tropical waters worldwide (Perrin and Hohn, 1994). Although there are coastal populations in shallow nearshore waters of Central America, most pantropical spotted dolphins occur in deep oceanic waters of the upper continental slope and deeper. Pantropical spotted dolphins have been sighted along the Florida shelf and slope waters and offshore in Gulf Stream waters southeast of Cape Hatteras (Waring et al., 2007). In the Atlantic, this species is considered broadly sympatric with Atlantic spotted dolphins (Perrin and Hohn, 1994). Most sightings of this species in the GOMEX occur over the lower continental slope (Davis et al., 1998), although they are widely distributed in waters beyond the shelf edge.

Atlantic Ocean, Offshore of the Southeastern United States

The pantropical spotted dolphin is a deepwater species (Jefferson et al., 1993). Pantropical spotted dolphins have been sighted along the Florida shelf and slope waters and offshore in Gulf Stream waters southeast of Cape Hatteras (Waring et al., 2007). In the Atlantic, this species is considered broadly sympatric with Atlantic spotted dolphins (Perrin and Hohn, 1994). The offshore form of the Atlantic spotted dolphin and the pantropical spotted dolphin can be difficult to differentiate at sea. Therefore, the low number of sightings of pantropical spotted dolphins in offshore waters may be more of a reflection of survey observers not distinguishing between the two species.

The only records documented in the VACAPES OPAREA include one sighting near the shelf break in summer and one bycatch record in winter in the southern portion of the VACAPES OPAREA. In addition, there are a few sightings recorded along the continental shelf break south of Chesapeake Bay in the VACAPES OPAREA during spring. There is only one sighting (off-effort) in the CHPT OPAREA during winter, even though this is a time of year with increased survey effort. In JAX/CHASN, most sightings during winter are recorded in shelf waters on the northern right whale calving grounds due to increased survey effort in this area. Note that survey effort does not cover all the deepwaters of the Southeast OPAREAs. Based on sighting data and known habitat preferences, occurrence is most likely in waters seaward of the shelf break throughout the Southeast OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

Spotted dolphins are found primarily south of Georges Basin, most of which are found in the summer, while scattered occurrences are found in the spring and fall.

Spotted dolphins are not expected to occur in the NE OPAREAs during winter.

In the springtime, spotted dolphins primarily occur in the southwest region of the NE OPAREAs, in waters over the continental slope and rise, with two occurrence records indicating that they may occur further north near the southern region of the Gulf of Maine.

In the summer, spotted dolphins occur primarily in those deeper waters over the southern region of the NE OPAREAs, including over the New England Sea Mount Chain, with few occurrences found on the continental self, from the northern flank of Georges Bank to the southern map extent. During this season, spotted dolphins may occur in greater concentrations in the waters over the northern flank of Georges Bank, outside any of the NE OPAREAs.

Lastly, in the fall, spotted dolphins primarily occur in deeper waters over the southern region of the study area, with the southern flank of Georges Bank representing the northern most limit of the distribution.

Gulf of Mexico

Pantropical spotted dolphins are widely distributed in oceanic waters of the Gulf (Mullin and Fulling, 2004). Based on sighting survey data, this is the most commonly seen cetacean in deep waters of GOMEX.

In the winter, the pantropical spotted dolphin occurs in waters beyond the shelf break. Areas of increased occurrence are over a few areas of the Florida Escarpment, including the area the Tortugas Gyre influences, and over the slope off the Texas-Louisiana border.

Spring is the season with the most survey effort and a large number of sightings throughout the entire area of survey coverage. The pantropical spotted dolphin is predicted to occur in oceanic waters throughout the vast majority of the northern Gulf. There is an area of increased occurrence in waters over the abyssal plain south of the Mississippi Canyon region. There may be areas of greater occurrence also in the DeSoto Canyon region and over the Florida Escarpment.

In summer, occurrence is predicted in oceanic waters throughout the vast majority of the northern Gulf. There may be areas of increased occurrence west of the Mississippi Canyon region and in two areas over the Florida Escarpment.

Fall is the season with the least amount of recorded sightings, likely due to decreased survey effort during this season and inclement weather conditions that can make sighting cetaceans difficult during this time of year. Patchy occurrence is predicted seaward of the shelf break in waters over the continental slope. No seasonal shifts in occurrence for this species are known for this area.

3.6.1.2.8 Atlantic Spotted Dolphins (*Stenella frontalis*)

Description – The Atlantic spotted dolphin tends to resemble bottlenose dolphins more than it does the pantropical spotted dolphin (Jefferson et al., 1993). In body shape, it is somewhat intermediate between the two, with a moderately long but rather thick beak. The dorsal fin is tall and falcate and there is generally a prominent spinal blaze. Adults are up to 2.3 m (7.5 ft) long and can weigh as much as 143 kg (315 lb) (Jefferson et al., 1993). Atlantic spotted dolphins are born spotless and develop spots as they age (Perrin et al., 1994c; Dudzinski, 1996; Herzing, 1997). Some Atlantic spotted dolphin individuals become so heavily spotted that the dark cape and spinal blaze are difficult to see (Perrin et al., 1994c; Dudzinski, 1996; Herzing, 1997).

There is marked regional variation in the adult body size of the Atlantic spotted dolphin (Perrin et al., 1987). There are two forms: a robust, heavily spotted form that inhabits the continental shelf, usually found within 250 to 350 km (135 to 189 NM) of the coast and a smaller, less-spotted form that inhabits offshore waters (Perrin et al., 1994c). The largest body size occurs in waters over the continental shelf of North America (East Coast and Gulf of Mexico) and Central America (Perrin, 2002a). The smallest Atlantic spotted dolphins are those around oceanic islands, such as the Azores and on the high seas in the western North Atlantic (Perrin, 2002a).

***Status* –** The best estimate of Atlantic spotted dolphin abundance in the western North Atlantic is 50,978 individuals (Waring et al., 2007). Recent genetic evidence suggests that there are at least two populations in the western North Atlantic (Adams and Rosel, 2006), as well as possible continental shelf and offshore segregations. Atlantic populations are divided along a latitudinal boundary corresponding roughly to Cape Hatteras (Adams and Rosel, 2006).

The best estimate of abundance for the Atlantic spotted dolphin in the northern GOMEX is 30,947 individuals (Fulling et al., 2003; Mullin and Fulling, 2004; Waring et al., 2006). The northern GOMEX population was recently confirmed to be genetically differentiated from the western North Atlantic populations (Adams and Rosel, 2006).

***Diving Behavior* –** The only information on diving depth for this species is from a satellite-tagged individual in the Gulf of Mexico (Davis et al., 1996). This individual made short, shallow dives to less than 10 m (33 ft) and as deep as 60 m (197 ft), while in waters over the continental shelf on 76 percent of dives.

***Acoustics and Hearing* –** A variety of sounds including whistles, echolocation clicks, squawks, barks, growls, and chirps have been recorded for the Atlantic spotted dolphin (Thomson and Richardson, 1995). Whistles have dominant frequencies below 20 kHz (range: 7.1 to 14.5 kHz) but multiple harmonics extend above 100 kHz, while burst pulses consist of frequencies above 20 kHz (dominant frequency of approximately 40 kHz) (Lammers et al., 2003). Other sounds, such as squawks, barks, growls, and chirps, typically range in frequency from 0.1 to 8 kHz (Thomson and Richardson, 1995). Recently recorded echolocation clicks have two dominant frequency ranges at 40 to 50 kHz and 110 to 130 kHz, depending on source level (i.e., lower source levels typically correspond to lower frequencies and higher frequencies to higher source levels (Au and Herzing, 2003). Echolocation click source levels as high as 210 dB re 1 µPa-m peak-to-peak have been recorded (Au and Herzing, 2003). Spotted dolphins in The Bahamas were frequently recorded during agonistic/aggressive interactions with bottlenose dolphins (and their own species) to produce squawks (0.2 to 12 kHz broad band burst pulses; males and females), screams (5.8 to 9.4 kHz whistles; males only), barks (0.2 to 20 kHz burst pulses; males only), and synchronized squawks (0.1-15 kHz burst pulses; males only in a coordinated group) (Herzing, 1996).

There has been no data collected on Atlantic spotted dolphin hearing ability. However, odontocetes are generally adapted to hear high-frequencies (Ketten, 1997).

Distribution – Atlantic spotted dolphins are distributed in warm-temperate and tropical Atlantic waters from approximately 45º N to 35º S; in the western North Atlantic, this translates to waters from northern New England to Venezuela, including the Gulf of Mexico and the Caribbean Sea (Perrin et al., 1987). Atlantic spotted dolphins may occur in both continental shelf and offshore waters (Perrin et al., 1994c). Known densities of Atlantic spotted dolphins are highest in the eastern GOMEX, east of Mobile Bay (Fulling et al., 2003). Atlantic spotted dolphins in the northern GOMEX are abundant in continental shelf waters (Fulling et al., 2003; Waring et al., 2006). In oceanic waters, this species usually occurs near the shelf break and upper continental slope waters (Davis et al., 1998; Mullin and Hansen, 1999).

Atlantic Ocean, Offshore of the Southeastern United States

The Atlantic spotted dolphin is found in tropical and warm-temperate waters of the Atlantic Ocean and the northern limit of its range is Cape Cod. The pantropical spotted dolphin is broadly sympatric (occupying the same geographical location without interbreeding) with the Atlantic spotted dolphin in the Atlantic Ocean. There are confirmed sightings of both Atlantic and pantropical spotted dolphins in the VACAPES OPAREA during winter, spring, and summer. They generally occur in waters with a bottom depth ranging from 10 to 20 m (33 to 66 ft), with an eastward extension to the 3,000 m (9,840 ft) isobath. Spotted dolphins are expected to occur in the vicinity of VACAPES OPAREA.

There are confirmed sightings and strandings of Atlantic spotted dolphins during all seasons in and near the CHPT OPAREA. There is only one confirmed record for a pantropical spotted dolphin during any of the seasons, but it is reasonable to assume that this species would occur in the CHPT OPAREA, given the large number of spotted dolphin sightings where species identity was not provided. Spotted dolphins are likely to occur in waters from the coastline to seaward of the eastern boundary of the CHPT OPAREA throughout the year.

Spotted dolphins are likely to occur from the coastline to seaward of the eastern boundary of the JAX/CHASN OPAREA throughout the year. The pantropical spotted dolphin is a deep-water species, and the Atlantic spotted dolphin may occur in both shelf and offshore waters. Sightings of spotted dolphins in coastal waters are most likely of the Atlantic spotted dolphin.

Atlantic Ocean, Offshore of the Northeastern United States

Spotted dolphins are found primarily south of Georges Basin, most of which are found in the summer, while scattered occurrences are found in the spring and fall. No occurrences of spotted dolphins are expected in the NE OPAREAs during the winter.

Spotted dolphins are not expected to occur in the NE OPAREAs during winter.

In the springtime, spotted dolphins primarily occur in the southwest region of the NE OPAREAs, in waters over the continental slope and rise, with two occurrence records indicating that they may occur further north near the southern region of the Gulf of Maine.

In the summer, spotted dolphins occur primarily in those deeper waters over the southern region of the NE OPAREAs, including over the New England Sea Mount Chain, with few occurrences found on the continental self, from the northern flank of Georges Bank to the southern map extent. During this season, spotted dolphins may occur in greater concentrations in the waters over the northern flank of Georges Bank, outside any of the NE OPAREAs.

Lastly, in the fall, spotted dolphins primarily occur in deeper waters over the southern region of the study area, with the southern flank of Georges Bank representing the northern most limit of the distribution.

Gulf of Mexico

Atlantic spotted dolphins in the northern GOMEX are abundant in continental shelf waters (Fulling et al., 2003; Waring et al., 2006). In oceanic waters, this species usually occurs near the shelf break and upper continental slope waters (Davis et al., 1998; Mullin and Hansen, 1999). Atlantic spotted dolphins are most abundant in the eastern GOMEX (Fulling et al., 2003). On the West Florida shelf, spotted dolphins are more common in deeper waters than bottlenose dolphins (Griffin and Griffin, 2003); Griffin and Griffin (2004) reported higher densities of spotted dolphins in this area during November through May.

In winter, there may be occurrence in waters over the continental shelf and along the shelf break throughout the entire northern GOMEX. Stranding data suggest that this species may be more common than the survey data demonstrate.

Occurrence during spring is primarily in the vicinity of the shelf break from central Texas to southwestern Florida. Sighting data reflect high usage of the Florida Shelf by this species.

In summer, occurrence is primarily in waters over the continental shelf, along the shelf break throughout the entire northern GOMEX, and over the Florida Escarpment. Sighting data shows increased usage of the Florida Shelf, as well as the Florida Panhandle and inshore of DeSoto Canyon. An additional area of increased occurrence is predicted in shelf waters off western Louisiana.

In fall, the sighting data demonstrate occurrence in waters over the continental shelf and along the shelf break throughout the entire northern GOMEX. There are numerous sightings in the Mississippi River delta region and Florida Panhandle. This is the season with the least amount of systematic survey effort, and inclement weather conditions can make sighting cetaceans difficult during this time of year.

3.6.1.2.9 Spinner Dolphin (*Stenella longirostris*)

Description – The spinner dolphin has a very long, slender beak (Jefferson et al., 1993). The dorsal fin ranges from slightly falcate to triangular or even canted forward in some geographic forms. The spinner dolphin generally has a dark eye-to-flipper stripe and dark lips and beak tip (Jefferson et al., 1993). This species typically has a three-part color pattern (dark gray cape, light gray sides, and white belly). Adults can reach 2.4 m (7.9 ft) in length (Jefferson et al., 1993). There are four known subspecies of spinner dolphins and probably other undescribed ones (Perrin, 1998; Perrin et al., 1999).

Status – No estimate of abundances are currently available for the western North Atlantic stock of spinner dolphins (Waring et al., 2007). Stock structure in the western North Atlantic is unknown (Waring et al., 2007). The best estimate of abundance for spinner dolphins in the northern GOMEX is 11,971 individuals (Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior – Spinner dolphins feed primarily on small mesopelagic fishes, squids, and sergestid shrimps, and they dive to at least 200 to 300 m (656 to 984 ft) (Perrin and Gilpatrick, 1994). Foraging takes place primarily at night when the mesopelagic community migrates vertically towards the surface and also horizontally towards the shore at night (Benoit-Bird et al., 2001; Benoit-Bird and Au, 2004). Rather than foraging offshore for the entire night, spinner dolphins track the horizontal migration of their prey (Benoit-Bird and Au, 2003). This tracking of the prey allows spinner dolphins to maximize their foraging time while foraging on the prey at its highest densities (Benoit-Bird and Au, 2003; Benoit-Bird, 2004).

Spinner dolphins are well known for their propensity to leap high into the air and spin before landing in the water; the purpose of this behavior is unknown. Norris and Dohl (1980) also described several other types of aerial behavior, including several other leap types, backslaps, headslaps, noseouts, tailslaps, and a behavior called "motorboating." Undoubtedly, spinner dolphins are one of the most aerially active of all dolphin species.

Acoustics and Hearing – Pulses, whistles, and clicks have been recorded from this species. Pulses and whistles have dominant frequency ranges of 5 to 60 kHz and 8 to 12 kHz, respectively (Ketten, 1998). Spinner dolphins consistently produce whistles with frequencies as high as 16.9 to 17.9 kHz with a maximum frequency for the fundamental component at 24.9 kHz (Bazúa-Durán and Au, 2002; Lammers et al., 2003). Clicks have a dominant frequency of 60 kHz (Ketten, 1998). The burst pulses are predominantly ultrasonic, often with little or no energy below 20 kHz (Lammers et al., 2003). Source levels between 195 and 222 dB re 1 µPa-m peak-to-peak have been recorded for spinner dolphin clicks (Schotten et al., 2004).

Distribution – Spinner dolphins are found in subtropical and tropical waters worldwide, with different geographical forms in various ocean basins. The range of this species extends to near 40° latitude (Jefferson et al., 1993). Distribution in the western North Atlantic is poorly known (Waring et al., 2007). Spinner dolphins occur year-round in the deep waters of the GOMEX.

Atlantic Ocean, Offshore of the Southeastern United States

The primary distribution of spinner dolphins is offshore, and spinner dolphin sightings off the northeastern U.S. coast have occurred exclusively in deeper waters. In the VACAPES OPAREA, this species is thought to occur from the continental shelf edge and to extends eastward of the VACAPES OPAREA boundary, with the Gulf Stream's warm water creating a northern boundary. Winter is the only season with sighting data for this species in the VACAPES OPAREA.

In the CHPT OPAREA, stranding records exist for North Carolina and represent the northernmost distribution records for this species in the western North Atlantic. There are numerous records for the spinner dolphin in deep waters off of North Carolina. Spinner dolphins are oceanic and are expected to occupy waters from the continental shelf edge (the 200 m [656 ft] isobath) to deep offshore waters. This species may occur in any season.

There are a few confirmed records for this species in the JAX/CHASN OPAREA and this species may occur in the waters seaward of the shelfbreak in any season.

Atlantic Ocean, Offshore of the Northeastern United States

Spinner dolphins may occur primarily in those deep waters over the southern region of the NE OPAREAs, with northern limits extending to 40ºN. There is one record of a spinner dolphin inside the Narragansett Bay OPAREA, which was during the summer.

Gulf of Mexico

Spinner dolphins occur year-round in the deep waters of the GOMEX. Mullin and Fulling (2004) noted that the vast majority of spinner dolphin sightings made by NMFS-SEFSC were over the continental slope in the northeastern GOMEX. During the Fritts aerial surveys of the 1980s sightings were recorded in waters off southern Florida with a bottom depth of less than 200 m (656 ft) (Fritts et al., 1983). Based on the known habitat preferences of the spinner dolphin in the Gulf of Mexico, it is now thought that these animals were misidentified (Jefferson and Schiro, 1997; Würsig et al., 2000). It is probable that these dolphins were actually Atlantic spotted dolphins, based on known habitat preferences and distribution of this species.

In winter, spinner dolphins occur seaward of the shelf break including waters over the continental slope, primarily east of the Mississippi River, although also in the Mississippi Canyon region. The area of greatest occurrence is suggested to be southeast of DeSoto Canyon. It should be noted that this is a time of year when Beaufort sea states are highest, making detection much more difficult (Mullin et al., 2004).

During the spring, as in winter, spinner dolphins occur seaward of the shelf break including waters over the continental slope, primarily east of the Mississippi River, although also in the Mississippi Canyon region. The areas of greatest occurrence are likely to be in the DeSoto Canyon region, in waters over the Florida Escarpment, and in the area influenced by the Tortugas Gyre. It would be realistic to expect that this species is not relegated to central and eastern GOMEX and likely occurs throughout deep waters of the GOMEX, with the greatest likelihood of encountering this species being east of the Mississippi River.

In the summer, spinner dolphins may occur in the deeper waters of the north-central Gulf from the Mississippi Canyon to the Florida Panhandle. Increased occurrences of spinner dolphins may be found in the deeper waters just south of the Alabama slope.

In the fall, the presence of spinner dolphins in the GOMEX is recognized only based on sparse sighting and stranding data. The available sighting data places the species in the region of the Mississippi Canyon and DeSoto Canyon. Spring is the season that is most likely representative of what to expect for this species' occurrence, particularly since no seasonality for the species is known.

3.6.1.2.10 Clymene Dolphin (*Stenella clymene*)

Description – Due to similarity in appearance, Clymene dolphins are easily confused with spinner and short-beaked common dolphins (Fertl et al., 2003). The Clymene dolphin, however, is smaller and more robust, with a much shorter and stockier beak. The dorsal fin is tall and only slightly falcate. A three-part color pattern consisting of a dark gray cape, light gray sides, and white belly is characteristic of this species (Jefferson and Curry, 2003). The cape dips in two places, first above the eye and then below the dorsal fin. The lips and beak tip are black. There is also a dark stripe on the top of the beak, as well as a dark variably shaped "moustache" on the middle of the top of the beak. The Clymene dolphin can reach at least 2 m (7 ft) in length and weights of at least 85 kg (187 lb) (Jefferson et al., 1993).

Status – Clymene dolphins have only been recognized as a valid species since 1981 (Perrin et al., 1981). The population in the western North Atlantic is currently considered a separate stock for management purposes although there is not enough information to distinguish this stock from the Gulf of Mexico stock(s) (Waring et al., 2007). The best estimate of abundance for the western North Atlantic stock of Clymene dolphins is 6,086 individuals (Waring et al., 2007). The best estimate of abundance for Clymene dolphins in the northern GOMEX is 17,355 individuals (Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior – There is no diving information available for this species.

Acoustics and Hearing – The only data available for this species is a description of their whistles. Clymene dolphin whistle structure is similar to that of other stenellids, but it is generally higher in frequency (range of 6.3 to 19.2 kHz) (Mullin et al., 1994a).

There is no empirical data on the hearing ability of Clymene dolphins; however, the most sensitive hearing range for odontocetes generally includes high frequencies (Ketten, 1997).

Distribution – Clymene dolphins are known only from the subtropical and tropical Atlantic Ocean (Perrin and Mead, 1994; Fertl et al., 2003). In the western Atlantic Ocean, Clymene dolphins are known from New Jersey to Brazil, including the Gulf of Mexico and Caribbean Sea (Fertl et al., 2003; Moreno et al., 2005). Although it is not clear if the actual density is higher, there are more Clymene dolphin records from the GOMEX than from the rest of this species' range combined (Jefferson et al., 1995; Fertl et al., 2003).

Atlantic Ocean, Offshore of the Southeastern United States

Sightings of Clymene dolphins have been recorded along the eastern United States as far north as New Jersey. In the VACAPES OPAREA, this dolphin most likely occurs during fall, winter, and spring from the continental shelf edge to the 4,000 m (13,120 ft) isobath, with the Gulf Stream's warm water creating a northern boundary. During the summer, this area extends further south, to beyond the eastern boundary of the OPAREA to encompass those warm waters. Summer is the only season with sighting data for the VACAPES OPAREA.

Summer is the only season with confirmed sightings of Clymene dolphins in the CHPT OPAREA, all of which were made during NMFS surveys. Based on these sightings, and on the preference of this species for warm waters, the Clymene dolphin is most likely to occur from the 100 m (328 ft) isobath to seaward of the eastern boundary of the CHPT OPAREA during the summer.

As a tropical species, the Clymene dolphin is likely to occur in the JAX/CHASN OPAREA primarily during the summer. Clymene dolphins have been found stranded along the coast of Florida adjacent to the JAX/CHASN OPAREA and further south throughout the year.

Atlantic Ocean, Offshore of the Northeastern United States

There is only one sighting and one stranding of the Clymene dolphin as far north as New Jersey. Based on the preference of this species for warmer waters, this species is expected to have an extralimital occurrence in the NE OPAREAs during all times of the year.

Gulf of Mexico

The Clymene dolphin is a deep water species. Mullin and Hansen (1999) noted that the majority of sightings for this species in the Gulf are west of the Mississippi River. Two mass strandings of Clymene dolphins were reported in the Florida Keys: one in July 1983 and the other in December 1992 (Jefferson et al., 1995). Both mass strandings took place over the course of a few days; therefore, they appear as multiple stranding records for the two events since carcasses were collected over the course of a few days.

There are few records during the winter; this is likely more an artifact of sparse survey effort and typically poor sighting conditions (e.g., rough seas) during this time of the year, since there are no known seasonal shifts in occurrence for this species in the Gulf.

Spring is the time of the year with the most survey effort and occurrence is expected seaward of the shelf break in most of the area of the western and central Gulf, with extension into the Mississippi River Delta region and the DeSoto Canyon.

During summer, Clymene dolphins may occur in deeper waters south of the continental slope, extending from the western Louisiana to the Florida Panhandle. Fewer occurrence records are available for the summer than spring.

In the fall, there is one sighting in very deep waters and a handful of strandings that are primarily in the Florida Keys which reflect the species' occurrence in the Gulf during this time of the year. No seasonality in occurrence is known for this species; anticipated occurrence is waters seaward of the shelf break.

3.6.1.2.11 Striped Dolphin (*Stenella coeruleoalba*)

Description – The striped dolphin is uniquely marked with black lateral stripes from eye to flipper and eye to anus. There is also a white V-shaped "spinal blaze" originating above and behind the eye and narrowing to a point below and behind the dorsal fin (Leatherwood and Reeves, 1983). There is a dark cape and white belly. This is a relatively robust dolphin with a long, slender beak and prominent dorsal fin. This species reaches 2.6 m (8.5 ft) in length.

Status – The best estimate of striped dolphin abundance in the western North Atlantic is 94,462 individuals (Waring et al., 2007). The best estimate of abundance for striped dolphins in the northern GOMEX is 6,505 individuals (Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior – Striped dolphins often feed in pelagic or benthopelagic zones along the continental slope or just beyond it in oceanic waters. A majority of their prey possesses luminescent organs, suggesting that striped dolphins may be feeding at great depths, possibly diving to 200 to 700 m (656 to 2,297 ft) to reach potential prey (Archer II and Perrin, 1999). Striped dolphins may feed at night in order to take advantage of the deep scattering layer's diurnal vertical movements.

Acoustics and Hearing – Striped dolphin whistles range from 6 to greater than 24 kHz, with dominant frequencies ranging from 8 to 12.5 kHz (Thomson and Richardson, 1995). A single striped dolphin's hearing range, determined by using standard psycho-acoustic techniques, was from 0.5 to 160 kHz with best sensitivity at 64 kHz (Kastelein et al., 2003).

Distribution – Striped dolphins are distributed worldwide in cool-temperate to tropical zones. In the western North Atlantic, this species occurs from Nova Scotia southward to the Caribbean Sea, Gulf of Mexico, and Brazil (Würsig et al., 2000). Striped dolphins are usually found beyond the continental shelf, typically over the continental slope out to oceanic waters and are often associated with convergence zones and waters influenced by upwelling (Au and Perryman, 1985). Along the Southeastern United States, striped dolphins are generally distributed north of Cape Hatteras (CETAP, 1982). As noted by Mullin and Hansen (1999), this species is generally distributed in deep waters throughout the entire northern GOMEX.

Atlantic Ocean, Offshore of the Southeastern United States

Striped dolphins are usually found outside the continental shelf, typically over the continental slope out to oceanic waters and often in waters associated with convergence zones and waters influenced by upwelling. In the VACAPES OPAREA, they are likely to occur at the shelf break and over the continental slope. Sightings predominantly occur along the north wall of the Gulf Stream, but not within this current where it travels through the southern portion of the VACAPES OPAREA.

Aside from strandings, there is only one record of the striped dolphin near the CHPT OPAREA—a sighting that is near the northern perimeter of the OPAREA. In contrast to the other dolphins in the stenellid dolphin group, the striped dolphin prefers more temperate waters. Striped dolphin may occur throughout the year from the 100 m (328 ft) isobath to seaward of the eastern boundary of the CHPT OPAREA. The striped dolphin is not likely occur in the deeper waters of this OPAREA.

The striped dolphin may occur but are not likely in the JAX/CHASN OPAREA throughout the year from the vicinity of the continental shelf break to seaward of the eastern boundary of the JAX/CHASN OPAREA. Based on their preference, in contrast to other dolphins, for more temperate waters, striped dolphins are more likely to occur well north of the JAX/CHASN OPAREA.

Atlantic Ocean, Offshore of the Northeastern United States.

Striped dolphins may occur in the waters over the continental slope and deeper waters of the Abyssal Plain, from the Scotian Shelf to the southern map extent. The distribution of occurrences is consistent with known occurrences (CETAP, 1982). In general, striped dolphins occur south of Georges Bank during winter, spring, and fall, with summer having the greatest number of occurrence records.

During the wintertime, striped dolphins occur primarily over the continental slope, extending out to the southern boundary of the Study Area, in waters from the southern flank of Georges Bank south towards the VACAPES OPAREA. Stranding records suggest that striped dolphins may occur as far north as the central coast of Maine.

In the springtime, striped dolphins generally occur in the waters over the continental slope and those deeper waters over the southern region of the NE OPAREAs, extending from the southern flank of Georges Bank and south towards the VACAPES OPAREA. Based on the relative frequency of sightings of unidentified Stenellids and the known distribution of the Stenellid species, it is likely that many of the animals that could not be identified in the available data are actually striped dolphins.

In the summertime, the general occurrence of striped dolphins extends from waters over the continental slope to those deeper waters over the southern region of the NE OPAREAs, from the Scotian Shelf to off the coast of Virginia. During this season, greater occurrences of striped dolphins may be found southeast of Browns Bank, over the New England Sea Mount Chain, the eastern and southern edged of Narragansett Bay OPAREA, and south of the Atlantic City OPAREA.

In the fall, striped dolphins may occur over the continental slope and rise waters, from the southern flank of Georges Bank to the northern coast of Virginia.

Gulf of Mexico

The striped dolphin is an oceanic species likely to occur seaward of the shelf break. As noted by Mullin and Hansen (1999), this species is generally distributed in deep waters throughout the entire northern GOMEX. During the Fritts aerial surveys of the early 1980s, striped dolphins were often recorded in shallow waters around southern Florida (Fritts et al., 1983). As noted earlier, striped dolphins have an apparent preference for deep waters. It is likely these sightings in waters over the continental shelf were misidentifications of Atlantic spotted dolphins (younger animals are not spotted and have a prominent spinal blaze like striped dolphins) (Jefferson and Schiro, 1997; Würsig et al., 2000).

In winter, striped dolphins are predicted to occur in waters over the continental slope, primarily in the central and eastern Gulf. Areas of greatest concentration are predicted for the Mississippi Canyon and DeSoto Canyon regions. This is a time of year with reduced survey effort, and it is more likely that occurrence is throughout the northern GOMEX seaward of the shelf break.

During spring, occurrence for the striped dolphins is predicted throughout the northern Gulf in waters over the continental slope and abyssal plain. The greatest concentration is in the DeSoto Canyon region, with an additional area over the abyssal plain. This is the season with the most survey effort and the largest (and most widespread) number of striped dolphin sightings.

In summer, occurrence is likely throughout the northern GOMEX near the shelf break and over the continental slope.

Fall is the season with the least amount of recorded sightings, likely due to decreased survey effort during this season and inclement weather conditions that can make sighting cetaceans difficult during this time of year. It is likely that the occurrence for the striped dolphin matches that in spring, and is predicted throughout the northern Gulf in waters over the continental slope and abyssal plain

3.6.1.2.12 Common Dolphin (*Delphinus* spp.)

Description – Two species of *Delphinus spp.* are present in the North Atlantic: the long-beaked common dolphin (*Delphinus capensis*) and the short-beaked common dolphin (*Delphinus delphis*) (Heyning and Perrin, 1994; Rosel et al., 1994). Only the short-beaked common dolphin is expected to occur in the U.S. western North Atlantic.

Short-beaked common dolphins are moderately robust dolphins, with a moderate-length beak, and a tall, slightly falcate dorsal fin. The beak is shorter than in long-beaked common dolphins, and the melon rises from the beak at a steeper angle (Heyning and Perrin, 1994). Short-beaked common dolphins are distinctively marked with a V-shaped saddle caused by a dip in the cape below the dorsal fin, yielding an hourglass pattern on the side of the body (Jefferson et al., 1993). The back is dark brownish-gray, the belly is white, and the anterior flank patch is tan to cream in color. The lips are dark, and there is a dark stripe from the eye to the apex of the melon and another one from the chin to the flipper (the latter is diagnostic to the genus). There are often variable light patches on the flippers and dorsal fin. Length ranges up to about 2.3 m (7.5 ft) (females) and 2.6 m (8.5 ft) (males); however, there is substantial geographic variation (Jefferson et al., 1993).

Status – The best estimate of abundance for the Western North Atlantic *Delphinus* spp. stock is 120,743 individuals (Waring et al., 2007). There is no information available for western North Atlantic common dolphin stock structure (Waring et al., 2007).

Diving Behavior – Diel fluctuations in vocal activity of this species (more vocal activity during late evening and early morning) appear to be linked to feeding on the deep scattering layer as it rises (Goold, 2000). Foraging dives up to 200 m (656 ft) in depth have been recorded off southern California (Evans, 1994).

Acoustics and Hearing – Recorded *Delphinus* spp. vocalizations include whistles, chirps, barks, and clicks (Ketten, 1998). Clicks range from 0.2 to 150 kHz with dominant frequencies between 23 and 67 kHz and estimated source levels of 170 dB re 1 μPa. Chirps and barks typically have a frequency range from less than 0.5 to 14 kHz, and whistles range in frequency from 2 to 18 kHz (Fish and Turl, 1976; Thomson and Richardson, 1995; Ketten, 1998; Oswald et al., 2003). Maximum source levels are approximately 180 dB 1 μPa-m (Fish and Turl, 1976).

This species' hearing range extends from 10 to 150 kHz; sensitivity is greatest from 60 to 70 kHz (Popov and Klishin, 1998).

Distribution – *Delphinus* is widely distributed globally in temperate, subtropical, and tropical seas. Common dolphins occur from southern Norway to West Africa in the eastern Atlantic and from Newfoundland to Florida in the western Atlantic (Perrin, 2002b), although this species more commonly occurs in temperate, cooler waters in the northwestern Atlantic (Waring and Palka, 2002).

Atlantic Ocean, Offshore of the Southeastern United States

The common dolphin occurs year-round in the VACAPES OPAREA. Winter and spring are the seasons with the most sightings and strandings. Common dolphins may occur during summer through winter from shoreward of the 50 m (164 ft) isobath to outside of the 3,000 m (9,840 ft) isobath. During summer, common dolphins are found in an area of the northeastern section of the VACAPES OPAREA. The common dolphin is likely to occur in the vicinity of the VACAPES OPAREA.

The common dolphin is uncommon off North Carolina, highly pelagic, and seldom encountered in shelf waters. It is widespread north of Cape Hatteras, but less common to the south, although it has been recorded as far south as Florida. The occurrence of common dolphins south of Cape Hatteras is questionable. Old confirmed records (pre-1970s) exist for common dolphins in this area, but no confirmed newer ones. Common dolphins are only likely to occur in the northernmost portion of the CHPT OPAREA to just south of Cape Hatteras, bounded on the east by the warmer waters of the Gulf Stream. Sixty-eight percent of common dolphins captured in foreign fishing activities were caught along the shelf edge north of the CHPT OPAREA.

In the past, the common dolphin was frequently found off the northeast coast of Florida but has been conspicuously absent since about 1960. The reasons for the apparent shift of range are not known. Based on the water temperature preferences of this species, they are not likely to occur during the winter, spring, and fall, and they are not expected to occur in the JAX/CHASN OPAREA during the summer.

Atlantic Ocean, Offshore of the Northeastern United States

Common dolphins occur year round throughout the NE OPAREAs in continental shelf and slope waters. Along the U.S. northeastern coast, common dolphins are concentrated between the 100 and 200 m (328 and 656 ft) isobaths. The overall distribution of occurrences found is consistent with reported sightings (Selzer and Payne, 1988; Evans, 1994). The general distribution of common dolphins shifts to the warmer waters in southern region of the NE OPAREAs during winter.

In the wintertime, common dolphins occur primarily over the continental shelf and slope, in waters from off Cape Cod and Georges Bank south towards the VACAPES OPAREA. Common dolphins may also occur in the deeper waters just south of the NE OPAREAs. During this season, common dolphins may occur near the shelf break in the Atlantic City OPAREA, with the greatest occurrences found outside of the NE OPAREAs off Virginia.

In the springtime, the general occurrence of common dolphins extends from waters over the continental shelf to those deeper waters over the continental rise, from Crowell Basin to the southern map extent. A few additional records (sightings) show common dolphins may also occur in the northern part of the Gulf of Maine. During this season, greater concentrations of common dolphins may occur in the vicinity of the shelf break along the southern flank of Georges Bank and in the Atlantic City OPAREA with the highest concentrations of common dolphins occurring just out of the NE OPAREAs in deeper water off the Virginia shelf break. Based upon their habitat preferences, it is not surprising that these animals are commonly found along the region's major escarpments and seamounts (Evans, 1994).

In the summertime, common dolphins generally occur in continental shelf and slope waters from the Bay of Fundy and Scotian Shelf (through much of the Boston OPAREA) to northern Virginia as well as an area directly south of the Great South Channel in deeper water. The highest concentrations of common dolphins are found from the southern flank of Georges Bank into the deeper waters over the continental rise.

In the fall, common dolphins are generally found in the waters of the continental shelf seaward from the northern coast of Maine to the southern coast of Virginia, when this species is particularly abundant along the northern edge of Georges Bank. During this season, common dolphins may be found in greater concentrations in the vicinity of the continental shelf edge extending from Georges Bank to the center of the Narragansett OPAREA.

Gulf of Mexico

The common dolphin is not expected to occur within the Gulf of Mexico. All reports of *Delphinus* spp. from the Gulf of Mexico were actually misidentified Clymene and spinner dolphins.

3.6.1.2.13 Fraser's Dolphin (*Lagenodelphis hosei*)

Description – The Fraser's dolphin reaches a maximum length of 2.7 m (8.5 ft) and is generally more robust than other small delphinids (Jefferson et al., 1993). This species has a short stubby beak, small flippers and flukes, and a small subtriangular dorsal fin. The most conspicuous feature of the Fraser's dolphin coloration is the dark band running from the face to the anus (Jefferson et al., 1997), although it is not present in younger animals and appears to be geographically variable (Jefferson, 2002a). The stripe is set off from the surrounding areas by thin, pale, cream-colored borders. There is also a dark chin-to-flipper stripe.

Status – No abundance estimate of Fraser's dolphins in the western North Atlantic is available (Waring et al., 2007). The best estimate of abundance for Fraser's dolphins in the northern GOMEX is 726 individuals (Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior – There is no information available on depths to which Fraser's dolphins may dive, but they are thought to be capable of deep diving.

Acoustics and Hearing – Fraser's dolphin whistles have been recorded having a frequency range of 7.6 to 13.4 kHz in the Gulf of Mexico (duration less than 0.5 sec) (Leatherwood et al., 1993).

There are no empirical hearing data hearing data available for this species.

Distribution – Fraser's dolphins are found in subtropical and tropical waters around the world, typically between 30º N and 30º S (Jefferson et al., 1993). Strandings in temperate areas are considered extralimital and usually are associated with anomalously warm water temperatures (Perrin et al., 1994b). Few records are available from the Atlantic Ocean (Leatherwood et al., 1993; Watkins et al., 1994; Bolaños and Villarroel-Marin, 2003). The first record for the GOMEX was a mass stranding in the Florida Keys in 1981 (Hersh and Odell, 1986). Since then, there have been documented strandings on the west coast of Florida and in southern Texas (Clark et al., 2002).

Atlantic Ocean, Offshore of the Southeastern United States

Fraser's dolphin is considered a deep-water species. There is one record for Fraser's dolphin in the VACAPES OPAREA—a sighting made during a summer shipboard survey, a group of Fraser's dolphins and melon-headed whales was sighted in waters east of Cape Hatteras, North Carolina, with a bottom depth of 3,000 m (9,843 ft). Due to the low number of sightings and the warm-water preference of this species, Fraser's dolphins are not likely in the VACAPES OPAREA. Based on this one sighting north of the CHPT OPAREA (in the VACAPES OPAREA) in waters seaward of the 2,000 m (6,560 ft) isobath and on the warm-water preference of this species, Fraser's dolphins are also not likely to occur in the CHPT OPAREA. There have been no confirmed sightings of Fraser's dolphin in the JAX/CHASN OPAREA. Fraser's dolphins may occur but are not likely to occur from the vicinity of the continental shelf break to waters seaward of the eastern boundary of the JAX/CHASN OPAREA throughout the year.

Atlantic Ocean, Offshore of the Northeastern United States

Fraser's dolphin is a deep-water species that prefers warm waters. The Fraser's dolphin is not expected to occur within the western North Atlantic Ocean offshore of the northeastern United States.

Gulf of Mexico

As noted by Mullin and Fulling (2004), this is a rare species that is thought to be present in the northern GOMEX, even during years with survey effort when they are not sighted. The Fraser's dolphin is an oceanic species; it is expected to occur off the shelf break. This determination was based on the distribution of sightings in the GOMEX and the known habitat preferences of this species. Fraser's dolphins are sighted over the abyssal plain in the southern GOMEX (Leatherwood et al., 1993).

3.6.1.2.14 Risso's Dolphin (*Grampus griseus*)

Description – Risso's dolphins are moderately large, robust animals reaching at least 3.8 m (12.5 ft) in length (Jefferson et al., 1993). The head is blunt and squarish without a distinct beak, and there is a vertical crease on the front of the melon. The dorsal fin is very tall and falcate. Young Risso's dolphins range from light gray to dark brownish gray and are relatively unmarked (Jefferson et al., 1993). Adults range from dark gray to nearly white and are heavily covered with white scratches and splotches.

Status – The best estimate of Risso's dolphin abundance in the western North Atlantic is 20,479 individuals (Waring et al., 2007). The best estimate of abundance for Risso's dolphins in the northern GOMEX is 2,169 individuals (Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior – Individuals may remain submerged on dives for up to 30 min and dive as deep as 600 m (1,967 ft) (DiGiovanni et al., 2005).

Acoustics and Hearing – Risso's dolphin vocalizations include broadband clicks, barks, buzzes, grunts, chirps, whistles, and combined whistle and burst-pulse sounds that range in frequency from 0.4 to 22 kHz and in duration from less than a second to several seconds (Corkeron and Van Parijs, 2001). The combined whistle and burst pulse sound (2 to 22 kHz, mean duration of 8 seconds) appears to be unique to Risso's dolphin (Corkeron and Van Parijs, 2001). Risso's dolphins also produce echolocation clicks (40 to 70 μs duration) with a dominant frequency range of 50 to 65 kHz and estimated source levels up to 222 dB re 1 μPa-m peak-to-peak (Thomson and Richardson, 1995; Philips et al., 2003; Madsen et al., 2004a).

Baseline research on the hearing ability of this species was conducted by Nachtigall et al. (1995) in a natural setting (included natural background noise) using behavioral methods on one older individual. This individual could hear frequencies ranging from 1.6 to 100 kHz and was most sensitive between 8 and 64 kHz. Recently, the auditory brainstem response technique has been used to measure hearing in a stranded infant (Nachtigall et al., 2005). This individual could hear frequencies ranging from 4 to 150 kHz, with best sensitivity at 90 kHz. This study demonstrated that this species can hear higher frequencies than previously reported.

Distribution – Risso's dolphins are distributed worldwide in cool-temperate to tropical waters from roughly 60º N to 60º S, where SSTs are generally greater than 10º C (Kruse et al., 1999). In the western North Atlantic, this species is found from Newfoundland southward to the Gulf of Mexico, throughout the Caribbean, and around the equator (Würsig et al., 2000). In general, U.S. Atlantic Risso's dolphins occupy the mid-Atlantic continental shelf year-round, although they are rarely observed in the Gulf of Maine (Payne et al., 1984). In the GOMEX, Risso's dolphins occur year-round in the waters from the outer continental shelf seaward

Atlantic Ocean, Offshore of the Southeastern United States

During the fall and winter, the Risso's dolphin is likely to occur from the 100 m (328 ft) isobath eastward of the boundary of the VACAPES OPAREA. In the spring and summer, Risso's dolphins may occur from the 50 m (164 ft) isobath eastward of the boundary of the OPAREA. During all four seasons, there have been Risso's dolphin sightings and by-catch records that are associated with the Gulf Stream.

The Risso's dolphin is likely to occur from the 50 m (164 ft) isobath to eastward of the boundary of the CHPT OPAREA throughout the year, and year-round from the 50 m (164 ft) isobath to seaward of the eastern boundary of the JAX/CHASN OPAREA. On the basis of the sporadic sightings in shallower waters well north of the JAX/CHASN OPAREA, Risso's dolphins are less likely to occur between the 30 and 50 m (98 and 164 ft) isobath throughout the year.

Atlantic Ocean, Offshore of the Northeastern United States

Risso's dolphins occur year-round in waters extending from the continental shelf to the continental rise, from the Scotian Shelf to the southern map extent. The overall distribution of Risso's dolphins in the NE OPAREAs seems to shift south during winter. The distribution of occurrences is consistent with known occurrences and seasonal distributions (CETAP, 1982; Payne et al., 1984).

In the wintertime, Risso's dolphins may occur over the continental shelf and slope, in waters extending from Jeffreys Bank south towards the VACAPES OPAREA.

In the springtime, the general occurrence of Risso's dolphins may be found over the continental shelf and slope waters, extending from the southern coast of Maine.

In the summertime, Risso's dolphins primarily occur in the vicinity of the continental slope and rise, in waters extending from Roseway Basin south towards the VACAPES OPAREA.

In the fall, Risso's dolphins generally occur over the continental shelf and slope waters, extending from Jeffreys Bank to the southern map extent. Greater occurrences of Risso's dolphins may be found near the northeast edge of the Atlantic City OPAREA and in the vicinity of the continental slope, off the coast of Virginia.

Gulf of Mexico

In general, Risso's dolphins occur year-round in the waters from the outer continental shelf seaward throughout the study area.

In the winter, Risso's dolphins are predicted to occur along the shelf break and over the continental slope. Interestingly, Mullin and Fulling (2004) found evidence for a three-fold increase in abundance in winter in the northeastern GOMEX compared to summer.

Spring is the season with the most survey effort and the largest (and most widespread) number of Rissos' dolphin sightings. Risso's dolphins are predicted not only along the shelf break and continental slope but also over deeper waters of the abyssal plain. Three areas of concentration off the DeSoto Canyon Region, off the Florida Escarpment, and in the region influenced by the Tortugas Gyre. These are all in areas of increased primary productivity, which would attract cephalopods, thereby attracting Risso's dolphins.

In the summer, Risso's dolphins may occur along the shelf break, over the continental slope, and over the abyssal plain. There may be a concentrated occurrence for Risso's dolphins in the region influenced by the Tortugas Gyre, which would be an area of increased biological productivity.

Fall is the season with the least amount of recorded sightings, likely due to decreased survey effort and inclement weather conditions that can make sighting cetaceans difficult during this time of year.

3.6.1.2.15 Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

Description – The Atlantic white-sided dolphin has a stocky body with a short thick beak and tall falcate dorsal fin. Individuals have a complex color pattern (Jefferson et al., 1993). They are black on the back, top of the beak, flippers, and flukes. The sides are gray. There is a white band below the dorsal that connects with a yellow band on the tail stock. Adults are 2.5 to 2.8 m (8.2 to 9.2 ft) in length.

Status – Three stock units have been suggested for the Atlantic white-sided dolphin in the western North Atlantic: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea (Palka et al., 1997; Waring et al., 2004). However, recent mitochondrial DNA analysis indicates that no definite stock structure exists (Amaral et al., 2001). The total number of white-sided dolphins along the United States and Canadian Atlantic coast is unknown. The Gulf of Maine stock occurs in the study area. The best estimate of abundance for the Gulf of Maine stock of white-sided dolphins is 51,640 individuals (Waring et al., 2004).

Diving Behavior **–** There is no diving information available for this species. However, it is known that Atlantic white-sided dolphins feed on pelagic and benthopelagic fishes, such as capelin, herring, hake, sand lance, smelt, and cod and cephalopods, such as squids (Katona et al., 1978; Sergeant et al., 1980; Kenney et al., 1985; Selzer and Payne, 1988; Waring et al., 1990; Overholtz and Waring, 1991; Weinrich et al., 2001).

Acoustics and Hearing **–** The only information available on Atlantic white-sided vocalizations is that the dominant frequency is 6 to 15 kHz (Thomson and Richardson, 1995). There are no hearing data available for this species.

Distribution **–** Atlantic white-sided dolphins are found in cold temperate to subpolar waters of the North Atlantic, from New England in the west and France in the east, north to southern Greenland, Iceland, and southern Norway (Jefferson et al., 1993). This species is most common over the continental shelf from Hudson Canyon north to the Gulf of Maine (Palka et al., 1997). Virginia and North Carolina appear to represent the southern edge of the range (Testaverde and Mead, 1980). Sighting data indicate seasonal shifts in distribution, perhaps a reflection of an inshore/offshore movement (CETAP, 1982; Payne et al., 1990b; Northridge et al., 1997). The spatial distribution of Atlantic white-sided dolphin sightings closely parallels sand lance distribution and abundance patterns (Selzer and Payne, 1988; Kenney et al., 1996).

During January to April, low numbers of white-sided dolphins may be found from Georges Bank to Jeffreys Ledge. Even lower numbers are found south of Georges Bank (also when a few strandings have been collected on Virginia and North Carolina beaches) (Payne et al., 1990b; Palka et al., 1997; Waring et al., 2004). From June through September, large numbers of white-sided dolphins are found from Georges Bank to the lower Bay of Fundy (Payne et al., 1990b; Waring et al., 2004). During this time, strandings occur from New Brunswick, Canada to New York (Palka et al., 1997). From October to December, white-sided dolphins occur at intermediate densities from southern Georges Bank to the southern Gulf of Maine. Sightings occur year-round south of Georges Bank, particularly around Hudson Canyon, but in low densities (CETAP, 1982; Payne et al., 1990b; Palka et al., 1997; Waring et al., 2004).

Atlantic white-sided dolphins have the ability to move through a wide-ranging area; a rehabilitated individual was tracked over 300 km (162 NM) in 64.3 hrs (Mate et al., 1994). Photo-identification work also indicates widespread movements (Weinrich et al., 2001).

Atlantic Ocean, Offshore of the Southeastern United States

This dolphin is known to occur only in the northern portion of the VACAPES OPAREA in all seasons, based on its preference for colder waters. Sightings are recorded mostly in the northern VACAPES OPAREA and vicinity. Strandings and bycatch records are also documented near the VACAPES OPAREA. Due to this species' preference for colder waters, the Gulf Stream may be a southern boundary for Atlantic white-sided dolphin distribution. This species is likely to occur primarily in waters over the continental shelf throughout the VACAPES OPAREA year-round. However, distribution may also range further offshore which is evidenced by the sighting records offshore in waters over the continental slope in and near the VACAPES OPAREA. Atlantic white-sided dolphins are not expected to occur in the CHPT or JAX/CHASN OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

Atlantic white-sided dolphins occur year-round throughout most of the northern region of the NE OPAREAs in continental shelf and slope waters. Overall, spring, summer, and fall have higher occurrences of Atlantic white-sided dolphins than winter.

In the wintertime, Atlantic white-sided dolphins occur primarily in the continental shelf and slope waters, in the western and southern regions of the Gulf of Maine, with scattered occurrences extending to the southern region of the NE OPAREAs. These areas include Jeffreys Ledge and a small section of Georges Bank, both of which have been documented as areas of low dolphin abundance during winter months (Payne et al., 1990b; Palka et al., 1997; Waring et al., 2004).

In the springtime, Atlantic white-sided dolphins occur primarily over the continental shelf and slope, in waters extending from Jeffreys Bank and Roseway Basin to the southern region of the NE OPAREAs. Atlantic white-sided dolphins may occur in greater concentrations in waters over the northern flank of Georges Bank, east of Cape Cod, and over Nantucket Shoals in the northern region of the Narragansett Bay OPAREA. During spring, the occurrence of Atlantic white-sided dolphins in the NE OPAREAs coincides with the distribution and period of peak abundance of sand lance.

In the summer, the general occurrence of Atlantic white-sided dolphins extends from waters over the continental shelf to those deeper waters over the continental rise, from the Bay of Fundy and the Scotian Shelf to the southern region of the NE OPAREAs. During this season, greater concentrations of Atlantic white-sided dolphins may be found in the waters over Jordan Basin, east of Cape Cod, and east of the Northeast Channel.

In the fall, Atlantic white-sided dolphins are general found in waters over the continental shelf and slope, from the Bay of Fundy and the Scotian Shelf to just east of New Jersey. During this season, Atlantic white-sided dolphins may occur in greater concentrations in waters over Jeffreys Bank and just east of Cape Cod. The distribution of white-sided dolphins is more dispersed throughout the Gulf of Maine in fall than in spring due to the reduced availability of sand lance in the area (Selzer and Payne, 1988).

Gulf of Mexico

The white-sided dolphin is not expected to occur within the Gulf of Mexico.

3.6.1.2.16 White-beaked Dolphin (*Lagenorhynchus albirostris*)

Description – The white-beaked dolphin is an extremely robust dolphin, which reaches lengths of 3.2 m and a maximum weight of 354 kg (780 lb) (Jefferson et al., 1993; Reeves et al., 1999b). The beak is short and thick. The back and sides of this species are basically black or dark gray. The beak and most of the belly are white to light gray, and the beak is often mottled (Jefferson et al., 1993). There may be dark or light flecks in the area between the eye and the flipper.

Status –At least two white-beaked dolphin stocks are present in the North Atlantic: one in the eastern and one in the western (Waring et al., 2007). An abundance of 573 white-beaked dolphins was estimated during a 1980 aerial survey between Cape Hatteras, North Carolina and Nova Scotia (CETAP, 1982). However, this out-dated count was not corrected for dive time or g(0) and is, therefore, not thought to accurately represent current population size. There are no current estimates of abundance for the western North Atlantic stock (Waring et al., 2007).

Diving Behavior – There is no information available on depths to which the white-beaked dolphin may dive.

Acoustics and Hearing **–** White-beaked dolphins produce sounds such as clicks and squeals. The clicks are presumably used for echolocation (Rasmussen et al., 2002). Maximum source levels of clicks are 219 dB re 1 μPa-m peak-to-peak (Rasmussen et al., 2002). Squeals range from 6.5 to 15 kHz (noted in Lien et al., 2001). There is no information available on the hearing capability of this species.

Distribution **–** The white-beaked dolphin is found only in cold-temperate and subarctic North Atlantic waters and appears to be more common in eastern rather than western waters (Lien et al., 2001). The range of the white-beaked dolphin overlaps that of the Atlantic white-sided dolphin, but the white-beaked dolphin is regarded as the more northerly of the two species (Leatherwood and Reeves, 1983). In addition, studies in the eastern North Atlantic suggest that the white-beaked dolphin has a more coastal feeding habit in contrast to the Atlantic white-sided dolphin which mainly feeds offshore (Das et al., 2003).

In the western North Atlantic, white-beaked dolphins occur from eastern Greenland through the Davis Strait and south to Massachusetts (Lien et al., 2001). White-beaked dolphins are found near the northern limits of their range between spring and late fall; they appear to winter further south and some may remain there until late spring or early summer (Leatherwood and Reeves, 1983). The northward shift that occurs during the summer appears to follow the progression of spawning capelin (Lien et al., 2001).

Off the northeastern United States, white-beaked dolphins sightings are concentrated in the western Gulf of Maine and around Cape Cod (CETAP, 1982). Prior to the 1970s, these dolphins were found primarily over the continental shelf in the Gulf of Maine and over Georges Bank. However, since then, they have occurred primarily in waters over the continental slope and have been replaced by Atlantic white-sided dolphins (Sergeant et al., 1980; Katona et al., 1993). This shift may result from a sand lance increase and herring decline in continental shelf waters (Payne et al., 1986; Payne et al., 1990b; Kenney et al., 1996).

Atlantic Ocean, Offshore of the Southeastern United States

The white-beaked dolphin is found in the north Atlantic Ocean in cold-temperate and subarctic waters. The lone sighting record for the white-beaked dolphin in the VACAPES OPAREA occurred on the continental shelf edge during spring. Any occurrences of the white-beaked dolphin in the VACAPES OPAREA are considered to be extralimital. It is unlikely that this species would occur in the VACAPES OPAREA during any season.

Atlantic Ocean, Offshore of the Northeastern United States

In general, white-beaked dolphins occur primarily in waters over the continental shelf from the Bay of Fundy to the Hudson Canyon. Overall, winter, spring, and summer have more occurrences of white-beaked dolphins in the NE OPAREAs than the fall.

In the wintertime, white-beaked dolphins occur primarily over the continental shelf waters, from just west of Georges Basin to Hudson Canyon. During this season, the greatest concentration of white-beaked dolphins may occur just west of Georges Basin. In the springtime, white-beaked dolphins occur over the continental shelf waters, in the western and southern region of the Gulf of Maine, and Nantucket Shoals. During this season, a greater concentration of white-beaked dolphins may occur over Nantucket Shoals, in the northern region of Narragansett Bay OPAREA. In the summertime, the general occurrence of white-beaked dolphins extends from the Bay of Fundy and Browns Bank to northern New Jersey, with a few occurrence records found in the northern region of Narragansett Bay OPAREA, primarily in waters over the continental shelf. A northward shift in white-beaked dolphin occurrence was noted, making it likely that this species may occur further north of the NE OPAREAs during this time of year (Lien et al., 2001). In the fall, white-beaked dolphins may be found in Cape Cod Bay and in waters over the eastern tip of Georges Bank.

Gulf of Mexico

The white-beaked dolphin is not expected to occur within the Gulf of Mexico.

3.6.1.2.17 Melon-headed Whale (*Peponocephala electra*)

Description – Melon-headed whales at sea closely resemble pygmy killer whales; both species have a blunt head with little or no beak. Melon-headed whales have pointed (versus rounded) flippers and a more triangular head shape than pygmy killer whales (Jefferson et al., 1993). The body is charcoal gray to black, with unpigmented lips (which often appear light gray, pink, or white) and a white urogenital patch (Perryman et al., 1994). This species also has a triangular face "mask" and indistinct cape (which dips much lower below the dorsal fin than that of pygmy killer whales). Melon-headed whales reach a maximum length of 2.75 m (9.02 ft) (Jefferson et al., 1993).

Status – There are no abundance estimates for melon-headed whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for melon-headed whales in the northern GOMEX is 3,451 individuals (Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior – Melon-headed whales prey on squids, pelagic fishes, and occasionally crustaceans. Most fish and squid prey are mesopelagic in waters up to 1,500 m deep, suggesting that feeding takes place deep in the water column (Jefferson and Barros, 1997). There is no information on specific diving depths for melon-headed whales.

Acoustics and Hearing – The only published acoustic information for melon-headed whales is from the southeastern Caribbean (Watkins et al., 1997). Sounds recorded included whistles and click sequences. Recorded whistles have dominant frequencies between 8 and 12 kHz; higher-level whistles were estimated at no more than 155 dB re 1 μPa-m (Watkins et al., 1997). Clicks had dominant frequencies of 20 to 40 kHz; higher-level click bursts were judged to be about 165 dB re 1 μPa-m (Watkins et al., 1997).

No empirical data on hearing ability for this species are available.

Distribution – Melon-headed whales occur worldwide in subtropical and tropical waters. There are very few records for melon-headed whales in the North Atlantic (Ross and Leatherwood, 1994; Jefferson and Barros, 1997). Maryland is thought to represent the extreme of the northern distribution for this species in the northwest Atlantic (Perryman et al., 1994; Jefferson and Barros, 1997). The first two occurrence records for this species in the GOMEX were strandings in Texas and Louisiana during 1990 and 1991, respectively (Barron and Jefferson, 1993).

Atlantic Ocean, Offshore of the Southeastern United States

Melon-headed and pygmy killer whales can be difficult to distinguish from one another, and on many occasions only a determination of "pygmy killer whale/melon-headed whale" can be made. Two sightings of melon-headed whales are recorded in deep (greater than 2,500 m [8,202 ft]) offshore waters along the path of the Gulf Stream in the southern VACAPES OPAREA. Based on warm water preferences, melon-headed whale occurrence in the VACAPES OPAREA during winter is likely influenced by the Gulf Stream. One sighting of melon-headed whales is recorded in offshore waters north of the CHPT OPAREA. One stranding of a melon-headed whale is recorded just inshore of the JAX/CHASN OPAREA along the coast of Florida. In March 2006, five adult melon-headed whales mass stranded along the central Atlantic coast of Florida just south of the OPAREA (Bossart et al., 2007). This is the first reported mass stranding of this species in the southeastern United States. The melon-headed whale is an oceanic species; it is likely to occur seaward of the shelf break year-round throughout the Southeast OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

The melon-headed whale is not expected to occur within the western North Atlantic Ocean offshore of the Northeastern United States.

Gulf of Mexico

The melon-headed whale is an oceanic species; this is confirmed by the distribution of sighting records, which show the species to occur in waters seaward of the shelf break. Mullin and Hansen (1999) noted that melon-headed whales appear to be more frequently sighted west of the Mississippi River. This is supported by the distribution of sighting records in the GOMEX. No seasonality to their occurrence is expected. The large number of sightings during the spring is due to high survey coverage during this time of year.

3.6.1.2.18 Pygmy Killer Whale (*Feresa attenuata*)

Description – The pygmy killer whale is often confused with the melon-headed whale and less often with the false killer whale. Flipper shape is the best distinguishing characteristic; pygmy killer whales have rounded flipper tips (Jefferson et al., 1993). The body of the pygmy killer whale is somewhat slender (especially posterior to the dorsal fin) with a rounded head that has little or no beak (Jefferson et al., 1993). The color of this species is dark gray to black with a prominent narrow cape that dips only slightly below the dorsal fin and a white to light gray ventral band that widens around the genitals. The lips and snout tip are sometimes white. Pygmy killer whales reach lengths of up to 2.6 m (8.5 ft) (Jefferson et al., 1993).

Status There are no estimates of abundances for pygmy killer whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for pygmy killer whales in the northern GOMEX is 408 individuals (Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior **–** There is no diving information available for this species.

Acoustics and Hearing – The pygmy killer whale emits short duration, broadband signals similar to a large number of other delphinid species (Madsen et al., 2004b). Clicks produced by pygmy killer whales have centroid frequencies between 70 and 85 kHz; there are bimodal peak frequencies between 45 and 117 kHz. The estimated source levels are between 197 and 223 dB re 1 µPa-m peak-to-peak (Madsen et al., 2004b). These clicks possess characteristics of echolocation clicks (Madsen et al., 2004b).

There are no empirical hearing data available for this species.

Distribution **–** Pygmy killer whales have a worldwide distribution in tropical and subtropical waters, generally not ranging north of 40º N or south of 35º S (Jefferson et al., 1993). Most records from outside the tropics are associated with unseasonable intrusions of warm water into higher latitudes (Ross and Leatherwood, 1994). There are relatively few records of this species in the western North Atlantic; this species does not appear to be common in the GOMEX (Davis and Fargion, 1996a; Jefferson and Schiro, 1997; Davis et al., 2000b; Würsig et al., 2000). Würsig et al. (2000) suggested that the sparse number of sightings might be at least in part due to the somewhat cryptic behavior of the pygmy killer whale.

Atlantic Ocean, Offshore of the Southeastern United States

Only one confirmed record, a fall stranding north of Cape Hatteras, is documented for pygmy killer whales in the VACAPES OPAREA and vicinity. Based on warm water preferences, pygmy killer whale occurrence in the VACAPES OPAREA during winter is likely influenced by the Gulf Stream. Few strandings and an offshore sighting are recorded near the CHPT OPAREA. Records of pygmy killer whales in this region include several strandings inshore of the JAX/CHASN OPAREA and two sightings in offshore waters of the JAX/CHASN OPAREA. The pygmy killer whale is an oceanic species; occurrence is likely seaward of the shelf break year-round throughout the Southeast OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

The pygmy killer whale should be considered rare in the Northeastern United.States during all times of the year; as it primarily occurs in tropical waters. Although no sightings have occurred within the NE OPAREAs, there are four occurrence records for this species in the Northeastern United States: one sighting during August 1981 (CETAP, 1982) and three during the course of two days of a NMFS shipboard survey in July 1995. The closest sighting was made during July 1995, 31.5 km (69.4 NM) south of the southwestern most corner of the Narragansett OPAREA.

Gulf of Mexico

As stated previously, pygmy killer whales and melon-headed whales can be difficult to distinguish from one another, and on many occasions, only a determination of "pygmy killer whale/melon-headed whale" can be made. The occurrence of both species is considered similar and therefore appears combined. In the northern GOMEX, the pygmy killer whale is found primarily in deeper waters beyond the continental shelf (Davis and Fargion, 1996a; Davis et al., 2000b; Würsig et al., 2000) extending out to waters over the abyssal plain. Pygmy killer whales are thought to occur year-round in the Gulf in small numbers (Würsig et al., 2000). No seasonality to their occurrence is expected. The large number of sightings during the spring is due to high survey coverage during this time of year.

3.6.1.2.19 False Killer Whale (*Pseudorca crassidens*)

Description – The false killer whale is a large, dark gray to black dolphin with a faint gray patch on the chest and sometimes light gray areas on the head (Jefferson et al., 1993). The false killer whale has a long slender body, a rounded overhanging forehead, and little or no beak (Jefferson et al., 1993). The dorsal fin is falcate and slender. The flippers have a characteristic hump on the S-shaped leading edge—this is perhaps the best characteristic for distinguishing this species from the other "blackfish" (an informal grouping that is often taken to include pygmy killer, melon-headed, and pilot whales; Jefferson et al., 1993). Individuals reach maximum lengths of 6 m (20 ft) (Jefferson et al., 1993).

Status – There are no abundance estimates available for this species in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for false killer whales in the northern GOMEX is 1,038 individuals (Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior – Few diving data are available, although individuals are documented to dive as deep as 500 m (1,640 ft) (Odell and McClune, 1999). Shallower dive depths (maximum of 53 m [174 ft]; averaging from 8 to 12 m [26 to 39 ft]) have been recorded for false killer whales in Hawaiian waters.

Acoustics and Hearing – Dominant frequencies of false killer whale whistles are from 4 to 9.5 kHz, and those of their echolocation clicks are from either 20 to 60 kHz or 100 to 130 kHz depending on ambient noise and target distance (Thomson and Richardson, 1995). Click source levels typically range from 200 to 228 dB re 1 µPa-m peak-to-peak (Ketten, 1998). Recently, false killer whales recorded in the Indian Ocean produced echolocation clicks with dominant frequencies of about 40 kHz and estimated source levels of 201-225 dB re 1 µPa-m peak-to-peak (Madsen et al., 2004b).

False killer whales can hear frequencies ranging from approximately 2 to 115 kHz with best hearing sensitivity ranging from 16 to 64 kHz (Thomas et al., 1988). Additional behavioral audiograms of false killer whales support a range of best hearing sensitivity between 16 and 24 kHz, with peak sensitivity at 20 kHz (Yuen et al., 2005). The same study also measured audiograms using the ABR technique, which came to similar results, with a range of best hearing sensitivity between 16 and 22.5 kHz, peaking at 22.5 kHz (Yuen et al., 2005). Behavioral audiograms in this study consistently resulted in lower thresholds than those obtained by ABR.

Distribution – False killer whales are found in tropical and temperate waters, generally between 50°S and 50°N latitude with a few records north of 50°N in the Pacific and the Atlantic (Baird et al., 1989; Odell and McClune, 1999). False killer whales are primarily offshore animals, although they do come close to shore, particularly around oceanic islands (Baird, 2002). Most sightings in the Gulf of Mexico have been made in oceanic waters greater than 200 m (656 ft) deep, although there are some sightings in waters over the continental shelf (Davis and Fargion, 1996a). Inshore movements are occasionally associated with movements of prey and shoreward flooding of warm ocean currents (Stacey et al., 1994).

Atlantic Ocean, Offshore of the Southeastern United States

The false killer whale is found primarily in deep-water and offshore areas in tropical and warm-temperate waters. The warm waters of the Gulf Stream likely influence occurrence in the southern VACAPES OPAREA. A small number of sightings and strandings are recorded near the VACAPES OPAREA; the sightings reflect the preference of this species for offshore waters. A small number of sightings are recorded in the CHPT OPAREA. A small number of sightings are recorded in offshore waters of the JAX/CHASN OPAREA. Strandings are also recorded in this region. Occurrence is likely seaward of the shelf break throughout the Southeast OPAREAs year-round.

Atlantic Ocean, Offshore of the Northeastern United States

The false killer whale is distributed worldwide throughout warm temperate and tropical oceans. False killer whales may occur in waters over Jeffreys Bank, south of the southern flank of Georges Bank and Narragansett Bay OPAREA, and in the vicinity of Cape Cod during summer, fall, and winter. No species sightings have occurred during the spring.

Gulf of Mexico

Most sightings in the Gulf of Mexico have been made seaward of the shelf break, although there are also sightings from over the continental shelf (Davis and Fargion, 1996a; Jefferson and Schiro, 1997; Mullin and Fulling, 2004). Mullin and Hansen (1999) and Mullin and Fulling (2004) reported that most NMFS-SEFSC sightings were east of the Mississippi River. There is the possibility of encountering false killer whales between the 50 m (164 ft) isobath and the shelf break based on the fact that false killer whales sometimes make their way into shallower waters, as well as the many sightings reported by sport fishermen in the mid-1960s of “blackfish” (most likely false killer whales based on the descriptions) in waters offshore of Pensacola and Panama City, Florida (Brown et al., 1966). There were also occasional reports of fish stealing by these animals (the false killer whale frequently has been implicated in such fishery interactions). No seasonal differences in the occurrence patterns of this species are expected in the GOMEX.

3.6.1.2.20 Killer Whale (*Orcinus orca*)

Description – Killer whales are probably the most instantly recognizable of all the cetaceans. The black-and-white color pattern of the killer whale is striking, as is the tall, erect dorsal fin of the adult male (1 to 2 m [3 to 6 ft] in height). The white oval eye patch and variably shaped saddle patch, in conjunction with the shape and notches in the dorsal fin, help in identifying individuals. The killer whale has a blunt head with a stubby, poorly defined beak and large, oval flippers. Females may reach 8 (25 ft) m in length and males 9 m (30 ft) (Dahlheim and Heyning, 1999). This is the largest member of the dolphin family.

Status **–** There are no estimates of abundance for killer whales in the western North Atlantic (Waring et al., 2007). Most cetacean taxonomists agree that multiple killer whale species or subspecies occur worldwide (Krahn et al., 2004; Waples and Clapham, 2004). However, at this time, further information is not available, particularly for the western North Atlantic. The best estimate of abundance for killer whales in the northern GOMEX is 133 individuals (Mullin and Fulling, 2004; Waring et al., 2006). The GOMEX population is considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the Atlantic Ocean stock(s) (Waring et al., 2006).

Diving Behavior **–** The maximum recorded depth for a free-ranging killer whale dive was 264 m (866 ft) off British Columbia (Baird et al., 2005a). A trained killer whale dove to 260 m (853 ft) (Dahlheim and Heyning, 1999). The longest duration of a recorded dive was 17 min (Dahlheim and Heyning, 1999). However, shallower dives were much more common for eight tagged individuals, where less than three percent of all dives examined were greater than 30 m (98 ft) in depth (Baird et al., 2003a).

Acoustics and Hearing **–** Killer whales produce a wide variety of clicks and whistles, but most of this species' social sounds are pulsed, with frequencies ranging from 0.5 to 25 kHz (dominant frequency range: 1 to 6 kHz) (Thomson and Richardson, 1995). Echolocation clicks recorded for Canadian killer whales foraging on salmon have source levels ranging from 195 to 224 dB re: 1 μPa-m peak-to-peak, a center frequency ranging from 45 to 80 kHz, and durations of 80 to 120 μs (Au et al., 2004). Echolocation clicks from Norwegian killer whales were considerably lower than the previously mentioned study and ranged from 173 to 202 re: 1 μPa-m peak-to-peak. The clicks had a center frequency ranging from 22 to 49 kHz and durations of 31 to 203 μs (Simon et al., 2007). Source levels associated with social sounds have been calculated to range from 131 to 168 dB re 1 μPa-m and have been demonstrated to vary with vocalization type (e.g., whistles: average source level of 140.2 dB re 1 μPa-m, variable calls: average source level of 146.6 dB re 1 μPa-m, and stereotyped calls: average source level 152.6 dB re 1 μPa-m) (Veirs, 2004). Additionally, killer whales modify their vocalizations depending on social context or ecological function (i.e., short-range vocalizations [less than 10 km [5 NM] range] are typically associated with social and resting behaviors and long-range vocalizations [10 to 16 km [5 to 9 NM) range] are associated with travel and foraging) (Miller, 2006). Likewise, echolocation clicks are adapted to the type of fish prey (Simon et al., 2007).

Acoustic studies of resident killer whales in British Columbia have found that they possess dialects, which are highly stereotyped, repetitive discrete calls that are group-specific and are shared by all group members (Ford, 2002). These dialects likely are used to maintain group identity and cohesion and may serve as indicators of relatedness that help in the avoidance of inbreeding between closely related whales (Ford, 1991 and 2002). Dialects have been documented in northern Norway (Ford, 2002) and southern Alaskan killer whales populations (Yurk et al., 2002) and are likely occur in other regions as well.

Both behavioral and ABR techniques indicate killer whales can hear a frequency range of 1 to 100 kHz and are most sensitive at 20 kHz, which is one of the lowest maximum-sensitivity frequency known among toothed whales (Szymanski et al., 1999).

***Distribution* –** Killer whales are found throughout all oceans and contiguous seas, from equatorial regions to polar pack ice zones of both hemispheres. Although found in tropical waters and the open ocean, killer whales are most numerous in coastal waters and at higher latitudes (Dahlheim and Heyning, 1999). Ford (2002) noted that this species has a sporadic occurrence in most regions. In the western North Atlantic, killer whales are known from the polar pack ice southward to Florida, the Lesser Antilles, and the Gulf of Mexico (Würsig et al., 2000), where they have been sighted year-round (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997; Würsig et al., 2000). Killer whales are sighted year-round in the northern GOMEX (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997; Würsig et al., 2000).It is not known whether killer whales in the Gulf of Mexico range more widely into the Caribbean Sea and the adjacent North Atlantic (Würsig et al., 2000). Year-round killer whale occurrence in the western North Atlantic is considered to be south of 35° N (Katona et al., 1988).

Atlantic Ocean, Offshore of the Southeastern United States

Several killer whale sightings are recorded in both shallow and deep waters of the VACAPES OPAREA and vicinity. A small number of killer whale sightings are recorded in both shallow and deepwaters of the CHPT and JAX/CHASN OPAREAs and vicinity. Strandings are also reported along the coasts of North Carolina and Florida. Occurrence would be likely seaward of the shoreline year-round based on sighting data and the diverse habitat preferences of this species.

Atlantic Ocean, Offshore of the Northeastern United States

Killer whales may occur year-round in the NE OPAREAs, primarily in waters over the continental shelf and rise, from the Bay of Fundy to New Jersey. They are characterized as uncommon in waters of the U.S. Atlantic EEZ.

Gulf of Mexico

Killer whales in the GOMEX are sighted most often in waters with a bottom depth greater than 200 m (656 ft) (averaging 1,242 m [4,075 ft]; range of 256 to 2,652 m [840 to 8,701 ft]), although there have also been occasional sightings over the continental shelf (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997). Killer whale sightings in the northern GOMEX are generally clumped in a broad region south of the Mississippi River Delta (O'Sullivan and Mullin, 1997). It should be noted, however, that southern Texas (specifically, the Port Aransas area) seems to be an area where there are a number of anecdotal reports of killer whale sightings.

Killer whales are not expected to occur during the winter, however, there are two historical stranding records in the Florida Keys (O'Sullivan and Mullin, 1997). There was a sighting of 14 individuals reported 90 NM (167 km) off Port Aransas, Texas on January 18, 2004 (Mauch, 2004; McCune, 2004).

During the spring, O'Sullivan and Mullin's (1997) assessment showed that killer whales are generally clumped south of the Mississippi River Delta. There is an area of concentration in deep waters of the Gulf that is likely a reflection of a sighting(s) of a large group(s) of individuals and probably does not reflect a true area of concentration for the species.

During summer, there are certainly less reported sightings during this time of year, with the Mississippi River Delta region and southern Texas having the most sightings.

During the fall, killer whales are not expected to occur, however, this is the season with the least amount of survey effort, and inclement weather conditions can make sighting cetaceans difficult during this time of year. Additionally, as noted earlier, killer whales are only sporadically sighted in the Gulf. O'Sullivan and Mullin (1997) erroneously report a November 1951 sighting off southern Texas, attributing this record to Gunter (1954); it should be noted that Gunter reports that sighting as occurring during summer 1951; this was verified by Jefferson and Schiro (1997). The one stranding lists a date of November 26, 1921. This is actually a December 26, 1921 stranding that is reported by Moore (1953) and verified by both Jefferson and Schiro (1997) and O'Sullivan and Mullin (1997) as occurring during December.

3.6.1.2.21 Long-finned and Short-finned Pilot Whales (*Globicephala* spp.)

Description – Pilot whales are among the largest dolphins, with long-finned pilot whales potentially reaching 6 m (19 ft) (females) and 7 m (22 ft) (males) in length. Short-finned pilot whales may reach 6 m (18 ft) (females) and 6 m (20 ft) (males) in length (Jefferson et al., 1993). Pilot whales have bulbous heads, with a forehead that sometimes overhangs the rostrum, and little or no beak. The falcate dorsal fin is distinctive; being generally longer than it is high, with a rounded tip and set well forward of the body's mid-length. The flippers of long-finned pilot whales are extremely long, sickle shaped, and slender, with pointed tips, and an angled leading edge that forms an "elbow". Long-finned pilot whale flippers range from 18 to 27 percent of the total body length. Short-finned pilot whale flippers are sickle shaped. Pilot whales are black, with a light-gray saddle patch behind the dorsal fin in some individuals. There is also a white to light-gray anchor-shaped patch on the chest. Short-finned pilot whales have flippers that are somewhat shorter than long-finned pilot whale at 16 to 22 percent of the total body length (Jefferson et al., 1993).

Status – The best estimate of pilot whale abundance (combined short-finned and long-finned) in the western North Atlantic is 31,139 individuals (Waring et al., 2007). Neither the long-finned or short-finned pilot whale is currently a strategic stock (Waring et al., 2007). Fullard et al. (2000) proposed a stock structure for long-finned pilot whales in the North Atlantic that was correlated with sea-surface temperature. This involved a cold-water population west of the Labrador and North Atlantic current and a warm-water population that extended across the North Atlantic in the warmer water of the Gulf Stream. The best estimate of abundance for the short-finned pilot whale in the northern GOMEX is 2,388 individuals (Mullin and Fulling, 2004; Waring et al., 2006).

Diving Behavior – Pilot whales are deep divers, staying submerged for up to 27 min and routinely diving to 600 to 800 m (1,967 to 2,625 ft) (Baird et al., 2003a; Aguilar de Soto et al., 2005). Mate (1989) described movements of a satellite-tagged, rehabilitated long-finned pilot whale released off Cape Cod that traveled roughly 7,600 km (4,101 NM) during the three months of the tag's operation. Daily movements of up to 234 km (126 NM) are documented. Deep diving occurred mainly at night, when prey within the deep scattering layer approached the surface. Tagged long-finned pilot whales in the Ligurian Sea were also found to make their deepest dives (up to 648 m [2,126 ft]) after dark (Baird et al., 2002). Two rehabilitated juvenile long-finned pilot whales released south of Montauk Point, New York made dives in excess of 26 min (Nawojchik et al., 2003). However, mean dive duration for a satellite tagged long-finned pilot whale in the Gulf of Maine ranged from 33 to 40 sec., depending upon the month (July through September) (Mate et al., 2005).

Acoustics and Hearing – Pilot whale sound production includes whistles and echolocation clicks. Short-finned pilot whale whistles and clicks have a dominant frequency range of 2 to 14 kHz and 30 to 60 kHz, respectively, at an estimated source level of 180 dB re 1 μPa-m peak-to-peak (Fish and Turl, 1976; Ketten, 1998).

There are no hearing data available for either pilot whale species. However, the most sensitive hearing range for odontocetes generally includes high frequencies (Ketten, 1997).

***Distribution* –** Long-finned pilot whales are distributed in subpolar to temperate North Atlantic waters offshore and in some coastal waters. Short-finned pilot whales are found worldwide in warm-temperate and tropical offshore waters. Short-finned pilot whales are considered to be a tropical species that usually does not range north of 50º N or south of 40º S (Jefferson et al., 1993). However, strandings have been reported as far north as New Jersey (Payne and Heinemann, 1993). The apparent ranges of the two pilot whale species overlap in shelf/shelf-edge and slope waters of the northeastern United States between 35°N and 38° to 39°N (New Jersey to Cape Hatteras, North Carolina) (Payne and Heinemann, 1993). The short-finned pilot whale usually does not range north of 50°N or south of 40°S, however, short-finned pilot whales have stranded as far north as Rhode Island. Strandings of long-finned pilot whales have been recorded as far south as South Carolina (Waring et al., 2007). Short-finned pilot whales are common south of Cape Hatteras (Caldwell and Golley, 1965; Irvine et al., 1979). Long-finned pilot whales appear to concentrate during winter along the continental shelf break primarily between Cape Hatteras and Georges Bank (Waring et al., 1990).

Pilot whales concentrate along the continental shelf break from during late winter and early spring north of Cape Hatteras (CETAP, 1982; Payne and Heinemann, 1993). This corresponds to a general movement northward and onto the continental shelf from continental slope waters (Payne and Heinemann, 1993). From June through September, pilot whales are broadly distributed over the continental shelf (Payne et al., 1990a), with the greater percentage of pilot whale sightings along the continental shelf breaks in the northeastern portion of Georges Bank and onto the Scotian Shelf. From May through October, pilot whales predominantly occur on the northern edge of central Georges Bank (Payne et al., 1990a). Movements from June through September continue northward into the Gulf of Maine and into Canadian waters. From September through December, the largest concentrations of pilot whales occur along the southwestern edge of Georges Bank. By December, many pilot whales have already moved offshore and southward (Payne and Heinemann, 1993).

Short-finned pilot whales seem to move from offshore to continental shelf break waters and then northward to approximately 39º N, east of Delaware Bay during summer (Payne and Heinemann, 1993). Sightings coalesce into a patchy continuum and, by December, most short-finned pilot whales occur in the mid-Atlantic slope waters east of Cape Hatteras (Payne and Heinemann, 1993). Although pilot whales appear to be seasonally migratory, sightings indicate common year-round residents in some continental shelf areas, such as the southern margin of Georges

Bank (CETAP, 1982; Abend and Smith, 1999). Only the short-finned pilot whale is known in the GOMEX.

Atlantic Ocean, Offshore of the Southeastern United States

Pilot whales are considered a shelf-edge species. The short-finned pilot whale is considered to be a more tropical species, common south of Cape Hatteras, North Carolina; however, strandings have been reported as far north as New Jersey. Pilot whales are likely to occur in the VACAPES OPAREA in spring, summer, and fall. Both species of pilot whales are likely to occur year-round in waters on the continental shelf, over the shelf break, and into deeper waters past the eastern boundary of the VACAPES OPAREA.

Identifying the species of pilot whale is difficult at sea, and the CHPT OPAREA is located in the overlap area for the ranges of both pilot whale species. North of Cape Hatteras, pilot whales are likely to occur in waters year-round on the continental shelf, over the shelf-edge, and into deep water past the CHPT OPAREA. Pilot whales may occur from the shore to across the continental shelf.

Pilot whales are likely to occur in the JAX/CHASN OPAREA from the vicinity of the continental shelf break into waters seaward of the OPAREA boundary. Pilot whales may occur between the shore and the vicinity of the continental shelf break for all seasons. This is based upon sightings of pilot whales on the continental shelf (including waters quite close to shore) to the north of the JAX/CHASN OPAREA.

Atlantic Ocean, Offshore of the Northeastern United States

Pilot whales may occur year-round, in waters extending from the continental shelf to the continental rise, from the Bay of Fundy south towards the VACAPES OPAREA. In general, spring and summer have the greatest occurrences of pilot whales in the Northeast.

In the wintertime, pilot whales may occur over the continental shelf and slope waters from Jeffreys Bank and south towards the VACAPES OPAREA. Pilot whales seem to primarily occur in the vicinity of the continental slope waters along the southern flank of Georges Bank south towards the VACAPES OPAREA and within Cape Cod Bay. The short-finned pilot whale is considered to be rare in the NE OPAREAs; the species boundary is considered to be in the New Jersey to Cape Hatteras area (Payne and Heinemann, 1993).

In the springtime, pilot whales occur primarily over the continental shelf and slope, in waters extending from Jordan Basin and the Scotian Shelf south towards the VACAPES OPAREA. Sightings are common in Georges Bank during this time of year (Payne and Heinemann, 1993). During this season, greater concentrations of pilot whales may be found just south of the New England Sea Mount Chain and south towards the VACAPES OPAREA, in the vicinity of the continental slope.

In the summertime, pilot whales are generally found in the waters of the continental shelf seaward from the Bay of Fundy and the Scotian Shelf and south towards the VACAPES OPAREA. Pilot whales seem to primarily occur in the vicinity of the continental shelf break in waters from the Scotian Shelf south towards the VACAPES OPAREA, and along the northern flank of Georges Bank. During this season, a greater concentration of pilot whales may occur at mouth of the Northeast Channel.

In the fall, pilot whales may occur in waters over the continental shelf and slope, from the Bay of Fundy and the Scotian Shelf and south towards the VACAPES OPAREA. During this season, pilot whales may be found in greater concentrations near the western tip of Georges Basin, with the greatest concentrations found south near the VACAPES OPAREA, in the vicinity of the continental slope.

Gulf of Mexico

As noted by Jefferson and Schiro (1997), the identifications of many pilot whale specimen records in the GOMEX, and most or all sightings, have not been unequivocally shown to be of the short-finned pilot whale. There are no confirmed records of long-finned pilot whales in the GOMEX (Würsig et al., 2000). Based on known distribution and habitat preferences of pilot whales, it is assumed that all of the pilot whale records in the northern GOMEX are of the short-finned pilot whale (Jefferson and Schiro, 1997; Würsig et al., 2000).

There is a preponderance of pilot whales in the historical records for the northern Gulf. Pilot whales, however, are less often reported during recent surveys, such as GulfCet (Jefferson and Schiro, 1997; Würsig et al., 2000). The reason for this apparent decline is not known, but Jefferson and Schiro (1997) suggested that abundance or distribution patterns might have changed over the past few decades, perhaps due to changes in available prey species which was noted off Catalina Island, California (Shane, 1994).

Mullin and Hansen (1999) noted that pilot whales are sighted almost exclusively west of the Mississippi River. There are a large number of historical strandings on the western coast of Florida and in the Florida Keys.

During the winter, there are no known seasonal changes in occurrence patterns for this species in the Gulf.

Spring is the season with the most survey effort. This species occurs in areas of steep bottom topography in most of the western Gulf, as well as in the region of the Mississippi River Delta and southwest of the Florida Keys.

In the summer, this species occurs in areas of steep bottom topography in most of the western Gulf, in the region of the Mississippi River Delta, and southwest of the Florida Keys. The pattern is similar in many respects to that predicted for spring, with some shifts in areas of concentration that might be indicative of temporal (yearly) differences in survey effort and sighting conditions.

In the fall, occurrence may be concentrated in locations around the shelf break, in particular, south of the Mississippi River Delta, over the continental slope. This is a time of a year with less survey effort than some other seasons (specifically spring and summer); therefore, it is possible that occurrence would be shown over a larger area if there was more survey effort during this time of year.

3.6.1.2.22 Harbor Porpoise (*Phocoena phocoena*)

Description – Harbor porpoises are the smallest cetaceans in the North Atlantic with a maximum length of 2 m (7 ft) (Jefferson et al., 1993). The body is stocky, dark gray to black dorsally and white ventrally. There may be a dark stripe from the mouth to the flipper. The head is blunt, with no distinct beak. The flippers are small and pointed and the dorsal fin is short and triangular, located slightly behind the middle of the back.

Status – There are four proposed harbor porpoise populations in the western North Atlantic: Gulf of Maine and Bay of Fundy, Gulf of St. Lawrence, Newfoundland, and Greenland stocks (Gaskin, 1992). The best estimate of abundance for the Gulf of Maine and Bay of Fundy stock is 89,700 individuals (Waring et al., 2007).

Diving Behavior – Harbor porpoises make brief dives, generally lasting less than 5 min (Westgate et al., 1995). Tagged harbor porpoise individuals spend 3 to 7 percent of their time at the surface and 33 to 60 percent in the upper 2 m (7 ft) (Westgate et al., 1995; Read and Westgate, 1997). Average dive depths range from 14 to 41 m (46 to 135 ft) with a maximum known dive of 226 m (741 ft) and average dive durations ranging from 44 to 103 sec (Westgate et al., 1995). Westgate and Read (1998) noted that dive records of tagged porpoises did not reflect the vertical migration of their prey; porpoises made deep dives during both day and night.

Acoustics and Hearing – Harbor porpoise vocalizations include clicks and pulses (Ketten, 1998), as well as whistle-like signals (Verboom and Kastelein, 1995). The dominant frequency range is 110 to 150 kHz, with source levels between 135 and 205 dB re 1 µPa-m (Ketten, 1998) (Villadsgaard, 2007). Echolocation signals include one or two low-frequency components in the 1.4 to 2.5 kHz range (Verboom and Kastelein, 1995).

A behavioral audiogram of a harbor porpoise indicated the range of best sensitivity is 8 to 32 kHz at levels between 45 and 50 dB re 1 µPa-m (Andersen, 1970); however, auditory-evoked potential studies showed a much higher frequency of approximately 125 to 130 kHz (Bibikov, 1992). The auditory-evoked potential method suggests that the harbor porpoise actually has two frequency ranges of best sensitivity. More recent psycho-acoustic studies found the range of best hearing to be 16 to 140 kHz, with a reduced sensitivity around 64 kHz (Kastelein et al., 2002a). Maximum sensitivity occurs between 100 and 140 kHz (Kastelein et al., 2002a).

Distribution – Harbor porpoises occur in subpolar to cool-temperate waters in the North Atlantic and Pacific (Read, 1999). Off the northeastern United States, harbor porpoise distribution is strongly concentrated in the Gulf of Maine/Georges Bank region, with more scattered occurrences to the mid-Atlantic (CETAP, 1982; Northridge, 1996). Stranding data indicate that the southern limit is northern Florida (Polacheck, 1995; Read, 1999). Genetic evidence suggests limited trans-Atlantic movement (Rosel et al., 1999a).

From July through September, harbor porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy, generally in waters less than 150 m (492 ft) deep (Palka, 1995), with a few sightings in the upper Bay of Fundy and on the northern edge of Georges Bank (Palka, 2000). From October through December, harbor porpoise densities are widely dispersed from New Jersey to Maine, with lower densities to the north and south of this region (NMFS, 2001a). Most harbor porpoises are found on the continental shelf, with some sightings in continental slope and offshore waters (Westgate et al., 1998; Waring et al., 2007). During this time, sightings are concentrated in the southwestern and northern Gulf of Maine, as well as in the Bay of Fundy (CETAP, 1982). From January through March, intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada (NMFS, 2001a). The New Jersey shore and approaches to New York harbor may represent an important January to March habitat (Westgate et al., 1998). A satellite tagged harbor porpoise, “Gus”, was rehabilitated and released off the coast of Maine and followed the continental slope south to near Cape Hatteras between January and March of 2004 (WhaleNet, 2004). During this time of year, significant numbers of porpoises occur along the mid-Atlantic shore from New Jersey to North Carolina, where they are subject to incidental mortality in a variety of coastal gillnet fisheries (Cox et al., 1998; Waring et al., 2007). Mid-Atlantic porpoise bycatches occur from December through May (Waring et al., 2007). Data indicate that only juvenile harbor porpoises are present in nearshore waters of the mid-Atlantic during this time (Cox et al., 1998). Harbor porpoises are not tied to shallow, nearshore waters during winter, as evidenced by a harbor porpoise caught in a pelagic drift net off North Carolina (Read et al., 1996). A largely offshore harbor porpoise distribution during winter explains the paucity of sightings in the Bay of Fundy and Gulf of Maine (CETAP, 1982). However, stocks rather than simply migrants from the Gulf of Maine and Bay of Fundy stock (Rosel et al., 1999b).

A noteworthy unusual mortality event took place between January 1, 2005 and March 28, 2005 during which 38 harbor porpoises stranded along the coast of North Carolina (Hohn et al., 2006; MMC, 2006). Most of the stranded individuals were calves and many were emaciated, indicating that the harbor porpoises had difficulty finding food (MMC, 2006).

Atlantic Ocean, Offshore of the Southeastern United States

The southern limit for this species in the western North Atlantic is northern Florida, based on stranding information. During the winter and spring, there is a concentration of recorded by-catch and strandings in the vicinity of Cape Hatteras, most probably due to catches in gillnets and driftnets. The harbor porpoise is restricted to cool waters, where aggregations of prey are concentrated. They are seldom found in waters warmer than 17°C (64°F). In the VACAPES OPAREA, this species primarily occurs on the continental shelf, but there are also recorded sightings in offshore waters. The harbor porpoise may occur in the fall, winter, and spring from the 2,000 m (6,561.7 ft) isobath to eastward of the boundary of the VACAPES OPAREA. During winter, high concentrations of harbor porpoises are likely in the area from the coastline to the 200 m (656.2 ft) isobath, based on the increase in sighting records of harbor porpoise in this area during winter.

Harbor porpoises are likely to occur only in the northwestern tip of the CHPT OPAREA (with the southern boundary of its occurrence being the Gulf Stream) in the fall and winter. Taken into consideration was the possibility that some individual harbor porpoises might make their way into the northern portion of this OPAREA at that time of the year. There are only some stranding records for south of the Virginia/Maryland border during the spring and fall, and no sightings or by-catch records. During summer, harbor porpoises are concentrated in the northern Gulf of Maine and lower Bay of Fundy region and are not likely to occur as far south as the CHPT OPAREA.

Atlantic Ocean, Offshore of the Northeastern United States

Harbor porpoises occur year-round throughout the northern region of the NE OPAREAs, primarily in continental shelf waters. The overall all distribution seems to be concentrated in the Gulf of Maine, which is consistent with reported findings (CETAP, 1982; Northridge, 1996). The general distribution seems to shift further north in summer and fall.

In the wintertime, harbor porpoises occur in the continental shelf waters, extending from the northern coast of Maine and south towards the VACAPES OPAREA. Most of the occurrence records are in the Gulf of Maine. During winter (January through March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada (NMFS, 2001a).

In the springtime, harbor porpoises generally occur over the continental shelf, in waters extending from the Bay of Fundy to off the coast of Maryland. The distribution of the occurrence records seem to be concentrated in the Gulf of Maine and over Georges Bank.

In the summertime, harbor porpoises primarily occur in waters over the continental shelf, extending from the Bay of Fundy and the Scotian Shelf to off the northern coast of New Jersey. The overall distribution of occurrences seems to shift to the northern regions, with a few scattered occurrences found near Georges Bank. During this season, the harbor porpoise may occur in greater concentrations near the coasts of southern New Brunswick and northern Maine.

In the fall, harbor porpoises may occur in waters over the continental shelf, extending from the Bay of Fundy. The general distribution occurs primarily in the Gulf of Maine. During this season, harbor porpoises may occur in greater concentrations near the southern coast of New Brunswick.

Gulf of Mexico

The harbor porpoise is not expected to occur within the Gulf of Mexico.

3.6.1.3 Pinnipeds

The composition and distribution of the seal population in the northeastern United States has become increasingly complex. The northern part of the U.S. eastern seaboard has experienced a significant increase in stranded ice seals since the late 1980s (Kraus and Early, 1995; McAlpine and Walker, 1999; Sadove et al., 1999; Slocum et al., 1999 and 2003; Mignucci-Giannoni and Odell, 2001). In the winter, there are harp and hooded seals in the Gulf of Maine in numbers never before observed. McAlpine and Walker (1999) speculated that the cause for this increase may be due to the collapsed fish stocks that can no longer support the currently large seal populations, forcing seals to move to less optimal feeding grounds further south. Alteration in the extent and productivity of ice-edge systems may affect the density of important ice-associated prey of pinnipeds, such as Arctic cod (Tynan and DeMaster, 1997).

Pinnipeds occur primarily close to shore in the northern part of the western North Atlantic, although they have been observed some distance from shore during spring in the vicinity of the Great South Channel. The seals commonly occurring in the waters of the Northeast use the numerous islands and ledges to haul out of the water where they rest, pup, and molt. Although there are a few sporadic sighting and bycatch records from MAB waters, pinnipeds do occur in the southern portion of the U.S. Northeast as indicated by the number of stranding records from New York and New Jersey. While more pinniped strandings occur in the winter and spring months, the number of seals sighted at sea and in coastal waters of Maine and Massachusetts is highest in spring and summer. The lower number of pinniped sightings in the fall and winter may be due to the decreased survey effort during those time periods. Hooded Seals (*Cystophora cristata*).

Description – Hooded seals are large; adult males are approximately 6 m (8 ft) in length and weigh on average 300 kg (661 lb), with some individuals reaching over 400 kg (882 lb) (Kovacs, 2002). Females are smaller, measuring approximately 2 m (7 ft) and weighing an average of 200 kg (441 lb) (Kovacs, 2002). Hooded seal pups are blue-black on their backs and silver-gray on their bellies; hence, the common name "blue-back" for the pups. Adults are gray to blue-black in color with an overlay pattern of black mottling (Reeves and Ling, 1981). The face is black to behind the eyes; the flippers are also dark (Reeves and Ling, 1981). The most unique feature of this species is the prominent two-part nasal ornament of sexually mature males that gives the species its common name; it is used to display to females and to other males during the breeding season. When relaxed, this nasal appendage hangs as a loose, wrinkled sac over the front of males' noses. However, when they clamp their nostrils shut and inflate the sac, it becomes a large, tight, bilobed "hood" that covers the front of the face and top of the head. Adult males also have a very elastic nasal septum that they can extrude through one of their nostrils as a membranous pink balloon.

Status – The world's hooded seal population consists of three separate stocks which are identified with a specific breeding site: Western North Atlantic (Newfoundland/Labrador and Gulf of St. Lawrence), eastern Greenland ("West Ice"), and Davis Strait (Waring et al., 2006). The Western North Atlantic stock is divided into two breeding herds: the Front herd breeds off the coast of Newfoundland and Labrador while the Gulf herd breeds in the Gulf of St. Lawrence (Waring et al., 2006). The other two stocks represent separate breeding herds. Recent genetic studies indicate that the world's hooded seals comprise a single panmictic genetic population; therefore, the four breeding herds are not genetically isolated (Coltman et al., 2007).

The best estimate of abundance for western North Atlantic hooded seals is 592,100 (Waring et al., 2007). There are no recent pup counts to assess the current population size in either U.S. waters (Waring et al., 2007). Dramatic increases in hooded seal numbers on Sable Island have occurred concurrently with the recent increases of extralimital occurrences along the northeastern United States (Lucas and Daoust, 2002).

Diving Behavior – Hooded seals feed primarily on deepwater fishes and squids (Reeves and Ling, 1981; Campbell, 1987; Kovacs, 2002). Adult hooded seals can dive to depths of over 1,000 m and remain underwater for nearly an hour (Folkow and Blix, 1999).

Acoustics and Hearing – Hooded seals emit five different vocalizations, although it is suspected that their vocal repertoire is more diverse (Ballard and Kovacs, 1995). Both males as females, as well as different age classes, have been recorded producing sounds (Ballard and Kovacs, 1995). Hooded seal calls are primarily aerial but can be produced underwater. Underwater sounds have most of their energy below 4 kHz and include "grungs", whoops, moans, trills, knocks, snorts, and buzzes (Terhune and Ronald, 1973; Ballard and Kovacs, 1995). Males produce low-frequency sounds in air that coincide with dominance displays utilizing the nasal appendage. Vester et al. (2003) recorded ultrasonic clicks produced by hooded seals, with a frequency range of 66 to 120 kHz and average source levels of 143 dB re 1 μPa-m in conjunction with hunting fish.

There are no direct measurements of the hearing abilities of the hooded seal (Kastelein, 2007; Southall, 2007). Composite Arctic seal hearing data is considered here in the absence of such information as recommended by NMFS (Southall, 2007). The range of underwater hearing for the ringed seal (*Pusa hispida*) ranges from 2.8 to 45 kHz, while in-air, they hear best in the range of 3 to 10 kHz (Terhune and Ronald, 1975). The harp seal's (*Pagophilus groenlandicus*) underwater hearing range is from 1 to 40 kHz, with increased sensitivity at 2 and 22.9 kHz (measured from 0.76 to 100 kHz) (Terhune and Ronald, 1972). In-air, they hear from 1 to 32 kHz with greatest sensitivity at 29 dB at 4 kHz (Terhune and Ronald, 1971).

***Distribution* –** Hooded seals inhabit the pack ice zone of the North Atlantic from the Gulf of St. Lawrence, Newfoundland, and Labrador in the west to the Barents Sea (Campbell, 1987). Hooded seals are not common south of the Gulf of St. Lawrence (Lucas and Daoust, 2002). There was one sighting of a female hooded seal in the Pacific Ocean in 1990; however, this is not typical as she was more than 12,800 km (6,907 NM) outside her normal range (Dudley, 1992). Hooded seals are concentrated in three discrete areas during the breeding season: in the "Front" off the coast of Newfoundland-Labrador and in the Gulf of St. Lawrence, in the Davis Strait, and on the "West Ice" around Jan Mayen Island off eastern Greenland (Campbell, 1987). After the breeding season, hooded seal adults feed along the continental slope off southern Newfoundland and the southern Grand Banks for roughly 20 days before moving northward across the Labrador Basin to west Greenland in June (Bowen and Siniff, 1999). Thereafter, individuals move into traditional molting areas on the southeast Greenland coast, near the Denmark Strait, or in a smaller patch along the northeast Greenland coast (Kovacs, 2002). After the molt in late June and August, hooded seals disperse. Some individuals move south and west around the southern tip of Greenland and then north along western Greenland. Others move to the east and north between Greenland and Svalbard during late summer and early fall (Waring et al., 2006). Not much is known about the activities of hooded seals during the remainder of the year from molting until they reassemble in February for breeding (Campbell, 1987).

The range of hooded seals may be considerably influenced by changes in ice cover and climate (Campbell, 1987; Johnston et al., 2005a). Hooded seals can make extensive movements and show a tendency toward wandering, with extralimital sightings documented as far south as Puerto Rico and the Virgin Islands (Mignucci-Giannoni and Odell, 2001; Mignucci-Giannoni and Haddow, 2002). Most extralimital sightings occur between late January and mid-May off the northeastern United States and during summer and fall off the southeastern United States and in the Caribbean Sea (McAlpine et al., 1999a; McAlpine et al., 1999b; Harris et al., 2001; Mignucci-Giannoni and Odell, 2001). These extralimital animals have primarily been immature individuals, although adults are occasionally reported, including an incidence of pupping in Maine (Richardson, 1975; Jakush, 2004). Between January and September 2006, a total of 55 hooded seals stranded along the East Coast and as far south as the U.S. Virgin Islands; the majority of these strandings occurred during July, August, and September (NOAA, 2006c).

Atlantic Ocean, Offshore of the Southeastern United States

Hooded seals are one of the two species of ice seals that are recognized as great wanderers but rarely venture into the VACAPES or CHPT regions. There are three records for hooded seals for North Carolina. Although they appear in places far from their normal breeding and foraging range, hooded seals are not expected to occur within these OPAREAs. There are five records for hooded seals for Georgia and Florida; the majority of these records are for July and August. Hooded seals are not expected to occur in JAX/CHASN OPAREA.

Atlantic Ocean, Offshore of the Northeastern United States

Hooded seals may occur throughout the NE OPAREAs, from the northern coast of Maine to the southern coast of Delaware. In general, the occurrence of hooded seals is greatest during winter.

Gulf of Mexico

The hooded seal is not expected to occur within the Gulf of Mexico.

3.6.1.3.1 Harp Seals (*Pagophilus groenlandicus*)

Description – These medium-sized phocid seals reach a size of 2 m (6 ft) and 130 kg (287 lb); females are slightly smaller (Lavigne, 2002). Adults typically have a light gray pelage, a black face, and a black saddle behind the shoulders. This black saddle extends in a lateral band on both sides toward the pelvis, forming a pattern that resembles a harp. Some adults are sparsely spotted, with the harp pattern not completely developed (Reeves et al., 2002b). Newborn pups, called "whitecoats" have a long, white coat that is replaced soon after weaning (at about 3 to 4 weeks) by a short, silver pelage with scattered, small dark spots.

Status – The harp seal is the most abundant pinniped in the western North Atlantic Ocean (Hammill and Stenson, 2005). The 2004 Canadian population is estimated at around 5.9 million seals and has changed little since 1996 (DFO, 2005). Data are insufficient to calculate a population estimate for U.S. waters (Waring et al., 2007). The total population of harp seals is divided among three separate breeding stocks in the White Sea, the Greenland Sea between Jan Mayen and Svalbard, and the western North Atlantic (Reeves et al., 2002b). The western North Atlantic stock is the largest; it is divided into two breeding herds: The "Front" herd breeds off the coast of Newfoundland and Labrador, while the "Gulf" herd breeds near the Magdalen Islands (Reeves et al., 2002b; Waring et al., 2007).

In addition to subsistence hunts in the Canadian Arctic and Greenland, harp seals are harvested commercially in the Gulf of St. Lawrence and off the coast of northeast Newfoundland and Labrador (DFO, 2003a).

Diving Behavior – Most foraging occurs at depths of less than 90 m (295 ft), although dives as deep as 568 m (1,864 ft) have been recorded (Lydersen and Kovacs, 1993; Folkow et al., 2004).

Acoustics and Hearing – The harp seal's vocal repertoire consists of at least 27 underwater and two aerial call types (Serrano, 2001). Harp seals are most vocal during the breeding season (Ronald and Healey, 1981). Serrano (2001) found that calls of low frequency and with few pulse repetitions were predominantly used outside the breeding season, while calls of high frequency and with a high number of pulse repetitions predominated in the breeding season. Terhune and Ronald (1986) measured source levels of underwater vocalizations of 140 dB re 1 μPa-m. Vester et al. (2001) recorded ultrasonic clicks with a frequency range of 66 to 120 kHz, with the main energy at 93±22 kHz and average source levels of 143+ dB re 1 μPa-m in conjunction with live fish hunting.

Behavioral audiograms have been obtained for harp seals (Terhune and Ronald, 1972). The harp seal's ear is adapted for better hearing underwater. Underwater, hearing measures between 0.76 to 100 kHz, with areas of increased sensitivity at 2 and 22.9 kHz (Terhune and Ronald, 1972). In air, hearing is irregular and slightly insensitive with the audiogram being generally flat (Terhune and Ronald, 1971).

Distribution – Harp seals are distributed in the pack ice of the North Atlantic and Arctic oceans, from Newfoundland and the Gulf of St. Lawrence to northern Russia (Reeves et al., 2002b). Most of the western North Atlantic harp seals congregate off the east coast of Newfoundland-Labrador (the Front) to pup and breed. The remainder (the Gulf herd) gather to pup near the Magdalen Islands in the Gulf of St. Lawrence (Ronald and Dougan, 1982). Females reach the breeding grounds at the Gulf of St. Lawrence by mid-February and at the Front by early March (Ronald and Dougan, 1982). During the early period of pupping, males are found in separate concentrations. Once mating has ended, harp seals move to more northerly ice in preparation for the annual molt, leaving the newly weaned pups at the breeding grounds. In April, juveniles of both sexes and adult males form dense molting concentrations on the pack ice at the Front. Adult females join these concentrations in late April. By mid-May, most of the population follows the retreating ice edge north. After molting in April, harp seals leave the drifting ice and move north along the east coast of Canada toward their Arctic summering grounds, spending this time in the open water among the ice floes of the Eastern Canadian Arctic or along the west coast of Greenland. Harp seals arrive in June when capelin (an important prey item) concentrate to spawn (Bowen and Siniff, 1999). With the formation of new ice in September, harp seals begin their southward movements along the Labrador coast, usually reaching the entrance to the Gulf of St. Lawrence by early winter (Waring et al., 2004). There, the population then splits into the two breeding groups, one moving into the Gulf of St. Lawrence and the other remaining off the coast of Newfoundland. During January and February, adult harp seals disperse widely throughout the Gulf of St. Lawrence and over the continental shelf off Newfoundland to fatten in preparation for reproduction. Not all juvenile harp seals make the southward mass movement; some remain in the Arctic along the southwestern coast of Greenland (Bowen and Siniff, 1999). The large-scale movements of harp seals represent an annual round trip of more than 4,000 km (2,158 NM) (Bowen and Siniff, 1999).

The number of sightings and strandings of harp seals off the northeastern U.S. has been increasing (McAlpine and Walker, 1990; Rubinstein, 1994; Stevick and Fernald, 1998; McAlpine et al., 1999a; McAlpine et al., 1999b; Harris et al., 2002). These occurrences are usually during January through May (Harris et al., 2002), when the western North Atlantic stock of harp seals is at its most southern point in distribution (Waring et al., 2004). Harp seals occasionally enter the Bay of Fundy; however, McAlpine and Walker (1999) suggested that winter ocean surface currents might limit the probability of extralimital occurrences into this bay.

Atlantic Ocean, Offshore of the Southeastern United States

On occasion, a harp seal wanders south of the normal feeding and breeding areas off Newfoundland during the wintertime. There is a record of an adult harp seal that was found in March, 1945 at Cape Henry, Virginia. A few of these wandering seals stay into the summer months in southern waters. Strandings outside of the normal species range occur between early February and late May and involve animals of both sexes and various ages. Harp seals are not expected to occur within the VACAPES, CHPT, or JAX/CHASN OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

Harp seals may occur in the NE OPAREAs from the northern coast of Maine to the southern coast of Delaware during winter and spring and from southern coast of Maine to Long Island during fall. Occurrence information is derived almost solely from the stranding record. There is only one occurrence record of harp seals near the southern coast of Maine during summer.

Gulf of Mexico

The harp seal is not expected to occur within the Gulf of Mexico.

3.6.1.3.2 Gray Seals (*Halichoerus grypus*)

Description **–** Gray seals are large and robust; adult males can reach 2 m (7 ft) in length and weigh 310 kg (683 lb) (Jefferson et al., 1993). The sexes are sexually dimorphic; males are up to three times larger than females (Bonner, 1981). The species name *grypus* means “hook-nosed”, referring to the Roman nose profile of the adult male (Hall, 2002). In Canada, the gray seal is often referred to as the ‘horse-headed” seal due to the elongated snout of the males (Lesage and Hammill, 2001). The head has a wide muzzle, and the nostrils form a distinctive, almost “W” shape (Jefferson et al., 1993). Pelage color and pattern are individually variable, with most gray seals seen in shades of gray, slightly darker above than below (Jefferson et al., 1993). There are usually numerous irregular blotches and spots on the back. Males are generally more uniformly dark when mature whereas females exhibit the more distinct markings on the fur (Hall, 2002).

Status **–** Next to harbor seals, gray seals are the most commonly sighted seal in the northeastern United States. There are at least three populations of gray seal in the North Atlantic Ocean: eastern North Atlantic, western North Atlantic, and Baltic (Boskovic et al., 1996). The western North Atlantic stock is equivalent to the eastern Canada breeding population (Waring et al., 2007). There are two breeding concentrations in eastern Canada: one at Sable Island and the other on the pack ice in the Gulf of St. Lawrence. These two breeding groups are treated as separate populations for management purposes (Mohn and Bowen, 1996). There is an estimated 195,000 gray seals in Canada (DFO, 2003a). The herd on Sable Island is thought be growing and may have more than doubled in number, but the Gulf of St. Lawrence population is declining (Bowen et al., 2003). This decline has been attributed to sharp decline in the quantity of suitable ice breeding habitat in the southern Gulf of St. Lawrence possibly due to climate change (Hammill et al., 2003).

Present data are insufficient to calculate the minimum population estimate for gray seals in U.S. waters (Baraff and Loughlin, 2000; Waring et al., 2007). Gray seal abundance appears to be increasing in the U.S. Atlantic EEZ (Waring et al., 2007).

Diving Behavior **–** While at sea, and even when traveling, gray seals do not swim at the water's surface (Thompson and Fedak, 1993). Gray seals are able to dive to depths up to 400 m (1,312 ft); however, the majority of dives are only 40 to 100 m (131 to 328 ft) (Goulet et al., 2001; Lesage and Hammill, 2001). The maximum dive duration is just over 9 min (Lydersen et al., 1994). In areas with deeper waters, gray seals are reported to dive for as long as 32 min (Thompson and Fedak, 1993; Goulet et al., 2001). Surface intervals between dives are most often 1.2 min (Boyd and Croxall, 1996).

Acoustics and Hearing **–** Ketten (1998) determined that most pinnipeds species have peak sensitivities between 1 to 20 kHz. Asselin et al. (1993) classified all gray seal vocalizations into seven call types. The majority of calls consisted of guttural "rups" and "rupes", ranging from 0.1 to 3 kHz, or low-frequency growls ranging from 0.1 to 0.4 kHz (Asselin et al., 1993).

Distribution **–** The gray seal is found throughout temperate and subarctic waters on both sides of the North Atlantic Ocean (Davies, 1957). In the western North Atlantic Ocean, the gray seal population is centered in the Canadian Maritimes, including the Gulf of St. Lawrence and the Atlantic Coasts of Nova Scotia, Newfoundland, and Labrador. The largest concentrations are found in the southern half of the Gulf of St. Lawrence (where most seals breed on ice) and around Sable Island (where most seals breed on land) (Davies, 1957; Hammill and Gosselin, 1995; Hammill et al., 1998).

Gray seals were historically distributed along the northeastern United States from Maine to Connecticut (Waters, 1967; Rough, 1995; Wood et al., 2003). It is thought they were extirpated during the 17th century, possibly due to Native American exploitation, European colonization/exploitation, and/or climate change (Waters, 1967; Wood et al., 2003). Gray seals currently range into the northeastern United States, with strandings as far south as North Carolina (Hammill et al., 1998; Waring et al., 2007). Small numbers of gray seals and pupping have been observed on several isolated islands along the central coast of Maine and in Nantucket Sound (the southernmost breeding site is Muskeget Island) (Andrews and Mott, 1967; Rough, 1995; Waring et al., 2007). Resident colonies and pupping has been observed in Maine since 1994, on a few islands (Seal and Green) in Penobscot Bay (Waring et al., 2007). Spring and summer sightings off Maine are primarily on offshore ledges of the central coast of Maine (Richardson, 1976). In the late 1990s, a breeding population of at least 400 animals was documented year-round on outer Cape Cod and Muskeget Island (Barlas, 1999; Waring et al., 2004). Hoover et al. (1999) reported sighting as many as 30 adult gray seals at one haul out site in New York. There are also gray seal sightings and strandings on Long Island Sound.

From December to February, gray seals in the western North Atlantic Ocean aggregate into two main breeding colonies located on Sable Island and in the southern Gulf of St. Lawrence. Post-breeding, gray seals disperse widely; they remain offshore until the spring molt (May to June) (Rough, 1995; Lesage and Hammill, 2001). After the molt is completed, there is a second dispersal; the destination of these dispersals off eastern Canada is varied and depends on the originating population (Sable Island versus non-Sable Island). In November to December, gray seals return to the southern Gulf of St. Lawrence or to Sable Island for the breeding season. Some gray seals found breeding in the northeastern United States bear brands and tags indicating that they had been born on Sable Island (Wood et al., 2003).

Atlantic Ocean, Offshore of the Southeastern United States

Gray seals occur from southern New England to Labrador, but the highest concentration of this species is centered in the Sable Island region off Nova Scotia. Vagrants have been reported as far south as Virginia. A female pupped at Assateague Island, Virginia, in 1986; another birth was reported at the same place in 1989. Gray seals are not expected to occur in the VACAPES, CHPT, or JAX/CHASN OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

Gray seals may occur year round throughout the continental shelf region of the NE OPAREAs. The distribution of gray seals is focused primarily in the Bay of Fundy during spring through fall, extending further south during winter and spring. Gray seals range south into the northeastern United States, with strandings reported as far south as North Carolina (Hammill et al., 1998; Waring et al., 2004).

In the wintertime, the general occurrence of gray seals extends from the Bay of Fundy to Delaware, in waters on the continental shelf and near the coast.

In the springtime, gray seals may occur in waters on the continental shelf and near the coast, extending from the Bay of Fundy to Delaware. During this season, gray seals may occur in greater concentrations in the Bay of Fundy.

In the summertime, gray seals generally occur in waters on the continental shelf and near the coast, extending from the Bay of Fundy and the Scotian Shelf to Long Island.

In the fall, gray seals may occur in waters on the continental shelf and near the coast, extending from the Bay of Fundy and the Scotian Shelf to Nantucket, with one record of occurrence near the Delaware coast. During this season, gray seals may occur in greater concentrations in the Bay of Fundy.

Gulf of Mexico

The gray seal is not expected to occur within the Gulf of Mexico.

3.6.1.3.3 Harbor Seals (*Phoca vitulina concolor*)

Description **–** The harbor seal (or common seal) is a small- to medium-sized seal. Adult males attain a maximum length of 1.9 m (6.2 ft) and weigh 70 to 150 kg (154 to 331 lb); females reach 1.7 m (5.6 ft) in length and weigh between 60 and 110 kg (132 to 243 lb) (Jefferson et al., 1993). The harbor seal has a dog-like head with nostrils that form a broad V-shape; this is one of the characteristics that distinguish them from immature gray seals (Baird, 2001). Adult harbor seals exhibit considerable variability in the color and pattern of their pelage; the background color is tannish-gray overlaid by small darker spots, ring-like markings, or blotches (Bigg, 1981).

Status **–** Five subspecies of *Phoca vitulin*a are recognized; *Phoca vitulina concolor* is the form found in the western North Atlantic (Rice, 1998). Harbor seals are the most common and frequently reported seals in the northeastern United States (Katona et al., 1993). Currently, harbor seals along the coast of the eastern United States and Canadian coasts are considered a single population (Waring et al., 2007).

Pressure from hunting bounties in the late 1800s through 1962 resulted in a reduction or complete elimination of harbor seals in heavily exploited areas (Barlas, 1999). A limit to the southward dispersion of harbor seals from Maine rookeries indirectly lead to their present seasonal occurrence. During the winter of 1980, a large-scale influenza epidemic in Gulf of Maine harbor seals resulted in a mass mortality event (Geraci et al., 1982). The population has since rebounded.

The best estimate of abundance of harbor seals in the western North Atlantic stock is 99,340 individuals (Waring et al., 2007). An estimated 5,575 harbor seals over-wintered in southern New England in 1999, increasing from an estimated 2,834 individuals in 1981 (Barlas, 1999). Kraus and Early (1995) suggested that the northeastern U.S. population increase could represent increasing southward shifts in wintering distribution.

Diving Behavior **–** Harbor seals are generally shallow divers. About 50 percent of dives are shallower than 40 m (131 ft) and 95 percent are shallower than 250 m (820 ft) (Gjertz et al., 2001; Krafft et al., 2002; Eguchi and Harvey, 2005). Dive durations are shorter than 10 min, with about 90 percent lasting less than 7 min (Gjertz et al., 2001). However, a tagged harbor seal in Monterey Bay dove as deep as 481 m (1,578 ft) and dive durations for older individuals may be as long as 32 min (Eguchi and Harvey, 2005). Harbor seal pups swim and dive with their mothers, although for shorter periods when mothers are performing bouts of relatively deep dives (Bowen et al., 1999; Jørgensen et al., 2001; Bekkby and Bjørge, 2003).

Acoustics and Hearing **–** Harbor seal males and females produce a variety of low-frequency in-air vocalizations including snorts, grunts, and growls, while pups make individually unique calls for mother recognition (main energy at 0.35 kHz) (Thomson and Richardson, 1995). Adult males also produce several underwater sounds such as roars, bubbly growls, grunts, groans, and creaks during the breeding season. These sounds typically range from 0.025 to 4 kHz (duration range: 0.1 sec to 11 seconds) (Hanggi and Schusterman, 1994). Hanggi and Schusteman (1994) found that there is individual variation in the dominant frequency range of sounds between different males, and Van Parijs et al. (2003) reported oceanic, regional, population, and site-specific levels of variation (i.e., could represent vocal dialects) between males.

Harbor seals hear nearly as well in air as underwater (Kastak and Schusterman, 1998). Harbor seals are capable of hearing frequencies from 1 to 180 kHz (most sensitive at frequencies between 1 kHz and 60 kHz using behavioral response testing) in water and from 0.25 to 30 kHz in air (most sensitive from 6 to 16 kHz using behavior and auditory brainstem response testing) (Richardson, 1995; Terhune and Turnbull, 1995; Wolski et al., 2003). Despite the absence of an external ear, harbor seals are capable of directional hearing in-air, giving them the ability to mask out background noise (Holt and Schusterman, 2007). Underwater sound localization was demonstrated by Bodson et al. (2006). TTS for the harbor seal was assessed at 2.5 kHz and 3.53 kHz (exposure level was 80 and 95 dB above threshold), by Kastak et al. (2005). Data indicated that the range of TTS onset would be between 183-206 dB re: 1μPa^2-s (Kastak et al., 2005).

Distribution **–** Harbor seals are one of the most widespread pinniped species and are found in subarctic to temperate nearshore waters. Their distribution ranges from the east Baltic west across the Atlantic and Pacific Oceans to southern Japan (Stanley et al., 1996). Harbor seals are year-round residents of eastern Canada (Boulva, 1973) and coastal Maine (Katona et al., 1993; Gilbert and Guldager, 1998). The greatest concentrations of harbor seals in northeastern U.S. waters are found along the coast of Maine, specifically in Machias and Penobscot bays and off Mt. Desert and Swans Islands (Katona et al., 1993).

Harbor seals occur south of Maine from late September through late May (Rosenfeld et al., 1988; Whitman and Payne, 1990; Barlas, 1999; Schroeder, 2000). During winter, the population divides and disperses offshore into the Gulf of Maine south into southern New England, and a portion remains in coastal waters of Maine and Canada. Harbor seals have recently been observed over-wintering as far south as New Jersey (Slocum et al., 1999). Payne and Selzer (1989) noted that 75 percent of harbor seals south of Maine are located at haulout sites on Cape Cod and Nantucket Island, with the largest aggregation occurring at Monomoy Island and adjacent shoals. Although harbor seals of all ages and both sexes frequent winter haulout sites south of Maine, many of the over-wintering individuals are immature, suggesting that there might be seasonal segregation resulting from age-related competition for haulout sites near preferred pupping ledges and age-related differences in food requirements (Whitman and Payne, 1990; Slocum and Schoelkopf, 2001). Extralimital occurrences have been observed as far south as Florida (Caldwell and Caldwell, 1969; Waring et al., 2007).

From at least October through December, harbor seal numbers decrease in Canadian waters (Terhune, 1985) but increase three to five fold south of Maine (Rosenfeld et al., 1988). A general southward movement along the Canadian coast and northeastern United States is thought to occur during this period (Rosenfeld et al., 1988). Tagging efforts by Gilbert and Wynne (1985) support this hypothesis. Tagged harbor seals in Nova Scotia and Maine were later resighted in Massachusetts. Prior to pupping, this generalized movement pattern reverses as animals move northward to the coasts of Maine and eastern Canada.

Atlantic Ocean, Offshore of the Southeastern United States

Vagrant harbor seals are occasionally found as far south as the Carolinas and Daytona Beach, Florida. Harbor seals are not expected to occur in the VACAPES, CHPT, or JAX/CHASN OPAREAs. Harbor seals that occur in these areas are apparently young individuals that disperse from the north during the winter.

Atlantic Ocean, Offshore of the Northeastern United States

Harbor seals may occur year round in waters over the continental shelf, extending from the Bay of Fundy to Delaware. Harbor seals occur south of Maine seasonally from late September through late May (Schneider and Payne, 1983; Payne and Schneider, 1984; Rosenfeld et al., 1988; Whitman and Payne, 1990; Barlas, 1999; Hoover et al., 1999; Schroeder and Kenney, 2001).The overall distribution of harbor seals shifts towards the southern region of the NE OPAREAs during winter and towards the northern region during summer. Few sighting records exist for harbor seals and all other seal species found in the NE OPAREAs due to low sightability of seals during aerial and shipboard surveys.

In the wintertime, harbor seals may be found in waters on the continental shelf and near the coast, extending from the southern coast of New Brunswick to the coast of Delaware.

In the springtime, harbor seals occur primarily in waters on the continental shelf and near the coast, extending from the Bay of Fundy to the southern tip of New Jersey. During this season, harbor seals may occur in greater concentrations off the western coast of Nova Scotia and northern coast of Maine.

In the summertime, harbor seals occur in waters on the continental shelf and near the coast, extending from the Bay of Fundy and Roseway Basin to Delaware. During this season, harbor seals may occur in greater concentrations in Roseway Basin, with the greatest occurrences found in Penobscot bays, near the coast of Maine just north of Jeffreys Bank. The greatest concentrations of seals in northeastern U.S. waters are found along the coast of Maine, specifically in Machias and Penobscot bays and off Mt. Desert and Swans islands (Katona et al., 1993).

In the fall, the general occurrence of harbor seals is found in waters on the continental shelf and near the coast, extending from the Bay of Fundy to Delaware.

Gulf of Mexico

The harbor seal is not expected to occur within the Gulf of Mexico.

3.6.1.3.4 Ringed Seals (*Pusa hispida*)

Description – The ringed seal is one of the smallest pinnipeds. Adults are up to 1.7 m (5.6 ft) in length and weigh 50 to 110 kg (110 to 245 lb). Ringed seals resemble harbor seals, but are decidedly plumper. The ringed seal's coloration is its most distinctive feature. Ringed seal fur is light gray with black spots circled with rings of lighter color (Jefferson et al., 1993).

Status – The ringed seal is the most numerous seal in the Northern Hemisphere (Frost and Lowry, 1981). There are five subspecies of the ringed seal; three occur in marine waters, while two are found in freshwater lakes (Amano et al., 2002). This species is primarily hunted throughout the Arctic for subsistence purposes (DFO, 2003a).

Diving Behavior – Median dive duration is less than 10 min for ringed seals (Lydersen, 1991; Teilmann et al., 1999; Gjertz et al., 2000). Ringed seals occasionally dive up to 50 min or longer (Gjertz et al., 2000). Ringed seals occasionally dive to depths of more than 250 m (820 ft) (Teilmann et al., 1999), though most dives are shallower than 100 m (328 ft) (Lydersen, 1991; Teilmann et al., 1999; Gjertz et al., 2000).

Acoustics and Hearing – Ringed seals produce clicks with a fundamental frequency of 4 kHz and varying harmonics up to 16 kHz (Schevill et al., 1963). Stirling (1973) described barks, high-pitched yelps, and low and high-pitched growls. Ringed seals appear to be most vocal during the breeding season (Stirling et al., 1983). Ringed seals are sensitivity to underwater sounds in the 8 to 60 kHz band (Terhune and Ronald, 1975 and 1976). The hearing ability of ringed seals has not been tested below 1 kHz (Terhune and Ronald, 1975).

Distribution – The ringed seal has a circumpolar distribution throughout the Arctic Ocean, Hudson Bay, and Baltic and Bering seas (Reeves et al., 2002b). The ringed seal is expected only as far south as Newfoundland (Frost and Lowry, 1981). Ringed seals are able to cover long distances in relatively short times, with extralimital strays occasionally found as far south as Portugal in the Atlantic Ocean and California in the Pacific (van Bree, 1996; Ridoux et al., 1998; Lucas and McAlpine, 2002). These extralimital strays are not necessarily lost to the population, since at least one individual is known to have returned to the vicinity of known normal ringed seal distribution (Ridoux et al., 1998).

Atlantic Ocean, Offshore of the Southeastern United States

The ringed seal is not expected to occur within the Atlantic Ocean, offshore of the Southeastern United States.

Atlantic Ocean, Offshore of the Northeastern United States

The ringed seal is extralimital at all times of the year offshore of the Northeastern United States. Although ringed seals sporadically strand in the Northeast United States (Katona et al., 1993; Slocum and Schoelkopf, 2001).

Gulf of Mexico

The ringed seal is not expected to occur within the Gulf of Mexico.

3.6.1.3.5 Walrus (*Odobenus rosmarus*)

Description – The walrus is a large pinniped. Adult males are substantially larger than females; males can attain lengths of 3.6 m (11.8 ft) and a weight up to 1,900 kg (4,189 lb), while females are up to 3 m (10 ft) in length and 1,200 kg (2,646 lb) in weight (Reeves et al., 2002b). The walrus has a large, robust torso, which is massive in adult males, that dwarfs its relatively small head (Fay, 1981). Perhaps the most distinguishing feature is the pair of long tusks, which are enlarged upper canine teeth that grow continually throughout the animal's life (Reeves et al., 2002b). Walruses use their tusks mainly in social interactions, such as when males compete with one another for females during the breeding season, but also as an aid in hauling out and moving on ice floes (Reeves et al., 2002b). Walruses are sparsely covered with hair.

Status – Rice (1998) recognizes three subspecies of walrus, though Born et al. (2001) recognizes only the Atlantic and Pacific walruses. *Odobenus rosmarus rosmarus* occurs in the Atlantic-Arctic (Rice, 1998). There are eight stocks of Atlantic walrus (Born et al., 2001). Subsistence hunting for walrus occurs throughout this species' normal range.

Diving Behavior – Walruses feed on benthic invertebrates at depths of less than 80 m (262 ft). The deepest recorded dive for this species was to 133 m (436 ft). Feeding walruses dive for approximately 5 min and then remain at the surface for 1 to 2 min.

Acoustics and Hearing**–** Walruses produce both aerial and underwater vocalizations; these are in the 0.5 to 8 kHz frequency range. The only source-level measurement of walrus vocalizations is of rutting whistles, which are 120 db re 1 μPa-m. During the breeding season, mature males produce underwater songs. There are four different types of these songs: coda song, diving vocalization song, intermediate song, and aberrant song. Walrus hearing is adapted to low frequency sound. The range of best hearing is from 1 to 12 kHz; maximum hearing sensitivity is at 12 kHz.

Distribution **–** The walrus has a disjunct circumpolar distribution in the Northern Hemisphere. The Atlantic walrus ranges from the eastern Canadian Arctic east to the Kara Sea in northern Russia (Reeves et al., 2002b). There are numerous extralimital records for walruses; in the western North Atlantic, walruses have been reported beyond their normal range in the Canadian Arctic, and as far south as Massachusetts in the northeastern United States (Allen, 1930; Manville and Favour, 1960; Harington, 1966; Wright, 1951; Mercer, 1967; Richer, 2003).

Because of their benthic mode of feeding, walrus are generally confined to the continental shelf where bottom depths are no greater than 80 to 100 m (262 to 328 ft) (NAMMC, 2004). The walrus primarily inhabits waters with moving pack ice. Walruses appear to prefer ice as a substrate on which to haulout, though they will also haulout on land (Fay, 1981).

Atlantic Ocean, Offshore of the Southeastern United States

The walrus is not expected to occur within the Atlantic Ocean, offshore of the Southeastern United States.

Atlantic Ocean, Offshore of the Northeastern United States

The walrus is extralimital at all times of the year to the NE OPAREAs.

Gulf of Mexico

The walrus is not expected to occur within the Gulf of Mexico.

3.6.1.4 Sirenians

3.6.1.4.1 West Indian Manatee (*Trichechus manatus*)

Description **–** The West Indian manatee is a rotund, slow-moving animal, which reaches a maximum length of 3.9 m (12.8 ft) (Jefferson et al., 1993). The manatee has a small head, a squarish snout containing two semi-circular nostrils at the front, and fleshy mobile lips. The tail is horizontal, rounded, and paddle-shaped. The body is gray or gray-brown and is covered with fine hairs that are sparsely distributed. The back of larger animals is often covered with distinctive scars from boat propeller cuts (Moore, 1956).

Status **–** West Indian manatees are classified as endangered under the ESA. West Indian manatee numbers are assessed by aerial surveys during the winter months when manatees are concentrated in warm-water refuges. Aerial surveys conducted in February 2006 produced a preliminary abundance estimate of 3,116 individuals (FMRI, 2006). Along Florida's Gulf Coast, observers counted 1,474 West Indian manatees, while observers on the Atlantic coast counted 1,639. In the most recent revision of the West Indian manatee recovery plan, it was concluded that, based upon movement patterns, West Indian manatees around Florida should be divided into four relatively discrete management units or subpopulations, each representing a significant portion of the species' range (USFWS, 2001). West Indian manatees found along the Atlantic U.S. coast are of the Atlantic Region subpopulation (USFWS, 2001). Manatees from the western coast of Florida make up the other three subpopulations: Upper St. Johns River Region, Northwest Region, and the Southwest Region (USFWS, 2001).

In 1976, critical habitat was designated for the West Indian manatee in Florida (USFWS, 1976). The designated area included all of the West Indian manatee's known range at that time (including waterways throughout about one-third to one-half of Florida) (Laist, 2002). This critical habitat designation has been infrequently used or referenced since it is broad in description, treats all waterways the same, and does not highlight any particular areas (Laist, 2002). There are two types of manatee protection areas in the state of Florida: manatee sanctuaries and manatee refuges (USFWS, 2001, 2002a and 2002b). Manatee sanctuaries are areas where all waterborne activities are prohibited while manatee refuges are areas where activities are permitted but certain waterborne activities may be regulated (USFWS, 2001, 2002a, and 2002b).

Diving Behavior – Manatees are shallow divers. The distribution of preferred seagrasses is mostly limited to areas of high light; therefore, manatees are fairly restricted to shallower nearshore waters (Wells et al., 1999). It is unlikely that manatees descend much deeper than 20 m (66 ft), and don't usually remain submerged for longer than 2 to 3 minutes. However, when bottom resting, manatees have been known to stay submerged for up to 24 minutes (Wells et al., 1999).

Acoustics and Hearing **–** West Indian manatees produce a variety of squeak-like sounds that have a typical frequency range of 0.6 to 12 kHz (dominant frequency range from 2 to 5 kHz), and last 0.25 to 0.5 s (Steel and Morris, 1982; Thomson and Richardson, 1995; Niezrecki et al., 2003). Recently, vocalizations below 0.1 kHz have also been recorded (Frisch and Frisch, 2003; Frisch, 2006). Overall, West Indian manatee vocalizations are considered relatively stereotypic, with little variation between isolated populations examined (i.e., Florida and Belize; Nowacek et al., 2003). However, vocalizations have been newly shown to possess nonlinear dynamic characteristics (e.g., subharmonics or abrupt, unpredictable transitions between frequencies), which could aid in individual recognition and mother-calf communication (Mann et al., 2006). Average source levels for vocalizations have been calculated to range from 90 to 138 dB re: 1 μPa (average: 100 to 112 dB re: 1 μPa) (Nowacek et al., 2003; Phillips et al., 2004). Behavioral data on two animals indicate an underwater hearing range of approximately 0.4 to 46 kHz, with best sensitivity between 16 and 18 kHz (Gerstein et al., 1999), while earlier electrophysiological studies indicated best sensitivity from 1 to 1.5 kHz (Bullock et al., 1982).

Distribution **–** West Indian manatees occur in warm, subtropical, and tropical waters of the western North Atlantic Ocean, from the southeastern United States to Central America, northern South America, and the West Indies (Lefebvre et al., 2001). West Indian manatees occur along both the Atlantic and Gulf coasts of Florida. West Indian manatees are sometimes reported in the Florida Keys; these sightings are typically in the upper Florida Keys, with some reports as far south as Key West (Moore, 1951a and 1951b; Beck, 2006a). During winter months, the West

Indian manatee population confines itself to inshore and inner shelf waters of the southern half of peninsular Florida and to springs and warm water outfalls (e.g., power plant cooling water outfalls) just beyond northeastern Florida. As water temperatures rise in spring, West Indian manatees disperse from winter aggregation areas. West Indian manatees are frequently reported in coastal rivers of Georgia and South Carolina during warmer months (Lefebvre et al., 2001). Historically, West Indian manatees were likely restricted to southernmost Florida during winter and expanded their distribution northward during summer. However, industrial development has made warm-water refuges available (e.g., power plant effluent plumes), and the introduction of several exotic aquatic plant species has expanded the available food supply. These factors have enabled an expansion of West Indian manatee winter range (USFWS, 2001; Laist and Reynolds III, 2005).

Several patterns of seasonal movement are known along the Atlantic coast ranging from year-round residence to long-distance migration (Deutsch et al., 2003). Individuals may be highly consistent in seasonal movement patterns and show strong fidelity to warm and winter ranges, both within and across years (Deutsch et al., 2003).

Although West Indian manatees are expected to inhabit nearshore areas, a few individuals have been sighted offshore. A West Indian manatee hit by a boat in Louisiana was determined to be an individual previously photographed in the Tampa Bay, Florida area (Fertl et al., 2005). A West Indian manatee photographed in January 2000 in the Bahamas was matched to a West Indian manatee sighted as a juvenile in 1994 on the west coast of Florida, indicating the potential for offshore movements (Reid, 2000). Reynolds and Ferguson (1984) reported sightings of two West Indian manatees 61 km (33 NM) northeast of the Dry Tortugas Islands, an area not considered to be part of this species' range. "Mo," a radio-tagged West Indian manatee that had been raised in captivity and released at Crystal River, Florida, wandered offshore and then apparently drifted south with offshore currents and was "rescued" in deepwater 37 km (20 NM) northwest of the Dry Tortugas (Lefebvre et al., 2001). Another West Indian manatee was also repeatedly sighted in the northern Gulf of Mexico, well over 100 km offshore in waters with a bottom depth of about 1,524 m (5,000 ft) (Fertl et al., 2005).

West Indian manatees off the east coast of Florida are also known to occasionally make their way further offshore. For example, "Xoshi" was radio-tagged and released in Biscayne Beach in March 1999. A few weeks later, she was "rescued" 60 km (32 NM) offshore of Port Canaveral, Florida in the Gulf Stream (Reid et al., 1991). Perhaps the most famous long distance movements of any West Indian manatee were exhibited by the animal known as "Chessie," who gained fame in the summer of 1995 by swimming to Rhode Island, returning to Florida for the winter, and traveling north again to Virginia where he was last seen in 1996 (USGS, 2001). In early September 2001, "Chessie" was once again sighted in Virginia (USGS, 2001). More recently, in August 2006, a West Indian manatee was sighted in waters off Rhode Island, Massachusetts, and in the Hudson River in New York City (Anonymous, 2006; Beck, 2006b).

Atlantic Ocean, Offshore of the Southeastern United States

The endangered West Indian manatee occurs in nearshore waters, shoreward of the JAX/CHASN OPAREA with some individuals making their way further north along the East Coast towards the VACAPES OPAREA. However, there are no records for manatees in the VACAPES OPAREA. Manatees are not likely to occur in the vicinity of the VACAPES OPAREA.

There are no records for manatees within the CHPT OPAREA. Manatees have been sighted in estuarine and coastal waters of North Carolina in all seasons, with the greatest number of reports occurring during summer and fall. Manatees are not likely to occur in the CHPT OPAREA.

Although manatees potentially occur, it is unlikely that they would be seen in the Southeast OPAREAs. The manatee occurs primarily in freshwater systems, estuaries, and shallow nearshore coastal waters.

Atlantic Ocean, Offshore of the Northeastern United States

The West Indian manatee is extralimital to the NE MRA study area at all times of the year. Sightings on the Atlantic coast drop off markedly north of South Carolina (Lefebvre et al., 2001). In 1995, "Chessie" made a 4,828 km (2,605 NM), round-trip journey between Florida and Rhode Island, leaving Rhode Island in mid-August (USGS, 2001).

Gulf of Mexico

West Indian manatees occur year-round in coastal waters from Pensacola, Florida south to the tip of Florida, although some sporadic occurrences have been documented as far west as Texas. This species is not likely to occur as far offshore as the OPAREA boundaries (3 NM [6 km]). There are sightings in waters within the OPAREA boundaries, although manatee experts note that these should be considered anomalies due to the known habitat preferences of this species (Beck, 2006a).

3.6.2 Threatened and Endangered Marine Mammals

The ESA, as amended (16 United States Code [U.S.C.] Sections 1531 to 1544), provides for the conservation of endangered and threatened species and their habitat. Volume 50 of the CFR contains the implementing regulations for the ESA. An endangered species is defined as one that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered in the foreseeable future throughout all or a significant portion of its range. The USFWS and/or NMFS publish a list of endangered or threatened species in the *Federal Register*.

The ESA prohibits the taking of any listed species, where "take" includes harassment, harm, pursuit, hunting, shooting, wounding, killing, trapping, capture, collection, or any attempts at these activities. Section 7(a)(2) of the ESA requires federal agencies to ensure that their actions do not jeopardize the continued existence of any listed endangered or threatened species. Section 7(a)(2) also requires that federal actions do not result in the destruction or adverse modification of designated critical habitat.

Of the marine mammals that may occur along the East Coast and Gulf of Mexico, six species of cetaceans, including five mysticete whales, one odontocete whale, and one sirenian species are currently listed as federally endangered. These species are:

- North Atlantic right whale.

- Humpback whale.
- Sei whale.
- Fin whale.
- Blue whale.
- Sperm whale.
- West Indian manatee.

The ESA requires federal agencies to ensure that actions they undertake, authorize, or fund are not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Under the ESA, the USFWS and/or NMFS designates critical habitat for each listed species. Critical habitat is defined as specific areas within or outside of the geographical area occupied by a listed species that contain physical or biological features essential to the species' conservation and that may require special management considerations or protection. Such features include food, water, shelter, breeding areas, and space for growth, among other requirements.

The endangered North Atlantic right whale is considered the rarest of all the large whale species. Most individuals in the North Atlantic migrate from wintering/calving areas in coastal waters off the southeastern United States to northern feeding/nursery grounds from New England to the Scotian Shelf. Critical habitat for the North Atlantic population of the North Atlantic right whale, exists in portions of the Boston (Northeast) and JAX OPAREAs, as shown in Figure 3-2 and discussed previously. The Navy will conduct all AFAST activities in the JAX OPAREA in a manner consistent with the 1997 Biological Opinion (NMFS, 1997). Hence, there would be no adverse modification to the North Atlantic right whale critical habitat in the JAX OPAREA since no significant changes to habitat or prey distribution would occur.

3.6.3 Cetacean Stranding Events

When a live or dead marine mammal swims or floats onto shore and becomes "beached" or incapable of returning to sea, the event is termed a "stranding" (Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007n). The legal definition for a stranding within the United States is that "a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance" (16 U.S.C. 1421h).

The majority of animals that strand are dead or moribund (i.e., dying) (NMFS, 2007n). For animals that strand alive, human intervention through medical aid and/or guidance seaward may be required for the animal to return to the sea. If unable to return to sea, rehabilitation at an appropriate facility may be determined as the best opportunity for animal survival. An event where animals are found out of their normal habitat is may be considered a stranding depending on circumstances even though animals do not necessarily end up beaching (Southhall, 2006).

Three general categories can be used to describe strandings: single, mass, and unusual mortality events. The most frequent type of stranding is a single stranding, which involves only one animal (or a mother/calf pair) (NMFS, 2007n).

Mass stranding involves two or more marine mammals of the same species other than a mother/calf pair (Wilkinson, 1991), and may span one or more days and range over several miles (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Walsh et al., 2001; Freitas, 2004). In North America, only a few species typically strand in large groups of 15 or more and include sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and rough-toothed dolphins (Odell 1987; Walsh et al. 2001). Some species, such as pilot whales, false-killer whales, and melon-headed whales occasionally strand in groups of 50 to 150 or more (Geraci et al. 1999). All of these normally pelagic off-shore species are highly sociable and usually infrequently encountered in coastal waters. Species that commonly strand in smaller numbers include pygmy killer whales, common dolphins, bottlenose dolphins, Pacific white-sided dolphin Frasier's dolphins, gray whale and humpback whale (West Coast only), harbor porpoise, Cuvier's beaked whales, California sea lions, and harbor seals (Mazzuca et al. 1999, Norman et al. 2004, Geraci and Lounsbury 2005).

Unusual mortality events (UMEs) can be a series of single strandings or mass strandings, or unexpected mortalities (i.e., die-offs) that occur under unusual circumstances (Dierauf and Gulland, 2001; Harwood, 2001; Gulland, 2006; NMFS, 2007n). These events may be interrelated: for instance, at-sea die-offs lead to increased stranding frequency over a short period of time, generally within one to two months. As published by the NMFS, revised criteria for defining a UME include the following (Hohn et al., 2006):

1. A marked increase in the magnitude or a marked change in the nature of morbidity, mortality, or strandings when compared with prior records.
2. A temporal change in morbidity, mortality, or strandings is occurring.
3. A spatial change in morbidity, mortality, or strandings is occurring.
4. The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.
5. Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (e.g., blubber thickness).
6. Potentially significant morbidity, mortality, or stranding is observed in species, stocks or populations that are particularly vulnerable (e.g., listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.
7. Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

UMEs are usually unexpected, infrequent, and may involve a significant number of marine mammal mortalities. As discussed below, unusual environmental conditions are probably responsible for most UMEs and marine mammal die-offs (Vidal and Gallo-Reynoso, 1996; Geraci et al., 1999; Walsh et al., 2001; Gulland and Hall, 2005).

Reports of marine mammal strandings can be traced back to ancient Greece (Walsh et al., 2001). Like any wildlife population, there are normal background mortality rates that influence marine mammal population dynamics, including starvation, predation, aging, reproductive success, and disease (Geraci et al., 1999; Carretta et al., 2007). Strandings in and of themselves may be reflective of this natural cycle or, more recently, may be the result of anthropogenic sources (i.e., human impacts). Current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause a marine mammal to strand (Geraci et al., 1999; Culik, 2002; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NRC, 2006). While post-stranding data collection and necropsies of dead animals are attempted in an effort to find a possible cause for the stranding, it is often difficult to pinpoint exactly one factor that can be blamed for any given stranding. An animal suffering from one ailment becomes susceptible to various other influences because of its weakened condition, making it difficult to determine a primary cause. In many stranding cases, scientists never learn the exact reason for the stranding. Specific potential stranding causes can include both natural and human influenced (anthropogenic) causes as listed below:

- Natural Stranding Causes
    - Disease
    - Natural toxins
    - Weather and climatic influences
    - Navigation errors
    - Social cohesion
    - Predation
- Human Influenced (Anthropogenic) Stranding Causes
    - Fisheries interaction
    - Vessel strike
    - Pollution and ingestion
    - Noise

Specific beaked whale stranding events associated with potential naval operations are as follows:

- May 1996: Greece (NATO/US)
- March 2000: Bahamas (US)
- May 2000: Portugal, Madeira Islands (NATO/US)
- September 2002: Canary Islands (NATO/US)
- January 2006: Spain, Mediterranean Sea coast (NATO/US)

These events represent a small overall number of animals (40 animals) over an 11 year period and not all worldwide beaked whale strandings can be linked to naval activity (ICES, 2005a; 2005b; Podesta et al., 2006). Four (Greece, Portugal, Spain) of the five events occurred during

NATO exercises or events where DON presence was limited. One (Bahamas) of the five events involved only DON ships. These five events are described briefly below. For detailed information on these events, refer to Appendix E, Cetacean Stranding Report.

- May 1996 Greece - Twelve Cuvier's beaked whales (*Ziphius cavirostris*) stranded along the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis, 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting sonar tests with signals of 600 Hz and 3 kHz and root-mean-squared (rms) sound pressure levels (SPL) of 228 and 226 dB re: 1µPa, respectively (D'Amico and Verboom, 1998; D'Spain et al., 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis, 1998). However, because information for the necropsies was incomplete and inconclusive, the cause of the stranding cannot be precisely determined.
- March 2000, Bahamas –Seventeen marine mammals comprised of Cuvier's beaked whales, Blainville's beaked whales (*Mesoplodon densirostris*), minke whale (*Balaenoptera acutorostrata*), and one spotted dolphin (*Stenella frontalis*), stranded along the Northeast and Northwest Providence Channels of the Bahamas Islands on March 15-16, 2000 (Evans and England, 2001). The strandings occurred over a 36-hour period and coincided with DON use of mid-frequency active sonar within the channel. Navy ships were involved in tactical sonar exercises for approximately 16 hours on March 15. The ships, which operated the AN/SQS-53C and AN/SQS-56, moved through the channel while emitting sonar pings approximately every 24 seconds. The timing of pings was staggered between ships and average source levels of pings varied from a nominal 235 dB SPL (AN/SQS-53C) to 223 dB SPL (AN/SQS-56). The center frequency of pings was 3.3 kHz and 6.8 to 8.2 kHz, respectively. Passive acoustic monitoring records demonstrated that no large scale acoustic activity besides the Navy sonar exercise occurred in the times surrounding the stranding event. The mechanism by which sonar could have caused the observed traumas or caused the animals to strand was undetermined.
- May 2000, Madeira Island, Portugal – Three Cuvier's beaked whales stranded on two islands in the Madeira Archipelago, Portugal, from May 10 – 14, 2000 (Cox et al., 2006). A joint NATO amphibious training exercise, named "Linked Seas 2000," which involved participants from 17 countries, took place in Portugal during May 2 – 15, 2000. The timing and location of the exercises overlapped with that of the stranding incident. Although the details about whether or how sonar was used during "Linked Seas 2000" is unknown, the presence of naval activity within the region at the time of the strandings suggested a possible relationship to Navy activity.
- September 2002, Canary Islands – On September 24, 2002, 14 beaked whales stranded on Fuerteventura and Lanzaote Islands in the Canary Islands (Jepson et al., 2003). At the time of the strandings, an international naval exercise called (Neo-Tapon, 2002) that involved numerous surface warships and several submarines was being conducted off the coast of the Canary Islands. Tactical mid-frequency active sonar was utilized during the exercises, and strandings began within hours of the onset of the use of mid-frequency sonar (Fernández et al., 2005). The association of NATO mid-frequency sonar use close in space and time to the beaked whale strandings, and the similarity between this stranding event and previous beaked whale mass strandings coincident with sonar use,

- suggests that a similar scenario and causative mechanism of stranding may be shared between the events.
- January 2006, Spain – The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26 to 28, 2006, on the southeast coast of Spain near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. From January 25-26, 2006, a NATO surface ship group (seven ships including one U.S. ship under NATO operational command) conducted active sonar training against a Spanish submarine within 50 nm of the stranding site. According to the pathologists, a likely cause of this type of beaked whale mass stranding event may have been anthropogenic acoustic activities. However, no detailed pathological results confirming this supposition have been published to date, and no positive acoustic link was established as a direct cause of the stranding.

By comparison, potential impacts to all species of cetaceans worldwide from fishery related mortality can be orders of magnitude more significant (100,000s of animals versus 10s of animals) (Culik, 2002; ICES, 2005b; Read et al., 2006). This does not negate the influence of any mortality or additional stressor to small, regionalized sub-populations which may be at greater risk from human related mortalities (fishing, vessel strike, sound) than populations with larger oceanic level distribution or migrations. ICES (2005a) noted, however, that taken in context of marine mammal populations in general, sonar is not a major threat, or significant portion of the overall ocean noise budget. A constructive framework and continued research based on sound scientific principles is needed in order to avoid speculation as to stranding causes, and to further our understanding of potential effects or lack of effects from military mid-frequency sonar (Bradshaw et al., 2006; ICES 2005b; Barlow and Gisiner, 2006; Cox et al. 2006).

Refer to Appendix E, Marine Mammal Stranding Report, for additional information on the history of stranding, a description of the above-listed stranding events, a review of the many different possible reasons for stranding, as well as the stranding investigation findings and conclusions.

3.7 SEA TURTLES

3.7.1 Description of Sea Turtles

Table 3-6 shows that all five sea turtle species occurring along the East Coast and in the Gulf of Mexico are listed as threatened or endangered. Current information about sea turtles indicates that their distribution is both specific to the species and to their stage in the life cycle. Most sea turtles associate with specific habitats during the life-cycle stages of post-hatchling, juvenile and subadult, and adult (Bolten et al., 1998). Nesting females and hatchling sea turtles make use of nesting beaches. Post-hatchling sea turtles prefer oceanic waters where *Sargassum* rafts are located (Lerman, 1986). Generally, larger juveniles and some adults (hard-shelled sea turtles) tend to favor benthic habitats in shallow nearshore waters, while other adults (leatherback sea turtles) are associated with deeper pelagic waters. Water temperature, seasonal changes, and migration patterns are other factors that affect the distribution of sea turtles.

Sea turtle distribution in temperate waters generally shifts seasonally based on changes in water temperature and prey availability (Musick and Limpus, 1997; Coles and Musick, 2000; and Plotkin, 2003). During winter months, sea turtles generally follow warmer water temperatures and prey abundance to areas offshore in southern regions of the East Coast. During other times, sea turtles may also commonly occur in nearshore and inshore waters. Some species are known to range as far north as Nova Scotia and Iceland during warmer months.

Table 3-6. Sea Turtles with Possible or Confirmed Occurrence along the East Coast of the U.S. and in the Gulf of Mexico

Common Name	Scientific Name	ESA Status	Location
Order Testudines (Turtles)			
Suborder Cryptodira (Hidden-necked turtles)			
Family Cheloniidae (Hard-shelled sea turtles)			
Green sea turtle	*Chelonia mydas*	Threatened[1]	East Coast and Gulf of Mexico
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	East Coast and Gulf of Mexico
Loggerhead sea turtle	*Caretta caretta*	Threatened	East Coast and Gulf of Mexico
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	East Coast and Gulf of Mexico
Olive ridley turtle	*Lepidochelys oliveacea*	Threatened[2]	Gulf of Mexico
Family Dermochelyidae (Leatherback sea turtle)			
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	East Coast and Gulf of Mexico

1. As a species, the green sea turtle is listed as threatened. However, the Florida and Mexican Pacific coast nesting populations are listed as endangered. It should be noted that green sea turtles found in the East Coast OPAREAs and eastern Gulf of Mexico might not all be from the Florida population.
2. As a species, the olive ridley is listed as threatened. However, the Pacific nesting population in Mexico is listed as endangered.

Sources: DON, 2005, 2007a, 2007b, 2007c, 2007d

Sea turtle hearing sensitivity, in air and underwater, is not well studied. Reception of sound is through bone conduction, with the skull and shell acting as receiving structures (Lenhardt et al., 1983). Typically, sea turtles hear frequencies from 30 to 2,000 Hz and have a range of maximum sensitivity between 100 to 800 Hz (Ridgway et al., 1969; Lenhardt, 1994). Green turtles can hear sounds ranging from 60 to 1,000 Hz and are most sensitive to airborne sounds ranging from 300 to 400 Hz (Ridgway et al., 1969). Moein Bartol et al., (1999) reported that juvenile loggerhead turtles hear sounds between 250 (lowest frequency that could be tested due to equipment) and 1,000 Hz (most sensitive at 250 Hz) using the auditory brainstem response (ABR) technique, while (Lenhardt, 2002) found that adults can hear sounds from 30 Hz to 1,000 Hz (most sensitive at 400 to 500 Hz) using startle response (i.e., contract neck or dive) and ABR techniques. Adult loggerheads have also been observed to initially respond (i.e., increase swimming speeds) and avoid air guns when received levels range from 151 to 175 dB re: 1 μPa, but they eventually habituate to these sounds (Lenhardt, 2002). Though, one turtle in study did exhibit TTS for up to two weeks after exposure to these levels (Lenhardt, 2002). Juveniles also have been found to avoid low-frequency sound (less than 1,000 Hz) produced by airguns (O'Hara and Wilcox, 1990). In a separate study, green and loggerhead sea turtles exposed to seismic air guns began to noticeably increase their swimming speed, as well swimming direction, when received levels reached 155 dB re: 1 $\mu Pa^2 s$ for green turtles and 166 dB re: 1 $\mu Pa^2 s$ for loggerhead turtles (McCauley et al., 2000). Though, auditory data has never been collected for the leatherback turtle, there is an anecdotal observation of this species responding to the sound of a boat motor (ARPA, 1995). It is unclear what frequencies of the sound this species was detecting. In terms of sound production, nesting leatherback turtles have been recorded producing sounds (sighs or belch-like sounds) up to 1,200 Hz with most energy ranging from 300 to 500 Hz (Mrosovsky, 1972; Cook and Forrest, 2005).

3.7.2 Sea Turtles of the U.S. North Atlantic and Gulf of Mexico

All six sea turtle species with records of occurrence along the East Coast or in the Gulf of Mexico are listed as threatened or endangered under the ESA. The hawksbill, Kemp's ridley, and leatherback turtles are listed as endangered, while the loggerhead turtle is listed as threatened. As a species, green turtles are listed as threatened, although specific nesting populations within this species' range are listed as endangered. As a species, the olive ridley is listed as threatened. However, the Pacific nesting population in Mexico is listed as endangered.

3.7.2.1 Green Sea Turtles (*Chelonia mydas*)

Description— The green turtle is the largest hard-shelled sea turtle; adults commonly reach 100 cm in carapace length and 150 kg (331 lb) in weight (NMFS and USFWS, 1991a). As hatchlings, green turtles are approximately 50 millimeters (mm) (2 inches [in]) long and 25 grams (g) (0.9 ounces (oz) in weight at birth. Green turtles in the Atlantic exhibit a decreased body weight growth rate as the carapace grows; this contrasts with the growth rates of Pacific greens (Bjorndal et al., 2000b). Adult carapaces range in color from solid black to gray, yellow, green, and brown in muted to conspicuous patterns; the plastron is a much lighter yellow to white. Hatchlings are distinctively black on the dorsal surface and white on the ventral. Greens are distinguishable by displaying four costal lateral scutes on the carapace and a serrated jaw, likely adapted for grazing (Ernst et al., 1994).

Status**—**Green turtles are classified as threatened under the ESA, with the Florida and Mexican Pacific coast nesting populations listed as endangered (NMFS and USFWS, 1991a). From 2001 to 2005, an average 5,055 green turtles nested in Florida; this estimate suggests Florida to have the second largest green turtle nesting population in the wider Caribbean (Meylan et al., 2006). Juvenile green turtles are the second most abundant sea turtle species in North Carolina summer developmental habitats (Epperly et al., 1995b). There is no estimate of the total number of green turtles in the GOMEX (NMFS and USFWS, 1991b).

Habitat Preferences**—**Post-hatchling and early-juvenile green turtles reside in convergence zones in the open ocean, where they spend an undetermined amount of time in the pelagic environment (Carr, 1987). The distinct coloration patterns of hatchlings and early-juvenile greens, a darker dorsal surface and lighter ventral surface, are ideal for an oceanic lifestyle. In laboratory experiments, (Mellgren et al., 1994) found that hatchling green turtles did not orient to or congregate in artificial weed beds or in real seaweeds. However, (Carr and Meylan, 1980) present direct evidence of hatchlings taking refuge in and around *Sargassum* rafts. (Mellgren et al., 1994) found green turtle post-hatchlings to spend a greater amount of time in the open ocean than other species known to associate with *Sargassum*. The suggested green turtle-*Sargassum* association may be due to the juvenile and *Sargassum* being passively brought together by convergence zones (Carr, 1995).

The oceanic transport of juvenile greens emerging from U.S. Atlantic beaches is similar to the model proposed for juvenile loggerheads; neonate greens leave nesting beaches on the eastern Florida coast to enter the Gulf Stream (Witham, 1980; Musick and Limpus, 1997). Juveniles are eventually transported to the North Atlantic Gyre, a system that carries them around the North Atlantic Basin during the "lost year" phase. Once in the North Equatorial Current, individuals likely reach a carapace length of 20 to 25 cm (7.9 to 9.8 in). At this time, they migrate to nearshore development habitats and feeding areas in Florida and the Caribbean, where they spend the majority of their lives as late juveniles and adults (NMFS and USFWS, 1991a; Bjorndal and Bolten, 1988; Musick and Limpus, 1997).

The optimal developmental habitats for late juveniles and foraging habitats for adults are warm, shallow waters (3 to 5 m [10 to 16 ft] in bottom depth) with abundant submerged aquatic vegetation and in close proximity to nearshore reefs or rocky areas (Ernst et al., 1994). Green turtles may forage in either deep waters or in shallow seagrass beds (Hirth, 1997); in Hawaii, green turtles forage in waters as deep as 20 to 50 m (66 to 164 ft) (Brill et al., 1995), Along the east coast of Florida, juvenile green turtles use high wave-energy nearshore reef environments as developmental habitats; these areas support an abundance of macro-algae and are less than 2 m in depth (Holloway-Adkins, 2006). Many individuals travel close to shore due to preferences for feeding in shallow waters with an abundance of submerged vegetation (Ernst et al., 1994). However, green sea turtles have been seen in the open ocean more than 1,600 km (863 NM) from land (Fritts et al., 1983). In the GOMEX region, the preferred habitats of green turtles are located primarily along the coasts of southwestern Florida and southern Texas (Renaud et al., 1995; Landry and Costa, 1999). Juvenile green turtles also utilize the inshore and nearshore waters of central Florida (e.g., Cedar Keys, Homosassa Springs, Crystal River, and Tampa Bay) throughout the year as developmental habitats (NMFS and USFWS, 1991b; Dodd, 1995).

***Distribution*—**Green turtles are distributed worldwide in tropical and subtropical waters (NMFS and USFWS 1991a). In U.S. Atlantic waters, greens are found around the U.S. Virgin Islands, Puerto Rico, and the continental United States from Texas to Massachusetts (NMFS and USFWS, 1991a). Important feeding areas for green turtles in the continental United States include waters in Florida and southern Texas, such as the Indian River Lagoon, Florida Keys, Florida Bay, Homosassa Springs, Crystal River, Cedar Keys, and the Laguna Madre Complex (NMFS and USFWS, 1991a; Landry and Costa, 1999). Benthic-feeding juveniles may be found in developmental habitats spanning the U.S. Atlantic coast. As adults, green turtles are restricted to more southern latitudes (Epperly et al., 1995a), and are only occasionally are found north of Florida. During non-breeding periods, adults and juvenile distributions may overlap in coastal feeding areas (Hirth, 1997).

As they grow, green turtles move through a series of developmental feeding habitats (Hirth, 1997). Along the U.S. Atlantic Coast, developmental habitats range from Long Island Sound south to the Caribbean (Musick and Limpus, 1997). Juvenile green turtles may primarily use Florida coastal waters as developmental habitat, but may also use estuarine waters along the U.S. Atlantic coast as summer developmental habitat, as north as Long Island Sound, Chesapeake Bay, and Core Sound, and Pamlico Sound (Musick and Limpus, 1997). In Florida, smaller juvenile green turtles may use worm-rock reefs as demersal developmental habitat, feeding on various types of algae, sponges, and benthic invertebrates (Guseman and Ehrhart, 1990; Bresette et al., 1998; Makowski et al., 2006). Makowski et al. (2006) found juvenile green turtles off Palm Beach, Florida to use the same worm-rock reefs for foraging and resting purposes.

Sea surface temperature is a major factor that often determines the distribution and abundance of green turtles along the U.S. Atlantic coast. Individuals occurring in temperate waters avoid becoming cold-stunned by either moving offshore or toward more southerly latitudes prior to the onset of winter. Cold-stunning usually happens when water temperatures drop to 10°C (50°F) or below and can result in death if the cold period is extended and/or the temperature drops below 6.5°C (43.7°F). Green turtles lose the ability to dive at 9°C (48.2°F)and remain floating horizontally until they either warm up or die (Schwartz, 1978). Most records of individuals found north of Florida are from the warmer part of the year, between late spring and early fall (CETAP, 1982; Epperly et al., 1995b) and are late juveniles to subadults (Lazell, 1980; Burke et al., 1992; Epperly et al., 1995b). Small numbers of these age classes regularly occur as far north as Long Island, New York from June through October, when the waters are warm enough to support green turtles (Morreale et al., 1992). The highest proportions of green turtles in North Carolina waters are observed in the fall (Epperly et al., 1995b), in conjunction with the southward migration of juvenile greens moving to warmer waters for the winter, although cold-stunning may occur off northeastern Florida as well (Mendonça, 1983).

The major Atlantic nesting colonies are located at Ascension Island (in the South Atlantic Ocean, about mid-way between South America and Africa), Aves Island (in the Caribbean Sea, about 180 km (97 NM) west of Guadaloupe), and on the beaches of Costa Rica and Suriname (in central and South America, respectively) (NMFS and USFWS, 1991a). Most nesting in North America occurs in southern Florida and Mexico (Meylan et al., 1995), with scattered records in the Florida Panhandle, Alabama, Georgia, and the Carolinas (Peterson et al., 1985; Schwartz, 1989; NMFS and USFWS, 1991a; USAF, 1996). Florida represents the major nesting site in the continental United States for adult females (Meylan et al., 2006). Most nesting in the GOMEX region occurs along the southern Florida and Mexican beaches, with scattered records from the Florida Panhandle, Alabama, and Texas (NMFS and USFWS, 1991b; Meylan et al., 1995; USAF, 1996). The highest concentration of nesting activity in the vicinity of the GOMEX study area occurs in Monroe County, FL, which includes most of the Florida Keys and the Dry Tortugas (Meylan et al., 1995).

Adult green turtles are known to undertake long migrations, the longest of which are between their foraging habitats and nesting beaches. For example, green turtles nesting on Ascension Island in the South Atlantic Ocean travel more than 2,200 km (1,187 NM) to feeding grounds off coastal Brazil (Ǻkesson et al., 2003). Mixed-stock analyses on foraging populations of juveniles have revealed that developmental feeding habitats likely contain green turtles from multiple stocks. Green turtles occurring on foraging grounds off the U.S. Atlantic and Gulf coasts include representatives hatched on nesting beaches in Costa Rica, the United States, Mexico, Aves Island, Suriname, Ascension Island, and Guinea Bissau (western Africa) (Lahanas et al., 1998). Off the central coast of Florida, in the area of Hutchinson Island, foraging green turtles originate from Costa Rica (53 percent), the United States, and Mexico (42 percent), and Aves Island and Suriname (4 percent) nesting populations (Bass and Witzell, 2000).

Atlantic Ocean, Offshore of the Southeastern United States

Green turtles may occur throughout the VACAPES OPAREA from spring through fall, and are least common within the OPAREA during the winter. Summer represents the peak time for green turtle occurrence in the VACAPES OPAREA due to the presence of summer developmental foraging habitat along the coast. During the winter, the highest concentration of greens occurs just north of Cape Canaveral, Florida, a known overwintering area for juveniles.

Green turtles may occur within the CHPT OPAREA year-round. Juvenile greens use developmental habitats adjacent to the CHPT OPAREA during the summer months as well as travel to and from these habitats during the spring and fall. During the winter, the highest concentration of greens occurs just north of Cape Canaveral, Florida, a known overwintering area for juveniles. During spring, summer, and fall, high concentrations of greens occur offshore the more northern states, specifically North Carolina, Virginia, Delaware, and New Jersey. Year-round, green turtle occurrence records are clustered along the North Carolina coast and within shelf waters.

Green turtles may occur within the JAX/CHASN OPAREA year-round. Year-round resident juvenile green turtles along the Atlantic coast of Florida are found in the Indian River Lagoon as well as Florida Bay/Florida Keys south of the OPAREA (NMFS and USFWS, 1991b). During the summer months, juvenile green turtles use developmental habitats outside of the OPAREA and migrate through the JAX/CHASN OPAREA to reach these habitats in the spring and fall. Throughout the year, green turtle occurrences in the OPAREA are concentrated over the continental shelf to the west of the Gulf Stream Current.

Atlantic Ocean, Offshore of the Northeastern United States

Generally, green turtles can occur from spring to fall in nearshore waters of the NE OPAREAs as far north as Cape Cod Bay and in offshore waters as far north as the southern flank of Georges Bank (NMFS and USFWS, 1991b; Prescott, 2000). Small numbers of juveniles regularly occur as far north as Long Island Sound, where waters are warm enough to support them from June through October (Burke et al. 1992). In spring, green turtles may be found in the southern portion of the NE OPAREAs as they make their way towards inshore developmental habitats (e.g, Long Island Sound, Peconic Bay, and possibly Nantucket Sound) from waters further south. These inshore, estuarine habitats, which possess an abundance of algae and eelgrass, are more often utilized by green turtles during summer and early fall than ocean habitats of the Mid-Atlantic Bight (Lazell, 1980; Morreale and Standora, 1998). The abundance of green turtles in inshore waters adjacent to the NE OPAREAs likely peaks in September (Berry et al., 2000). In fall, green turtles will begin to emigrate from these inshore areas and will pass through the Narragansett Bay and Atlantic City OPAREAs on their way to overwintering habitats south of Cape Hatteras or associated with the Gulf Stream Current. Green turtles that do not vacate the area in late fall may become susceptible to cold-stunning, as evidenced by the large number of strandings that occur along the beaches of Long Island and Cape Cod. The absence of sighting records in the NE OPAREAs during fall demonstrates the difficulties inherent in observing young hard-shelled sea turtles during marine surveys, as green turtles are no doubt present in nearshore waters of the Mid-Atlantic at that time of year.

Gulf of Mexico

In the winter, outside of the Florida Keys, there are few sighting records available for green turtles in the study area during winter. This lack of sightings may be attributable to the possible underwater hibernation of overwintering green turtles in the northern GOMEX (Ogren and McVea, 1982) or the difficulty in identifying green turtles to species during winter sighting surveys (as sighting conditions are typically the worst during this season). During winter, green turtles may occur in the Key West, Pensacola, and Panama City OPAREAs.

In spring as water temperatures rise from April to June, green turtles begin to appear in greater numbers in the continental shelf waters of the northern GOMEX. However, sighting records for the area remain infrequent and occurrences are only predicted for one area located beyond the continental shelf. Green turtles found in these deeper waters are likely adults that are migrating from resident foraging grounds to distant nesting grounds (Meylan, 1995). Stranding activity along Florida's Atlantic and Gulf coasts remains high in spring, indicating a likely presence of green turtles in waters either just offshore or further inshore. Although continental shelf waters off western Florida have been documented as preferred habitats of the species during much of the year (Fritts et al., 1983b; NMFS and USFWS, 1991b), the lack of survey effort in this area precludes a definitive determination of green turtle occurrence in those waters during spring. The sparse sighting records in Louisiana and Texas waters as well as nesting records on the southern Texas coast indicate that green turtles are found in the northwestern Gulf during spring, although not in nearly the numbers that occur in the northeastern Gulf.

In summer, the occurrence pattern of green turtles in the GOMEX during summer is similar to that of spring, i.e., throughout the waters of the northern GOMEX continental shelf, although green turtles occur in greater numbers during summer. Sightings in the area are sporadic and were recorded in shelf waters during summer although survey effort extended beyond the continental shelf in several areas of the northern GOMEX. The post-nesting route of green turtle "Halie" shows that adult green turtles routinely traverse the study area waters during their late summer migrations back to resident feeding areas. Reasons for the lack of green turtle occurrences in the study area could include difficulties inherent in identifying green turtles during sighting surveys and their tendency to reside in inshore or very nearshore waters during summer months.

In fall, the highest concentrations of green turtles may occur in continental shelf waters from Charlotte Harbor south to the Florida Keys (Key West OPAREA). Multiple sightings were recorded in these waters during NMFS-SEFSC aerial surveys of the eastern GOMEX and only few sighting observations were recorded elsewhere in the area. In addition, Kinzel et al. (2003) have documented a high and continuous utilization of southwestern Florida waters by post-nesting female green turtles in late fall, winter, and early spring. Other areas of likely fall occurrence include the Cedar Keys region off central Florida, continental shelf waters off Galveston Bay, and waters associated with the continental shelf break northeast of the Corpus Christi OPAREA. Nesting also has been recorded during fall in one Panhandle Florida county, so it is likely that green turtles also occur at least sporadically in this region during fall.

3.7.2.2 Hawksbill Sea Turtles (*Eretmochelys imbricata*)

Description—The hawksbill turtle is a small to medium-sized sea turtle; adults typically range between 65 and 90 cm (26 to 35 in) in carapace length and weigh around 80 kg (176 lb) (Witzell, 1983; NMFS and USFWS, 1993). Hawksbills are distinguished from other sea turtles by their hawk-like beaks, posteriorly overlapping carapace scutes, and two pairs of claws on their flippers (NMFS and USFWS, 1993). The carapace of this species is often brown or amber with irregularly radiating streaks of yellow, orange, black, and reddish-brown.

Status—Hawksbill turtles are listed as endangered under the ESA and are second to the Kemp's ridleys in terms of endangerment (NMFS and USFWS, 1993; Bass, 1994). The most recent estimate of hawksbill abundance in the Wider Caribbean was 4,975 nesting females calculated by Meylan in 1989 (Meylan and Donnelly, 1999). An estimated 1,900 to 4,300 adult females comprise the Mexican Atlantic nesting population (Garduño-Andrade et al., 1999). Only five regional populations worldwide remain with more than 1,000 females nesting annually (Seychelles, Mexico, Indonesia, and two in Australia) (Meylan and Donnelly, 1999). Very little is known about the status or abundance of this species along the U.S. Atlantic Coast aside from the recognition that hawksbill populations in this area are neither declining nor showing indications of recovery (Dodd, 1995; Plotkin, 1995). Little is known about the status of this species in the GOMEX (Dodd, 1995). In the Caribbean, there is designated critical habitat for hawksbills at Mono and Monito islands, Puerto Rico (NMFS, 1998).

***Habitat Preferences*—**Hawksbill post-hatchlings and early juveniles inhabit oceanic waters where they are sometimes associated with floating patches of *Sargassum* (NMFS and USFWS, 1993; Parker, 1995). Hawksbills recruit to benthic foraging grounds when they are 20 to 25 cm (7.9 to 9.8 in) in length (NMFS, 1993). The developmental habitats for juvenile benthic-stage hawksbills are the same as the primary feeding grounds for adults; these include tropical, nearshore waters associated with coral reefs or mangroves (Musick and Limpus, 1997). Shallow seagrass beds may also serve as important developmental habitats for late juvenile hawksbills (Bjorndal and Bolten, 1988; Diez et al., 2003). Several sporadic reports exists of hawksbills residing in seagrass habitats; for example, there is a development habitat for juvenile hawksbills at Saona Island, Dominican Republic (Diez et al., 2003).

Coral reefs are recognized as optimal hawksbill habitat for juveniles, sub-adults, and adults. Preference for these habitats is likely related to the presence of sponges, a favored prey item of hawksbills which comprises as much as 95 percent of their diet in some locations (NMFS and USFWS, 1993; Diez et al., 2003). Ledges, caves, and root systems, which are often interspersed among these habitats, provide hawksbills refuge and shelter (NMFS and USFWS, 1993). Sparse hard-bottom communities and cliff-wall habitats with soft corals and invertebrates are also considered important hawksbill benthic developmental habitat (Diez et al., 2003).

Hawksbills prefer alternate sites for resting and foraging. Resting sites tend to be of greater depths than foraging areas, although bottom topography influences site selection as well (Houghton et al., 2003). In neritic habitats, resting areas for late juvenile and adult hawksbills are typically located in deeper waters, such as sandy bottoms at the base of a reef flat, than their foraging areas (Houghton et al., 2003). Late juveniles generally reside on shallow reefs less than 18 m deep. However, as they mature into adults, hawksbills move to deeper habitats and may forage to depths greater than 90 m (295 ft). Benthic-stage hawksbills are seldom found in waters beyond the continental or insular shelf, unless they are in transit between distant foraging or nesting grounds (NMFS and USFWS, 1993).

Hawksbill turtles prefer to nest on the same tropical high-energy beaches as green turtles. Although hawksbills exhibit a wide tolerance for nesting substrate type, they prefer undisturbed, deep-sand beaches underneath vegetative cover (NMFS and USFWS, 1993; Comer, 2002). The hawksbill's small size and agility allows it to access nesting sites atop narrow and steeply sloped beaches as well as across fringing reefs, areas that are rarely accessible to other sea turtle species (NMFS and USFWS, 1993; Comer, 2002).

***Distribution*—**Hawksbill turtles are circum-tropical in distribution, generally occurring from 30°N to 30°S within the Atlantic, Pacific, and Indian oceans (Witzell, 1983). In the western North Atlantic Ocean, this species is found throughout the Gulf of Mexico, the Greater and

Lesser Antilles, southern Florida, and along the mainland of Central America south to Brazil (NMFS and USFWS, 1993). Juvenile and adult hawksbills are regularly found in the Gulf of Mexico, the Caribbean Sea, and along the Atlantic coast of southern Florida (Witzell, 1983; NMFS and USFWS, 1993). Major foraging populations in U.S. waters occur in the vicinity of the coral reefs surrounding Mona Island, Puerto Rico and Buck Island, St, Croix, U.S. Virgin Islands (Van Dam and Diez, 1996; Starbird et al., 1999). Smaller populations of hawksbills reside in the hard bottom habitats that surround the Florida Keys and other small islands in Puerto Rico and the U.S. Virgin Islands (Witzell, 1983; NMFS and USFWS, 1993).

The hawksbill is rare north of Florida (Plotkin 1995). Morreale et al. (1989) recorded a hawksbill specimen in the Long Island Sound, and (Parker, 1995) documented several sightings of juveniles and "lost year" hatchlings off the coasts of Massachusetts, Virginia, North Carolina, and Georgia. There are four other published records of hawksbills in North Carolina waters, including one 32 km (17 NM) east of Oregon Inlet (Lee and Palmer, 1981). Unpublished reports include a young hawksbill stranding cold-stunned on the Outer Banks of North Carolina in 2001 (Mazarella, 2001) and a yearling hawksbill stranding near the North Carolina/Virginia border in 2003 (Godfrey, 2003). In 1990, a hawksbill was captured in Virginia at the mouth of the James River (Keinath et al., 1991), and in 2000, another individual stranded live at Virginia Beach (USFWS, 2001).

Hawksbills were originally thought to be a non-migratory species due to the close proximity of suitable nesting beaches to coral reef feeding habitats and high rates of local recaptures. However, individuals are now known to travel long distances over the course of their lives (Meylan, 1999) mainly between nesting and foraging areas. Transoceanic migrations are known in some cases from both tagging and genetic analyses (Bellini et al., 2000; Bowen et al., 2007). For example, a subadult tagged in Sueste Bay at archipelago of Fernando de Noronha Archipelago, Brazil and captured at Cap Esterias, Gabon represents the longest documented movements for this species – a straight line distance of 4,669 km (2,519 NM) (Bellini et al., 2000). The 1,600 km (863 NM) journey of a post-nesting female traveling between Santa Isabel Island, Soloman Islands and Port Moresby, Papua New Guinea is also noteworthy (Meylan, 1995).

Tag return, genetic, and telemetry studies have indicated that Caribbean hawksbill turtles use multiple developmental habitats as they progress from one age class to another. Within a given life stage, such as the later juvenile stage, some hawksbills may choose to be sedentary within a specific developmental habitat for a long period of time (Meylan, 1999). For example, in February 1985, a benthic-stage juvenile was captured from the coastal waters surrounding an islet in the southern Ryukyu Islands. A year and a half later, the same individual was recaptured in a lagoon only 9 km (5 NM) away from its original capture site (Kamezaki, 1987).

The largest nesting aggregation in the Caribbean occurs along the Yucatán Peninsula, Mexico (NMFS and USFWS, 1993). Other small, yet important, nesting assemblages are found in Belize, Nicaragua, Panama, Venezuela, Cuba, Antigua, and the Grenadines (NMFS and USFWS, 1993). Within the continental United States, hawksbill nesting is restricted to beaches in southern Florida and the Florida Keys, although even there it is extremely rare (Dodd, 1995). Nesting has been documented at Jupiter Island, Biscayne National Monument, and the Canaveral National Seashore on the eastern Florida coast (Lund, 1985).

Atlantic Ocean, Offshore of the Southeastern United States

Hawksbills are rare within the VACAPES OPAREA, yet may occur throughout the year. Based upon limited data, occurrences are likely to be more common within shelf waters or along the shelf break). As this species is typically tropical, any occurrences within the VACAPES OPAREA are likely accidental. Many hawksbill strandings adjacent to the OPAREA have been small juveniles (Frick, 2001; Mazarella, 2001; Godfrey, 2003) suggesting individuals may enter the OPAREA from pelagic juvenile habitat. Sightings and bycatch records along the shelf break may support this. However, VACAPES OPAREA waters do not offer optimal developmental habitat for juvenile or foraging habitat for adults (NMFS and USFWS, 1993; Diez et al., 2003), and individuals would not be likely to remain in the OPAREA.

Although rare, hawksbills may occur within the CHPT OPAREA at any time during the year. Based upon sighting and stranding records, occurrences are generally likely to be inshore and within shelf waters. As this species is typically tropical, any occurrences within the CHPT OPAREA are likely accidental. Many hawksbill strandings in North Carolina have been small juveniles (Frick, 2001; Mazarella, 2001; Godfrey, 2003) suggesting individuals may enter the CHPT OPAREA from pelagic juvenile habitat. Yet as North Carolina waters do not offer optimal developmental habitat for juvenile or foraging habitat for adults adults (NMFS and USFWS, 1993; Diez et al., 2003), individuals would not be likely to remain in the OPAREA.

Although rare, hawksbills may occur within the JAX/CHASN OPAREA at any time during the year. Based on sighting, stranding, and bycatch data, hawksbills may occur throughout the OPAREA. The majority of animals stranded or sighted in or near the JAX/CHASN OPAREA are immature (Meylan, 1992; Parker, 1995). The hawksbill is a tropical species and is more likely to be found along the southern portion of Florida (NMFS, 2007n) (Meylan and Redlow 2006); however a recent hypothesis suggests that the Florida current and the Gulf Stream may represent a dispersal corridor for Caribbean and Gulf region post-hatchlings (Meylan and Redlow, 2006).

Atlantic Ocean, Offshore of the Northeastern United States

This species likely does not occur in the study area with any regularity, although infrequent sightings and strandings have been recorded during three of the four seasons. Currently, Massachusetts is recognized as the northern limit of the species' range (NMFS and USFWS, 1993). However, most scientists believe that any sightings in this region of the western North Atlantic Ocean should be considered rare or even accidental (Lazell, 1980; Prescott, 2000). In addition, coral reefs and live/hard bottom habitats, which are the preferred habitats of hawksbills, are not very prevalent in the study area. If a hawksbill were to occur in the waters of the NE OPAREAs, it would likely be during summer when water temperatures peak. It is possible that there are more hawksbills in the area during summer months than the survey data imply, as individuals of this species are likely below the size threshold for effective detection by aerial observers (Mitchell et al., 2002).

Gulf of Mexico

Like the green turtle, the hawksbill primarily inhabits shallow, nearshore waters off southern Florida. Small numbers of hawksbill occurrences are documented from winter to summer from southeastern Florida (Palm Beach, Broward, and Dade Counties) through the Florida Keys to coastal waters just northwest of Tampa Bay, where the northernmost stranding records occur, but the greatest number of hawksbill turtles is found off southern Florida in fall. The prevalence of coral reef and hard bottom habitats in off southern Florida should incite small populations of juveniles and adults to feed there throughout the year. Further north and west, hawksbills are rarely observed in waters off the Florida Panhandle, Alabama, Mississippi, Louisiana, and Texas (Rabalais and Rabalais, 1980; Witzell, 1983; Rester and Condrey, 1996). Hawksbill sightings in these areas likely involve early juveniles that are born on nesting beaches in Mexico and have drifted north with the dominant currents (Landry and Costa, 1999). Aside from documentations of early juveniles associated with *Sargassum* mats and long-distance tag returns from migrating adult females, scientists know relatively little about the offshore distribution of this species in the GOMEX.

The only available winter sighting records in the area are from the Florida Keys. All other hawksbill occurrence records for winter are strandings, which take place from southeastern Florida to just north of Tampa Bay. Sighting effort is non-existent in several areas off southern Florida where hawksbills are likely to be found throughout the year. Winter water temperatures in the northern GOMEX waters are likely outside the thermal tolerance of hawksbill turtles, which is a likely factor for the absence of occurrence records for the Florida Panhandle, Alabama, Mississippi, Louisiana, and eastern Texas. Winter strandings of hawksbills off central Florida are probably the result of low water temperatures in the area.

In spring, hawksbill turtles may expand their range into the northernmost waters of the GOMEX, as evidenced by the sighting record off Louisiana's Chandeleur Islands and in the deeper waters off the Florida shelf. These Florida waters lie a short distance west of Christmas Ridge (a known live/hard bottom community) and north of Pulley Ridge (a known coral reef community); it is unclear whether the hawksbills observed in Florida were in transit to or from potential feeding areas. Stranding records remain restricted to the central and southern Florida regions. Multiple strandings in the Florida Keys and along the southeast Florida coast indicate a likely greater presence of hawksbills in those southern Florida coastal areas compared to offshore waters beyond the west Florida shelf.

In summer, although there are fewer hawksbill occurrence records for the area compared to the other three seasons, hawksbills are still expected to occur at least rarely in the subtropical, nearshore waters off southern Florida. Low levels (less than three) of nesting activity are also known to take place on west Florida beaches during this season (Meylan et al., 1995). Hawksbill turtles should be more abundant in the area during summer compared to any other season due to the potential for nesting turtles (which may come from distant waters such as the Caribbean Sea) to inhabit the area with resident foraging populations.

Due to the rigorous NMFS-SEFSC aerial surveys over the eastern GOMEX in 1994, fall is by far the season with the most hawksbill sighting records, clustered off southern Florida. Based upon the concentration and clustering of available sightings off southwestern Florida, the sighting data indicates that hawksbills are regular inhabitants of waters surrounding the westernmost islands of the Florida Keys and may be found on the west Florida shelf as far north as Charlotte Harbor. Fall occurrences may also be possible in the northwestern GOMEX, as demonstrated by a hawksbill sighting in continental shelf waters south of the Texas/Louisiana border.

3.7.2.3 Loggerhead Sea Turtles (*Caretta caretta*)

Description—Loggerheads are large, hard-shelled sea turtles. The mean straight carapace length (SCL) of adult loggerheads in southeastern U.S. waters is approximately 92 cm (36 in) and the average weight is 113 kg (249 lb) (NMFS and USFWS, 1991b). The size of a loggerhead turtle's head compared to the rest of its body is substantially larger than that of other sea turtles. Adults are mainly reddish-brown in color on top and yellowish underneath.

Status—Loggerhead turtles are listed as threatened under the ESA and endangered under the IUCN (IUCN, 2004). The loggerhead is the most abundant sea turtle occurring in U.S. waters. Annual nesting totals of loggerheads on the U.S. Atlantic and Gulf coasts ranged from 53,016 to 89,034 nests during 1989 to 1998 (TEWG, 2000). The South Florida Nesting Subpopulation is the largest known loggerhead nesting assemblage in the Atlantic Ocean (annual nesting totals ranged from 48,531 to 83,442 nests from to 1985 through 2000) and is the second largest in the world (TEWG, 2000). Nesting trends indicate that the number of nesting females associated with the South Florida Subpopulation is likely increasing (Epperly et al., 2001). The Florida Panhandle subpopulation appears to be the third largest in size of the US nesting subpopulations with annual nesting numbers between 113 and 1,295 between 1989 and 2002 (NMFS and USFWS, 2003). However, both the Northern (North Carolina to northeast Florida) and Florida Panhandle Nesting Subpopulations are believed to be in decline as a result of decreasing numbers of nesting females over the past several years (NMFS, 2002c). In 1998, loggerhead nesting totals from North Carolina, South Carolina, Georgia, and Northern Florida were approximately 7,500 nests (TEWG, 2000). From 1989 to 1998, the Northern nesting subpopulation accounted for 8.5 percent of nesting on the U.S. Atlantic and Gulf coasts (TEWG, 2000).

Habitat Preferences—The loggerhead turtle occurs worldwide in habitats ranging from coastal estuaries to waters far beyond the continental shelf (Dodd, 1988). Loggerheads are primarily oceanic as post-hatchlings and early juveniles, often occurring in *Sargassum* drift lines where they are transported throughout the ocean by dominant currents, such as the North Atlantic Gyre (Caldwell, 1968; Carr, 1987; Witherington, 1994b; Bolten and Balazs, 1995). *Sargassum* likely provides optimal foraging opportunities and habitat for loggerhead hatchlings, yet individuals may also be sighted at the surface off the Florida coast and unassociated with *Sargassum* drift lines (Smith, 1968).

Loggerhead migrations consist of travel to early juvenile nursery habitat, later juvenile developmental habitat, adult foraging habitat, and adult internesting or breeding habitat, and may be based upon the ontogeny of life stages (Musick and Limpus, 1997). Post-hatchling loggerheads are transported throughout the ocean by dominant currents (Bolten and Balazs 1995) and often use the currents of the North Atlantic Gyre System to aid in travel during developmental migrations (Bolten et al., 1998). Juveniles may also use small scale surface currents for transportation, migrating counter to North Atlantic prevailing currents (Cejudo et al., 2006). Once departing western Atlantic nesting grounds, post-hatchlings travel to oceanic waters surrounding the Azores and Madeira, the Great Banks (Newfoundland, Canada), and the Mediterranean Sea (Bowen et al., 2004). Genetic evidence demonstrates that pelagic loggerheads found near the Azores are often derived from the nesting populations in the southeastern U.S. (Bolten et al., 1994, Bolten et al., 1998). After reaching a certain size, early juvenile loggerheads will then make a trans-oceanic crossing back towards the western Atlantic Ocean (Musick and

Limpus, 1997), actively swimming to neritic feeding grounds near their natal beach of origin (Bowen et al., 2004). Based on growth rate estimates, the duration of the pelagic juvenile stage for North Atlantic loggerheads is estimated to be approximately 8.2 years, with Pacific loggerheads recruiting to demersal habitats at a larger size (Bjorndal et al., 2000a).

Small benthic-feeding immatures are the predominant loggerhead size class found along the northeast and mid-Atlantic U.S. coast (TEWG, 1998); adults are known to use the entire continental shelf area (Hopkins-Murphy et al., 2003). Juveniles are frequently observed in developmental habitats; such habitats include coastal inlets, sounds, bays, estuaries, and lagoons of less than 100 m (328 ft) in depth (TEWG, 1998; Hopkins-Murphy et al., 2003). Juveniles recruit to these neritic feeding grounds at the size of approximately 40 cm (16 in) (Carr, 1987). Core Sound and Pamlico Sound, North Carolina represent important developmental habitat for juvenile loggerheads (Epperly et al., 1995b). Although these habitats are also used by other species, such as greens and Kemp's ridleys, loggerheads represent the most abundant sea turtle species within the North Carolina summer developmental habitats (Epperly et al., 1995b).

Based on growth models, immature loggerheads may occupy coastal feeding grounds for 20 years before their first reproductive migration (Bjorndal et al., 2001). Juvenile loggerheads are also known to inhabit offshore waters in the North Atlantic Ocean where they are often associated with natural and/or artificial reefs (Fritts et al., 1983). These offshore habitats provide juveniles with an abundance of prey as well as sheltered locations where they can rest (Rosman et al., 1987). As later juveniles and adults, loggerheads most often occur on the continental shelf and along the shelf break of the U.S. Atlantic and Gulf coasts as well as coastal estuaries and bays (CETAP, 1982; Shoop and Kenney, 1992). Sub-adult and adult loggerhead turtles tend to inhabit deeper offshore feeding areas along the western Atlantic coast, from mid-Florida to New Jersey (Hopkins-Murphy et al., 2003); (Roberts et al., 2005). Hawkes et al. (2007) found adult females to forage predominantly in shallow coastal waters along the U.S. Atlantic coast less than 100 m deep, likely exploiting benthic prey. Turtles were found to use significantly shallower water and larger areas for foraging than for overwintering as well as exhibit site fidelity to these areas (Hawkes et al., 2007).

Loggerheads typically nest on high-energy beaches close to reef formations and adjacent to warm-temperature currents (Dodd, 1988). Nesting beaches facing the open ocean or situated along narrow bays are preferred (NMFS and USFWS, 1991b). Nest site selection tends to depend more upon beach slope and width than temperature, moisture, or salinity (Wood and Bjorndal, 2000). Adult loggerheads exhibit strong site fidelity to nesting beaches by consistently returning to their natal beaches to nest (Comer, 2002).

Distribution**—**Loggerhead turtles are found in subtropical and temperate waters throughout the world (NMFS and USFWS, 1991b). The loggerhead numbers in the thousands throughout inner continental shelf waters of the Atlantic coast from Cape Cod to southern Florida and the Gulf Coast from southern Florida to southern Texas.

Off the eastern United States, loggerheads are commonly sighted across the shelf from the shore to the shelf break as far north as Long Island, although far north and east sightings are sparse (CETAP, 1982); (Shoop and Kenney, 1992). North of Cape Hatteras, North Carolina, loggerhead occurrence is highly seasonal (CETAP, 1982; Lutcavage and Musick, 1985; Shoop and Kenney, 1992). South of Cape Hatteras, loggerheads are resident year-round. Based on aerial survey data, it is estimated that only 12 percent of all western North Atlantic loggerheads reside in the eastern GOMEX and that the vast majority of these individuals occur in western Florida waters (TEWG, 1998; Davis et al., 2000b).

Low water temperatures affect loggerhead turtle activity, and cold-stunned loggerheads have been found in various locales, including Long Island Sound, NY; Cape Cod Bay, MA; Indian River Lagoon, FL; and at sites in Texas (Burke et al., 1991; Morreale et al., 1992; NOAA, 1993). Loggerheads become lethargic at about 13 to 15°C (55.4 to 59°F) and adopt a stunned floating posture in water around 10°C (50°F) (Mrosovsky,1980). Coles and Musick (2000) identified preferred sea surface water temperatures to range between 13.3 to 28°C and (55.9 to 82.4°F) for loggerhead turtles off North Carolina. Cold-stunned loggerheads are often found between December and February offshore of Cape Lookout, North Carolina (Schwartz, 1989). Some loggerheads are believed to escape cold conditions by burying themselves in the bottom sediment; the reason for this is unknown. Over-wintering loggerheads may exhibit this behavior in Cape Lookout Bight, although this is yet to be confirmed (Schwartz, 1989). An age difference exists in the loggerhead's cold tolerance, with younger turtles being more resistant (Schwartz, 1978).

Loggerhead turtles nest almost exclusively in warm-temperate regions. Throughout the world, nesting on warm-temperate beaches is much more common than nesting in the tropics (TEWG, 2000). Beach temperatures may also determine sex of hatchlings; male hatchlings typically occur on cooler temperature beaches (Mrosovsky, 1980). Intraseasonal nesting patterns for females vary; some females may nest only once a season while others may nest several times (Webster and Cook, 2001). In the western North Atlantic Ocean, there are at least five demographically independent loggerhead nesting groups or subpopulations: (1) Northern: North Carolina, South Carolina, Georgia and northeast Florida; (2) South Florida: occurring from 29°N on the east coast to Sarasota on the west coast; (3) Florida Panhandle: Eglin Air Force Base and the beaches near Panama City, Florida; (4) Yucatán: the eastern shore of the Yucatán Peninsula, Mexico; and (5) Dry Tortugas: near Key West, Florida (Encalada et al., 1998; TEWG, 2000; Epperly et al., 2001). Small but significant nesting aggregations are also known from the Bahamas, Cuba, the Dry Tortugas, and Alabama (Dodd, 1988; Phillips, 2005). Southeastern Florida represents the principal nesting site for loggerheads along the U.S. Atlantic coast (NMFS and USFWS, 1991b).

Genetic evidence has shown that assemblages of benthic-feeding immature loggerheads on foraging grounds comprise a mix of subpopulations (Sears et al., 1995; TEWG, 1998; Epperly et al., 2001). At least three of the western North Atlantic subpopulations intermingle on foraging grounds off the northeast U.S. coast. Mixed stock analyses of stranded loggerheads have shown that the Northern (25 percent), South Florida (58 percent), and Yucatán (17 percent) subpopulations of loggerheads intermingle on foraging grounds in northeast U.S. waters (Rankin-Baransky, 1997). Many of the loggerheads feeding offshore in the Northeast Florida-North Carolina foraging areas are derived from the Florida nesting assemblage (65 percent) and the nearby Northeast Florida- North Carolina nesting assemblage (19.1 percent) (Roberts et al. 2005). Epperly et al. (2001) reported that the northern nesting subpopulation (Northeast Florida to North Carolina) accounts for 46 percent of the loggerheads in Virginia but only 25 to 28 percent of the loggerheads off the Carolinas. The south Florida subpopulation also contributes significantly to loggerheads off the Carolinas (66 percent) and in North Carolina's Albemarle-Pamlico Estuarine Complex (Epperly et al., 2001). The genetic origins of benthic immature loggerheads in the GOMEX have not been determined (MMS, 2001).

Atlantic Ocean, Offshore of the Southeastern United States

Loggerheads occur year-round in the VACAPES OPAREA using waters of the OPAREA for foraging and transit to nesting beaches. Seasonal water temperatures influence loggerhead occurrence within the OPAREA. A high concentration of loggerheads occurs in shelf waters offshore Maryland during the spring and northern North Carolina during the fall. During spring and fall, loggerheads are likely transiting the OPAREA to access summer foraging or overwintering habitats.

Loggerheads occur year-round in the CHPT OPAREA, using North Carolina waters for overwintering, foraging, and traveling to nesting beaches. Seasonal water temperatures influence loggerhead occurrence offshore North Carolina although loggerheads are resident year-round south of Cape Hatteras, NC. The occurrence trend shows a preference for shelf waters throughout the year; during the winter, loggerhead presence may extend further offshore. Spring and summer represent peak nesting time for loggerheads in North Carolina; during these seasons, individuals may transverse the OPAREA en route to nesting beaches.

Loggerheads occur year-round in the JAX/CHASN OPAREA, using the waters for overwintering, foraging, migrating, and traveling to nesting beaches. The occurrence records show a preference for shelf waters and are correlated with the Gulf Stream throughout the year. Spring and summer represent peak nesting time for loggerheads in the area; during these seasons, individuals may transverse the OPAREA en route to nesting beaches. Loggerheads migrate south to the warmer waters of the JAX/CHASN OPAREA (Hopkins-Murphy et al., 2003; Morreale and Standora, 2005) while waters just south of the OPAREA serve as an overwintering ground (Carr et al., 1980; Henwood, 1987).

Atlantic Ocean, Offshore of the Northeastern United States

In general, loggerhead turtles can be found during any season in both continental shelf and slope waters of the U.S. Atlantic from Cape Cod to the Florida Keys. In summer, the overall distribution of loggerheads likely extends into the Gulf of Maine and waters over the Scotian Shelf, with some individuals venturing as far north as Newfoundland. Loggerhead abundance in the area likely peaks during summer (Shoop and Kenney, 1992), with the largest numbers of individuals occurring in mid-continental shelf waters off New Jersey. At the onset of winter, the species' range is presumed to contract to waters south of where the Gulf Stream Current deflects off Cape Hatteras. Despite low levels of survey effort beyond the continental shelf break, loggerheads are commonly sighted in deep, offshore waters of the Mid-Atlantic Bight. However, it is in the region's continental shelf waters where loggerhead turtles are believed to most often concentrate (Shoop and Kenney, 1992; Mitchell et al., 2002).

In winter, the vast majority of loggerhead encounters in U.S. Atlantic waters during occur in areas well south of the NE OPAREAs. Most loggerheads overwinter in waters associated with the Gulf Stream Current from Cape Hatteras south (Epperly et al., 1995; Mitchell et al., 2002). Strandings along Cape Cod and Long Island and sightings near the southern boundary of the NE OPAREAs provide evidence that small numbers of loggerheads may remain in the area during winter. Those individuals that do remain will likely be highly susceptible to cold-stunning and

hypothermia, as winter water temperatures in the area often drop well below the species' thermal tolerance (Burke et al., 1991).
In spring, loggerhead turtles begin to migrate into the NE OPAREAs in April and May, as evidenced by the increase in sighting records from winter to spring. Loggerheads are likely to occur throughout the Atlantic City and Narragansett Bay OPAREAs and in the southern portion of the Boston OPAREA (off Cape Cod) during this season, but aren't likely to enter the northern sector of the Boston OPAREA (i.e., the waters of the Gulf of Maine) until mid-summer (Shoop and Kenney, 1992).

During summer, loggerhead turtles can occur in the area as far north as the Gulf of Maine, although the scientific literature, and the available sighting, stranding, and bycatch records indicate that they most commonly occur in waters over the continental shelf and slope south of Long Island (Shoop and Kenney, 1992). As water temperatures rise from July to September, loggerheads will move further north and inshore along the U.S. Atlantic coast. Shoop and Kenney (1992) estimated that a minimum of 8,000 to 11,000 loggerheads are present in northeastern U.S. waters each summer. The area of highest summer occurrence likely runs through the center of the Atlantic City OPAREA, encompassing waters over the mid-continental shelf from roughly Delaware Bay to Hudson Canyon. Juvenile loggerheads are regular visitors to the area during this season, often using the region's inshore and nearshore waters as developmental foraging habitats. Delaware Bay, Long Island Sound, and Cape Cod Bay are three of the most often utilized juvenile developmental habitats along the northeast U.S. coast (Burke et al., 1991; Prescott, 2000; UDSG, 2000).

Based on the available sighting and bycatch data, loggerhead turtles are likely to occur in both continental shelf and slope waters of the Atlantic City and Narragansett Bay OPAREAs during fall. The large number of stranding records along the northeast U.S. coast from Cape Cod south indicates that loggerheads are also likely to be found in the southern portion of the Boston OPAREA during this season. As water temperatures drop from October to December, most loggerheads will emigrate from their summer developmental habitats and eventually return to warmer waters south of Cape Hatteras, where they will spend the winter months (Morreale and Standora, 1998). Areas of high fall occurrence probably occur south of the area in continental shelf waters off Cape Hatteras, as loggerheads are often concentrated in that area as they pass through (Keinath et al., 1996). Loggerheads that are unable to vacate inshore habitats such as Long Island Sound and Cape Cod Bay in the fall often end up stranding on the region's beaches as a result of hypothermia (Burke et al., 1991).

Gulf of Mexico

In general, loggerhead turtles can be found during all seasons in both continental shelf and slope waters of the GOMEX. The sea turtle occurrence data illustrate that loggerheads are the most often sighted and stranded species of sea turtle in the northern GOMEX throughout the year. Sighting and nesting surveys have demonstrated that the density and abundance of loggerhead turtles is much higher in the northeastern Gulf than in the northwestern Gulf (Fritts et al., 1983b; Davis et al., 2000b). Adult loggerheads do not heavily utilize the beaches of the Texas and Louisiana as nesting habitats and juvenile loggerheads appear to primarily use the developmental habitats found in the northwestern Gulf (Landry and Costa, 1999). Loggerhead turtles are occasionally associated with offshore oil platforms and banks in the western portion of the area (Lohoefener et al., 1990; Gitschlag and Herczeg, 1994) but are more often documented in association with natural and artificial reefs off of Florida (Rosman et al., 1987; Davis et al., 2000b). Significant concentrations of loggerheads are likely found in the Key West OPAREA, although far less survey effort has taken place in those waters.

The occurrence of loggerhead turtles during winter is likely concentrated in the northeastern Gulf, in Alabama and Florida Panhandle shelf waters. This trend, however, may reflect the amount of survey effort expended over those waters. Loggerheads also occur in the deeper off-shelf waters from Texas to Florida during winter, although not as prevalently as in shelf waters. The high number of strandings along the central and southern Florida coasts as well as the numerous sighting records from the Florida Keys indicates that loggerheads are likely just as common in waters off southern Florida as they are off Alabama and the Florida Panhandle (Pensacola and Panama City OPAREAs) during this season. In fact, ocean waters off southern Florida and in the Key West Complex should be more suitable for loggerheads during winter since they are several degrees warmer in temperature. Winter sightings in the northwestern Gulf are less concentrated, yet they occur in both continental shelf and slope waters off Texas and Louisiana.

In spring, as evidenced by the available sighting, stranding, and incidental bycatch data, loggerheads can be found from inshore, estuarine waters to oceanic habitats far beyond the continental shelf break. It is likely that loggerhead turtles may be found in every Navy GOMEX OPAREA during this season. During spring months, loggerhead stranding activity along much of the south Florida and Panhandle coasts remains high. In addition, loggerhead nesting activity begins in several areas of the northern GOMEX, including south Texas, Alabama, the Florida Panhandle, and south Florida. Fritts et al. (1983b) sighted the highest numbers of loggerheads in the GOMEX during spring.

Loggerhead turtle abundance throughout the area likely peaks during summer, when water temperatures and nesting activity reach their highest levels. Occurrence of loggerheads is likely in all continental shelf waters of the area in summer. Sightings are common throughout the GOMEX continental shelf waters, including southeastern Florida and the Florida Keys. Strandings occur uniformly in the Florida Keys and much of the western Florida, Alabama, and Mississippi coasts. Nesting activity in Florida coastal counties and along Alabama shores remains at the same level as occurred in spring. Off-shelf occurrences are infrequent, possibly due to the movement of most loggerheads further north and inshore during summer months. Braun-McNeill and Epperly (2004) concluded that increases in nearshore loggerhead occurrences during summer months are more profound in more western GOMEX waters.

Based on the available sighting and bycatch data, loggerhead turtles continue to occur throughout the continental shelf waters of the GOMEX and southeastern Florida during fall. The highest concentrations of loggerheads in the area are predicted to occur in fall just offshore of Tampa Bay, with other aggregations occurring in waters along much of the inner Florida shelf to the Florida Keys. Loggerheads occur along much of the inner Texas and Louisiana shelf waters as well, although occurrences are not as likely off southern Texas and much of the Corpus Christi OPAREA due to a lack of documented sightings. Although nesting activity in the region tapers off significantly during fall, the post-nesting migrations of several individuals satellite-tagged on nesting beaches in the Gulf Islands indicate that adult loggerheads likely remain in continental shelf waters of the northern GOMEX throughout the season. Only when water temperatures drop dramatically at the onset of winter will most loggerheads move further offshore or to more southerly waters.

3.7.2.4 Kemp's Ridley Sea Turtles (*Lepidochelys kempii*)

***Description*—**The Kemp's ridley is the smallest sea turtle; adult straight carapace length is approximately 65 cm (26 in) and less than 45 kg (99 lb) in weight (USFWS and NMFS, 1992). The carapace is round to somewhat heart-shaped and distinctly light gray.

***Status*—**The Kemp's ridley turtle is classified as endangered under the ESA; it is considered the world's most endangered sea turtle (USFWS and NMFS, 1992). The worldwide population declined from tens of thousands of nesting females in the late 1940s to approximately 300 nesting females in 1985. From 1985 to 1999, the number of nests at Rancho Nuevo, Tamaulipas (eastern coast of Mexico) increased at a mean rate of 11.3 percent per year (TEWG, 2000).

Approximately 5,373 nests and 2,339 nesting females were recorded at Rancho Nuevo in 2003; however, these numbers represent a 94 percent decrease from historical records (Márquez-M. et al., 2005). In 2005, 6,947 nests were recorded in Rancho Nuevo (USFWS, 2005). Positive trends in 2005 were also recorded in other areas of the Mexican Gulf Coast at Barra del Tordo (701 nests) and Barra de Tepehuajes (1,610 nests). Nests at Veracruz decreased from 164 nests 2002 to 62 nests in 2005 (USFWS, 2005). Nesting levels at Padre Island National Seashore in Texas, the site of a Kemp's ridley head-starting and imprinting program from 1978 to 1988, have shown a slow but steady rise throughout time. During 2002, 38 Kemp's ridley nests were recorded, as opposed to 13 nests in 1998 and 16 nests in 1999 (Márquez-M et al., 2005). In 2006, 64 nests were recorded there (NPS, 2006).

There are an estimated 3,900 to 8,100 juvenile Kemp's ridleys that utilize developmental habitats annually along the western North Atlantic coast (Seney and Musick, 2005).

***Habitat Preferences*—**Kemp's ridley turtles occur in open-ocean and *Sargassum* habitats of the North Atlantic Ocean as post-hatchlings and small juveniles (e.g., Manzella et al., 1991). They move to benthic, nearshore feeding grounds along the U.S. Atlantic and Gulf coasts as large juveniles and adults (Morreale and Standora, 2005). Habitats frequently utilized include warm-temperate to subtropical sounds, bays, estuaries, tidal passes, shipping channels, and beachfront waters where its preferred food, the blue crab (*Callinectes sapidus*), is known to exist (Lutcavage and Musick, 1985; Landry and Costa, 1999).

Water temperature is a limiting factor in the distribution and abundance of Kemp's ridley turtles present in the north Atlantic Ocean. In temperature less than 13°C (55.4°F), Kemp's float, make awkward movements, and may even die of cold-stunning (Burke et al., 1991; Márquez-M., 1994). Several mechanism have been suggested for Kemp's ridley survival of cold temperatures during the winter; one hypothesis is migration to warmer waters while others theorize that these turtles bury themselves in mud bottoms to avoid the low temperatures (Márquez-M., 1994). Kemp's ridleys are likely only to be found along the mid-Atlantic coast from spring to fall but may be found throughout the waters of the South Atlantic Bight (SAB) and GOMEX year-round (Lazell, 1980; Lutcavage and Musick, 1985; Weber, 1995).

In addition to water temperature, habitat factors of critical importance to Kemp's ridley turtles include water depth and prey abundance. Using what is known about the affinity of this species for shallow coastal waters and their aversion to cold temperatures, scientists have made developed a habitat suitability index (HSI) estimating the suitability of various habitats in the northwestern Atlantic and GOMEX for the species (Coyne et al., 1998). In this theoretical, quantitative model, the most optimal habitats for Kemp's ridleys are those with a bottom depth less than 10 m (32.8 ft) and a sea surface temperature between 22° and 32°C (71.6° and 89.6°F) (Coyne et al. 1998). A cycling of HSI model outputs by month for the Atlantic and Gulf coasts can be viewed at http://www.seaturtle.org/research/hsi.html.

Distribution—-The Kemp's ridley is restricted to the North Atlantic Ocean (Marquez-M. 1994). Adults are largely confined to the Gulf of Mexico, with moderate numbers along the U.S. Atlantic Coast as far north as Nova Scotia (Lazell, 1980); (Morreale et al., 1992). It is mostly juveniles that occupy the northern part of the range (Morreale and Standora, 2005), with juvenile Kemp's ridleys most often sighted along the eastern coast of Florida (Henwood and Ogren, 1987). There is evidence of transoceanic migrations, with some Kemp's ridleys reported as far east as northern Europe and the Mediterranean Sea (Brongersma, 1995; Tomás et al., 2003).

Oceanic transport of hatchling Kemp's ridleys is controlled primarily by hydrography in the Gulf of Mexico (Collard, 1990b). Upon leaving the nesting beach of Rancho Nuevo, hatchling Kemp's ridleys enter the Mexican Current, and are swept eastward into the northern Gulf of Mexico (Musick and Limpus, 1997). Many juveniles are retained in the northern Gulf until they migrate inshore to demersal habitat. Others may be carried south from the northern Gulf into the Loop Current, where they are swept into the Florida Current and, subsequently, the Gulf Stream (Musick and Limpus, 1997). Once they reach a size of approximately 20 to 30 cm, or 2 years of age, they actively migrate to neritic developmental habitats along the U.S. Atlantic Coast (Musick and Limpus, 1997). Alternatively, the North Atlantic Gyre may work in conjunction with the Gulf Stream to carry juveniles into the eastern North Atlantic Ocean, to areas such as the Azores and Madeira (Brongersma, 1995; Musick and Limpus ,1997).

Adults appear to remain in the Gulf of Mexico, with occasional occurrences in the Atlantic Ocean. Satellite-tracking results of an adult Kemp's ridley of unknown sex showed a travel route from the Gulf of Mexico through the Florida Straits and into the Atlantic Ocean (Renaud and Williams, 2005). Adult females in the Gulf of Mexico movements are expected to be more extensive than those of males, and likely influenced by foraging and reproductive needs; Renaud and Williams (2005) tracked one adult female from her foraging grounds offshore Louisiana to the nesting beach in Rancho Nuevo, Mexico. Adult male Kemp's ridleys exhibit small range movements and may reside offshore nesting beaches year-round due to prey availability and mating opportunities (Shaver et al., 2005).

Environmental conditions play a major role in determining the number of Kemp's ridleys in an area. A decrease in air and surface water temperature in the fall, influenced by the passage of cold fronts, likely triggers Kemp's ridley seasonal migrations (Renaud and Williams, 2005). Migrations tend to take place in nearshore waters along the mid-Atlantic Coast; juvenile and adults typically travel within the 18 m (59 ft) depth contour (Renaud and Williams, 2005). This migratory corridor is a narrow band running within continental shelf waters, possibly spanning the entire length of the U.S. Atlantic Coast (Morreale and Standora, 2005).

Mature Kemp's ridleys likely forage along the eastern Gulf of Mexico and eastern coast of Florida (Henwood and Ogren, 1987; Schmid and Barichivich, 2005). Although (Renaud, 1995) indicated that adult Kemp's ridley turtles may travel along the entire Gulf Coast when looking for optimal foraging habitat, Schmid and Barichivich (2005) found adult Kemp's ridleys to establish site fidelity at foraging areas in coastal waters.

Nesting occurs primarily on a single nesting beach at Rancho Nuevo, Tamaulipas, on the eastern coast of Mexico (USFWS and NMFS, 1992), with a few additional nests in Texas, Florida, South Carolina and North Carolina (Meylan et al., 1990; Weber, 1995; Godfrey, 1996; Foote and Mueller, 2002; NPS, 2003).

Atlantic Ocean, Offshore of the Southeastern United States

Kemp's ridleys occur within the VACAPES OPAREA year-round although occurrence is most common during the summer. They are likely to occur from the shoreline to the 50 m (164 ft) isobath from spring through fall. Adults are not often found in waters deeper than 50 m (164 ft) (Byles, 1989). Water temperature is likely the most influential factor in the seasonal occurrence of Kemp's ridleys within the VACAPES OPAREA. Juvenile Kemp's ridleys are the second most common, after loggerheads, to use Virginia developmental habitat (Mansfield 2006). Kemp's ridley hatchlings may occur offshore near the eastern edge of the VACAPES OPAREA and Gulf Stream in *Sargassum*. Spring and fall appear to experience the greatest amount of strandings.

Kemp's ridleys occur within the CHPT OPAREA year-round although occurrence is most common during the winter and summer months. Water temperature is likely the most influential factor in the seasonal occurrence of Kemp's ridleys within the OPAREA. Kemp's ridley hatchlings may occur offshore near the eastern edge of the CHPT OPAREA and Gulf Stream in *Sargassum*. Spring and fall appear to experience the greatest amount of strandings.

Kemp's ridleys occur within the JAX/CHASN OPAREA year-round. Water temperature is an influential factor in the occurrence and distribution of Kemp's ridleys within the OPAREA. Additionally, increased survey efforts due to North Atlantic right whale surveys in the late fall and winter seasons greatly increase the number of sightings recorded during those seasons. Kemp's ridley hatchlings may occur offshore seaward of shelf break near the Gulf Stream in *Sargassum* and older animals, sub-adults and adults, may be found in the warm Gulf Stream waters during the colder months.

Atlantic Ocean, Offshore of the Northeastern United States

Overall, Kemp's ridley turtles could occur during any season in the continental shelf waters of the study area to as far north as Massachusetts Bay, with the highest concentrations likely occurring during summer in the western portion of the Atlantic City OPAREA. Sighting records for the remaining three seasons are sparse, yet the lack of sightings may be due to low sightability rather than low occurrence. Kemp's ridleys are very difficult to sight during aerial and shipboard surveys, especially at times of the year when sighting conditions are not optimal (Shoop and Kenney, 1992; Keinath et al., 1996). Generally, sighting conditions in the western North Atlantic Ocean are best during summer.

In winter, Kemp's ridley turtles may occur in the area infrequently (i.e., in very low numbers). Prior to the onset of winter, most Kemp's ridley turtles move to warmer waters further south or within the Gulf Stream Current (Keinath et al., 1996; Morreale and Standora, 1998). The only winter occurrences in the area are several strandings recorded on Long Island and Cape Cod. The stranding records and scientific literature suggest that some individuals remain. However, in most cases, these turtles will experience hypothermia and ultimately strand on the region's beaches (Burke et al., 1991; Morreale et al., 1992; Still et al., 2003).

The occurrence of Kemp's ridley turtles in the area likely remains low during spring. There are no spring sighting records, however, strandings along the beaches of Long Island and Cape Cod demonstrate that there is the potential for this species to be present in the area during spring. Satellite-tracking studies and in-water surveys have also provided conclusive evidence that Kemp's ridley turtles begin their northward seasonal movements into the area's waters from further south during this season. Kemp's ridley turtles begin arriving in Mid-Atlantic waters off New Jersey and New York in June; yet do not occur there in large numbers until the summer and fall months (Morreale and Standora, 1998).

Kemp's ridley turtles have been recorded in waters as far north as Massachusetts Bay during the summer, yet the majority of sightings in the area occur in continental shelf waters off New Jersey. Kemp's ridleys are likely to occur in these nearshore waters, as well as within Delaware Bay and Long Island Sound, where they are presumably preying on blue crabs, their preferred prey (UDSG, 2000). Cape Cod Bay has also been identified as an area of known summer concentration (Burke et al., 1993; Weber, 1995; Morreale and Standora, 1998; Prescott, 2000), so this species probably occurs in waters further north than the sighting records indicate (at least to Massachusetts Bay). Although few sighting records exist for Cape Cod Bay, it is identified as the northernmost summer feeding habitat for juvenile Kemp's ridleys in the western North Atlantic Ocean (Danton and Prescott, 1988; Still et al., 2002).

Based on the large numbers of strandings that are recorded along the coasts of Long Island and Cape Cod on an annual basis, it is likely that this species occurs in shelf waters from Cape Cod Bay south during fall (Danton and Prescott, 1988; Prescott, 2000; Still et al., 2002). Even though only one fall sighting record exists in the area, the scientific literature states that Kemp's ridley turtles generally occur in the area through October (Keinath et al., 1996; Morreale and Standora, 1998; UDSG, 2000). As water temperatures rapidly decline from October through December, Kemp's ridleys become increasingly susceptible to stranding as a result of hypothermia. Kemp's ridleys that are unable to emigrate from the area in early fall often suffer from cold-stunning and then strand on the region's beaches (Burke et al., 1991; Morreale et al., 1992; Still et al., 2003).

Gulf of Mexico

Kemp's ridley turtles primarily occur in shallow (less than 50 m [164 ft]) continental shelf waters of the northern GOMEX year-round. Tidal passes and beachfront environments are their most preferred habitats in this region (Landry and Costa, 1999). The low number of sighting records for the area is likely due to low survey effort and poor sightability of this species rather than low to no occurrence; Kemp's ridley turtles are very difficult to sight during aerial and shipboard surveys, especially at times of the year when sighting conditions are not optimal (Shoop and Kenney, 1992; Keinath et al., 1996). It is likely that Kemp's ridley turtles may be observed in all GOMEX OPAREAs during the year, particularly in the inner shelf waters.

Kemp's ridley turtle sightings in the area are sparse during winter, with the most numerous cluster occurring off Panhandle Florida. Numerous stranding records from southern Florida; several bycatch, nest, and stranding records along the Texas coast; and sighting records off Louisiana suggest that these turtles may be found in continental shelf waters of the northern GOMEX and southeastern Florida. This conclusion is supported by the information from marine surveys and platform observation programs that indicate little prolonged utilization of offshore habitat by this species in winter (Landry and Costa, 1999). It is surprising that most winter sightings occur in the northernmost waters of the GOMEX, as the suitability of those waters in winter is low (Coyne et al., 2000). Movement data from tagged individuals suggests that the species' attraction to nearshore habitats weakens with the onset of cooler water temperatures.

The occurrence of Kemp's ridley turtles in the area likely remains low in waters beyond the continental shelf during spring. However, regular nesting occurs along the coast of Texas and the numerous strandings along the coast of Florida demonstrate the continued presence of Kemp's ridley turtles in nearshore waters of the northern GOMEX. As these waters warm from April to June, the suitability of nearshore habitats increases from low to high (Coyne et al., 2000). Kemp's ridleys nesting in south Texas either come from Mexican waters or from northern GOMEX waters. Individuals coming from the east likely travel in close proximity to the shore, as evidenced by recaptures of pre- and post-nesting females at Sabine and Calcasieu Passes along the upper Texas/Louisiana coasts (Landry and Costa, 1999). Spring nesting has also been documented along the coast of southern Florida, although these occurrences are rare (Foote and Mueller, 2002).

The suitability of continental shelf habitats in the northern GOMEX and off southeastern Florida peaks during summer, while the suitability of off-shelf habitats remains poor to unsuitable (Coyne et al., 2000). As a result, nearly all sighting and bycatch records continue to be recorded in continental shelf waters of the area from Texas through Florida. Kemp's ridleys may occur ubiquitously throughout shelf waters of the entire area. Shrimp and blue crabs, the preferred prey of Kemp's ridleys, are both very abundant off southern Louisiana during summer months (Manzella et al., 1988) and the coastal waters off southern Louisiana and western Florida have also been documented as important developmental regions for juvenile turtles (Rudloe et al., 1991; MMS, 2001; Schmid et al., 2002). Kemp's ridley turtles may likely occur in all OPAREAs except the New Orleans OPAREA during summer.

Line-transect survey effort over Kemp's ridley suitable habitat in the area is most extensive during fall, with a large amount of that effort directed to the west Florida shelf. Areas of highest Kemp's ridley occurrence, as shown through the occurrence records, include the Cedar Keys region, waters within and offshore of Tampa Bay, and nearshore waters off Monroe County in southwestern Florida. These are areas where adult Kemp's ridleys, which are more easily recognizable during aerial and shipboard surveys, likely congregate throughout the year. Since juveniles are known to prefer nearshore waters of the northwestern GOMEX year round (Renaud, 1995; ACE, 2005), it is likely that occurrence records in Texas and Louisiana waters represent a different size-class than those recorded for Florida nearshore waters. The likely explanation for fewer sighting records in the preferred waters of juvenile Kemp's in the northwestern Gulf during this season is that juvenile Kemp's ridley turtles are less likely to be spotted during sighting surveys. Nevertheless, Kemp's ridleys are likely as abundant in those waters as they are off Florida.

3.7.2.5 Olive Ridley Sea Turtle (*Lepidochelys olivacea*)

Description**—**The olive ridley is a small, hard-shelled sea turtle named for its olive green colored shell. Adults often measure between 60 and 70 cm (24 and 28 in) in carapace length (NMFS and USFWS, 1998). The olive ridley has a smaller head, a narrower carapace, and several more lateral carapace scutes than does its relative, the Kemp's ridley turtle.

Status**—**Olive ridleys are classified as threatened under the ESA, although the Mexican Pacific coast population is classified as endangered. Since listing under the ESA, a general decline in the abundance of this species has occurred (NMFS and USFWS, 1998). For example, nesting populations in the western North Atlantic Ocean have declined more than 80 percent since 1967 (Reichart, 1993). However, in terms of absolute numbers, the olive ridley is considered the most abundant of the world's sea turtles, although there are no current estimates of worldwide abundance.

Habitat Preferences**—**Olive ridley turtles typically inhabit offshore waters, foraging either at the surface or at depth (up to 150 m [492 ft]). Strangely enough, the habitat preferences of the olive ridley more closely parallel those of the leatherback sea turtle rather than those of its relative, the Kemp's ridley (NMFS and USFWS, 1998). Olive ridleys and leatherbacks both occupy oceanic habitats and both nest primarily on the Pacific shores of the American tropics and in the Atlantic along the shores of the Guiana's. Both species also nest in moderate numbers in tropical West Africa and southern Asia and in relatively small numbers elsewhere (both rarely nest in Australia and on other smaller oceanic islands in the Pacific Ocean).

Distribution**—**The olive ridley sea turtle is a pantropical species, occurring worldwide in tropical and warm temperate waters. In the Atlantic Ocean, the olive ridley occurs along the coasts of both Africa and South America but probably not in great abundance. Atlantic olive ridleys nest primarily in the French Guiana, Surinam, and Guyana; however, they are rarely found in the Caribbean Sea and have been documented in Puerto Rico, the Dominican Republic, and Cuba (Foley et al., 2003).

Atlantic Ocean, Offshore of the Southeastern United States

The olive ridley sea turtle is not expected to occur within the Atlantic Ocean, offshore of the Southeastern United States.

Atlantic Ocean, Offshore of the Northeastern United States

The olive ridley sea turtle is not expected to occur within the Atlantic Ocean, offshore of the Northeastern United States.

Gulf of Mexico

There are no olive ridley sighting records available for the area. Only three occurrences have ever been documented in the vicinity of the GOMEX, all of which are strandings. Between 1999 and 2001, three olive ridley turtles stranded between Miami-Dade County and Marathon in the Florida Keys (one in summer, two in fall). Two were confirmed to be adult males, while the other was determined to be an early juvenile male. Originally identified as Kemp's ridley turtles, these individuals were later reclassified as olive ridleys following a review of photographic data and comparison of genetic samples (Foley et al., 2003). These three stranding records represent the northernmost known occurrences of olive ridleys in the northwestern Atlantic Ocean and should, therefore, be deemed as extralimital. In the western North Atlantic, the species' center of distribution is located several thousands of kilometers to the south along the north coast of South America.

3.7.2.6 Leatherback Sea Turtles (*Dermochelys coriacea*)

Description**—**The leatherback turtle is the largest living sea turtle. This species is placed in a separate family from all other sea turtles, in part because of its unique carapace structure. A leatherback turtle's carapace lacks the outer layer of horny scutes possessed by all other sea turtles; it is instead composed of a flexible layer of dermal bones underlying tough, oily connective tissue and smooth skin. The body of a leatherback is barrel-shaped and tapered to the rear with seven longitudinal dorsal ridges, and it is almost completely black with variable spotting. All adults possess a unique pink spot on the dorsal surface of their head; this marking can be used by scientists to identify specific individuals (McDonald and Dutton, 1996). Adult curved carapace lengths (CCL) range from 137 to 183 cm (54 and 72 in). Adult leatherbacks typically weigh between 200 and 700 kg (441 and 1,543 ft) (NMFS and USFWS, 1992), although larger individuals are documented (Eckert and Luginbuhl, 1988).

Status**—**Leatherback turtles are listed as endangered under the ESA (NMFS and USFWS, 1992). Counts of nesting females typically provide the best available index of leatherback sea turtle population status; the largest leatherback populations are located in the Western Atlantic Ocean and Caribbean Sea regions (Spotila et al., 1996). The most recent summary of sea turtle nesting status in the Atlantic Ocean estimates approximately 1,437 to 1,780 (individuals occurring throughout the Caribbean Islands, with an estimated global population of 34,500 females (Spotila et al., 1996). Although leatherback nesting in Florida was once considered rare, leatherback nesting numbers are now significant in this state and have increased over time (Meylan et al., 2006). Populations nesting in Culebra, Puerto Rico, and St. Croix, U.S. Virgin Islands (USVI) are also believed to be increasing due to heightened protection and monitoring of the nesting habitat over the past 20 years (Hillis-Starr et al., 1998; Fleming, 2001; Thompson et al., 2001; Dutton et al., 2005).

Habitat Preferences**—**Throughout their lives, leatherbacks are essentially oceanic, yet they enter into coastal waters for foraging and reproduction. There is limited information available regarding the habitats utilized by post-hatchling and early juvenile leatherbacks as these age classes are entirely oceanic (NMFS and USFWS, 1992). These life stages are restricted to waters greater than 26°C (78.8°F) and, therefore, spend much time in tropical waters (Eckert, 2002). They are not considered to associate with *Sargassum* or other flotsam, as is the case for all other sea turtles species in the North Atlantic Ocean (NMFS and USFWS, 1992). Upwelling areas, such as the Equatorial Convergence Zones, serve as nursery grounds for post-hatchling and early juvenile leatherbacks; these areas also provide a high biomass of gelatinous prey (Musick and Limpus, 1997).

Late juvenile and adult leatherback turtles are known to range from mid-ocean to continental shelf and nearshore waters (Schroeder and Thompson, 1987; Shoop and Kenney, 1992; Grant and Ferrell, 1993). Juvenile and adult foraging habitats include both coastal feeding areas in temperate waters and offshore feeding areas in tropical waters (Frazier, 2001). The movements of adult leatherbacks appear to be linked to the seasonal availability of their prey and the requirements of their reproductive cycle (Collard, 1990a; Davenport and Balazs, 1991).

Leatherbacks commonly nest on wide sandy beaches which are inclined and backed with vegetation (Eckert, 1987; Hirth and Ogren, 1987). Many eggs may be lost to erosion due to their preference for high-energy, steeply sloped beaches (NMFS and USFWS, 1992). During the nesting season (March through July), females are highly mobile and often move between several beaches. Results from tagging studies have indicated that Caribbean leatherbacks often nest on multiple islands during a nesting season (Eckert et al., 1989; Keinath and Musick, 1993).

Distribution—Leatherback turtles occur circumglobally in tropical, subtropical, and warm-temperate waters throughout the year and in cooler temperate waters during warmer months (NMFS and USFWS, 1992; James et al., 2005a). Leatherbacks in the North Atlantic Ocean are broadly distributed from the Caribbean region to as far north as Nova Scotia, Newfoundland, Labrador, Iceland, the British Isles, and Norway (Bleakney, 1965; Brongersma, 1972; Threlfall, 1978; Goff and Lien, 1988). This species migrates further and moves into cold waters more than any other sea turtle species (Bleakney, 1965; Lazell, 1980; Shoop and Kenney, 1992).

In the North Atlantic Ocean, leatherbacks show strong seasonal distribution patterns and make extensive movements between temperate and tropical waters (James et al., 2005a, 2005b, 2005c). One leatherback caught in the Chesapeake Bay was tagged, released, and then caught again over a year later off southern Cuba, for a minimum distance of 2,168 km (Keinath and Musick, 1990). Leatherbacks tagged on Caribbean nesting beaches travel great distances across the North Atlantic Ocean and vary in pan-oceanic movements. Some individuals travel north to foraging habitats off the Atlantic coasts of the United States and Canada. Others travel northeast to temperate waters surrounding the British Isles and the Azores while some individuals travel east to the coast of Africa (Hays et al., 2004). Female leatherbacks tagged in the USVI, Colombia, French Guiana, and Costa Rica have been found stranded along the Atlantic and Gulf coasts of the United States (Thompson et al., 2001). Tagging studies also indicate many variations in overwintering and onshore-offshore occurrence patterns (Lee and Palmer, 1981). For example, a leatherback satellite-tagged on a Florida nesting beach traveled directly to the coast of Virginia after her last nest of the season; while there, she remained within 100 km of shore during her entire four-month stay (CCC, 2002).

According to aerial survey data, there is a northward movement of individuals along the southeast coast of the United States in the late winter/early spring. In February and March, most leatherbacks along the U.S. Atlantic coast are found in the waters off northeast Florida. By April and May leatherbacks begin to occur in larger numbers off the coasts of Georgia and the Carolinas (NMFS, 1995; NMFS, 2000). In late spring/early summer, leatherbacks appear off the mid-Atlantic and New England coasts, while by late summer/early fall, many will have traveled as far north as the waters off eastern Canada (CETAP, 1982; Shoop and Kenney, 1992; Thompson et al., 2001). Leatherbacks may also exhibit east-west movement patterns, migrating seasonally from coastal waters to offshore in the late summer; leatherbacks may be observed in the mid-Atlantic Bight during this time (Eckert, 2006). Eckert et al. (2006) found leatherback foraging areas in the western Atlantic to be located on the continental shelf (30 to 50°N) as well as offshore (42°N, 65°W). The location of these foraging areas changed seasonally. From March through November, foraging areas occurred on the North American continental shelf yet shifted to off- shelf waters from December through February (Eckert et al., 2006).

North Carolina waters may be utilized by foraging leatherbacks or individuals in transit. The coastal area immediately adjacent to Cape Hatteras is recognized as a migratory pathway for leatherbacks (Lee and Palmer, 1981). Leatherbacks are observed in areas of high jellyfish concentrations along the Carolina coastlines (Grant and Ferrell, 1993). Jellyfish prey occurs south of Cape Hatteras from May to November; at this time, individuals congregate along the coast and forage in areas such as North Topsail Island, North Carolina and Myrtle Beach, South Carolina (Grant and Ferrell, 1993).

Leatherback nesting in the western North Atlantic is restricted to coarse-grained beaches in subtropical and tropical latitudes (NMFS and USFWS, 1992). Nesting occurs along the coasts of North, Central, and South America (from the southeastern United States to Brazil) and throughout the Greater and Lesser Antilles. The most significant nesting populations occur at French Guiana, Suriname, Guyana, Colombia, Panama, Costa Rica, and Trinidad (Thompson et al., 2001). Nesting populations at Culebra, Puerto Rico and St. Croix, USVI are on the rise (Dutton et al., 2005; Eckert, S.A., WIDECAST, pers. comm., February 28, 2006). In the northern Caribbean, Sandy Point National Wildlife Refuge, St. Croix, USVI is the principal nesting beach for leatherbacks (Hillis-Starr et al., 1998). Leatherback nesting along the East Coast most commonly takes place in Florida; although previously rare, nesting numbers are significant in this area (Meylan et al., 2006).

Atlantic Ocean, Offshore of the Southeastern United States

Seasonal movements of large subadult and adult leatherbacks have been documented by aerial surveys along the U.S. Atlantic Coast (Shoop and Thompson, 1983; Schroeder and Thompson, 1987; NMFS, 1995); however, leatherbacks are likely not constrained by seasonal temperature variations. Leatherback occurrence is seasonal along the U.S. Atlantic coast, with the number of sightings along the northern area of the coast increasing from winter to summer.

Leatherbacks are found year-round in the VACAPES OPAREA with the greatest occurrence during the summer. As evidenced by a combination of sighting and bycatch records, this species may occur in VACAPES OPAREA shelf waters or offshore waters just beyond the shelf break. The greatest concentrations of leatherbacks likely to occur in the OPAREA vary seasonally by location. For example, leatherback presence is expected to peak in off Virginia in May and July and in North Carolina from mid-April through mid-October (Keinath et al., 1996).

Leatherbacks are found year-round in North Carolina waters (Schwartz, 1989); within the CHPT OPAREA, the majority of leatherback sightings occur on the continental shelf, although several bycatch records exist for waters beyond the shelf break. As evidenced by a combination of sighting and bycatch records, this species occurs in offshore waters, especially north of Cape Lookout (Lee and Palmer, 1981; Schwartz, 1989). The greatest concentrations of leatherbacks are likely to occur in North Carolina from mid-April through mid-October (Keinath et al., 1996); the greatest abundance of leatherback in the CHPT OPAREA is likely during the spring and summer.

Leatherbacks are found year-round in the JAX/CHASN OPAREA, occurring in the shallows waters over the continental shelf (Lee and Palmer, 1981) or in offshore waters (Schwartz, 1989). The JAX/CHASN OPAREA and vicinity may be used by leatherbacks for foraging, transit, or nesting purposes. For example, a post-nesting leatherback, satellite-tagged on a Florida nesting beach in 2000, traveled along the U.S. Atlantic Coast to New Jersey, passing through the JAX/CHASN OPAREA on her northward migration (Eckert et.al., 2005). Leatherback turtles are generally concentrated off the northeastern Florida coast during the winter beginning in November and December (NMFS, 1995).

Atlantic Ocean, Offshore of the Northeastern United States

Overall, leatherback turtles could occur within the area during any season, although they are most prevalent during summer. Large concentrations of leatherbacks are likely to be found in the following portions of the area during summer: off southern New Jersey, off the southeastern end of Long Island, and off southern Nova Scotia. Due to their highly evolved thermoregulatory capabilities, leatherbacks are frequently encountered in waters far beyond the northern and eastern extents of the area, yet many individuals, especially juveniles, remain in tropical or subtropical waters of the Atlantic Ocean throughout the year (Shoop and Kenney, 1992; Eckert, 2002). Although the available sighting records indicate a likely preference for continental shelf waters of the area, an abundance of incidental bycatch records shows that this species may also be found in deeper waters beyond the shelf break, where survey effort is minimal. As leatherbacks are the largest and most easily identifiable sea turtles, it is feasible that the sighting data accurately depict the species' actual occurrence within portions of the area that are adequately surveyed.

Leatherback turtles appear to be rare inhabitants of the area during winter. There are two winter sighting records off Cape Cod and a handful of stranding records along the northeast U.S. coast. During winter months, the vast majority of leatherback turtles in the Atlantic Ocean are likely found in tropical and subtropical waters located a good distance south of the area (e.g., in the Caribbean Sea or off Florida) (Thomspon et al., 2001). As evidenced by the cluster of sighting and bycatch records, some individuals may occur in continental slope waters off Cape Hatteras that are associated with the Gulf Stream Current.

In spring, leatherback turtles begin to appear in greater numbers off the northeast U.S. coast. The sighting records indicate an occassional presence of leatherbacks in waters as far north as the Gulf of Maine. The large number of incidental bycatch records in waters beyond the continental shelf break demonstrates that this species may be primarily oceanic during the spring, choosing to inhabit warmer waters that are proximal to the Gulf Stream Current rather than cooler waters closer to shore. Shoop and Kenney (1992) observed that leatherback turtle sightings off the northeast United States most often occurred around the 2,000 m (6,562 ft) isobath during spring.

Leatherback turtle abundance increases dramatically in the NE OPAREAs waters during summer, as evidenced by the large number of sighting and bycatch records located over the region's continental shelf. Monthly sighting frequencies in northeastern U.S. waters peak at the end of summer, as an estimated minimum of 100 to 900 individuals take up residence in the area (Shoop and Kenney, 1992). During this season, leatherbacks can occur as far north as the waters off Newfoundland and Labrador (Bleakney, 1965; Goff and Lien, 1988). Leatherbacks appear to move closer to shore during summer, as nearshore water temperatures rise. At this time of year, leatherbacks commonly occur around the mouths of the region's bays and sounds, feeding on large aggregations of jellyfish found in those waters (James and Herman, 2001).

During fall, leatherbacks may continue to occur in the NE OPAREAs waters as far north as the Gulf of Maine and the Scotian Shelf. Thomspon et al. (2001) note that leatherbacks are found in Canadian waters through October, after which they begin their southward migration to warmer waters. From Georges Bank south to Cape Hatteras, a large number of fall sightings and bycatches have been recorded in waters along the continental shelf break. This clustering of records could imply that the continental shelf break serves as an important geographical feature that migrating leatherbacks follow when returning to more tropical waters prior to winter. However, it could also indicate a concentration of survey and fishing effort in those waters. Of note are the multiple stranding records that occur along the New Jersey, New York, and southern New England coasts during this season. Based on the entire set of occurrence data (sightings, strandings, and bycatches), as well as this species' broad habitat preferences, leatherbacks probably occur throughout the area during fall.

Gulf of Mexico

Overall, the leatherback turtle is the most oceanic of all sea turtle species occurring in the area. The high number of sighting and bycatch records occurring beyond the continental shelf is evidence of this species' habitat preference. Leatherbacks use the deep, offshore waters of the area (especially waters in the vicinity of DeSoto Canyon) for feeding, resting, and as migratory corridors (Landry and Costa, 1999; Davis et al., 2000b). Leatherbacks can also occur in shallow waters on the continental shelf, especially during nesting season; during aerial surveys off Naples, eight of nine leatherback sightings occurred in waters less than 50 m (164 ft) deep (Fritts et al., 1983b). Leatherbacks have been observed feeding on dense aggregations of jellyfish in nearshore waters off the Florida Panhandle, the Mississippi River Delta, and the Texas coast (Leary, 1957; Collard 1990a; Lohoefener et al. 1990). Leatherbacks may also enter the nearshore waters of the northern Gulf to nest. In recent years, low levels of nesting activity have been documented on both Florida Panhandle and south Florida beaches (LeBuff, 1990; Meylan et al., 1995). The distribution of sighting records in the area supports the pattern of leatherback occurrence in the northern GOMEX being fairly similar throughout the year suggested by Davis et al., 2000b.

The occurrence of leatherback turtles during winter is fairly patchy with occurrence most likely in the deeper waters off the continental shelf throughout the northern Gulf. The winter occurrence of this species may also include the outermost shelf waters off western Florida and Louisiana as well but it is unlikely that leatherbacks will occur in the inner shelf waters off Texas or Louisiana. Occurrence records show that leatherbacks occur in the shallow waters of the Florida Keys and in the northern part of the Key West OPAREA during winter. A slightly higher occurrence is expected along the shelf break waters of central-western Florida. Sparse winter stranding records have been documented only along the west Florida coast, which may imply that leatherbacks are rare inhabitants of these continental shelf waters (Landry and Costa, 1999) or may signify that leatherbacks are not as susceptible to stranding in winter as hard-shelled sea turtles due to their advanced thermoregulatory capabilities. Survey effort is lowest during winter, particularly off western Florida, so the occurrence of this species may not be definitely defined for this season.

While occurrence records indicate that leatherbacks occur primarily in the waters of the north-central Gulf during spring, especially in deeper waters well off the shelf, nesting records and rare sighting records indicate that leatherbacks also occur off southern Florida as well. It is unlikely that this species will be observed in the far western Gulf or in the Corpus Christi OPAREA during this season. The increase in the number of incidental bycatch events in waters far beyond the continental shelf break likely indicates an increase in fishing activity in those waters rather than an increase in leatherback abundance in deep waters. At this time of year leatherback nesting commences on Florida beaches adjacent to the area and small numbers of female adult leatherbacks will enter the coastal waters of the northeastern GOMEX in order to reproduce. However, since spring survey effort over these nearshore waters is minimal, occurrences are rarely recorded. Similar to winter, leatherback occurrence on the Texas shelf is unlikely but occurrence is likely in the New Orleans, Pensacola, and Panama City OPAREAs.

A distributional shift of leatherback turtles inshore and eastward appears to occur in the summer, with an increasing number of sightings located in the shallower shelf waters of the northeastern Gulf. No occurrence records are available for the waters off Texas or southern Florida, despite an increase in survey effort over those areas during this season. It is unlikely, therefore, that leatherbacks will occur in Texas waters during summer. Although not supported by the presence of bycatch or stranding records, the likelihood that leatherbacks may occur, at least rarely, in southern Florida shelf waters is increased due to the location of known nesting activity in Palm Beach County, southwestern Florida. Adult leatherbacks that nest along the Florida Panhandle likely utilize DeSoto Canyon as a post-nesting habitat due to its close proximity to the shore. Leatherbacks occupy the deeper waters of the central Gulf as well during this season as supported by the bycatch and sighting records. Occurrence in the Corpus Christi and Key West OPAREAs during this season is unlikely.

During fall, leatherbacks exhibit a patchy occurrence throughout the northern Gulf, inhabiting continental shelf waters off Louisiana, Mississippi, Alabama, and Florida with occurrence not likely in the inner shelf waters off western Louisiana and northern Texas. Leatherbacks also occur in the deepest waters of the central and western GOMEX (as evidenced by bycatch records) as well as off the Dry Tortugas. A noteworthy difference in the occurrence of leatherbacks during fall is the potential occurrence of this species in the shelf waters off central Texas and the northern part of the Corpus Christi OPAREA. The very patchy occurrence of leatherbacks in western Florida waters is supported by the results of dedicated aerial surveys (e.g., NMFS-SEFSC, 1994) in which few leatherbacks were recorded during this season, indicating that leatherbacks likely do not inhabit inner Florida shelf waters with any regularity during any season.

3.7.3 Threatened and Endangered Sea Turtles

All six sea turtle species found along the East Coast and in the Gulf of Mexico are listed as threatened or endangered (see Table 3-6 for ESA status of sea turtle species).

- Green sea turtle (*Chelonia mydas*) – endangered (while green sea turtles are listed as threatened, the Florida and Mexican Pacific coast nesting populations are listed as endangered)

- Hawksbill sea turtle (*Eretmochelys imbricata*) – endangered
- Loggerhead sea turtle (*Caretta caretta*) – threatened
- Kemp's (Atlantic) ridley sea turtle (*Lepidochelys kempii*) – endangered
- Olive ridley sea turtle (*Lepidochelys oliveacea*) – threatened
- Leatherback sea turtle (*Dermochelys coriacea*) – endangered

3.7.4 Turtle-Excluder Devices

Perhaps the most important step forward for sea turtles came in 1989, when all shrimpers in the United States were required to use special "turtle-excluder devices" (TEDs), which permit turtles accidentally caught in nets to escape through a trap door. Before TEDs were required, an estimated 150,000 sea turtles died each year when shrimp nets entrapped them and the animals drowned (Sea Turtle Restoration Project, 2007). In 2005, 25 sea turtles were reported stranded (i.e., dead, sick, or injured) in Bay County while 1,589 sea turtles stranded throughout Florida (FWC, 2005).

3.7.5 Marine Turtle Protection Act

The FWC has established a Marine Turtle Protection Act that, like the ESA, regulates and prohibits the taking, killing, disturbing, mutilating, molesting, harassing, or destroying of any marine turtle. Furthermore, a permit must be obtained prior to conducting any activity involving marine turtles (FWC, 2007).

3.8 ESSENTIAL FISH HABITAT

3.8.1 Description of EFH

The Magnuson-Stevens Fishery Conservation and Management Act of 1976 (Magnuson-Stevens Act) (16 U.S.C. 1801) was amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) and established the requirement to describe and identify EFH in each fishery management plan. EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. "Waters" include aquatic areas and their associated physical, chemical, and biological properties. "Substrate" includes sediment underlying the waters. Federal agencies must consult with NMFS on any proposed federal action that may adversely affect EFH.

The Fishery Management Councils (FMCs) classify EFH for temperate and subtropical-tropical managed species in terms of five basic lifestages: (1) Eggs, (2) Larvae, (3) Juveniles, (4) Adult, and (5) Spawning Adult. Eggs are those individuals that have been spawned but not hatched and are completely dependent on the egg's yolk for nutrition. Larvae are individuals that have hatched and can capture prey, while Juveniles are those individuals that are not sexually mature but possess fully formed organ systems that are similar to adults. Adults are sexually mature individuals that are not necessarily in spawning condition. Finally, spawning adults are those individuals capable of spawning.

Although the individual lifestage terms and definitions are the same as those defined by the FMCs, NMFS categorizes the lifestages of managed tuna, swordfish, and billfish somewhat differently, resulting in three categories that are based on common habitat usage by all lifestages in each group: (1) Spawning Adults, Eggs, and Larvae; (2) Juveniles and Subadult; and (3) Adult. Subadults are those individuals just reaching sexual maturity. The category of Spawning Adult, Eggs, and Larvae is associated with spawning location and the circulation patterns that control the distribution of the eggs and larvae.

NMFS uses a different lifestage classification system for sharks; the system bases the lifestage combinations on the general habitat shifts that accompany each developmental stage. The three resulting categories are: (1) Neonate and Early Juvenile (including newborns and pups less than one year old), (2) Late Juvenile and Subadult (age one to adult), and (3) Adult (sexually mature sharks). In Amendment 1 to the Fisheries Management Plan for the Atlantic Tunas, Swordfish, and Sharks, the first two lifestages were modified as follows: the Neonate and Early Juvenile category was renamed "Neonate," which primarily includes neonates and small young-of-the-year sharks; and the Late Juveniles and Subadults category was renamed "Juveniles," which includes all immature sharks from young to late juveniles.

EFH has been designated for 100 fish and invertebrate species within the Study Area, not including the more than 100 species of corals. In this EIS/OEIS, the managed species are categorized as temperate, subtropical-tropical, and highly migratory species. Of the 100 managed species with EFH designation, 31 are classified as temperate, 33 are considered subtropical-tropical (not including the coral species), and 36 are defined as highly migratory species.

3.8.1.1 Atlantic Ocean, Offshore of the Southeastern United States

3.8.1.1.1 VACAPES OPAREA

Many features of the MAB environment affect the distribution of fishes. These characteristics include habitat (coastal, open shelf, reef, shelf edge, and shelf slope), water temperature, salinity, circulation, current patterns, and bottom composition. The pelagic and demersal fish fauna of this area generally include (1) warm-temperate species with permanent populations south of Cape Hatteras and northern distribution limits south of Cape Cod, and (2) cold-temperate species with permanent populations north of Cape Cod and southern range limits north of Cape Hatteras (Table 3-7).

Cape Hatteras is considered the boundary between the warm-temperate and cold-temperate fish species; however, significant overlap occurs between these two types of species. Warm-water species, such as bluefish and weakfish, enter the region as temperatures rise in the spring and the summer, while cold-water species like Atlantic cod, Atlantic herring, and American shad migrate north. Similarly, as fall approaches, warm-water species such as summer flounder, butterfish, and black sea bass may migrate offshore toward deeper waters and then move southward, while cold-water species move south into the MAB area.

Table 3-7. Fish and Invertebrates for Which EFH Has Been Designated in the Study Area for the Southeastern Atlantic Coast OPAREAs

Temperate Species[1]	Subtropical-Tropical Species[1]	Highly Migratory Species[1]
Atlantic cod	Atlantic Calico scallop	Albacore tuna
Atlantic herring	Blackfin snapper	Atlantic angel shark
Atlantic mackerel	Blueline tilefish	Atlantic sharpnose shark
Atlantic surfclam	Brown rock shrimp	Basking shark
Black sea bass	Brown shrimp	Bigeye thresher shark
Bluefish	Caribbean Spiny lobster	Bigeye tuna
Butterfish	Cobia	Bignose shark
Clearnose skate	Dolphinfish	Blacknose shark
Goosefish/Monkfish	Pompano dolphinfish	Blacktip shark
Haddock	Golden deepsea crab	Blue marlin
Little skate	Goliath grouper	Blue shark
Longfin inshore squid	Gray snapper	Bluefin tuna
Northern shortfin squid	Greater amberjack	Bonnethead shark
Ocean pout	King mackerel	Bull shark
Ocean quahog	Mutton snapper	Dusky shark
Offshore hake	Pink shrimp	Finetooth shark
Red deepsea crab	Red drum	Great hammerhead shark
Red hake	Red porgy	Lemon shark
Rosette skate	Red snapper	Longbill spearfish
Scup	Royal red shrimp	Longfin mako shark
Sea scallop	Scamp	Night shark
Silver hake/Whiting	Silk snapper	Nurse shark
Spiny dogfish	Snowy grouper	Oceanic whitetip shark
Summer flounder	Spanish mackerel	Sailfish
Tilefish	Speckled hind	Sand tiger shark
White hake	Tilefish	Sandbar shark
Windowpane flounder	Vermillion snapper	Scalloped hammerhead shark
Winter flounder	Wahoo	Shortfin mako shark
Winter skate	Warsaw grouper	Silky shark
Witch flounder	White grunt	Skipjack tuna
Yellowtail flounder	White shrimp	Spinner shark
	Wreckfish	Swordfish
	Yellowedge grouper	Tiger shark
		White marlin
		White shark
		Yellowfin tuna

1. Taxonomy follows Nelson et al. (2004) for fishes, Turgeon et al. (1998) for mollusks, and Williams et al. (1989) for decapod crustaceans.

3.8.1.1.2 CHPT OPAREA

Two distinct fish faunas occur in the area: temperate (northern) and subtropical/tropical (southern) (Table 3-7). Cape Hatteras is generally considered the transition point between these assemblages. Southern species are more abundant due to the influence of the Gulf Stream. However, species occurrence is dynamic, and extensive migrations of southern and northern species occur through the area as they follow water temperature gradients.

Extensive estuary systems exist in North Carolina, and many fish common to the CHPT OPAREA use estuaries during a portion of their life cycle. In addition, many pelagic species are represented, including tunas and lanternfish. Species associated with coral reefs are also abundant in the OPAREA. Although coral reefs do not occur in the OPAREA, coral-associated species are likely attracted by patchy bottom structures such as rocky/hardbottom areas, shipwrecks, and artificial reefs.

3.8.1.1.3 JAX/CHASN OPAREA

The dynamic interaction between cold currents from the north and warm Gulf Stream waters from the south influences the fish fauna found at any given time. Seasonal variations in water temperature and current patterns shape the population structure, local movements, and regional migrations of many species. Fish move in and out of the area throughout the year based on thermal tolerances, prey availability, and other environmental/ecological variables. Fish that are more typical of regions to the north or to the south of the OPAREA may occur at certain times depending on variations in the aforementioned factors. Species in this area are likely attracted by patchy bottom structures such as rocky/hardbottom areas, shipwrecks, and artificial reefs.

3.8.1.2 Atlantic Ocean, Offshore of the Northeastern United States

Regulators have designated EFH for 64 fish and invertebrate species in the northeastern Atlantic coast OPAREAS of the AFAST Study Area (Table 3-8). Hereafter, for all sections on EFH, these designated species are referred to as “managed species.” These managed species are further grouped as temperate, subtropical-tropical, and highly migratory species. Of the 64 managed species, 39 are temperate, 3 are subtropical-tropical, and 22 are highly migratory species.

Table 3-8. EFH Designations in the Study Area for the Northeastern Atlantic Coast OPAREAs

Temperate Species	Subtropical-Tropical Species	Highly Migratory Species
American plaice	Cobia	Albacore tuna
Atlantic cod	King mackerel	Atlantic angel shark
Atlantic halibut	Spanish mackerel	Atlantic sharpnose shark
Atlantic herring		Basking shark
Atlantic mackerel		Bigeye tuna
Atlantic surfclam		Blue marlin
Barndoor skate		Blue shark
Black sea bass		Bluefin tuna
Bluefish		Dusky shark
Butterfish		Longfin mako shark
Clearnose skate		Porbeagle shark
Goosefish/Monkfish		Sand tiger shark
Haddock		Sandbar shark
Little skate		Scalloped hammerhead shark
Longfin inshore squid		Shortfin mako shark
Northern shortfin squid		Skipjack tuna
Ocean pout		Swordfish
Ocean quahog		Thresher shark
Offshore hake		Tiger shark
Pollock		White marlin
Red deepsea crab		White shark
Red hake		Yellowfin tuna
Acadian redfish		
Deepwater redfish		
Rosette skate		
Scup		
Sea scallop		
Silver hake/Whiting		
Smooth skate		
Spiny dogfish		
Summer flounder		
Thorny skate		
Tilefish		
White hake		
Windowpane flounder		
Winter flounder		
Winter skate		
Witch flounder		
Yellowtail flounder		

3.8.1.3 Eastern Gulf of Mexico

EFH has been designated for all 26 fish species managed by the Gulf of Mexico Fishery Management Council (GMFMC) and for 20 of the highly migratory species managed by NMFS within the eastern Gulf of Mexico. In the Gulf of Mexico, designations are divided into estuarine and marine waters. Marine waters include all waters and substrates (mud, sand, rock, hard bottom, and associated biological communities) from the shore to the EEZ boundary; this includes all coral habitats, sub-tidal vegetation (seagrass and algal beds), and adjacent intertidal vegetation (wetlands and mangroves). In addition to the species listed in Table 3-9, corals and *Sargassum* are also included as EFH.

Table 3-9. Managed Species for Which Essential Fish Habitat Has Been Identified in the Eastern Gulf

Invertebrates	Highly Migratory Fishes	Fishes
Brown shrimp	Blue marlin	Black grouper
Pink shrimp	White marlin	Bluefish
Royal red shrimp	Sailfish	Cero
Stone crab	Swordfish	Cobia
Spiny lobster	Atlantic bigeye tuna	Dolphin (mahi)
White shrimp	Albacore tuna	Gag grouper
	Bluefin tuna	Greater amberjack
	Skipjack tuna	Gray snapper
	Yellowfin tuna	Gray triggerfish
	Blacktip shark	King mackerel
	Bull shark	Lesser amberjack
	Dusky shark	Lane snapper
	Silky shark	Little tunny
	Tiger shark	Red drum
	Atlantic sharpnose shark	Red grouper
	Longfin mako shark	Red snapper
		Scamp
		Spanish mackerel
		Tilefish
		Vermillion snapper
		Yellowtail snapper

3.8.1.4 Western Gulf of Mexico

As shown in Table 3-10, there are 41 fish species for which EFH have been designated in the western Gulf of Mexico. Of the 41 managed species with EFH designations, 7 are further classified as invertebrates, and another 14 are further classified as highly migratory fishes. All 26 species managed by the GMFMC are listed for both the eastern and western Gulf of Mexico regions.

The GMFMC is one of eight regional FMCs to co-manage the country's fisheries with NMFS (Gulf Restoration Network [GRN], 2005). NMFS also directly manages several species in the Gulf of Mexico including sharks, tuna, and billfish, which make up the majority of highly migratory fishes in the Gulf of Mexico. Currently, of the 57 species under GMFMC management, 6 are considered "overfished," and 29 of the species in the Gulf of Mexico that are directly under NMFS management are also considered "overfished" (GRN, 2005). Several of the managed species in the Gulf of Mexico region that are overfished but not listed as species for which EFH have been designated include the goliath grouper, sandbar shark, spinner shark, Caribbean reef shark, lemon shark, sand tiger shark, bigeye sand tiger shark, nurse shark, scalloped shark, hammerhead shark, great hammerhead shark, whale shark, and the white shark (GRN, 2005).

Table 3-10. Managed Species for Which EFH has been Designated in the Western Gulf

Invertebrates	Highly Migratory Fishes	Fishes
Brown shrimp	Blue marlin[1]	Almaco jack
Pink shrimp	White marlin[1]	Banded rudderfish
Royal red shrimp	Sailfish[1]	Cobia
Stone crab	Swordfish	Dolphin (mahi)
Gulf stone crab	Bluefin tuna[1]	Gag grouper
Spiny lobster	Skipjack tuna	Greater amberjack[1]
White shrimp	Yellowfin tuna	Gray snapper
	Blacktip shark[1]	Gray triggerfish
	Bull shark[1]	Jewfish
	Dusky shark[1]	King mackerel
	Silky shark[1]	Lesser amberjack
	Tiger shark[1]	Lane snapper
	Atlantic sharpnose shark	Nassau grouper[1]
	Longfin mako shark	Red drum[1]
		Red grouper[1]
		Red snapper[1]
		Scamp
		Spanish mackerel
		Tilefish
		Yellowtail snapper

1. Managed species that have been identified as "overfished."

3.8.2 Cooperative Habitat Protection Program

NOAA's Habitat Protection Division is in the process of developing a proposal that will establish a Cooperative Habitat Protection Program. This purpose of this program would be to work with local communities, government entities, and grassroots nongovernmental organizations to protect nearshore fish habitats. The draft proposal focuses on local partnerships, watershed planning, communication, and technical assistance or small grants to "equip local communities with the tools and information needed to protect coastal and marine fish habitat" (NOAA, 2007h).

3.9 MARINE FISH

The Magnuson-Stevens Act establishes management authority over all fishing within the U.S. EEZ, all anadromous fish throughout their migratory range, and all fish on the continental shelf.

Fish species in the AFAST Study Area are managed or co-managed by the following entities:

- Atlantic States Marine Fisheries Commission (ASMFC); jurisdiction is state waters from Maine through eastern Florida.
- New England Fishery Management Council (NEFMC); jurisdiction is federal waters from Maine to Connecticut.
- Mid-Atlantic Fishery Management Council (MAFMC); jurisdiction is federal waters from New York to North Carolina.
- South Atlantic Fishery Management Council (SAFMC); jurisdiction is federal waters from North Carolina to eastern Florida at Key West.

- Gulf of Mexico Fishery Management Council (GMFMC); jurisdiction is federal waters from western Florida to Texas.
- National Marine Fisheries Service (NMFS); jurisdiction over highly migratory species in federal waters off the U.S. Atlantic coast and the Gulf of Mexico.

In addition, these entities may designate EFH outside of their region of jurisdiction.

3.9.1 Threatened/Endangered and Species of Concern Marine Fish

There are a number of fish in the AFAST Study Area that, for various reasons, are listed as species of concern or are on the threatened and endangered species list. Overfishing is generally the primary cause of fish becoming either a species of concern (Table 3-11) or listed as threatened/endangered species (Table 3-12). Overfishing occurs when targeted or nontargeted fish are pulled up by catch. Other causes for reduction in species numbers can be due to changes in habitat conditions, direct and indirect construction and dredging, runoff of polluted water and materials, and some oil and gas exploration activities. It is critical that the following lists are reviewed for relevance to each OPAREA.

Table 3-11. Fish Species of Concern

Species of Concern/Candidate Report		
Inverted Common Name	**Scientific Name**	**Listing Status**
Alabama Shad	*Alosa alabamae*	
Alewife	*Alosa pseudoharengus*	
Atlantic halibut	*Hippoglossus hippoglossus*	
Atlantic salmon	*Salmo salar*	Candidate
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Candidate
Atlantic wolffish	*Anarhichas lupus*	
Barndoor skate	*Dipturus laevis*	
Blueback herring	*Alosa aestivalis*	
Cusk	*Brosme brosme*	Candidate
Dusky shark	*Carcharhinus obscurus*	
Ivory Bush Coral	*Oculina varicosa*	
Largetooth sawfish	*Pristis pristis*	
Mangrove rivulus	*Rivulus marmoratus*	
Nassau grouper	*Epinephelus striatus*	
Night shark	*Carcharinus signatus*	
Opossum pipefish	*Microphis brachyurus lineatus*	
Porbeagle shark	*Lamna nasus*	
Rainbow smelt	*Osmerus mordax*	
Saltmarsh topminnow	*Fundulus jenkinsi*	
Sand tiger shark	*Carcharias taurus*	
Speckled hind	*Epinephelus drummondhayi*	
Striped Croaker	*Bairdiella sanctaeluciae*	
Thorny skate	*Amblyraja radiata*	
Warsaw grouper	*Epinephelus nigritus*	
White Marlin	*Tetrapturus albidus*	Candidate

Table 3-12. Fish Species/Threatened or Endangered

Endangered/Threatened Species Report		
Inverted Common Name	**Scientific Name**	**Listing Status**
Cavefish, Alabama	*Speoplatyrhinus poulsoni*	E
Chub, slender	*Erimystax cahni*	T
Chub, spotfin	*Erimonax monachus*	T
Darter, amber	*Percina antesella*	E
Darter, boulder	*Etheostoma wapiti*	E
Darter, Cherokee	*Etheostoma scotti*	T
Darter, duskytail	*Etheostoma percnurum*	E
Darter, Etowah	*Etheostoma etowahae*	E
Darter, fountain	*Etheostoma fonticola*	E
Darter, goldline	*Percina aurolineata*	T
Darter, Maryland	*Etheostoma sellare*	E
Darter, Okaloosa	*Etheostoma okaloosae*	E
Darter, slackwater	*Etheostoma boschungi*	T
Darter, snail	*Percina tanasi*	T
Darter, vermilion	*Etheostoma chermocki*	E
Darter, watercress	*Etheostoma nuchale*	E
Gambusia, Big Bend	*Gambusia gaigei*	E
Gambusia, Clear Creek	*Gambusia heterochir*	E
Gambusia, Pecos	*Gambusia nobilis*	E
Gambusia, San Marcos	*Gambusia georgei*	E
Logperch, Conasauga	*Percina jenkinsi*	E
Logperch, Roanoke	*Percina rex*	E
Madtom, yellowfin	*Noturus flavipinnis*	T
Minnow, Devils River	*Dionda diaboli*	T
Minnow, Rio Grande silvery	*Hybognathus amarus*	E
Pupfish, Comanche Springs	*Cyprinodon elegans*	E
Pupfish, Leon Springs	*Cyprinodon bovinus*	E
Salmon, Atlantic	*Salmo salar*	E
Salmon, chinook	*Oncorhynchus (=Salmo) tshawytscha*	T
Salmon, sockeye	*Oncorhynchus (=Salmo) nerka*	E
Sawfish, smalltooth	*Pristis pectinata*	E
Sculpin, pygmy	*Cottus paulus (=pygmaeus)*	T
Shiner, Arkansas River	*Notropis girardi*	T
Shiner, blue	*Cyprinella caerulea*	T
Shiner, Cahaba	*Notropis cahabae*	E
Shiner, Cape Fear	*Notropis mekistocholas*	E
Shiner, palezone	*Notropis albizonatus*	E
Silverside, Waccamaw	*Menidia extensa*	T
Sturgeon, Alabama	*Scaphirhynchus suttkusi*	E
Sturgeon, gulf	*Acipenser oxyrinchus desotoi*	T
Sturgeon, pallid	*Scaphirhynchus albus*	E
Sturgeon, shortnose	*Acipenser brevirostrum*	E

E - endangered; T - threatened

3.9.2 Description of Marine Fish Acoustics

Marine fish occupy an important part of the marine food chain, and serve as prey for many other species including humans, seabirds, and other marine species including other fish. Seabirds eat small marine fish, squid, shellfish, and a variety of crustaceans. Cetaceans are primarily carnivores, while baleen whales have evolved special filter-like structures to gather small shrimp, small fish, squid, and plankton. Some cetaceans actively hunt prey, either alone or in cooperative groups, primarily eating whatever fish are found in the oceanic zone that they inhabit. Many marine mammals also eat squid, octopus, shrimp, and crabs.

Most marine fish spend part of their lives in saltwater and part of their lives in freshwater. Different life cycles for marine fish include the following:

- Estuarine-dependant fish depend on bays and/or estuaries for part of their life cycle.
- Catadromous fish spawn in saltwater, then migrate into freshwater to grow to maturity.
- Anadromous fish are born in fresh water, migrate to the ocean to grow into adults, and return to fresh water to spawn (FWS, 2007).
- Some fish are totally marine species and spend their entire lives at sea.

3.9.2.1 Hearing in Marine Fish

Marine fish spend at least part of their life in salt water. Broadly, fishes can be categorized as either hearing specialists or hearing generalists (Scholik and Yan, 2002). Fishes in the hearing specialist category have a broad frequency range with a low auditory threshold due to a mechanical connection between an air filled cavity, such as a swimbladder, and the inner ear. Specialists detect both the particle motion and pressure components of sound and can hear at levels above 1 kHz. Generalists are limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich, 2005). It is possible that a species will exhibit characteristics of generalists and specialists and will sometimes be referred to as an "intermediate" hearing specialist. For example, damselfish are typically categorized as generalists, but because some larger damselfish have demonstrated the ability to hear higher frequencies expected of specialists, they are sometimes categorized as intermediate.

Although hearing capability data only exists for fewer than 100 of the 27,000 fish species (Hastings and Popper, 2005), current data suggest that most species of fish detect sounds from 0.05 to 1.0 kHz (NRC, 2003). Moreover, studies indicate that hearing specializations in marine species are quite rare and that most marine fish are considered hearing generalists (Popper, 2003; Amoser and Ladich, 2005). Specifically, the following species are all believed to be hearing generalists: elasmobranchs (i.e., sharks and rays) (Casper et al., 2003; Casper and Mann, 2006; Myrberg, 2001), scorpaeniforms (i.e., scorpionfishes, searobins, sculpins) (Lovell et al., 2005), scombrids (i.e., albacores, bonitos, mackerels, tunas) (Iversen, 1967; Iversen, 1969; Popper, 1981; Song et al., 2006), damselfishes (Egner and Mann, 2005; Kenyon, 1996; Wright et al., 2005; Wright et al., 2007), and more specifically, midshipman fish (*Porichthys notatus*) (Sisneros and Bass, 2003), Atlantic salmon (*Salmo salar*) (Hawkins and Johnstone, 1978), and Gulf toadfish (*Opsanus beta*) (Remage-Healey et al., 2006). Moreover, it is believed that the majority of marine fish have their best hearing sensitivity at or below 0.3 kHz (Popper, 2003). However, it has been demonstrated that marine hearing specialists, such as some clupeids, can detect sounds above 100 kHz. Refer to Table 3-13 for a list of marine fish hearing sensitivities.

Table 3-13. Marine Fish Hearing Sensitivities

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
				Low	High		
Ariidae	Catfish	Hardhead sea catfish	*Ariopsis* (*Arius*) *felis**	0.05	1		generalist
Batrachoididae	Toadfishes	Midshipman	*Porichthys notatus*		0.34		generalist
		Gulf toadfish	*Opsanus beta*			<1	generalist
Clupeidae	Herrings, shads, menhadens, sardines	Alewife	*Alosa psuedoharengus*		120+		specialist
		Blueback herring	*Alosa aestivalis*		120+		specialist
		American shad	*Alosa sapidissima*	0.1	180	0.2-0.8 and 25-150	specialist
		Gulf menhaden	*Brevoortia patronus*		100+		specialist
		Bay anchovy	*Anchoa mitchilli*		4		specialist
		Scaled sardine	*Harengula jaguana*		4		specialist
		Spanish sardine	*Sardinella aurita*		4		specialist
		Pacific herring	*Clupea pallasii*	0.1	5		specialist
Chondrichthyes [Class]	Cartilaginous fishes, rays, sharks, skates			0.2	1		generalist
Gadidae	Cods, gadiforms, grenadiers, hakes	Cod	*Gadus morhua*	0.002	0.5	0.02	generalist
Holocentridae	Squirrelfish and soldierfish	Shoulderbar soldierfish	*Myripristis kuntee*	0.1	3.0		specialist
		Hawaiian squirrelfish	*Adioryx xantherythrus*	0.1	0.8		generalist
Pomacentridae	Damselfish	Sergeant major damselfish	*Abudefduf saxatilis*	0.1	1.6	0.1-0.4	Generalist/ intermediate
		Bicolor damselfish	*Stegastes partitus*		1.6	0.5	Generalist/ intermediate
		Nagasaki damselfish	*Pomacentrus nagasakiensis*	0.1	2.0	<0.3	Generalist/ intermediate
Salmonidae	Salmons	Atlantic salmon	*Salmo salar*		0.58		generalist
Sciaenidae	Drums, weakfish,	Atlantic croaker	*Micropogonias undulates*	0.1	1.0	0.3	generalist

Table 3-13. Marine Fish Hearing Sensitivities Cont'd

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz) Low	Hearing Range (kHz) High	Greatest Sensitivity (kHz)	Sensitivity Classification
	croakers	Spotted sea trout	*Cynoscion nebulosus*				specialist
		Kingfish	*Menticirrhus americanus*				generalist
		Spot	*Leiostomus xanthurus*		0.7		generalist
		Black drum	*Pogonias cromis*	0.1	0.8	0.1-0.5	generalist
		Weakfish	*Cynoscion regalis*		2.0		specialist
		Silver perch	*Bairdiella chrysoura*		4.0		specialist
Scombridae	Albacores, bonitos, mackerels, tunas	Bluefin tuna	*Thunnus thynnus*		1.0		generalist
		Yellowfin tuna	*Thunnus albacares*	0.5	1.1		generalist
		Kawakawa	*Euthynnus affinus*	0.1	1.1	0.5	generalist
		Skipjack tuna	*Katsuwonus pelamis*				generalist
Scorpaenidae	Scorpionfishes, searobins, sculpins	Sea scorpion	*Taurulus bubalis*				generalist

* Referenced as *Arius felis* by Popper and Tavolga, 1981.

Sources: Astrup, 1999; Astrup and Mohl, 1993; Casper and Mann, 2006; Casper et al., 2003; Coombs and Popper, 1979; Dunning et al., 1992; Egner and Mann, 2005; Gregory and Clabburn, 2003; Hawkins and Johnstone, 1978; Higgs et al., 2004; Iversen, 1967, 1969; Jorgensen et al., 2004; Kenyon, 1996; Lovell et al., 2005; Mann et al., 1997, 2001, 2005; Myrberg, 2001; Nestler et al., 2002; Popper, 1981; Popper and Carlson, 1998; Popper and Tavolga, 1981; Ramcharitar and Popper, 2004; Ramcharitar et al., 2001, 2004, 2006, Remage-Healey, et al., 2006; Ross et al., 1996; Sisneros and Bass, 2003; Song et al., 2006; Wright et al., 2005, 2007; Seaworld, 2007

In contrast to marine fishes, several thousand freshwater species are thought to be hearing specialists. Nelson (1994) estimates that 6,600 of 10,000 freshwater species are otophysans (catfish and minnows), which are hearing specialists. Interestingly, many generalist freshwater species, such as perciforms (percids, gobiids) and scorpaeniforms (sculpins) are thought to have derived from marine habitats (Amoser and Ladich, 2005). It is also thought that clupeids may have evolved from freshwater habitats (Popper et al., 2004). This supports the theory that hearing specializations likely evolved in quiet habitats common to freshwater and the deep sea because only in such habitats can hearing specialists use their excellent hearing abilities (Amoser and Ladich, 2005).

Moreover, Amoser and Ladich (2005) hypothesized that, within a family of fish, different species can live under different ambient noise conditions, which requires them to adapt their hearing abilities. To increase an animal's probability of survival it would be beneficial to increase the range over which the acoustic environment, consisting of various biotic (sounds from other aquatic animals) and abiotic (wind, waves, precipitation) sources, can be detected (Amoser and Ladich, 2005). In the marine environment, Amoser and Ladich (2005) cite the differences in the hearing ability of two species of Holocentridae. Both the shoulderbar soldierfish (*Myripristis kuntee*) and the Hawaiian squirrelfish (*Adioryx xantherythrus*) can detect sounds at 0.1 kHz. However, the high frequency end of the auditory range extends towards 3 kHz for the shoulderbar soldierfish but only to 0.8 kHz for the Hawaiian squirrelfish (Coombs and Popper, 1979). While knowledge of natural ambient noise in marine habitats is very limited and comparative studies are lacking, Amoser and Ladich (2005) suggested that different genera live under different ambient noise conditions as an explanation for the great diversity in sensitivity among Holocentridae.

It has also been shown that susceptibility to the effects of anthropogenic sound can be influenced by developmental and genetic differences in the same species of fish. In an exposure experiment, Popper et al. (2007) found that experimental groups of rainbow trout (*Oncorhynchus mykiss*) had substantial differences in hearing thresholds. While fish were attained from the same supplier, it is possible different husbandry techniques may be reason for the differences in hearing sensitivity. These results emphasize that caution should be used in extrapolating data beyond their intent.

Among all fishes studied to date, perhaps the greatest variability is found within the family Sciaenidae (i.e., drumfish, weakfish, croaker), where there is extensive diversity in inner ear structure and the relationship between the swim bladder and the inner ear. Specifically, the Atlantic croaker's (*Micropogonias undulatus*) swim bladder has forwardly directed diverticulae that come near the ear but do not actually touch it. However, the swim bladders in the spot (*Leiostomus xanthurus*) and black drum (*Pogonias cromis*) are further from the ear and lack anterior horns or diverticulae. These differences are associated with variation in both sound production and hearing capabilities (Ladich and Popper, 2004). Ramcharitar and Popper (2004) discovered that the black drum responded to sounds from 0.1 to 0.8 kHz and was most sensitive between 0.1 and 0.5 kHz, while the Atlantic croaker responded to sounds from 0.1 to 1 kHz and was most sensitive at 0.3 kHz. Additional sciaenid research by Ramcharitar et al. (2006) investigated the hearing sensitivity of weakfish (*Cynoscion regalis*) and spot. Weakfish were found to detect frequencies up to 2 kHz, while spot detected frequencies only up to 0.7 kHz.

The sciaenid with the greatest hearing sensitivity discovered thus far is the silver perch (*Bairdiella chrysoura*), which has demonstrated auditory thresholds similar to goldfish, responding to sounds up to 4 kHz (Ramcharitar et al., 2004). Silver perch swim bladders have anterior horns that terminate close to the ear. The Ramcharitar et al. (2004) research supports the suggestion that the swim bladder can potentially expand the frequency range of sound detection. Furthermore, Sprague and Luczkovich (2004) calculated silver perch are capable of producing drumming sounds ranging from 128 to 135 dB. Since drumming sounds are produced by males during courtship, it can be inferred that silver perch detect sounds within this range.

The most widely noted hearing specialists are otophysans, which have bony Weberian ossicles, along which vibrations are transmitted from the swim bladder to the inner ear (Amoser and Ladich, 2003; Ladich and Wysocki, 2003). However, only a few otophysans inhabit marine waters. In an investigation of a marine otophysan, the hardhead sea catfish (*Ariopsis felis*), Popper and Tavolga (1981) determined that this species was able to detect sounds from 0.05 to 1 kHz, which is considered a much lower and narrower frequency range than that common to freshwater otophysans (i.e., above 3 kHz) (Ladich and Bass, 2003). The difference in hearing capabilities in the respective freshwater and marine catfish appears to be related to the inner ear structure (Popper and Tavolga, 1981).

Experiments on marine fish have obtained responses to frequencies up to the range of ultrasound; that is, sounds between 40 to 180 kHz (University of South Florida, 2007). These responses were from several species of the clupeid genus (i.e., herrings, shads, and menhadens) (Astrup, 1999); however, not all clupeid species tested have responded to ultrasound. Astrup (1999) and Mann et al. (1998) hypothesized that these ultrasound detecting species may have developed such high sensitivities to avoid predation by odontocetes. Studies conducted on the following species showed avoidance to sound at frequencies over 100 kHz: alewife (*Alosa pseudoharengus*) (Dunning et al., 1992; Ross et al., 1996), blueback herring (*A. aestivalis*) (Nestler et al., 2002), Gulf menhaden (*Brevoortia patronus*) (Mann et al., 2001) and American shad (*A. sapidissima*) (Popper and Carlson, 1998). The highest frequency to solicit a response in any marine fish was 180 kHz for the American shad (Gregory and Clabburn, 2003; Higgs et al., 2004). The *Alosa* species have relatively low thresholds (about 145 dB re 1 Pa-m), which should enable the fish to detect odontocete clicks at distances up to about 200 m (656 ft) (Mann et al., 1997). For example, echolocation clicks ranging from 200 to 220 dB could be detected by shad with a hearing threshold of 170 dB at distances from 25 to 180 m (82 to 591 ft) (University of South Florida, 2007). In contrast, the clupeids bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), and Spanish sardine (*Sardinella aurita*) did not respond to frequencies over 4 kHz (Gregory and Clabburn, 2003; Mann et al., 2001).

Wilson and Dill (2002) demonstrated that there was a behavioral response seen in Pacific herring (*Clupea pallasii*) to energy levels associated with frequencies from 1.3 to 140 kHz, although it was not clear whether the herring were responding to the lower-frequency components of the experiment or to the ultrasound. However, Mann et al. (2005) advised that acoustic signals used in the Wilson and Dill (2002) study were broadband and contained energy of less than 4 kHz to ultrasonic frequencies. Contrary to the Wilson and Dill (2002) conclusions, Mann et al. (2005) found that Pacific herring could not detect ultrasonic signals at received levels up to 185 dB re 1 µPa-m. Pacific herring had hearing thresholds (0.1 to 5 kHz) that are typical of clupeids that do not detect ultrasound signals.

Species that can detect ultrasound do not perceive sound equally well at all detectable frequencies. Mann et al. (1998) reported that the American shad can detect sounds from 0.1 to 180 kHz with two regions of best sensitivity: one from 0.2 to 0.8 kHz, and the other from 25 to 150 kHz. The poorest sensitivity was found from 3.2 to 12.5 kHz.

Although few non-clupeid species have been tested for ultrasound (Mann et al., 2001), the only other non-clupeid species shown to possibly be able to detect ultrasound is the cod (*Gadus morhua*) (Astrup and Mohl, 1993). However, in Astrup and Moh's (1993) study it is feasible that the cod was detecting the stimulus using touch receptors that were over driven by very intense fish-finding sonar emissions (Astrup, 1999; Ladich and Popper, 2004). Nevertheless, Astrup and Mohl (1993) indicated that cod have ultrasound thresholds of up to 38 kHz at 185 to 200 dB re 1 µPa-m, which likely only allows for detection of odontocete's clicks at distances no greater than 10 to 30 m (33 to 98 ft) (Astrup, 1999).

As mentioned above, investigations into the hearing ability of marine fishes have most often yielded results exhibiting poor hearing sensitivity. Experiments on elasmobranch fish (i.e., sharks and rays) have demonstrated poor hearing abilities and frequency sensitivity from 0.02 to 1 kHz, with best sensitivity at lower ranges (Casper et al., 2003; Casper and Mann, 2006; Myrberg, 2001). Though only five elasmobranch species have been tested for hearing thresholds, it is believed that all elasmobranchs will only detect low-frequency sounds because they lack a swim bladder, which resonates sound to the inner ear. Theoretically, fishes without an air-filled cavity are limited to detecting particle motion and not pressure and therefore have poor hearing abilities (Casper and Mann, 2006).

By examining the morphology of the inner ear of bluefin tuna (*Thunnus thynnus*), Song et al. (2006) hypothesized that bluefin tuna probably do not detect sounds to much over 1 kHz (if that high). This research concurred with the few other studies conducted on tuna species. Iversen (1967) found that yellowfin tuna (*T. albacares*) can detect sounds from 0.05 to 1.1 kHz, with best sensitivity of 89 dB (re 1 µPa) at 0.5 kHz. Kawakawa (*Euthynnus affinus*) appear to be able to detect sounds from 0.1 to 1.1 kHz but with best sensitivity of 107 dB (re 1 µPa) at 0.5 kHz (Iversen, 1969). Additionally, Popper (1981) looked at the inner ear structure of a skipjack tuna (*Katsuwonus pelamis*) and found it to be typical of a hearing generalist. While only a few species of tuna have been studied, and in a number of fish groups both generalists and specialists exist, it is reasonable to suggest that unless bluefin tuna are exposed to very high intensity sounds from which they cannot swim away, short- and long-term effects may be minimal or nonexistent (Song et al., 2006).

Some damselfish have been shown to be able to hear frequencies of up to 2 kHz, with best sensitivity well below 1 kHz. Egner and Mann (2005) found that juvenile sergeant major damselfish (*Abudefduf saxatilis*) were most sensitive to lower frequencies (0.1 to 0.4 kHz); however, larger fish (greater than 50 millimeters) responded to sounds up to 1.6 kHz. Still, the sergeant major damselfish is considered to have poor sensitivity in comparison even to other hearing generalists (Egner and Mann, 2005). Kenyon (1996) studied another marine generalist, the bicolor damselfish (*Stegastes partitus*), and found the bicolor damselfish responded to sounds up to 1.6 kHz with the most sensitive frequency at 0.5 kHz. Further, larval and juvenile Nagasaki damselfish (*Pomacentrus nagasakiensis*) have been found to hear at frequencies between 0.1 and 2 kHz, however, they are most sensitive to frequencies less than 0.3 kHz (Wright et al., 2005; Wright et al., 2007). Thus, damselfish appear to be primarily generalists with some ability to hear slightly higher frequencies expected of specialists.

Female midshipman fish apparently use the auditory sense to detect and locate vocalizing males during the breeding season. Interestingly, female midshipman fish go through a shift in hearing sensitivity depending on their reproductive status. Reproductive females showed temporal encoding up to 0.34 kHz, while nonreproductive females showed comparable encoding only up to 0.1 kHz (Sisneros and Bass, 2003).

The hearing capability of Atlantic salmon indicates a rather low sensitivity to sound (Hawkins and Johnstone, 1978). Laboratory experiments yielded responses only to 0.58 kHz and only at high sound levels. Salmon's poor hearing is likely due to the lack of a link between the swim bladder and inner ear (Jorgensen et al., 2004).

Furthermore, investigations into the inner ear structure of fishes belonging to the order Scorpaeniformes have suggested that these fishes have generalist hearing abilities (Lovell et al., 2005). Although an audiogram (which provides a measure of hearing sensitivity) has yet to be performed, the lack of a swimbladder is indicative of this species having poor hearing ability (Lovell et al., 2005).

The lateral line system of a fish also allows for sensitivity to sound (Hastings and Popper, 2005). This system is a series of receptors along the body of the fish that detects water motion relative to the fish that arise from sources within a few body lengths of the animal. The sensitivity of the lateral line system is generally below a few hundred Hz (Hastings and Popper, 2005). The only study on the effect of exposure to sound on the lateral line system suggests no effect on these sensory cells (Hastings et al., 1996). While studies on the effect of sound on the lateral line are limited, Hasting et al.'s (1996) work, limited sensitivity to within a few body lengths and to sounds below a few hundred Hz make the effect of the mid-frequency sonar of the Proposed Action unlikely to affect a fish's lateral line system. Therefore, further discussion of the lateral line in this analysis in unwarranted.

Of the fish species with distributions overlapping the AFAST Study Area for which hearing sensitivities are known, most are hearing generalists.

3.9.3 Occurrence of Marine Fish

3.9.3.1 Atlantic Ocean, Offshore of the Southeastern United States

3.9.3.1.1 VACAPES OPAREA

The VACAPES OPAREA is located in the southern portion of the MAB, which is the region between Cape Cod and Cape Hatteras. Ichthyofauna of the MAB is dynamic due to seasonal and climatic changes, varying life history strategies, hydrographic effects, fishing pressure, and natural cycles of abundance.

While distinct faunal assemblages exist in the cold-temperate waters north of Cape Cod and in the warm-temperate waters south of Cape Hatteras, few endemic fish species inhabit the variable MAB waters. The species composition of the MAB is diverse because many species, including commercially and recreationally important ones, migrate seasonally through this region to spawn. Northern (temperate) and southern (subtropical/tropical) fish populations also undergo extensive migrations through the OPAREA as they follow temperature isotherms. More than 300 fish species may occur in the MAB, with the majority being from southern (warm water) assemblages. Table 3-14 provides examples of fish, delineated by habitat type, that occur in the VACAPES OPAREA.

Table 3-14. Typical Fish Assemblages in the VACAPES OPAREA

Habitat Type	Area Found	Examples of Fish Supported
Coastal Pelagic	Continental shelf break to inshore	Coastal: Sharks Atlantic mackerel Atlantic menhaden Bluefish alewife Butterfish
Ocean Pelagic	Open ocean, close associations with the Gulf Stream	Pelagic: Tuna Swordfish White marlin Wahoo Blue marlin Dolphin Sailfish *Sargassum* community: Juvenile fish Jacks Triggerfish Large predatory species: Billfish Mackerels
Demersal	Continental shelf (distribution/abundance influenced by pressure/temperature preference or tolerance, competitive exclusion, food availability)	Sand or mud bottom habitats: Summer flounder Windowpane flounder

3.9.3.1.2 CHPT OPAREA

Nearly 700 fish species representing 149 families have been documented in the CHPT OPAREA. The dominant families of fish in the OPAREA include Serranidae (sea basses), Carangidae (jacks), Gobiidae (gobies), Bothidae (left-eyed flounders), Sciaenidae (drums and croakers), Triglidae (sea robins), Labridae (wrasses), Carcharhinidae (requiem sharks), Clupeidae (herrings), and Lutjanidae (snappers). Table 3-15 characterizes habitats and the fish species they typically support in the CHPT OPAREA.

Table 3-15. Typical Fish Assemblages in the CHPT OPAREA

Habitat Type	Location	Examples of Fish Supported
Coastal	Beyond the Outer Banks, extending north and south along the North Carolina coast and seaward along gradually sloping bottom to 110 m (362 ft) depth	Dependent upon season and associated water temperature and currents: Summer: Pelagic fish—throughout water column Demersal fish (except sharks)—deeper, cooler, offshore waters Fall Most fish migrate out of estuaries to south or from offshore waters into nearby shelf waters for winter

Table 3-15. Typical Fish Assemblages in the CHPT OPAREA, Cont'd

Habitat Type	Location	Examples of Fish Supported
Open Shelf	To the south of Cape Hatteras	Seasonal pelagic fish: Wrasses Damselfish Sharks Jacks Sea bass Anchovies Sand perch Marlins Pigfish Tunas Snappers Porgies Coastal habitat fish, seasonally: Flounders (fall) Porgies (fall) Winter species in dense schools: Drums Puffers Goosefish Spiny dogfish
Open Shelf: Shelf edge	Transition zone between inshore habitats, reefs, and continental slope	Little is known about the fish of this habitat Congregations: Groupers Snappers Porgies
Open Shelf Fisheries: Shelf edge	Reef habitats found at or near shelf break	Reef fishes (require complex habitats): Black sea bass Pinfish Tautog Crested blenny Red snapper Gray triggerfish Silk snapper Bigeye
Open Shelf Fisheries: Shelf edge	South of Cape Lookout, which is characterized by gradual slope and fine and medium sand and silty clay	Muddy bottom of the lower shelf edge: Macrouridae (rattails and grenadiers) Gadidae (cods) Water column: Many species of pelagic fish

3.9.3.1.3 JAX/CHASN OPAREA

The fish assemblage of the JAX/CHASN OPAREA is represented by hundreds of species. Estuarine-dependent species, such as drums and croakers, are abundant in the OPAREA due to the extensive network of estuaries occurring along bordering states. Pelagic and coral reef-associated species are also well represented. Although coral reefs do not occur in the OPAREA, fishes typically associated with this habitat are common. Table 3-16 summarizes the habitats and associated features and functions found within the OPAREA and provides examples of fish assemblages that occur within each habitat type.

Table 3-16. Typical Fish Assemblages in the JAX/CHASN OPAREA

Habitat Type	Features/Functions	Types of Fish Supported
Estuarine	Breeding and feeding grounds; Protection from predators	Drums, croakers
Reef (Hard-bottom, Shipwrecks, and Artificial Reefs)	Habitat complexity	Groupers, snappers, and over 300 other species
Pelagic (open water)	Water column niches; ocean fronts; *Sargassum* habitats	Tuna, lanternfish, flounder

3.9.3.2 Atlantic Ocean, Offshore of the Northeastern United States

The Northeastern Atlantic Coast OPAREAs include the northern portion of the MAB, Georges Bank, and the Gulf of Maine. The MAB includes the region between Cape Cod and Cape Hatteras. Each of these three areas possesses distinct physical characteristics and species distributions. Typically, the number of different species decreases northward from the MAB to the Gulf of Maine; only half of the number of species occurs in the Gulf of Maine compared with the MAB. Seasonal temperature fluctuations are one of the primary factors that influence the distribution of species, especially fishes, in these marine regions. Approximately 300 species of fishes and over 260 species of macroinvertebrates exist here.

Approximately 113 species of fish inhabit the Gulf of Maine and Georges Bank. The majority encompasses temperate (i.e., species with temperature preferences below 15ºC [59ºF]) year-round fish species and includes members of the cod family (i.e., cod, haddock, and hake species) and various species of flounders. Alternatively, the MAB includes a high proportion of seasonal fish species that are subtropical-tropical species (i.e., species with preferences of temperatures above 20ºC [68ºF]). Tropical species only make up about 15 percent of the fish species. This portion of the Study Area also supports a variety of macroinvertebrates (e.g., ocean quahog, red deepsea crab, and Atlantic surfclam) and highly migratory pelagic fishes (e.g., billfishes, tunas, swordfish, and sharks). Many of the juvenile fishes and invertebrates that are commercially important species use estuaries and coastal waters for critical nursery and settlement habitat. Table 3-17 provides examples of fish, delineated by habitat type, that occur in this region.

Table 3-17. Typical Fish Assemblages in the Northeastern Atlantic Coast OPAREAs

Habitat Type	Area Found	Examples of Fish Supported
Coastal	Includes bays, harbors, and estuaries; used for spawning, nursery grounds.	Atlantic halibut (larval to early juveniles) Atlantic mackerel Black sea bass Butterfish White hake Windowpane flounder Winter flounder Yellowtail flounder Tiger shark
Demersal: Inshore	Shelf areas; inshore Gulf of Maine; southern Georges Bank; MAB 100-m (328-ft) isobath; Maine to Cape Cod out to 100 m (328 ft); Gulf of Maine to northern Georges bank out to 275 m (902 ft); western Gulf of Maine and coastal southern New England to 180 m (591 ft)	Generally found over mud, sand, and/or rock Groundfish: American plaice Atlantic cod Pollock Winter flounder Redfish Silver hake (whiting) Red hake Windowpane flounder
Demersal: Offshore	Outer shelf regions	Groundfish: Atlantic cod Yellowtail flounder Haddock White hake Witch flounder

3.9.3.3 Eastern Gulf of Mexico

Over 550 species of fishes are found in the Gulf of Mexico. These fishes are taxonomically and ecologically diverse. Some species are economically important and support recreational and commercial fisheries. Only one species, the Gulf sturgeon (threatened status), is considered under the ESA and has been reported to occur in the eastern Gulf of Mexico.

The eastern Gulf of Mexico also includes a variety of habitats that, in turn, support a wide diversity of fishes. The key habitat features include coral reefs off southern Florida, a broad continental shelf off western Florida, submarine canyons (DeSoto and Mississippi), a major river delta (Mississippi) extending into the Gulf as part of Louisiana, and deepwater areas beyond the continental shelf. Physiographic and oceanographic features of the environment (e.g., salinity, primary productivity, bottom type, and currents) affect the distribution, abundance, and diversity of fishes in the Gulf of Mexico. The abundance and distribution of fish occurring in the eastern Gulf of Mexico are affected not only by their physical environment but also by the habitat available to them.

Table 3-18 summarizes the habitats and associated features and functions found within the eastern Gulf of Mexico and provides examples of fish assemblages that occur within each habitat type.

Table 3-18. Typical Fish Assemblages in the Eastern Gulf of Mexico

Habitat Type	Area Found	Examples of Fish Supported
Reef	Includes Florida Keys coral reefs	Triggerfish Jacks Wrasses Snapper Tilefish Grouper Surgeonfish Parrotfish Damselfish
Sea floor	Areas of vertical relief	Seabass Damselfish Porgis Snapper
Open water	Open water of the Gulf	Coastal migratory pelagic fish: Mackerel Cobia Cero Little tuny Dolphin (genus *Coryphaena*) Bluefish Pelagic offshore fish: Atlantic spadefish Tomtate Gray snapper Blue angelfish, Belted sandfish Cubbyu White grunt

Source: REEF, 2001

3.9.3.3.1 Western Gulf of Mexico

Fish assemblages and habitats within the western Gulf of Mexico are similar to that of the eastern Gulf of Mexico (Table 3-18). Large predatory oceanic species associated with open water include marlins, sailfish, swordfish, tunas, mahi, wahoo, and sharks. Smaller prey species include flyingfishes and halfbeaks. These species typically occur beyond the shelf edge and are often associated with fronts and eddies. *Sargassum* provides feeding and nursery habitat for many of the oceanic species (MMS, 2003a). Midwater or mesopelagic fishes are dominated by lanternfish, hatchet fish, and other deep-dwelling species that make extensive upward vertical migrations during the night from depths of up to 1,000 m (3,280.8 ft) (MMS, 2003a). Two Elkhorn coral colonies located in the Flower Garden Banks, on the edge of the outer continental shelf in the northwestern Gulf of Mexico, are essential constituents for an abundant fish habitat.

3.9.4 ESA-Listed Fish Species

Three endangered species (the shortnose sturgeon, subadult and adult Gulf sturgeon, and the smalltooth sawfish) may occur in the AFAST Study Area. In addition, a Gulf sturgeon critical habitat has been designated in the Gulf of Mexico. A discussion of each of these three endangered species, as well as the Gulf sturgeon critical habitat, is provided below.

3.9.4.1 Short Nose Sturgeon

The endangered short nose sturgeon is an anadromous species that occurs in most major river systems along the eastern U.S. seaboard. The short nose sturgeon spends most of the year in brackish or salt water and moves into fresh water only to spawn. The range generally extends from New Brunswick, Canada, to the St. Johns River in Florida. However, the short nose sturgeon is a coastal/estuarine inhabitant and is not expected to be present in the training areas.

3.9.4.2 Gulf Sturgeon

Subadult and adult Gulf sturgeons may be found in the nearshore marine waters within close proximity to the boundary of the eastern Gulf of Mexico, particularly along the northern Gulf of Mexico. The Gulf sturgeon in this area has been observed 1.9 km (1 NM) from shore (Ross et al., 2002). Gulf sturgeons have been observed off the Suwannee River area as far as 16.7 km (9 NM) from shore (USFWS and NMFS, 2003). The Gulf sturgeon is not expected to be present in the training areas since it is a coastal inhabitant.

3.9.4.3 Gulf Sturgeon Critical Habitat

The USFWS has designated critical habitat for the Gulf sturgeon in the Gulf of Mexico. This protected habitat encompasses coastal waters from the mean high water line and out to 1.9 km (1 NM) offshore. The units for critical habitat include the Pearl River system in eastern Louisiana; the Pascagoula River system in Mississippi; the Escambia, Yellow, Apalachicola, Choctawhatchee, and Suwannee river systems in northwestern Florida; the Pensacola, Apalachicola, and Choctawhatchee bays in northwestern Florida; the Lake Borgne, Mississippi Sound, and Lake Pontchartrain systems in Mississippi and Louisiana; the Santa Rosa and Suwannee sounds in northwestern Florida; and the Florida Nearshore Gulf of Mexico area that stretches from Escambia to Gulf counties (50 CFR Part 226). The AFAST Study Area is located outside the Gulf sturgeon's critical habitat.

3.9.4.4 Smalltooth Sawfish

The smalltooth sawfish was listed under the ESA on 6 April 2003 following the NMFS announcement on April 1, 2003 of a final determination for this species (NMFS, 2006d).

The smalltooth sawfish is one of two sawfish species in the waters of the United States. Once common throughout the Gulf of Mexico from Texas to Florida, their current distribution ranges primarily throughout peninsular and southern Florida. They are only commonly found in the Everglades and in shallow areas with mangrove forests in Florida Bay and the Florida Keys, as well as off southern Florida. They reside typically within 1.9 km (1 NM) of land in estuaries, shallow banks, sheltered bays, and river mouths with sandy and muddy bottoms. Occasionally, they are found offshore on reefs or wrecks and over hard or mud bottoms. The smalltooth sawfish feed on fish and crustaceans, using their long flat snouts to stun and kill their prey. Very little is known about their life history in Florida.

This shark relative was not highly targeted for direct commercial takings but was frequently entangled in fishing nets and caught in shrimp trawls. Once entangled, this sawfish has little chance for successful release. A study by C.A. Simpfendorfer (2000) suggests that the complete recovery of this species will take decades and possibly centuries due to their population size and slow reproductive potential. Habitat degradation has also contributed to their demise. Smalltooth sawfishes cannot be "taken" in Florida (or Louisiana) (NMFS, 2006d).

The smalltooth sawfish is not expected to be present within the training areas because its current distribution is limited to peninsular Florida, and it is only rarely found offshore.

3.10 SEA BIRDS

This section focuses on birds (specifically sea birds) that occur in the AFAST Study Area. Seabirds are birds whose normal habitat and food source is the sea, whether they use coastal (nearshore) waters, offshore waters (continental shelf), or pelagic waters (open sea) (Harrison, 1983). While some seabirds are permanent residents to an area, other seabirds migrate to the area annually. Specifically, a migratory bird is any species or family of birds that lives, reproduces, or migrates within or across international borders at some point during its annual life cycle. These species are protected under the Migratory Bird Treaty Act (MBTA). This legislation was enacted to ensure the protection of shared migratory bird resources and currently protects a total of 836 bird species, 58 of which are currently legally hunted as game birds. The MBTA prohibits the take, possession, import, export, transport, selling, purchase, barter, or offering for sale, purchase or barter, any migratory bird, their eggs, parts, and nests, except as authorized under a valid permit. Current regulations authorize permits for takes of migratory birds for activities such as scientific research, education, depredation control, and lawful military readiness activities.

The states that border the eastern Gulf of Mexico and the East Coast lie within the Atlantic Flyway, a major migration route. During the fall and spring migratory seasons, large numbers of birds use the flyway. The coastal route of the Atlantic Flyway generally follows the shoreline, and migratory birds are typically associated with the coast. In the eastern Gulf of Mexico, however, there is a migratory route located offshore for passerines (i.e., land birds or song birds). However, most migratory land birds are nocturnal flyers, usually beginning at sunset and ending by dawn or when they find suitable habitat (Moore et al., 1995). Migration generally peaks in late April and early May, and the majority of migratory birds fly in large flocks at altitudes ranging from about 150 m (about 500 ft) to about 4,000 m (about 13,000 ft) above the surface of the water.

3.10.1 Foraging Habits

Overall, the majority of birds likely to occur in the AFAST Study Area feed in shallow waters and typically do not fully submerge themselves in the water. Rather, these seabirds plunge-dive from the air into the water and aerial dipping (dip (the act of taking food from the water surface in flight) (Slotterback, 2002). Other common feeding methods include surface-seizing (sitting on water and taking food from surface), surface-dipping (swimming and then dipping to pick up items below the surface), jump-plunging (swimming, then jumping upward and diving under water), or picking up food while walking (Burger and Gochfeld, 2002). For example, shearwaters and petrels tend to skim waves in search of food, while the majority of gull and tern species eat only small fish and feed by plunge-diving head-first from flight, often from a hovering position (National Geographic, 2002; MMS, 2006b). The gull-billed tern and sooty tern, however, pluck food from the water's surface (MMS, 2006b). In addition, diving birds such

Table 3-19. Seabird Foraging Habits Cont'd

as cormorants, anhingas, loons, and grebes generally feed by pushing themselves underwater with their wings and/or feet.

For seabirds that dive for food, research indicates that the longest recorded dive times were 30 seconds for the Northern gannets and 28 seconds for double-crested cormorants. Minimum dive times for the Northern gannetgannets and double-crested cormorant cormorants were 5 seconds and 19.3 seconds, respectively (Hatch and Weseloh, 1999; Mowbray, 2002). The Northern gannet also had the longest recorded dive depth of 15 m (49 ft) (Mowbray, 2002), followed by the pied-billed grebe with a maximum dive depth of 12 m (39 ft) (Muller and Storer, 1999), and the double-crested cormorant with 7.9 m (26 ft) (Hatch and Weseloh, 1999). However, the average dive length for the double-crested cormorant was approximately 5 m (16 ft) (Hatch and Weseloh, 1999). In addition, the wintering double-crested cormorants in Mississippi had much shorter dive durations with average dive times of 11.9 seconds in waters 1.4 m (5 ft) in depth. The mean dive depth for the pied-billed grebe was 3.69 m (12 ft) (Muller and Storer, 1999). A representative overview of foraging habits for birds likely to occur in the AFAST Study Area is presented in Table 3-19.

Table 3-19. Seabird Foraging Habits

Bird	Food Selection	Food Location of Feeding	Feeding Behavior
Anhingas *(Anhinga anhinga)*	Mainly slow-moving, laterally flattened fish, but also crayfish, amphibians, snakes, lizards, mollusks, leeches, and aquatic insects	Shallow, freshwater habitats	Surface dipping and side-spearing
Band-Rumped Storm Petrels *(Oceanodroma castro)*	Squid and small fish from ocean surface; few crustaceans	Internal wave crests at or just below surface	Aerial dipping
Bonaparte's Gulls *(Larus philadelphia)*	Small fish, krill, amphipods, and insects such as snails, marine worms, grasshoppers, beetles, locusts, ants, and bees	shallow (< 3 ft) habitats including lakes, ponds, muskegs, rivers, large bays, coastal estuaries, tidal rips, surf, and open ocean	Plunge-diving, aerial dipping, surface-seizing, surface-dipping, jump-plunging, and walking
Bridled Terns *(Sterna anaethetus)*	Primarily small schools of fish near the ocean's surface, crustaceans, and	Air-sea boundary layer, typically 3 to 7 ft above and on sea surface	Aerial dipping (pecking)
Brown Pelicans *(Pelecanus occidentalis)*	Primarily small schools of fish near the ocean's surface such as menhaden and mullet along Atlantic and Gulf Coasts	Shallow habitats within 11 NM of shore	Plunge-dives and aerial dipping
Double-Crested Cormorants *(Phalcrocorax auritus)*	Mostly slow-moving schooling species; occasionally insects, amphibians, and crustaceans	Shallow open water (< 26 ft deep) and close to shore (< 3 NM)	Plunge-diving

Table 3-19. Seabird Foraging Habits Cont'd

Bird	Food Selection	Food Location of Feeding	Feeding Behavior
Forster's Tern *(Sterna forsteri)*	Primarily small fish; some arthropods	Shallow saltwater estuaries and coastal areas (< 3 ft), over flood-tide mudflats, marshes, lakes, and water channels	Aerial dipping
Gull Billed Terns *(Sterna nilotica)*	Terrestrial and aquatic animals such as insects, lizards, fish, and chicks of other birds	Beaches and salt marshes, inland over plowed fields, and shrubby habitats	Does not generally plunge-dive; Insteadinstead plucks food from the water
Horned Grebes *(Podiceps auritus)*	Fish and crustaceans, including amphipods and crayfish	Shallow- to moderately deep (<20 ft) habitats	Surface-swimming and plunge-diving
Laughing Gulls *(Larus atricilla)*	Aquatic and terrestrial invertebrates such as earthworms, flying insects, beetles, snails, crabs, fish, and squid;; garbage; and berries	Coastal edge and inland	Surface-dipping, walking, plunge-diving, and pirating food from other species
Least Terns *(Sterna antillarum)*	Small fish, shrimp, and other invertebrates	Shallow water habitats such as marine coasts, bays, lagoons, estuaries, river and creek mouths, tidal marshes, and lakes	Plunge-diving
Northern Gannets *(Morus bassanus)*	Surface-schooling fish such as mackerel and herring	Shallow continental-shelf waters	Primarily plunge-diving
Parasitic Jaegers *(Stercorarius parasiticus)*	Depends on breeding populations, but can include birds, eggs, and rodents	Near colonies of nesting seabirds	Plunge-diving and pirating food from other species
Pied-Billed Grebes *(Podilymbus podiceps)*	Readily available fish such as crayfish, aquatic insects, and their larvae	Open water among rooted aquatic plants, near shoreline, and amongst vegetation	Plunge-diving
Red-Throated Loons *(Gavia stellata)*	Primarily live, marine fish	Coastal, tidal estuaries, mudflats in streams, rivers, and lakes	Peering from surface and/or hunting underwater
Sandwich Terns *(Sterna sandvicensis)*	Small marine fish, squid, and crustaceans	Coastal marine areas such as open ocean and bays, inlets, and outflows; usually < 1 NM off shore	Plunge-diving
Sooty Terns *(Sterna fuscata)*	Small pelagic fish and squid; feeds over large predatory fish including tuna	Within 4 in of the ocean surface, far at sea in tropical, and subtropical oceanic waters	Plunge-diving

ft – feet; in – inch; NM – nautical mile

Sources: Braune, 1987a, Frederick and Siegel-Causey, 2000; Slotterback, 2002; Burger and Gochfeld, 2002; Burger and Gochfeld, 2006; Haney et al., 1999; Shields, 2002; Hatch and Weseloh, 1999; McNicholl et al., 2001; Parnell et al., 1995; Palmer, 1962; Stedman, 2000; Burger, 1996; Thompson et al., 1997; Mowbray, 2002; Wiley and Lee, 1999; Muller and Storer, 1999; Barr et al., 2000; Shealer, 1999; Schreiber et al., 2002

3.10.2 Seabird Hearing

Little is known about the general hearing or underwater hearing capabilities of sea birds, but research suggests an in-air maximum auditory sensitivity between 1 and 5 kHz for most bird species (NMFS, 2003a).

3.10.3 Occurrence of Seabirds

The following sections provide information on seabirds and migratory birds that are not protected under the ESA. Section 3.10.4 describes the threatened and endangered seabird species that may potentially occur in the AFAST Study Area.

3.10.3.1 Atlantic Ocean, Offshore of the Southeastern United States

The Atlantic Ocean, offshore of the southeastern United States, is populated by both resident and migratory seabirds. Seabirds known to use the coastal and offshore waters of the southeastern OPAREAs are categorized as summer, wintering, or permanent residents.

Summer residents are present and breed during spring/summer months. Examples include black-capped petrels, various shearwaters, Wilson's storm-petrels, band-rumped storm-petrels, anhingas (VACAPES, CHPT, and CHASN OPAREAs), south polar skuas, sandwich terns, Forster's terns, gull-billed terns, least terns, bridled terns, and sooty terns (National Geographic, 2002). Wintering residents are found only during winter months. Examples include red-throated loons, common loons, horned grebes, northern gannets, parasitic jaegers, and Bonaparte's gulls (National Geographic, 2002). Permanent residents are found year-round. Examples include pied-billed gebes, double-crested cormorants, brown pelicans, anhingas (JAX OPAREA), and laughing gulls (National Geographic, 2002).

3.10.3.2 Atlantic Ocean, Offshore of the Northeastern United States

The Atlantic Ocean, offshore of the northeastern United States, is populated by summer and winter residents. Seabirds known to use the coastal and offshore waters of the northeastern OPAREAs are categorized as summer, wintering, or permanent residents.

Summer residents include pied-billed grebes, sooty shearwaters, Cory's shearwaters, greater shearwaters, manx shearwaters, Audubon's shearwaters, Wilson's storm-petrels, double-crested cormorants, south polar skuas, brown pelicans, laughing gulls, roseate terns, common terns, and least terns (National Geographic, 2002). Wintering residents include common and red-throated loons, horned grebes, red-necked grebes, great cormorants, northern fulmars, northern gannets, great skuas, black-legged kittiwakes, Bonaparte's gulls, black-headed gulls, little gulls, and ringed-billed gulls (National Geographic, 2002). Red phalaropes and pomarime jaegers are found pelagically in the region during nonbreeding seasons (Alsop, 2001). Permanent residents include great black-backed gulls and herring gulls (Blodget, 2002).

3.10.3.3 Eastern Gulf of Mexico

The eastern Gulf of Mexico is populated by both resident and migratory seabirds. While some species of seabirds inhabit only pelagic habitats in the Gulf of Mexico (e.g., boobies, petrels and shearwaters), most Gulf seabird species inhabit waters of the continental shelf and adjacent coastal and inshore habitats. The Gulf of Mexico seabirds are categorized as summer, wintering, or permanent residents.

Summer residents include Audubon's shearwaters, Wilson's storm-petrels, magnificent frigatebirds, sandwich terns (Florida Panhandle), least terns, and sooty terns (National Geographic, 2002). Wintering residents include common loons, horned grebes, northern gannets, great cormorants, pomarine jaegers, parasitic jaegers, Bonaparte's gulls, and ringed-billed gulls (National Geographic, 2002). Permanent residents include pied-billed grebes, anhingas, double-crested cormorants, brown pelicans, laughing gulls, royal terns, and Caspian terns (National Geographic, 2002).

3.10.3.4 Western Gulf of Mexico

The western Gulf of Mexico is populated by both resident and migratory seabirds. Seabirds known to use the coastal and offshore waters of this area are categorized as summer, wintering, or permanent residents.

Summer residents include Audubon's shearwaters, Wilson's storm-petrels, magnificent frigatebirds, least terns, and sooty terns (National Geographic, 2002). Wintering residents include common loons, horned grebes, eared grebes, northern gannets, pomarine jaegers, parasitic jaegers, Bonaparte's gulls, and ringed-billed gulls (National Geographic, 2002). Permanent residents include pied-billed grebes, least grebes, anhingas, neotropic cormorants, double-crested cormorants, brown pelicans, laughing gulls, sandwich terns, royal terns, and Caspian terns (National Geographic, 2002).

3.10.4 Threatened and Endangered Seabirds

The ESA provides for the conservation of endangered and threatened species and their habitat. CFR Volume 50 contains the implementing regulations for the ESA. The ESA prohibits the taking of any listed species, and Section 7(a)(2) of the ESA requires federal agencies to ensure their actions do not jeopardize their continued existence and do not result in the destruction or adverse modification of designated critical habitat. The following sections provide information on birds throughout the AFAST Study Area that are listed under the ESA.

Of the birds that may occur along the East Coast and Gulf of Mexico, five species are currently listed as federally endangered or threatened:

- Bermuda petrel
- Brown pelican
- Least tern
- Roseate tern
- Piping plover

The occurrence of these birds is described in the following sections.

3.10.4.1 Bermuda Petrel

The Bermuda petrel (*Pterofroma cahow*) is an endangered seabird that inhabits and nests in Bermuda and its surrounding waters but has been observed off the Carolina Capes following West Indian hurricanes (MMS, 2006g). Since this species only nests on islets off Bermuda, the Carolina sightings are considered rare. This species is not expected to be encountered in the Study Area.

3.10.4.2 Brown Pelican

The brown pelican (*Pelecanus occidentalis*) is an endangered marine bird that occurs in the south and mid-Atlantic regions. This species is a colonial nester that uses relatively undisturbed coastal islands in salt and brackish waters to feed and rear their young. It feeds by diving for its prey (MMS, 2006g).

The eastern brown pelican (*Pelicanus occidentalis carolinensis*) is one of two pelican species occurring in North America. It inhabits coastal habitats and forages within coastal waters and waters of the inner continental shelf, typically less than 32 km (17.3 NM) from the coast. It feeds entirely upon fishes captured by plunge diving in coastal waters. Subsequent to the ban of the insecticide dichlorodiphenyltrichloroethane (DDT), the population of brown pelicans and their habitat in Alabama, Florida, Georgia, North and South Carolina, and points northward along the Atlantic coast were removed from the endangered species list in 1985. However, within the remainder of the range, which includes coastal areas of Texas, Louisiana, and Mississippi, where populations are not secure, the brown pelican remains listed as endangered. No critical habitat has been designated for this species (MMS, 2006b; MMS, 2006g).

Brown pelicans are considered year-round residents to the eastern Texas coast (National Geographic, 2002).

3.10.4.3 Least Tern

The least tern (*Sterna antillarum*) is the smallest North American tern. Three subspecies of New World least terns were recognized by the American Ornithologists' Union (1957). These include the interior least tern (*Sterna antillarum athalossus*), the eastern or coastal least tern (*Sterna antillarum antillarum*), and the California least tern (*Sterna antillarum browni*). According to the *Federal Register*, "Because of the taxonomic uncertainty of least tern subspecies in eastern North America, the [U.S. Fish and Wildlife] Service decides not to specify the subspecies in this final rule. Instead the Service designates as endangered the subspecies of least terns (hereinafter referred to as interior least tern) occurring in the interior of the United States [*Sterna antillarum athalossus*]" (MMS, 2006g).

The entire Atlantic and Gulf coasts are part of the least tern's breeding range. However, the least tern nests in colonies on beaches and sandbars (National Geographic, 2002). Since AFAST activities occur away from beaches and sandbars under all four alternatives, it is unlikely that least terns will be encountered.

3.10.4.4 Roseate Tern

The endangered roseate tern (*Sterna dougallii*) nests on rocky coastal islands, outer beaches, or salt marsh islands along the northeastern U.S. coast (National Geographic, 2002; USFWS, 2007b). Roseate terns are plunge-divers, typically feeding occurs in waters less than 10 m (32.8 ft) in depth over sand (USFWS, 2007b). Threats to this species include habitat loss and disturbance, predation, egg collection (locally), and competition from expanding gull populations (MMS, 2006g). Since AFAST activities in the northeast will occur over the open ocean away from beaches and shallow waters, it is unlikely that roseate terns will be encountered.

3.10.4.5 Piping Plover

The piping plover (*Charadrius melodus*) is a shorebird that inhabits coastal sandy beaches and mudflats. This species has experienced major declines over its entire range, followed by some recovery. Some regional declines are still occurring. Strong threats related primarily to human activity, disturbance by humans, predation, and development pressure are pervasive threats along the Atlantic coast (MMS, 2006g). It is listed as a result of historic hunting pressure and loss and degradation of habitat (66 *Federal Register* [FR] 36038-36079) (MMS, 2006g). Since AFAST activities will occur away from beaches it is unlikely that piping plovers will be encountered.

3.11 MARINE INVERTEBRATES

Invertebrates can be described as animals that lack a backbone or spinal column. Invertebrates include 97 percent of all animal species (with the exception of fish, reptiles, amphibians, birds, and mammals) and range from simple animals, such as sponges and flatworms, to complex animals such as arthropods and mollusks.

According to the NRC, very little information exists regarding the hearing capability of marine invertebrates, although a number of cephalopods (e.g., octopods and squid), as well as crustaceans (e.g., crabs), possess statocytes, or structures that resemble the ears of fishes (NRC, 2003). Wilson et al. (2007) exposed squid to sound pressure levels ranging from 179 to 193 dB re 1 mPa^2-s to determine whether toothed whale echolocation clicks can incapacitate squid and whether squid can detect and respond to such clicks. No behavioral changes were reported in the squid when exposed to the two types of echolocation clicks. The results of the experiment did not reveal any behavioral change in squid. The statocytes may assist with determining the species' head position (NRC, 2003). Some species of semiterrestrial fiddler crabs and ghost crabs detect sounds and use sounds to communicate; as such, it is possible that marine crabs are also capable of detecting sounds, although it has not been proven (NRC, 2003).

3.12 MARINE PLANTS AND ALGAE

3.12.1 Marine Plants

Ecologically speaking, marine plants are classified as primary producers; thus, they have the ability to use inorganic materials to produce organic compounds through photosynthesis. Ecologists use "primary production" to describe an increase in biomass of higher plants and by analogy, aquatic ecologists have used it to describe micro- as well as macrophytic algal production (American Society of Limnology and Oceanography, Inc, 1988).

There are several categories of marine plants; these categories include seagrasses, mangroves, and algae. Seagrasses, such as Johnson's seagrass, are true flowering plants that have adapted to life in the marine environment.

Seagrasses are among the most productive ecosystems in the world and perform a number of irreplaceable ecological functions that range from chemical cycling and physical modification of the water column and sediments, to providing food and shelter for commercial, recreational, and ecologically important organisms. This is evident not only by the scientific literature but also by the increasing public notices occurring in newspapers regarding their loss (e.g., in Chesapeake Bay and Florida Bay). With the exception of Georgia and South Carolina, there are a minimum of 13 species of seagrass recognized as occurring in U.S. territorial waters. Off Georgia's and South Carolina's coast, freshwater inflow, high turbidity, and tidal amplitude inhibit their growth. Mangroves are also true flowering plants and are found in coastal waters of varying salinities.

Since marine plants are submerged, they are susceptible to damage by human activities such as nutrient loading, light reduction, propeller scarring, and dredge-fill operations (Stephan and Bigford, 1997). Dredge and fill operations are no longer a primary cause of major losses of seagrass habitat due to the recognition of their ecological role and the vigilance of state and federal regulatory activities relative to permits. Propeller scouring and fishing gear-related impacts remain a concern. This physical damage is long-lasting and often results in sediment destabilization and continued habitat loss. The increasing number of small boats traveling estuarine and coastal waters has made the prop-scarring impacts more widespread, and there has been a recognized need in some quarters for both enhanced management of these systems and increased awareness by the boating public.

3.12.2 Algae

Algae are not true flowering plants and range in size from microscopic phytoplankton to large seaweed species (Thayer et al., 1997). As such, they provide the basis for most of the aquatic food chain. *Sargussum* can be described as a generally planktonic macroalgae or brown algae (seaweed). *Sargussum* originates in the Sargasso Sea, a region of the Central Atlantic. The Sargasso Sea is in the middle of the Atlantic Ocean and covers some 3 million km^2 (2 million square miles [mi^2]) between the West Indies and the Azores. It is encircled by the Gulf Stream and the North Equatorial Current. This causes the oval-shaped sea to move in a slow, clockwise drift. The Sargasso Sea is also known as "the floating desert" (Florida Department of Environmental Protection [FDEP], 2007). Tiny air bladders keep the *Sargassum* afloat. It can form streamers that stretch for miles along the boundaries between water masses, or it can form big yellow and brown "mats" that cover large areas of the surface. Strong currents around the Sargasso Sea can carry *Sargassum* around the world. *Sargassum* is commonly found in the beach drift near *Sargassum* beds where they are also known as Gulfweed (FDEP, 2007).

Thick masses of *Sargassum* provide an environment for a distinctive and specialized group of marine biota, many of which are not found elsewhere in the world (Science and the Sea, 2007). Specifically, planktonic *Sargassum* serves as a temporary habitat for four species of sea turtle hatchlings, as well as larval and juvenile stages of over 100 fish species. Fish are attracted to the drifting algal mats for a number of reasons, including use as a foraging area, for protection from larger predators, as a spawning ground, and as a nursery habitat. The habitat created by *Sargassum* aggregations also supports a diverse and highly adapted resident assemblage of marine organisms such as fungi, micro- and macro-epiphytes, hydroids, and crustaceans.

In addition, *Sargassum* provides food and shelter to juvenile sea turtles. Sea turtle hatchlings are known to associate with pelagic *Sargassum* habitat during their "lost years" when they drift along with the planktonic mats. This association is thought to play a vital role in the life of young turtles. Any *Sargassum* mats drifting at sea have the potential to host young sea turtles, since both are found with currents and can travel for long distances from their points of origin.

3.12.3 Occurrence of Marine Plants and Algae

In the area managed by the Atlantic States Fishery Management Council, eelgrass (*Zostera marina*) dominates, with two other species also occurring: Cuban shoalgrass (*Halodule wrightii*) in North Carolina and widgeon grass (*Ruppia maritime*), which is cosmopolitan. Specifically, areas of seagrass concentration in North Carolina include southern and eastern Pamlico Sound, Core Sound, Back Sound, Bogue Sound, and the numerous small southern sounds located behind the beaches in Onslow, Pender, Brunswick, and New Hanover counties. In addition, areas of seagrass concentration along Florida's east coast include Mosquito Lagoon, Banana River, Indian River Lagoon, Lake Worth and Biscayne Bay. Shoalgrass is a subtropical species that has its northernmost distribution at Oregon Inlet, North Carolina. Eelgrass, a temperate species, has its southernmost distribution in North Carolina.

In the Gulf of Mexico, turtlegrass (*Thalassia testudinum*) and manatee grass (*Syringodium filiforme*) are dominate species along with several species of *Halophila*. One species of seagrass, Johnson's seagrass (*Halophila johnsonii*), was listed in 1999 as a threatened species under the ESA. The presence of *Sargassum* is transient (temporary), unpredictable, and dependent on prevailing surface currents. Aggregations of *Sargassum* can be found throughout tropical areas of the world and are often the most obvious macrophyte in nearshore areas where *Sargassum* beds often occur near coral reefs. They grow subtidally and attach to coral, rocks, or shells in moderately exposed or sheltered rocky or pebble areas. In some cases (e.g., the Sargasso Sea), there are floating populations of *Sargassum* (FDEP, 2007). The Gulf of Mexico is second to the Sargasso Sea in the quantity of *Sargassum* present in the area. Moreover, the Florida Keys and its smaller islands are well known for their high levels of *Sargassum* covering their shores (FDEP, 2007).

3.12.4 Fishery Management Plan for Pelagic Sargassum Habitat

In 2003, the SAFMC approved the "Fishery Management Plan for Pelagic Sargassum Habitat in the South Atlantic Region." This plan regulates the commercial harvesting of *Sargassum* south of North Carolina and South Carolina and prohibits harvesting *Sargassum* within 161 km (86.8 NM) from shore (SAFMC, 2007).

3.13 NATIONAL MARINE SANCTUARIES

The National Marine Sanctuary Program (NMSP) designates and manages national marine sanctuaries. These areas of the marine environment possess special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities. The primary objective of the NMSP is to manage marine resources. These include coral reefs, sunken historical vessels or unique habitats (NMSP, 2007e). The NMSP currently manages 14 marine protected areas. Five of these areas are located within the AFAST Study Area. A description of each of these sanctuaries along with a brief description of regulations is provided in subsequent paragraphs. Regulations governing management of each sanctuary can be found in 15 CFR 922.

3.13.1 Atlantic Ocean, Offshore of the Southeastern United States

In 1973, a group of scientists aboard a Duke University Research vessel located the remains of a shipwreck nearly 70 m (230 ft) below the surface and approximately 26 km (14 NM) off Cape Hatteras in North Carolina. The following year, it was confirmed that the shipwreck the scientists located was the USS Monitor.

The USS Monitor was a steam-powered ironclad ship that was equipped with a rotating gun turret. The vessel is famous for its design and its part in the 1862 Battle of Hampton Roads against the Confederate ironclad *Virginia*. The battle resulted in minor damage to either vessel and resulted in a draw. Later, in the same year of the battle, the USS Monitor sank in a storm off Cape Hatteras while in transit from Rhode Island to North Carolina for repairs (NMSP, 2007d). Although, the Monitor's brief career was fairly uneventful, with the exception of the engagement with the CSS Virginia, the vessel remains an important symbol for its role in shaping U.S. naval history.

The Monitor National Marine Sanctuary was established in 1975 in order to preserve the historical and cultural artifacts of one of the most famous ships that have ever been built for naval warfare. The location of the sanctuary is defined by the shipwreck and the surrounding area, which is composed of a column of water extending from the ocean's surface to the seabed and is 1.85 km (1 NM) in diameter. The small size of the sanctuary limits the number of marine life that permanently inhabits the area. However, many species pass through the area, and a small ecosystem has developed around the wreck site following the permanent establishment of several organisms on the wreck (NMSP, 2007d).

A permit is required to gain access to the shipwreck. Permits are typically limited to scientific research visits and in some cases, a special-use permit will be granted for nonresearch visits. Other regulations prohibit anchoring, stopping, and drifting within the sanctuary, disturbing the seabed by conducting underwater detonation, drilling, laying cable, and trawling (NMSP, 2007d).

Gray's Reef became a national marine sanctuary in 1981 and is one of the three marine sanctuaries that make up the Southeast Region. It is one of the largest nearshore sandstone reefs in the southeastern United States and is an important calving ground for the endangered North

Atlantic right whale. The 32.4 km^2 (17.5 NM^2) that constitute Gray's reef is located 32.4 km (17.5 NM) off Sapelo Island, Georgia, and is the only natural area protected off the Georgia coast.

Gray's Reef is popular for recreational fishing and diving because of its "live bottom habitat" that supports an unusual assemblage of organisms and temperate and tropical marine flora and fauna that attach to the rocky platform. The area is characterized by a series of rock ledges and sand expanses that have created deep burrows, troughs, and caves that attract an array of different species including black sea bass, snapper, grouper, and mackerel. Since the reef lies in a transition area between temperate and tropical waters, the composition of fish population changes seasonally. Dominant invertebrates that inhabit the area include sponges, barnacles, sea fans, hard coral, crabs, lobsters, and snails. The area supports endangered and threatened species such as loggerhead turtles, which are present year-round. The reef is also part of the only known winter calving grounds for the North Atlantic right whale (NMSP, 2007c).

Sport fishing and diving occurs year-round at Gray's Reef. However, certain types of equipment are restricted in the area such as wire fish traps, bottom trawls, and explosives. Commercial fishing, military activities, mineral extraction, and ocean dumping is restricted. Also, prohibited in the area is any alteration of the seabed including removal or damage to bottom formations and other natural or cultural resources and disposal of materials or substances (NMSP, 2007c).

3.13.1.1 Atlantic Ocean, Offshore of the Northeastern United States

Stellwagen Bank is located on the eastern edge of Massachusetts Bay, which lies between Cape Ann and Cape Cod, in the southwest corner of the Gulf of Maine. The bank is a characterized as shallow sandy feature that extends for nearly 31 km (16 NM) and is approximately 10 km (5 NM) across at is widest point. It is the bay's most prominent feature and the centerpiece of the Stellwagen Bank National Marine Sanctuary.

As a result of the 1992 reauthorization and amendment to Title III of the Marine Protection, Research and Sanctuaries Act (MPRSA), the Stellwagen Bank National Marine Sanctuary was established. Stellwagen Bank is New England's first sanctuary and the nation's twelfth. The sanctuary encompasses a total of 1,182.3 km (638 NM) and occurs entirely within federal waters. Stellwagen Bank was designated for a national marine sanctuary for a variety of reasons but one of the most notable reasons is the two distinct peak productivity periods that produce a complex system of midwater and benthic habitats. The area provides cover and anchoring locations for invertebrates and also provides feeding and nursery grounds for other types of species, particularly a variety of endangered species such as leatherback and Kemp's ridley sea turtles, and the humpback, right, sei, and fin whales (NMSP, 2007f). The abundant variety of species supports a variety of activities including whale watching, bird watching, boating, and commercial and sport fishing.

Another important feature of the Stellwagen Bank National Marine Sanctuary is the presence of nearly 50 shipwrecks. Major shipping lanes to Boston go through the sanctuary creating a constant flow of large vessel traffic. However, a shift in the shipping lanes took effect on 1 July 2007. The International Maritime Organization approved a 12-degree northward adjustment in shipping lanes through the sanctuary in order to reduce the threat of ship strikes to endangered whales in the sanctuary. The relocation will avoid popular right whale, fin, and humpback whales feeding grounds and is expected to reduce the risk of ship strikes to right whales by 58 percent and up to 81 percent for all other large whale species (NMSP, 2007g).

The NOAA's office of Law Enforcement, the U.S. Coast Guard, and the Massachusetts Environmental Police are responsible for enforcing federal laws in the sanctuary. Recreational fishing, whale watching, and diving are regulated activities in the sanctuary. There is no permit required for fishing; however, regulations govern the number of species, and types of species caught. There are three sanctuary specific regulations for diving, which include no alteration to seabed, no transportation of a historical resource, and no possession of a historical or natural resource (NMSP, 2007g).

3.13.1.2 Eastern Gulf of Mexico

The Florida Keys are located on the southern tip of the Florida peninsula and extend from the southern end of Key Biscayne to 144.8 km (78 NM) north of Cuba. Adjacent to and nearly 9.7 km (5.2 NM) seaward of the 202.8 km (126 mi) of the archipelago, lies the most extensive and only living coral reef in North America. The coral reef is a complex marine ecosystem that supports a unique and diverse biological community.

The Florida Keys National Marine Sanctuary (FKNMS) was designated in 1990 due to concerns for the health of the coral reefs. The FKNMS encompasses 9,500 km^2 (2,800 NM^2), which surrounds the entire chain of islands and includes the Florida Bay, the Gulf of Mexico, and the Atlantic Ocean (NMSP, 2007a).

There are sanctuary-wide regulations as well as regulations by zone. Sanctuary-wide regulations focus on reducing direct and indirect threats to the reef by focusing on protecting critical habitats and resources and improving water quality. The zones in the sanctuary include the Western Sambo Ecological Reserve (ER), 18 Sanctuary Preservation Areas (SPA), 27 Wildlife Management Areas (WMA), 4 Special Use Areas, and existing management areas (NMSP, 2007a).

3.13.1.3 Western Gulf of Mexico

The Flower Garden Banks National Marine Sanctuary is located in the northwestern Gulf of Mexico nearly 177 km (96 NM) off the coast of Texas and Louisiana and harbors the northernmost coral reefs in the United States. The area serves as a regional reservoir of shallow water Caribbean reef fish and invertebrate, making it one of the premier diving destinations around the world.

Designated in 1992, the sanctuary serves to protect the coral reef ecosystem and its associated biological communities from increasing human activities such as oil and gas exploration. The sanctuary is made up of three separate areas, known as East Flower Garden, West Flower Garden, and Stetson Banks. The total area of the sanctuary is approximately 145.7 km^2 (42.4 NM^2 or 36,000 acres) and supports nearly 280 different documented fish species, loggerhead and hawksbill sea turtles, and a variety of shark and ray species (NMSP, 2007b).

The Flower Garden Banks National Marine Sanctuary is internationally recognized as a no-anchoring area, which minimizes damage from commercial shipping. The area is also protected by mooring buoys that prevent anchor damage to the habitats. Other activities that are regulated in the area include discharges, taking of marine mammals and sea turtles, injury or possession of sanctuary resources, and fishing and related activities (NMSP, 2007b).

3.14 AIRSPACE MANAGEMENT

Airspace management is defined as the direction, control, and handling of flight operations in the volume of air that overlies the geopolitical borders of the United States and its territories. Airspace is a resource managed by the Federal Aviation Administration (FAA), which has established policies, designations, and flight rules to protect aircraft in the airfield and en route environment, in Special Use Airspace (SUA) identified for military and other governmental activities, and other military training airspace.

The management of airspace considers how airspace is designated, used, and administered to best accommodate the individual and common needs of military, commercial, and general aviation. Because of these multiple and sometimes competing demands, the FAA considers all aviation airspace requirements in relation to airport operations, Federal Airways, Jet Routes, military flight training activities, and other special needs to determine how the National Airspace System can best be structured to satisfy all user requirements.

3.14.1 Description of Airspace Types

The FAA has designated four types of airspace above the United States: controlled, uncontrolled, special use, and other. A description of each type of airspace is as follows:

- *Controlled airspace* is categorized into five separate classes: Class A, B, C, D, and E airspace. These classes identify airspace that is controlled, airspace supporting airport operations, and designated airways affording en route transit from place-to-place. The classes also dictate pilot qualification requirements, rules of flight that must be followed, and the type of equipment necessary to operate within that airspace.
- *Uncontrolled* airspace is designated Class G airspace and has no specific prohibitions associated with its use. Class G airspace includes all airspace not otherwise designated as A, B, C, D, or E. Operations within Class G airspace are governed by the principle of "see and avoid."
- *Special Use Airspace* is designated airspace in which flight activities are conducted that require confinement of participating aircraft or that place operating limitations on nonparticipating aircraft. Restricted Areas, Military Operating Areas, and Warning Areas are examples of SUA. Warning Areas may contain hazards to nonparticipating aircraft in international airspace. Warning Areas are established beyond the 5.6 km (3 NM) limit. Since the U.S. territorial limit was extended to 22.2 km (12 NM) in 1988, Special Federal Aviation Regulation 53 establishes certain regulatory Warning Areas within the new 5.6 to 22.2 km (3 to 12 NM) territorial airspace to allow continuation of military activities while further regulatory requirements are determined.
- *Other airspace* consists of advisory areas, areas that have specific flight limitations or designated prohibitions, areas designated for parachute jump operations, Military Training Routes, and Aerial Refueling Tracks. This category also includes Air Traffic

Control Assigned Airspace (ATCAA). When not required for other needs, ATCAA is airspace authorized for military use by the managing Air Route Traffic Control Center (ARTCC), usually to extend the vertical boundary of SUA.

3.14.2 Occurrence of Airspace

AFAST activities involving flight operations will generally occur in special use Warning Areas, which are plotted on aeronautical charts so all pilots are aware of their location and the potential for military flight training in the respective airspace. The airspace between and adjacent to the Warning Areas is designated as ATCAA. The FAA ARTCCs are responsible for air traffic flow control or management within this airspace transition. There are currently 22 ARTCCs in the United States (FAA, 2007). Within the AFAST Study Area, ARTCCs are located in New Hampshire, Virginia, and Florida (FAA, 2007).

The following sections describe the management of the Warning Areas within the AFAST Study Area.

3.14.2.1 Atlantic Ocean, Offshore of the Southeastern United States

The VACAPES OPAREA is a major area of military usage. The DoD has used the area extensively for military and National Aeronautics and Space Administration (NASA) training, testing, and ordnance and rocket firing exercises. The Fleet Air Control Surveillance Facility (FACSFAC) VACAPES provides fleet surveillance and functional area support services that include scheduling, monitoring, and controlling air traffic from just south of Nantucket Island, Massachusetts, to Charleston, South Carolina, and eastward more than 371 km (200 NM) into the Atlantic Ocean. The FACSFAC VACAPES reports to the Commander, Fleet Forces Command, via the Commander, Naval Air Forces Atlantic.

NASA's Goddard Space Flight Center, Wallops Flight Facility, is located on Wallops Island, Virginia. Launch activities can occur at the facility Monday through Friday, 6:00 AM to 6:00 PM (NASA, 2007a; 2007b). The Wallops Restricted Area (R-6604) connects Wallops with the Mid-Atlantic Test Range Warning Area. Because of their location, air traffic is minimal; however, when a mission requires additional airspace, NASA will coordinate with FACSFAC VACAPES (NASA, 2007b).

The CHPT OPAREA overlaps Warning Area 122 (W-122). This area is designated as SUA, which is managed by FACSFAC VACAPES.

The JAX OPAREA overlaps W-157, W-158, and W-159. These areas are designated as SUA, which is managed by FACSFAC JAX. FACSFAC JAX has responsibility for the OPAREA and Warning Areas from Charleston, South Carolina, to Daytona Beach, Florida, and is a subordinate command of Commander, Naval Air Force, U.S. Atlantic Fleet. The FACSFAC JAX is assigned additional duties by Commander, Navy Region Southeast.

The CHASN OPAREA overlaps W-132, W-133, W-134, W-74, W-161, and W-177. These areas are designated as SUA and are managed by FACSFAC JAX.

3.14.2.2 Atlantic Ocean, Offshore of the Northeastern United States

The Narragansett Bay OPAREA overlaps W-105 and W-106. Both of these Warning Areas are designated as SUA. The airspace is managed by FACSFAC VACAPES.

3.14.2.3 Eastern Gulf of Mexico

FACSFAC Pensacola, which is a branch of the Air Traffic Control Facility at Pensacola Naval Air Station (NAS), is responsible for scheduling, coordinating, and monitoring airspace near W-155 and five ATCAAs adjacent to W-155. However, W-151, where torpedo exercises (TORPEX) activities will occur, is scheduled through the 46th Test Wing at Eglin AFB, Florida. FACSFAC Pensacola is responsible for coordinating naval airspace requests with Eglin AFB.

3.14.2.4 Western Gulf of Mexico

W-228, located off the coast of Corpus Christi NAS in Texas, supports the Chief of Naval Air Training, units of the Texas Air National Guard, and NASA aircraft from the Johnson Space Center. However, W-228 is primarily used for student pilot and navigator training. To emphasize the training mission, the airspace is considered “exclusive.” Use of W-228 is augmented by use of Alert Area 632A. A-632A is not “exclusive” and not restricted on nonparticipants; however, the designation of this airspace allows nonparticipating pilots to recognize the high density aircraft, oftentimes engaged in training operations. NAS Corpus Christi coordinates military usage of the area.

3.15 ENERGY (WATER, WIND, OIL, AND GAS)

3.15.1 Water Energy

Although the potential advantages for development in water energy have been recognized for many years dating back to the late 1700s, the industry has only recently begun to advance. Scientists have concluded that only 0.2 percent of ocean energy could supply power to the world, yet the potential remains significantly undeveloped (Renewable Energy, 2007). Three types of ocean-wind energy exist: tidal, wave, and ocean thermal energy conversion.

Tidal energy requires extreme differences in tidal states while thermal conversion requires tropical weather. Therefore, these two developments are limited primarily to Maine and Alaska, where great differences in tides occur, and to Hawaii and the U.S. Atlantic Southeast, both of which possess a more tropical climate (California Energy Commission, 2007). Wave energy has a more general, universal application and has the possibility to generate up to 40 times more power than windmills with similar gear. Water possesses 1,000 times more energy density as compared with wind (Davidson, 2007; Pernick, 2005). Therefore, the required equipment and the potentially associated construction costs would be smaller than wind farms.

Wave-generated energy would be underwater or just above the ocean’s surface (Pernick, 2005). Unlike wind and solar energy, waves, tides, and currents provide predictable and dependable potential sources (Andrews and Jelley, 2007). The types of equipment developed for ocean energy exploration range from buoys that convert bobbing of the waves into high-pressure flow to rotating turbines coupled with generators that turn the motion into energy. Some designs such as the more complex turbine require anchors or other attachment methods to the sea floor while others such as the buoys drift passively in the ocean (Pernick, 2005).

The first large-scale wave-generated project was established in Scotland off the Island of Islay in November 2000. The Land Installed Marine Powered Energy Transformer (LIMPET) generates approximately 500 kilowatt (kW) of energy, which is sufficient to support 400 homes (Environment News Service [ENS], 2000). Other countries that have recently tapped into this potential energy source include nations with long coastlines such as Great Britain and Australia (Andrews and Jelley, 2007).

The Federal Energy Regulatory Commission (FERC) has permitted 19 preliminary sites to study the potential of underwater turbine energy. Most of the areas are located off of Florida, San Francisco, California, and the Olympic peninsula in Washington state. Various companies are seeking permits for approximately 35 sites to study the potential for water-generated energy over a 36 month period (Burnham, 2007).

Studies have estimated that the amount of energy available in U.S. ocean waters is 9 to 10 times the potential generated by all hydroelectric dams. The potential generation of energy from coastal and ocean waters in the United States is higher on the west coast where waves are greater (Pernick, 2005).

3.15.1.1 Atlantic Ocean, Offshore of the Southeastern United States

The Gulf Stream has been identified as an area where water movement could provide advantageous conditions for the development of offshore water energy. Current and projected future developments in the southeastern United States include the development and improvement of infrastructure offshore of Dania Beach, Florida, near Fort Lauderdale by Ocean Renewable Power Company (ORPC), Limited Liability Company (LLC) (ORPC, 2007). A submersible platform is being designed and built for support of the required equipment and will be anchored by an underwater mooring system. The platform and module to harness the power will be installed off Dania Beach, Florida, at the western edge of the Florida Current (ORPC, 2007). Once the 12 month monitoring period has concluded, the system will be improved and final design and installation will take place. This refinement will allow for future developments in deep waters. Additional sites have been identified in Miami, Florida, and West Palm Beach, Florida (ORPC, 2007). All of these sites are located outside of the AFAST Study Area. There are currently no proposed ocean energy activities within the Study Area.

3.15.1.2 Atlantic Ocean, Offshore of the Northeastern United States

Western Passage Project Adjacent to Eastport, Maine ORPC and the city of Eastport, Maine entered into a Memorandum of Understanding (MOU) to develop two tidal energy sites off the city's coast. This area, known as the Western Passage, was determined to have high tidal power potential. The system proposed is similar to the Dania Beach, Florida, infrastructure, which was described previously. ORPC has submitted the applications for preliminary permits to the FERC. A plan has been initiated to connect to the electrical grid in Maine (OPRC, 2007). OPRC is coordinating more studies to find additional sites with potential for tidal power in the state.

A number of sites have been proposed by a handful of companies as potential areas where waves and tides could be harnessed for energy generation. These locations include Piscataqua River (between Maine and New Hampshire); Merrimack River, Massachusetts; Amesbury, Massachusetts; and Indian River Inlet, Delaware. These sites are in various stages of preliminary test development and have been submitted for consideration by the FERC in the permitting process.

3.15.1.3 Eastern Gulf of Mexico

There are currently no proposed wave or tidal energy activities in this area.

3.15.1.4 Western Gulf of Mexico

There are currently no proposed wave or tidal energy activities in this area.

3.15.2 Wind-Based Energy

Wind, when harvested by wind turbines, can be used to generate electricity (Energy Information Administration, 2007). Private financial and investment firms supported the first wind farms, which U.S. aerospace and construction companies built in California in the early 1980s. Since then, installed capacity (or, how much power installed wind projects produce) has grown fivefold. Today, U.S. wind energy installations produce enough electricity on a typical day to power the equivalent of over 2.5 million homes (Department of Energy [DOE], 2007a). Overall, however, wind-based electricity represents a small percentage of the total electric capacity (or the maximum amount of energy that can be produced, measured in kilowatts).

In 1986 Pacific Northwest Laboratory estimated wind resources for the DOE. This assessment identified areas that were potentially suitable for wind energy applications. These areas were classified as having poor, marginal, fair, good, excellent, or outstanding wind resource potential (Elliott et al., 1986). Wind resource potential is linked to regions with topographic indicators (surface features) such as exposed coastal sites with strong upper-air winds or strong thermal/pressure gradients. In general, the assessment identified the exposed northeastern coastal areas from Maine to North Carolina and the Texas coastal area as having wind resource potential (Elliott et al., 1986).

3.15.2.1 Atlantic Ocean, Offshore of the Southeastern United States

Due to the relative flatness of the southeastern U.S. coastal plain from Florida to South Carolina, little potential exists to use wind as an energy source (Elliot et al., 1986). However, based on some of the more mountainous terrain of North Carolina and Virginia, some wind resource potential exists within these two states (Elliot et al., 1986). Winergy Power LLC (Winergy), a company that develops offshore wind energy, proposed the construction of 271 windmills offshore of Eastern Virginia in 2003. Since that time, the company has reduced the project significantly to encompass only 10 turbines after NASA and the Navy objected to the proposed locations and environmentalists objected to the potential effects to migratory birds and waterfowl (Virginia Department of Environmental Quality, 2007). Subsequently, Winergy has abandoned this proposal, and no other wind proposals exist for the state of Virginia waters. However, new research suggests that wind resources along the mid-Atlantic coast could provide a significant amount of energy to over nine states in the eastern United States; as such, the possibility for future construction of offshore windmills in this area exists (University of Delaware, 2007).

3.15.2.2 Atlantic Ocean, Offshore of the Northeastern United States

The wind resource potential along the coastal areas of the northeastern United States is categorized as good to outstanding. Specifically, good wind resource potential encompasses the exposed coastal areas and offshore islands and outstanding wind resource potential includes the outer capes and islands, including Cape Cod and Nantucket Island (Elliot et al., 1986). Based on these characteristics, three proposals have been made to develop wind energy in the northeast. They include projects in Buzzards Bay (located in the state waters of Massachusetts); Nantucket Sound (located in the territorial waters offshore of Massachusetts); and Long Island Sound (located in the territorial waters offshore of New York). Of these projects, MMS would regulate the Nantucket and Long Island projects while the State of Massachusetts would regulate the Buzzards Bay wind farm. Each of these projects is currently undergoing project evaluation and environmental analysis (Patriot Renewables, 2006; MMS, 2007d, 2007e).

3.15.2.3 Eastern Gulf of Mexico

The coastal areas around Florida have a marginal wind resource potential as with the rest of the eastern and central Gulf of Mexico states (Elliot et al., 1986). This is most likely due to the relative flatness of the region. Based on these characteristics, no companies have included the eastern and central gulf in proposals for future wind generation projects.

3.15.2.4 Western Gulf of Mexico

The Texas coast in the Gulf of Mexico is estimated to have a fair wind resource potential (Elliot et al., 1986). Given this potential and the support in communities for the energy industry in general, two companies have proposed offshore wind farm projects in waters offshore of the Texas coast. They include a 150 MW wind farm located about 11 km (5.9 NM) off of Galveston Island, Texas and a 500 MW wind farm located between 4 and 13 km (2.2 and 7 NM) off the coast of Padre Island (DOE, 2005; Texas General Land Office [TGLO], 2005; Washington Post, 2006). MMS would regulate the proposal submitted by Galveston-Offshore Wind, LLC, while the State of Texas would regulate the proposal submitted by Superior Renewable Energy, LLC. The 30-year lease at the Galveston site would include 50 turbines over approximately 46 km^2 (18 mi^2). This site would produce electricity equivalent to the amount of energy produced by 20.7 million barrels of oil (TGLO, 2005). The wind farm off of Padre Island is expected to have more than 100 turbines over 161 km^2 (62 mi^2) and would generate the energy equivalent to burning 69 million barrels of oil. An EIS for this particular project is currently being developed (Washington Post, 2006).

3.15.3 Oil and Gas Exploration

The MMS recently completed an assessment of the crude oil, natural gas liquids, and natural gas resources of the outer continental shelf. The assessment reflects data and information available as of 1 January 2003 (MMS, 2006c). The amounts in Table 3-20 reflect the average of the 95 percent and 5 percent probability of the estimated amounts being present. The table presents undiscovered technically recoverable resources (UTRRs), which is oil and/or gas that can be produced as a consequence of natural pressure, artificial lift, pressure maintenance, or other secondary recovery methods. UTRRs do not consider economic viability. In addition, the table presents undiscovered economically recoverable resources (UERRs), which is the portion of the undiscovered conventionally recoverable resources that is economically recoverable under imposed economic and technologic conditions. Table 3-20 presents three discrete oil/gas price pairs.

Table 3-20. Undiscovered Technically and Economically Recoverable Resources of Outer Continental Shelf Planning Areas

Region	UTRR		UERR					
	Oil (Bbo)	Gas (Tcfg)	$46/Bbl $6.96/Mcf		$60/Bbl $9.07/Mcf		$80/Bbl $12.10/Mcf	
			Oil (Bbo)	Gas (Tcfg)	Oil (Bbo)	Gas (Tcfg)	Oil (Bbo)	Gas (Tcfg)
Northeastern Atlantic Coast	1.91	17.99	1.15	6.91	1.32	8.65	1.45	10.32
Southeastern Atlantic Coast	1.91	18.99	1.08	6.79	1.24	8.64	1.39	10.43
Western Gulf of Mexico	10.70	66.25	8.69	51.86	9.25	56.47	9.71	59.87
Eastern Gulf of Mexico	34.2	166.28	27.08	110.96	28.93	128.3	30.49	141.67

Source: MMS, 2006d
Bbl = barrel; Bbo = billion barrels of oil; Mcf = thousand cubic feet; Tcfg = trillion cubic feet of gas; UERR = undiscovered economically recoverable resources; UTRR = undiscovered technically recoverable resources

3.15.4 Proposed Final Program for the Outer Continental Shelf Oil and Gas Leasing Program 2007-2012

The MMS developed a Proposed Final Program for the Outer Continental Shelf Oil and Gas Leasing Program 2007-2012. The outer continental shelf is the submerged lands ranging anywhere from 4.8 to 321.9 km (2.6 to 173.7 NM) seaward of the state coastline.

The Proposed Final Program was prepared in accordance with the Outer Continental Shelf Lands Act, which requires the preparation of an oil and gas leasing program indicating a five-year schedule of lease sales designed to best meet the nation's energy needs. The Proposed Final Program is the first in a series of leasing proposals developed for public review before the Secretary of the Interior can take final action to approve the new five-year program for 2007-2012 (MMS, 2007h). The current five-year program ended on 30 June 2007. A summary of options proposed for the East Coast and Gulf of Mexico are provided below.

3.15.4.1 Atlantic Ocean, Offshore of the Southeastern United States

Four sales have been held between 1978 and 1983, and there were six exploratory wells drilled in the southern Atlantic (South Carolina, Georgia, and Florida) area, with no commercial discoveries. There are no existing leases, and this area has been under annual congressional restrictions since 1990 and will be under presidential withdrawal through 2012 (MMS, 2006e).

Three options are presented in the Proposed Final Program for the coastline of Virginia. The first option involves one special interest sale (in 2011), including a 40 km (22 NM) buffer and a no-obstruction zone from the mouth of the Chesapeake Bay off the coastline of Virginia. The second option invoves one special interest sale (in 2011), but with a 80 km (43 NM) buffer and a no-obstruction zone from the mouth of the Chesapeake Bay off the coastline of Virginia. The third option was considered a no sale (MMS, 2007h). The Draft Proposed Program is not proposing any area along the South Carolina, Georgia, or Florida coastlines for leasing consideration.

3.15.4.2 Atlantic Ocean, Offshore of the Northeastern United States

One lease sale was held in 1979, and there were eight exploratory wells drilled with no commercial discoveries. There are no existing leases, and this area has been under annual congressional restrictions since 1984 and will be under presidential withdrawal through June 2012 (MMS, 2007h). The Proposed Final Program is not proposing any area along the Atlantic Ocean for leasing consideration.

3.15.4.3 Gulf of Mexico

There are three planning areas in the Gulf of Mexico Region: Western, Central, and Eastern Gulf of Mexico. The Western and Central areas constitute the most active areas of the outer continental shelf program. The majority of the Eastern Gulf Planning Area is currently under presidential withdrawal and is subject to annual congressional moratoria, with the exception of the area identified as Sale 181. Much of the Sale 181 area is now in the Central Gulf Planning Area (MMS, 2007h).

3.15.4.4 Eastern and Central Gulf of Mexico

The Gulf of Mexico Energy Security Act of 2006 opened 2,347.2 km^2 (684.3 NM^2; 580,000 acres) of the Eastern Gulf of Mexico Planning Area (Figure 3-4) for oil and gas leasing (MMS, 2006e). Specifically, the Act mandated leasing options for two areas: the Eastern Gulf of Mexico Planning Area and the Central Gulf of Mexico Planning Area. The Eastern Gulf of Mexico Planning Area allows for oil and gas leasing in two areas: "181 Area," which comprises 8,093.7 km^2 (2,359.7 NM^2; 2 million acres) in the Central Gulf of Mexico Planning Area and approximately 2,347.2 km^2 (684.3 NM^2; 580,000 acres) in the Eastern Gulf of Mexico Planning Area. The second area, "181 South Area," is located in the Central Gulf of Mexico Planning Area south of the "181 Area" and is approximately 23,471.8 km^2 (6,843.3 NM^2; 5.8 million acres). These leasing opportunities are located west of the Military Mission Line. The military practices aerial maneuvers and bombing trials east of the Military Mission Line (National Ocean Industry Association [NOIA], 2006). The Central Gulf of Mexico portion of the 181 Area will be available for lease in Sale 205 scheduled for early fall of 2007 (MMS, 2006e).

3.15.4.5 Western Gulf of Mexico

One option discussed in the 2007 Final Proposed Program would continue the policy of holding area-wide annual sales in one of the two areas with the most resources and highest values. Two whole and portions of other blocks within the boundary of the Flower Garden Banks National Marine Sanctuary are excluded from the area available for leasing (MMS, 2007h).

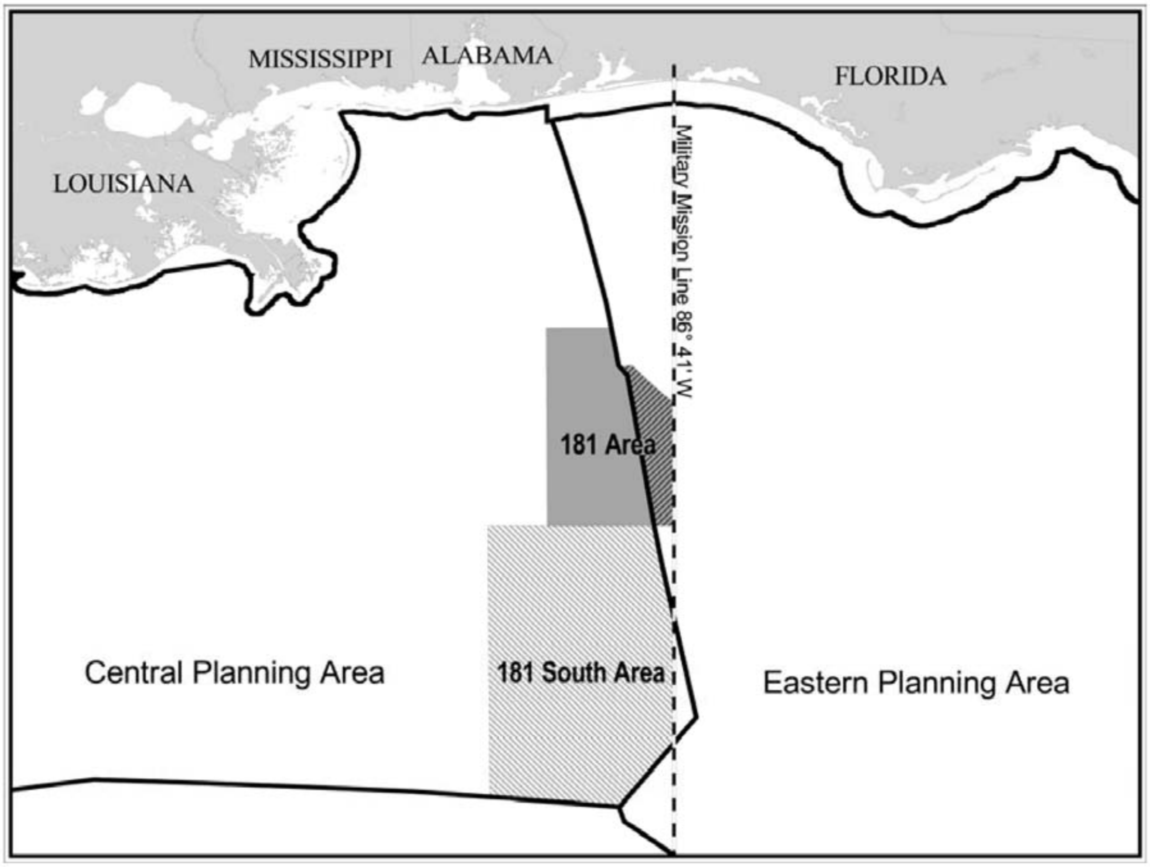

Figure 3-4. Eastern Gulf of Mexico Planning Area
Source: MMS, 2006d

3.16 RECREATIONAL BOATING

3.16.1 Atlantic Ocean, Offshore of the Southeastern United States

Recreational activities offshore of Virginia's coast are primarily composed of game and sport fishing, charter boat fishing, sport diving, whale watching, sailing, power cruising, and other recreational boating activities. Five artificial reefs are located offshore of the Virginia coast. Three of these offshore artificial reefs (Blackfish Bank, Parramore Reef, and Wachapreague Reef) are located north of the mouth of Chesapeake Bay (DON, 2005).

The waters and coastal areas around the CHPT Range Complex are popular for sport fishing, diving, shipwreck exploration, and other recreational activities (e.g., boating or kayaking). Navy operations and recreational ocean activities have coexisted in the Navy Cherry Point Range Complex for decades. The Navy's public safety and mitigation measures, such as advance notification of scheduled activities, minimize inconveniences to public interests and help ensure the continued safe and cooperative coexistence (DON, 2007b).

The primary recreational activities along the east coast of Florida include game and sport fishing, charter boat fishing, sport diving, sailing, power cruising, and other recreational boating activities. Recreational fishing and other recreational boats travel throughout the coastal waters and during all four seasons. Many sites that are known as fishing hotspots attract divers. Fishing hotspots and other dive sites (including artificial reefs, coral patches, and shipwrecks) are used throughout the year by recreational vessels and commercial chartered boats, but use is highest during the summer.

3.16.2 Atlantic Ocean, Offshore of the Northeastern United States

Within the northeastern AFAST Study Area, recreational boating activities mainly include game and sport fishing, charter boat fishing, sport diving, whale watching, sailing, power cruising, and of other such recreational boating activities. Boating off the northeastern Atlantic coast takes place from Maine to Maryland. Many sites that are known as fishing hotspots attract divers. These fishing hotspots and other dive sites (including artificial reefs and shipwrecks) are used throughout the year by recreational vessels, but use is highest during the summer. Most recreational boating occurs within a few miles of shore, while U.S. naval operations normally occur far offshore. The Navy would typically conduct these exercises in federal waters not in inshore state waters near recreational boaters.

3.16.3 Eastern Gulf of Mexico

Recreational boating activities in the eastern Gulf of Mexico are primarily associated with sport fishing, charter boat fishing, sport diving, sailing, power cruising, and other recreational boating activities. Recreational fishing boats and other recreational boats range throughout coastal waters in the northeast Gulf of Mexico, depending on the season and weather conditions. Most recreational fishing and boating occurs within a few miles of shore, with boats generally returning to the point of departure. Fishing charters and recreational fishing boats pursuing sport fishing opportunities in deeper water can be expected to traverse the eastern Gulf of Mexico. Fishing parties may also enter the eastern Gulf of Mexico to fish at artificial reefs. Numerous artificial reefs have been established along the coast of the northeastern Gulf, many of them at considerable distances from shore (DON, 2007d).

3.16.4 Western Gulf of Mexico

The 590.6 km (367 mi) of Texas Gulf Coast shoreline, along with the 5,310.8 km (2,867.6 NM) of bay-estuary-lagoon shoreline, make the coastal region a popular place for a variety of recreational activities including boating, fishing, and bird watching. Approximately 621,000 boats were registered in Texas in 2005, placing the state fifth in the country (Texas Parks and Wildlife Department [TPWD], 2006b).

3.17 COMMERCIAL AND RECREATIONAL FISHING

3.17.1 Commercial Fishing

Data were collected on commercial fisheries landings, fishing gear used, fishing effort, and known fishing hotspots.

3.17.1.1 Atlantic Ocean, Offshore of the Southeastern United States

3.17.1.1.1 Landings

Between 1996 and 2006, the commercial landings of food and baitfish in the southeast, measured by weight, averaged about 323.3 million kg (712.8 million lb). Commercial landings peaked in 1996 at almost 424.9.4 million kg (936.8 million lb). The lowest landings occurred 10 years later in 2006, when commercial fisherman landed about 244.9 million kg (539.9 million lb) of finfish and shellfish (NMFS, 2007h).

The dollar values of the landings averaged approximately $304 million over the decade. The total values ranged from a low of about $258 million in 2006 to a high of over $338 million in 2000. Landings by weight decreased by more than 42 percent over the decade, and on average, landings by value decreased by 20 percent (NMFS, 2007h).

During 2006, Virginia, North Carolina, and Florida were the top three states in terms of overall commercial landings by weight and total value of commercial landings in the southeast. Commercial landings in Virginia accounted for nearly 79 percent of the total commercial landings measured by weight in the southeast, followed by North Carolina accounting for nearly 13 percent, and Florida accounting for nearly 5 percent. In terms of total value of commercial landings in the southeast, Virginia accounted for 43 percent, North Carolina accounted for 28 percent, and Florida accounted for 16 percent (NMFS, 2007h).

Atlantic menhaden was the dominant species by weight in the southeast, and blue crab was the second most dominant species. With landings of about 169.2 million kg (373 million lb), Atlantic menhaden comprised 69 percent of the total landings in the southeast in 2006. Blue crab comprised 11 percent of the total landing, with landings of approximately 57 million pounds (NMFS, 2007i).

By weight, over 51 percent of the landings in the southeast in 2006 were from state waters; approximately 49 percent were from federal waters. However, by value, landings from state waters accounted for 47 percent of the total value of the southeast marine fisheries, whereas landings from federal waters amounted to 53 percent (NMFS, 2007j).

Finfish dominated the catches in southeast state waters in 2006, representing approximately 73 percent of the catch by weight. Shellfish comprised just over 27 percent of the catch. However, in terms of value, finfish accounted for approximately 32 percent, and shellfish comprised over 68 percent of the total value of the landings in southeast state waters (NMFS, 2007j).

Similar to state waters, the majority of the catch in federal waters by weight was finfish, and shellfish accounted for a larger share of the value of the southeast Commercial fishery landings. By weight, 93 percent of the landings from federal waters were finfish, and 7 percent were shellfish. However, when measured by value, shellfish accounted for over 56 percent of the total landings, while finfish accounted for nearly 44 percent (NMFS, 2007j).

3.17.1.1.2 Fishing Gear and Fishing Effort

Purse seines were the principal gear used to harvest marine fishery resources (including menhaden) in the southeast during 2006. They accounted for nearly 68 percent of the total commercial landings for the southeast in pounds and eight percent of the total value of all commercial landings in the southeast. Otter trawls were also highly used, and landings caught by all types of otter trawls (i.e., crab, fish, scallop, and shrimp) combined accounted for over 21 percent of the total value of all commercial landings in the southeast (NMFS, 2007k).

3.17.1.2 Atlantic Ocean, Offshore of the Northeastern United States

3.17.1.2.1 Landings

Between 1996 and 2006, the commercial landings of food and baitfish in the Northeast, measured by weight, averaged over 419 million kg (924 million lb). Commercial landings peaked in 2004 at over 450 million kg (992 million lb). The lowest landings occurred four years before the peak, when commercial fisherman landed about 386 million kg (850 million lb) of finfish and shellfish (NMFS, 2007h).

The dollar values of the landings averaged almost $953 million over the decade. Total values ranged from a low of over $786 million in 1998, to a high of over $1,256 million seven years later in 2005. Although landings by weight decreased by 3 percent over the entire decade, total value of landings increased by almost 50 percent (NMFS, 2007h).

Atlantic herring was the dominant species by weight in the northeast area, and Atlantic mackerel was the second most dominant species. With landings of over 93 million kg (206 million lb), Atlantic herring comprised almost 22 percent of the total landings in this area in 2006. Atlantic mackerel comprised over 13 percent of the total landings, with a commercial catch amount of approximately 57 million kg (125 million lb) (NMFS, 2007i).

By weight, about 34 percent of the landings along the northeast Atlantic coast in 2006 were from state waters; approximately 67 percent were from federal waters. However, by value, landings from state waters and federal waters were closer by percentage, with 47 percent of the total value of the northeast marine fisheries coming from state waters, whereas landings from federal waters amounted to approximately 53 percent (NMFS, 2007j).

In 2006 shellfish dominated the catches, by weight, in state waters of the northeastern OPAREAs, representing approximately 58 percent. Finfish comprised nearly 42 percent of the catch. In terms of value, finfish accounted for only 8 percent, and shellfish comprised approximately 92 percent of the total value of the landings in northeast state waters (NMFS, 2007j).

The majority of the catch in federal waters, by weight, was finfish at about 71 percent, while shellfish represented 29 percent. However, shellfish accounted for 71 percent of the total value of landings in federal waters, whereas finfish accounted for over 29 percent of the value of landings here (NMFS, 2007j).

3.17.1.2.2 Fishing Gear and Fishing Effort

Trawls were the principal gear used to harvest marine fishery resources in the northeast during 2006. Commercial operations use trawls to catch various types of species on the bottom and in the middle of the water column; those species include the following: northeast groundfish, monk fish, skates, spiny dog fish, clams, Atlantic herring, American lobster, northern shrimp, and winter trawl. Trawls accounted for nearly 47 percent of the total commercial landings (in pounds) for the region and 14 percent of the total value of all commercial landings (NMFS, 2007k). Dredges and pots/traps were also highly used, and those landings caught by all types of dredges combined and by pots/traps accounted for over 32 percent and 35 percent of the total value of all commercial landings, respectively (NMFS 2007k).

3.17.1.3 Eastern Gulf of Mexico

3.17.1.3.1 Landings

Between 1996 and 2006, the commercial landings of food and baitfish off the eastern Gulf of Mexico measured, by weight, averaged about 142 million kg (313 million lb). Commercial landings ranged between a high of nearly 172 million kg (382 million lb) in 1999 to a low of approximately 119 million kg (262 million lb) seven years later in 2005 (NMFS, 2007h).

The total value of all commercial landings off the eastern Gulf of Mexico averaged about $237 million. over the decade. Values ranged from a high of $280 million in 2000 to a low of approximately $199 million in 2005. Landings by weight increased 15 percent over the decade, however total value of landings decreased by nearly 8 percent (NMFS, 2007h).

Menhaden was the dominant species of commercial landings by weight in 2006, accounting for close to 65 percent of the total landings in the eastern Gulf of Mexico, landing over 96 million kg (211 million lbs). Shrimp species, such as brown, pink, white, and rock shrimp, were the second most dominant species landing around 44 million kg (50 million lbs), representing approximately 15 percent by weight of the total landings (NMFS, 2007i).

By weight, 82 percent of the landings in the eastern Gulf of Mexico were from state waters; approximately 18 percent were from federal waters. Landings from state waters also accounted for 53 percent of the total value of the marine fisheries in the eastern Gulf of Mexico. The total value of landings from federal waters amounted to more than 47 percent (NMFS, 2007j).

In 2006, finfish dominated the catches in state waters in the eastern Gulf of Mexico, representing approximately 86 percent of the landings by weight. Shellfish comprised just 14 percent of the catch. Although there were more finfish landings in state waters according to weight, shellfish accounted for the majority of the value. Shellfish accounted for over 83 percent of the total value of the landings in state waters in the eastern Gulf of Mexico, while finfish only accounted for 17 percent (NMFS, 2007j).

Shellfish represented the majority of the catch in federal waters. By weight, 58 percent of the landings from federal waters were shellfish, and 42 percent were finfish. Shellfish also comprised the majority of the landings by value, with 65 percent, while finfish accounted for the remaining 35 percent (NMFS, 2007j).

3.17.1.3.2 Fishing Gear and Fishing Effort

Purse seines for catching menhaden were the principal gear in the eastern Gulf of Mexico during 2006. They accounted for nearly 65 percent of the commercial landings by weight for the eastern Gulf of Mexico region, but only four percent of the total value of commercial landings. Otter trawls were second, accounting for over 15 percent of the commercial landings by weight and 38 percent of the total value of the landings. Pots and traps were also highly used, while only accounting for over five percent of the commercial landings by weight, they accounted for over 16 percent of the total value of commercial landings in the eastern Gulf of Mexico region (NMFS, 2007k)

3.17.1.4 Western Gulf of Mexico

3.17.1.4.1 Landings

The total commercial landings in the western Gulf of Mexico between 1996 and 2006, measured by weight, averaged 583 million kg (1,286 million lb). Commercial landings ranged from a high of 730 million kg (1,609 million lbs) in 1999, to a low of 423 million kg (932 million lbs) seven years later in 2005 (NMFS, 2007h).

The total value of all commercial landings in the western Gulf of Mexico averaged about $506 million over the decade. Values ranged from a high of $710 million in 2000 to a low of approximately $423 million in 2005. Landings by weight decreased 1 percent over the decade, and total value of landings decreased by only 1 percent (NMFS, 2007h).

Menhaden was the dominant species of commercial landings by weight in 2006, accounting for over 67 percent of the total landings in the western Gulf of Mexico, landing nearly 313 million kg (690 million lbs). White shrimp were the second most dominant species landing close to 54 million kg (119 million lbs), representing approximately 12 percent by weight of the total landings (NMFS, 2007i).

By weight, 44 percent of the landings in the western Gulf of Mexico were from state waters; approximately 56 percent were from federal waters. However, landings from state waters accounted for 55 percent of the total value of the marine fisheries in the western Gulf of Mexico, whereas, the total value of landings from federal waters amounted to nearly 45 percent (NMFS, 2007j).

In 2006, finfish dominated the catches in state waters in the western Gulf of Mexico, representing over 60 percent of the landings by weight. Shellfish comprised 40 percent of the catch. Although there were more finfish landings in state waters according to weight, shellfish accounted for the majority of the value. Shellfish accounted for approximately 92 percent of the total value of the landings in state waters in the western Gulf of Mexico, while finfish only accounted for 8 percent (NMFS, 2007j).

Finfish represented the majority of the catch in federal waters. By weight, 84 percent of the landings from federal waters were finfish, and nearly 16 percent were shellfish. Although there were more finfish landings in federal waters according to weight, shellfish accounted for the majority of the value. Shellfish accounted for 77 percent of the total value of commercial landings in federal waters in the western Gulf of Mexico, while finfish accounted for the remaining 23 percent (NMFS, 2007j).

3.17.1.4.2 Fishing Gear and Fishing Effort

Otter trawls were the principal gear used in the western Gulf of Mexico during 2006. They accounted for 18 percent of commercial landings by weight for the western Gulf of Mexico and over 55 percent of the total value. Pots and traps were second, accounting for over five percent of commercial landings by weight, and over seven percent of the total value of commercial landings in the western Gulf of Mexico. Dredges were also used, while accounting for only one percent of commercial landings by weight, they accounted for eight percent of the total value of commercial landings in the western Gulf of Mexico (NMFS 2007k).

3.17.2 Recreational Fishing

This section provides baseline recreational fishing information for areas located within the AFAST Study Area. Nationwide, recreational saltwater fishing generated over $30 billion in sales in 2000, nearly $12.0 billion in income, and supported nearly 350,000 jobs (Steinbeck et al., 2004).

3.17.2.1 Atlantic Ocean, Offshore of the Southeastern United States

Sportfishing has long been one of America’s most popular recreational activities. Participation in the sport, nationwide, has grown nearly 10 percent in five years. In 2006, there were 13 million saltwater fishermen, 89 million fishing trips, 475 million fish caught, and 55 percent of fish caught were released. Florida is the most popular fishing state followed by North Carolina. Florida had more 6.7 million anglers and 29.3 million number of trips in 2006 while North Carolina had 2.2 million anglers.

3.17.2.1.1 Landings

Marine recreational catch off the coast of the southeastern United States, by weight, averaged approximately 111 million pound per year between 1996 and 2006. Recreational catch reached a period low of nearly 77 million in 1996 and a period high of almost 132 million in 2006 (NMFS, 2007h).

The majority of catches were from state waters followed by catches in federal waters and lastly, state territorial seas. Striped bass and Atlantic croaker were the most popular catch, according by weight, reported in state and state territorial waters in the southeast region. Other popular species included spots, bluefish, dolphin, black sea bass, and other tunas and mackerels.

3.17.2.1.2 Fishing Effort

The total number of anglers who participated in recreational marine fishing in the southeastern Atlantic regions in 2006 reached over 5.7 million. The total number of trips to state territorial seas, state waters, and federal waters combined totaled over 44 million trips in 2006, an increase of 7 percent from 2001. The majority of trips were made to state waters.

3.17.2.1.3 Tournaments in the Southeastern OPAREAs

Various organizations host recreational fishing tournaments throughout the year along the southeastern Atlantic coast from Virginia to Florida. The majority of tournaments take place during the weekends (Friday through Sunday) or from the middle of the week through the weekend (Wednesday to Sunday). The majority of fishing takes place at hotspots like canyons and humps. Along the Virginia coast, many of the same canyons (Washington Canyon, Poor Man's Canyon, Massey's Canyon, 26 Mile Hill, the Hot Dog, the Lumps, Lumpy Bottom, and the Boomerang) mentioned in the northeastern United States section below apply to Virginia. Other canyons that are fished but not mentioned in the northeastern United States section include Norfolk Canyon, 100 Fathom Curve, 30 Fathom Lumps, Cigar Hill, 21 Mile Hill, and the Parking Lot. Off the coast of North Carolina, South Carolina, Georgia, and some of Florida, such areas as Edisto Banks, Georgetown Hole, Sow Pen, the Deli, the Deep Water Wreck, Triple Ledge, the South Ledge, and the South Hump, are fished for the mentioned species. Similar to the northeastern Atlantic coast, species fished include blue fin tuna, yellow fin tuna, wahoo, dolphin, big eye tuna, white marlin, and blue marlin. All of these species are found in the above hotspots and are best fished during the spring and summer months. Fishing methods include trolling, still fishing, casting, drifting, and chunking.

A majority of the fishing tournaments that occur along the southeastern Atlantic coast last for a few days in the months of April, May, and June through August, with some occurring in September and October and continuing into December and January. The six biggest tournaments of the southeastern Atlantic coast occur off the coast of Florida. These tournaments include 70th Silver Sailfish Derby in Palm Beach, Florida; Pelican Yacht Club 27th Annual Invitational Billfish Tournament in Fort Pierce, Florida; Palm Beach Sailfish Classic in Palm Beach Shores, Florida; 35th Annual Bluewater Tournament in St. Augustine, Florida; Halifax Sport Fishing Club Billfish Blowout in Ponce Inlet, Florida; and Halifax Sport Fishing Club 19th Annual Offshore Lady Anglers Tournament in Ponce Inlet, Florida. These events occur Wednesday to Saturday, Tuesday to Saturday, Tuesday to Saturday, Sunday to Saturday, Friday to Saturday, and Friday to Sunday, respectively.

3.17.2.2 Atlantic Ocean, Offshore of the Northeastern United States

For the purposes of this study, seven states including: Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, New Jersey, and New York are considered part of the northeastern United States. Within these areas comprise Narragansett Bay Complex, Boston Complex, and the Atlantic City OPAREA. Within the vicinity of these OPAREAS, New Jersey and New York ranked as the third and fifth most popular saltwater fishing states in 2006, respectively. Recreational fishing in New York and New Jersey combined totaled more than $1.5 billion in economic output in 2001.

3.17.2.2.1 Landings

Marine recreational catch off the coast of the northeastern United States, by weight, averaged approximately 35.4 million kg (78 million lb) per year between 1995 and 2005. During the 10-year period, recreational catch reached a low of 22.2 million kg (49 million lb) in 1998 and a high of 42.1 million kg (92.8 million lb) in 2000.

Reported recreational catches in the state waters, state territorial seas, and federal waters in the northeast fluctuated between 1995 and 2005 but had an overall increase of 8 percent during the period. The majority of catches were from state waters that accounted for more than half of all recreational catch. Striped bass were the most prevalent recreational catch, according by weight, in state and state territorial waters off the coast of the Atlantic in the northeastern area in 2005. Striped bass catch totaled over 5.44 million kg (12 million lb) and accounted for over 15 percent of the total reported marine recreational catch in that year. The Atlantic cod was the most caught species in federal waters and accounted for only 3.5 percent of the total recreational catch in 2005.

3.17.2.2.2 Fishing Effort

The total number of anglers who participated in recreational marine fishing in the northeastern Atlantic in 2006 reached over 3.6 million. The total number of trips to state territorial seas, state waters, and federal waters combined totaled over 29 million trips in 2006, an increase of 4 percent from 2001. The majority of those trips were made to state waters.

3.17.2.2.3 Tournaments in the Northeastern OPAREAs

Recreational fishing tournaments occur throughout the year from Maine to New Jersey along the northeastern Atlantic coast. A large proportion of the activities take place during the weekend, beginning on Friday and ending on Saturday or Sunday. However, longer tournaments, which comprise the majority of the activities along the northeastern Atlantic coast, begin either Wednesday or Thursday and/or extend through the following Monday or Tuesday. The majority of fishing takes place at hotspots along canyons and humps, including such places as Baltimore Canyon, Poor Man's Canyon, Washington Canyon, the Hot Dog, Lumpy Bottom, the Lumps, Massey's Canyon, and the Boomerang. Species that are fished include blue fin tuna, yellow fin tuna, wahoo, dolphin, big eye tuna, white marlin, and blue marlin. All of these species are found in the above hotspots and are best fished during the summer months. Fishing methods include trolling, still fishing, casting, drifting, and chunking.

Most fishing tournaments in this area last for a few days in the months of June to August, but some extend to September and even into October. Tournaments include the following: 20th Annual Ocean City Tuna Tournament in Ocean City, Maryland; Mid-Atlantic $500,000 Tournament at South Jersey Marina in Cape May, New Jersey; 7th Annual Giant Blue Fin Invitational Tournament at Hyannis Marina in Cape Cod, Massachusetts; and 7th Annual Sturdivant Island Tuna Tournament at Spring Point Marina in South Portland, Maine. These activities occur Wednesday to Sunday, Sunday to Friday, Thursday to Sunday, and Thursday to Saturday, respectively.

3.17.2.3 Eastern Gulf of Mexico (Florida)

Saltwater sportfishing in Florida provided a total economic output of more than $5.4 billion in 2001. Retail sales amounted to almost $3 billion, while the sport supported over 59,000 jobs and over $1.4 billion in wages and salaries. The total federal income taxes from saltwater fishing amounted to over $239.7 million (ASA, 2007a). Florida has been ranked the top state by overall economic output (ASA, 2007b), and moreover, has been ranked the top fishing destination among nonresidents. Over 1 million nonresident anglers provide more than $1.5 billion of the state's total economic output (ASA, 2007b).

3.17.2.3.1 Landings

The marine recreational catch in the Eastern Gulf of Mexico, averaged 44.7 million kg (98.6 million lb) per year between 1995 and 2005 in state territorial seas, state waters, and federal waters combined. During that period, catches reached a low in 2005 with about 34.2 million kg (75.4 million lb), a decrease from the high of nearly 46.86 million kg (103.3 million lb) caught in 1997.

Reported catch in state territorial seas, state waters, and federal waters have declined since 1995. In state territorial seas, catch declined by the largest amount, with a 35 percent decrease in pounds between 1995 and 2005, while catch declined by 10 percent in state waters and 32 percent in federal waters, by total weight (NMFS, 2007c).

Spotted sea trout represent the majority of species caught, according to weight, by marine recreational anglers in 2005 within state territorial seas and state waters. The spotted sea trout accounted for approximately 16 percent of catch in state waters, by weight, and 18 percent of catch in state territorial seas. The most caught species in federal waters was the mycteroperca grouper, a type of sea bass, which comprised nearly 24 percent of all catch in federal waters (NMFS, 2007c).

3.17.2.3.2 Fishing Effort

The total number of anglers who participated in recreational marine fishing in the eastern Gulf of Mexico in 2005 reached over 2.46 million, an increase of approximately 8 percent from 2000 estimates. The total number of trips to state territorial seas, state waters, and federal waters, combined, averaged over 15.7 million trips over the five-year period (2000-2005). The majority of those trips made were to state waters (NMFS, 2007c).

3.17.2.3.3 Tournaments

The three major fishing tournaments held each year in the eastern Gulf of Mexico include the following: Mobile Big Game Fishing Club Memorial Day Tournament in Orange Beach, Alabama; Bay Point Billfish Invitational Tournament in Panama City, Florida; and Orange Beach Billfish Classic in Orange Beach, Alabama. These events occur from Friday to Monday and from Friday to Sunday, respectively, and participants target popular fishing locations. The majority of fishing takes place on artificial reefs and at hotspots like canyons and humps. Species fished include blue fin tuna, yellow fin tuna, wahoo, dolphin, big eye tuna, white marlin, and blue marlin. All of these species are found along hotspots, artificial reefs, and open ocean during the summer months. The fishing tournaments mentioned above last for a few days in the months of May, June, July, and August. Fishing methods include trolling, still fishing, casting, drifting, and chunking.

3.17.2.4 Western Gulf of Mexico

Saltwater sportfishing in Texas provided a total economic output of more than $1.3 billion in 2001. Retail sales amounted to over $600 million, while the sport supported over 13,000 jobs and over $339.3 million in wages and salaries. Total federal income taxes from saltwater fishing amounted to over $55.6 million (ASA, 2007a). Texas has been ranked in the top states by overall economic output (ASA, 2007b).

3.17.2.4.1 Fishing Effort

Between 2000 and 2001, recreational anglers in Texas caught 2.5 million fish in the Gulf of Mexico. The American Sportfishing Association estimates the total economic value of recreational fishing in the Gulf of Mexico at $8 billion per year, while other estimates suggest the economic value of commercial fishing is only $692 million. However, this figure for commercial fishing does not include the value of the commercial fishing industry's total economic contribution such as employment and revenue generated from businesses, whereas estimates for recreational fishing generally do include these economic values (Staats, 2003). The daily recreational fishing effort and anglers' estimated willingness-to-pay (WTP) along the Gulf Coast states was highest in west Florida and lowest in Texas (Lynch and Harrington, 2003). The WTP is a measure often used to estimate the value of a resource that does not have a monetary value attached.

Recreational fishing occurs offshore of Port Isabel, Texas, in the vicinity of the OPAREA (Green et al., 2002). The species fished for include red snapper (*Lutjanus campechanus*), king mackerel (*Scomberomorus cavalla*), dolphin (*Coryphaena hippurus*), yellowfin tuna (*Thunnus albacares*), blackfin tuna (*Thunnus atlanticus*), cobia (*Rachycentron canadum*), wahoo (*Acanthocybium solanderi*), shark (various species), amberjack (*Serioloa dumerili*) and vermilion snapper (*Rhomboplites aurorubens*).

3.17.2.4.2 Tournaments

Major fishing tournaments in the western Gulf of Mexico occur from Venice, Louisiana, to South Padre Island, Texas. The majority of the events in the region generally run from the middle of the week through the weekend (Wednesday through Sunday). The majority of fishing takes place on artificial reefs and at hotspots like canyons and humps. Similar to the eastern and central Gulf of Mexico, species fished in the western Gulf of Mexico include blue fin tuna, yellowfin tuna, wahoo, dolphin, big eye tuna, white marlin, and blue marlin. These species can be found along hotspots, artificial reefs, and the open ocean during summer months. Fishing methods include trolling, still fishing, casting, drifting, and chunking.

Four major fishing tournaments are known to occur in this area: Texas Legends Billfish Tournament in Port Arkansas, Texas; Texas International Fishing Tournament in South Padre Island, Texas; Cajun Canyons Billfish Classic in Venice, Louisiana; and Houston Invitational Billfish Tournament in Galveston Yacht Basin, Texas. These activities occur Thursday to Sunday, Wednesday to Sunday, Thursday to Sunday, and Thursday to Saturday, respectively.

3.18 COMMERCIAL SHIPPING

3.18.1 Atlantic Ocean, Offshore of the Southeastern United States

The waters off the U.S. Atlantic coast support a large volume of maritime traffic heading to and from foreign ports, as well as traveling north and south to various U.S. ports. Commercial shipping makes up a large portion of this traffic, and a number of commercial ports are located along the southeastern U.S. coast.

The VACAPES OPAREA is in the direct path of commercial ship traffic traveling between the major ports of New York and Boston along the northeastern seaboard and Miami and other ports in the southeast (Figure 3-5). There are several major shipping lanes in the VACAPES OPAREA. Most of the lanes are oriented roughly parallel to the coastline, but two major lanes split into two additional lanes once they are beyond the shore. It is very likely that commercial ship traffic would be present in nearly all parts of the OPAREA, with the exception of the southeastern-most section.

The CHPT OPAREA is in the direct path of commercial ship traffic traveling between the major ports of New York and Boston along the northeastern seaboard and Miami and other ports in the southeast (Figure 3-5). There are seven major shipping lanes in the CHPT OPAREA. Most of the lanes are oriented roughly parallel to the coastline, but several branch off the main routes. It is very likely that commercial ship traffic would be found in nearly all parts of the OPAREA.

The JAX/CHASN OPAREA is in the direct path of commercial ship traffic traveling between the major ports of New York and Boston along the northeastern seaboard and Miami and other ports in the southeast (Figure 3-5). Nearshore shipping lanes aid ocean-going vessels in avoiding navigational conflicts and collisions in areas leading into and out of major ports. Offshore, there are no designated shipping lanes; vessels generally follow routes determined by their destination, depth requirements, and weather conditions.

3.18.2 Atlantic Ocean, Offshore of the Northeastern United States

As shown in Figure 3-5, the northwestern Atlantic Ocean has some of the busiest shipping lanes in the world, and a large volume of ship traffic transits the Study Area. Maritime traffic includes ships traveling within New England and mid-Atlantic ports in the United States as well as traffic to eastern Canada and the eastern Atlantic Ocean. Commercial (domestic and international) shipping constitutes the vast majority of this traffic. One primary shipping lane in the Study Area is off northern New England with many arteries leading to ports in Massachusetts, New Hampshire, and Maine. The majority of the eastern portion of the Boston OPAREA is free from commercial traffic, but commercial traffic can be expected in the western part of the OPAREA. Several primary shipping lanes crisscross the Narragansett Bay OPAREA, leading to the major ports of New York City, New York, and Newark, New Jersey, as well as Providence, Rhode Island. Similarly, the Atlantic City OPAREA contains several primary shipping lanes leading from New York City and Newark to ports in Delaware Bay and the mid-Atlantic United States. It is, therefore, highly likely that commercial ship traffic will be encountered throughout the greater part of all the northeastern OPAREAs.

Some of the largest ports in the United States are found in the vicinity of the northeastern OPAREAs. The port complex of New York City/Newark is ranked third in the United States, while New England’s largest port, Boston, is ranked twenty-second in the United States, as determined by the Port Import/Export Reporting Service. The port complex of New York City/Newark has more scheduled services to a wider variety of trade lanes than any other port in North America. This port complex is the leading container volume gateway on the east coast. Since Halifax, Canada, is closer to northern Europe than any other major North American port, the complex is frequently used as the first inbound port or last outbound port in North America. The Boston port is rapidly becoming one of the fastest growing high-end cruise ship markets in the country.

The major U.S. ports are governed by Traffic Separation Schemes established by the U.S. Coast Guard and the U.S. Department of Transportation according to 33 CFR Chapter 1 Part 167. These channels, with specific latitude/longitude coordinates, direct incoming and outgoing traffic into different lanes for safe negotiation into U.S. ports. These schemes also provide Precautionary Areas where the direction of traffic is recommended. In Canada, the Canadian Traffic Separation Scheme was altered in 2003 to accommodate right whale critical habitat. Traffic was shifted east to avoid areas of right whale high density in the Bay of Fundy. In July 2007, the east-west leg of the Boston Traffic Separation Scheme was shifted approximately 12 degrees north to redirect shipping traffic through the Stellwagen Bank National Marine Sanctuary from an area of high whale density to an area of significantly lower whale density.

3.18.3 Eastern Gulf of Mexico

Major commercial shipping ports in the northeast Gulf of Mexico include Mobile, Alabama, and Tampa, Florida (Figure 3-6). Based on year 2,000 gross-tonnage data, these ports are respectively the thirteenth and seventeenth largest in the United States (USACE, 2004b). Lesser ports in the region include Charlotte, Panama City, Pensacola, and Port Manatee, all in Florida. Significant vessel traffic entering and leaving these ports crosses the Gulf to other U.S. and foreign ports.

A major shipping route traverses the eastern Gulf of Mexico, extending from the Port of New Orleans and passing to the south of the Florida Keys. The ports of New Orleans, Louisiana, and Houston, Texas, are two of the busiest shipping ports in the United States. Seven of the 10 largest ports in the United States, based on gross tonnage for the year 2000, are situated on the Gulf of Mexico (USACE, 2004b).

3.18.4 Western Gulf of Mexico

As the largest maritime state, Texas receives major economic benefits from its ports. There are 14 deepwater ports along the Gulf Coast with access to both the Pacific and Atlantic Oceans and served by the Gulf Intracoastal Waterway system (Figure 3-6). Houston is the busiest port in Texas, followed by Beaumont, Corpus Christi, and Texas City. Houston is ranked among the top three ports of the United States The Port of Houston is also second to the Port of South Louisiana, which is the largest volume shipping port in the Western Hemisphere and fourth largest in the world (USACE, 2004a). Houston ranked first in the nation in total foreign tonnage handled, second in total tonnage in the United States, and tenth busiest in the world (Port of Houston Authority, 2006). In 2005, approximately 200 million tons of cargo moved through the port (Port of Houston Authority, 2006). Petroleum and petroleum products compose a large portion of shipments destined for other parts of the country. Two major railroads and 150 trucking lines connect the port to various parts of the United States, Canada, and Mexico.

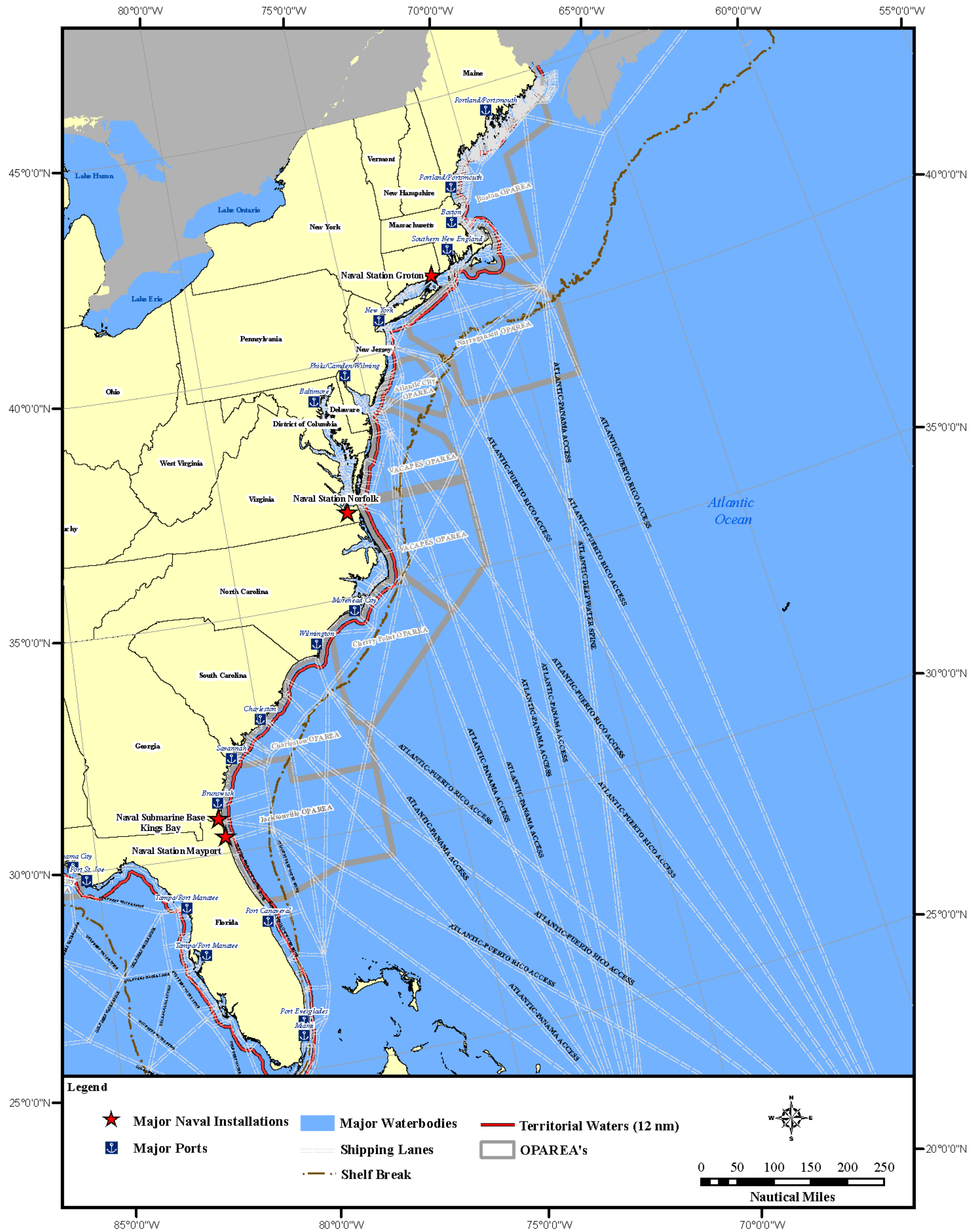

Figure 3-5. Atlantic Shipping Routes

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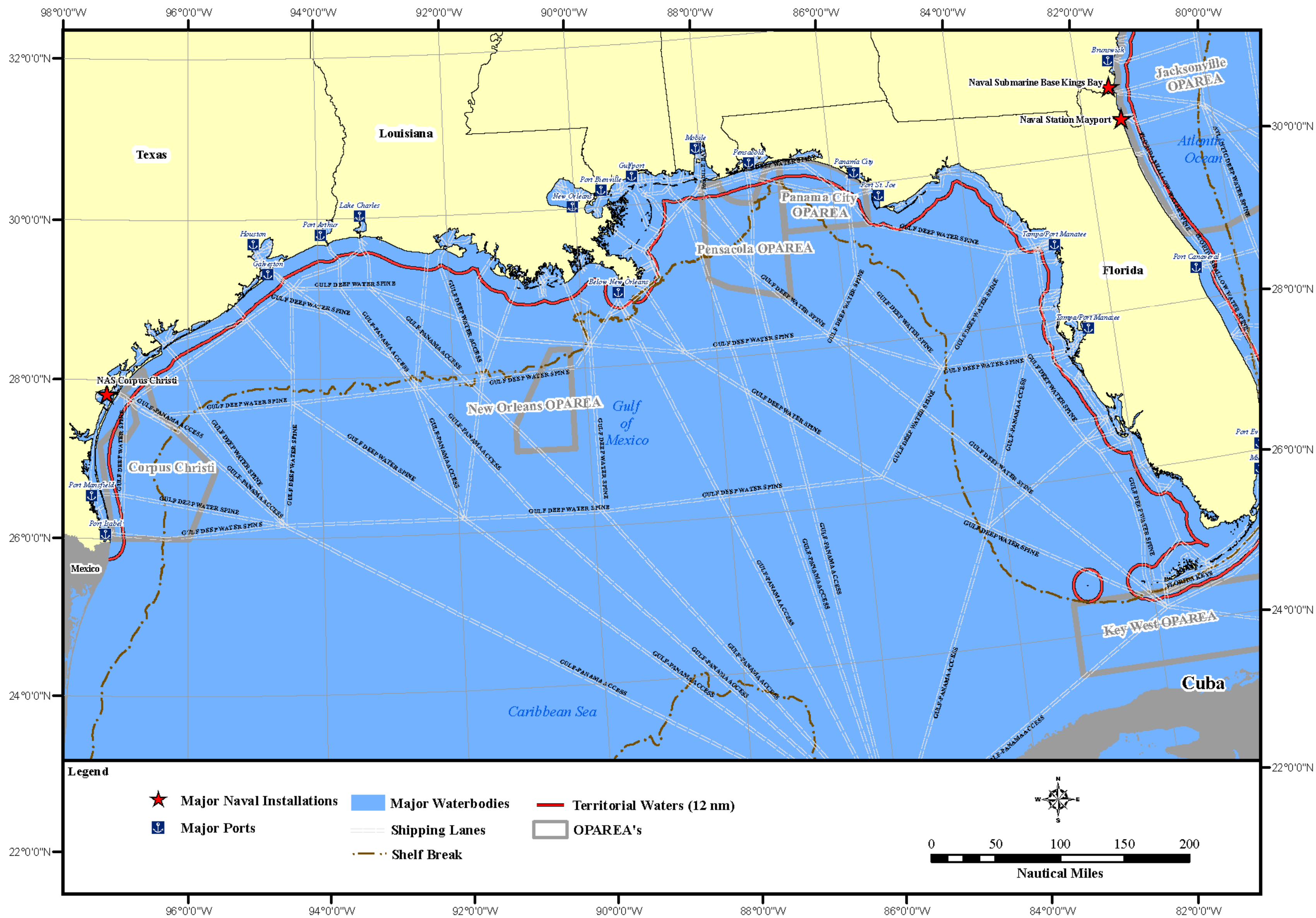

Figure 3-6. Gulf of Mexico Shipping Routes

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3.19 SCUBA DIVING

3.19.1 Atlantic Ocean, Offshore of the Southeastern United States

Five artificial reefs are located in the ocean off the Virginia coast and support offshore sport fishing and recreational diving. Three of these offshore artificial reefs—Blackfish Bank, Parramore Reef, and Wachapreague Reef—are located north of the mouth of Chesapeake Bay. Although recreational fishing and other recreational boats range throughout the Virginia and Maryland coastal waters, most recreational diving occurs within a few miles of shore.

Scuba diving and snorkeling are popular recreational activities along the entire coastline. The CHPT OPAREA and North Carolina, with its warm Gulf Stream waters and preponderance of shipwrecks, provides ideal diving locations. Although diving occurs year-round, it varies in intensity with season (i.e., there are more diver trips in summer than in winter). There are 47 named diving spots; all are located within 40 km (22 NM) of shore.

Scuba diving and snorkeling are popular year-round recreational activities in the southeastern United States. In the winter, the warmer waters of the southeast make for a more pleasant diving experience than colder, more northerly waters (e.g., those off the coasts of Virginia and Maryland). Most recreational scuba diving occurs at points of interest (such as shipwrecks, reefs, and marine sanctuaries) usually close to shore in less than 60 m (197 ft) of water.

3.19.2 Atlantic Ocean, Offshore of the Northeastern United States

The area within and adjacent to the northeastern OPAREAs contains a number of sites popular with scuba divers and snorkelers. A variety of natural and artificial habitats offer diverse types of experiences. Of the many sites frequented by recreational divers in the area, very few are natural. Unlike dive sites in the Caribbean Sea that are associated with coral reefs, dive sites in this area are typically associated with artificial habitats (i.e., human-made submerged structures that are colonized by or attract organisms). These structures range widely in size and type and are composed of a wide variety of materials.

Recreational diving in New England is focused mainly on wreck diving. Hundreds of ship wrecks are in the northeastern OPAREAs Study Area, many of which are accessible by divers. Another focus of scuba divers is on artificial reefs not formed by wrecks. These are composed of sunken tanks, tires, and other expended materials.

Spearfishing is a popular activity by recreational divers in these areas as well. Recreational divers can access dive sites by boat or by entering the water directly from the beach. For the recreational diver, there are many opportunities in the Study Area for dives of less than 39.6 m (130 ft). Many popular dive sites can be found right along the coast of Massachusetts and are accessible from the beach or by boat. New Jersey has many diving opportunities ranging from wreck dives to artificial reefs. Even in the colder waters of Maine and Nova Scotia, recreational diving is still a popular activity.

3.19.3 Eastern Gulf of Mexico

The area within and adjacent to the Gulf of Mexico contains many sites popular with scuba divers and snorkelers. Many of the favored dive sites are wrecks and artificial reefs. There are close to 300 named dive sites off Florida from the Florida Keys to Pensacola. The vast majority of these sites are located within 40 km (21.7 NM) of shore and can be explored year-round. Most of the many sites frequented by divers in the eastern Gulf of Mexico are artificial reefs. A modest number of these artificial reefs are shipwrecks; many of these are quite old, with little of the structure remaining.

3.19.4 Western Gulf of Mexico

Most recreational diving in Gulf of Mexico waters off Texas occurs at the Flower Garden Banks National Marine Sanctuary, or NMS. The Flower Garden Banks was designated as an NMS in 1992 as a result of the combined efforts of recreational divers and researchers and is one of 13 NMSs managed by NOAA (NOAA, 2006a).

There are three separate areas of the Flower Garden Banks NMS: East Flower Garden, West Flower Garden, and Stetson Banks. The Flower Gardens are some of the most unique areas in the Gulf of Mexico because they contain the northernmost coral reefs in the United States. Together, the East and West Flower Gardens are composed of nearly 1.4 km^2 (0.4 NM^2) of coral reef. There have been at least 280 different species of fish documented within the sanctuary as well as loggerhead turtles and 20 species of sharks and rays (NOAA, 2006a). The variety of species living in this unique habitat allows the area to be used for a diverse number of activities including recreational diving and recreational and commercial fishing. Recreational divers are the most frequent and largest users of the sanctuary. The area is visited by nearly 3,000 divers a year, and this number is expected to increase as the area is consistently rated as a favorite spot for dives in North America (NOAA, 2006a).

The Flower Garden Banks is also a prime location for oil and gas production. An estimated 150 production platforms are located within 40.2 km (21.7 NM) of the sanctuary and serve as an artificial reef that provides a habitat for an array of different species and an attractive spot for recreational divers (NOAA, 2006a). Hiett and Milon (2002) estimated that the market value for diving at artificial reefs created by oil and gas structures in the Gulf of Mexico was $119 per person per day. Meanwhile, Ditton and Baker (1999) found the market value estimates for diving at various types of artificial reefs in Texas totaled $184.68 for residents and $193.80 for nonresidents (Pendleton, 2004). These estimates do not include nonmarket values. Based on two types of contingent valuation methods of estimates for diving, the nonmarket value of various types of artificial reefs in Texas ranges from $44.46 to $74.93 per person per day.

The preferred diving depth for most dive charters is 21.3 to 30.5 m (70 to 100 ft) (Pendleton, 2004). The Texas Parks and Wildlife Department reef sites off Galveston, Port Aransas, and Freeport are reported as the most popular destinations for boat captains. These areas are visited most frequently in the summer months (June through August) and visited less frequently in the spring (Pendleton, 2004).

3.20 MARINE MAMMAL WATCHING

Marine mammal watching, often referred to as whale watching, includes any cetacean species such as dolphins, whales, and porpoises. Tours are conducted by boat, aircraft, or from land. This type of marine tourism includes any of these activities, formal or informal, that possesses at least some commercial component whereby consumers view, swim with, or listen to any of these approximately 83 cetacean species (Hoyt, 2001). Hoyt (2001) has conducted the most recent, comprehensive survey of the whale-watching industry in the past decade. His findings show that whale watching is growing at a rapid pace worldwide. Between 1991 and 1998, an increase on average of 12.1 percent per year has been realized internationally, with a mean of 13.6 percent per year from 1994 to 1998. Compared to these worldwide figures, the whale-watching industry in the United States has only grown at a pace of about 7.8 percent from the period of 1994 to 1998. During the last year comprehensively surveyed, approximately 4.3 million people participated in the industry, contributing nearly $357 million dollars in sales to operators of whale-watching tours (Hoyt, 2001).

Of the whale watches operating in the AFAST EIS/OEIS Study Area, New England has the greatest number of businesses (36) and sales ($1.24 million). New England ranks fourth in whale watching by operator numbers and economics in the United States and follows the states of Alaska, California, and Hawaii. At the time of this comprehensive study (Hoyt, 2001), whale watching occurred in 22 communities in New England. The majority of operations occurred within Massachusetts where 17 operators were conducting whale watching out of popular ports such as Gloucester, Provincetown, Boston, Barnstable, and Plymouth. The 25-year focus of whale watching on the Stellwagen Bank area has contributed to its popularity and helped to establish the current NMS there. Table 3-21 provides an overview of the statistics by state in New England. The most commonly viewed whales in the New England portion of the AFAST Study Area includes humpback whales, fin whales, right whales, minke whales, sei whales, and Atlantic white-sided dolphins (Whale Center of New England [WCNE], 2007).

Table 3-21. Overview of Whale Watch Statistics by State in the New England Area

State	Number of Operators	Number of Boats	Sales (in millions)
Massachusetts	17	30 – 35	$24
New Hampshire	4	6 – 10	$1.9
Maine	14	18 – 24	$4.4
Rhode Island	1	1	$0.3

Source: Hoyt, 2001

Hoyt (2001) examined the rest of the eastern United States and Gulf of Mexico as a combined region. He found that the region ranked sixth out of seven areas in the United States behind the state of Washington. The study concluded that 25 operators bring in about $355,000 from boat-based and land-based whale watching. Concentrations of the industry are highest for the AFAST Study Area in Hilton Head Island, South Carolina; St. Petersburg, Florida; Panama City, Florida; and Jupiter, Florida. A number of single operators exist in cities extending along the entire west coast of Florida, all the way to Key West. Other noted areas for whale watches include Corpus Christi, Texas, and for educational and/or academic-related tours there are Pascagoula, Mississippi; Galveston, Texas; and Sarasota, Florida (Hoyt, 2001). Based on the distribution and abundance of the various marine mammal species and the location of these popular ports for whale watching, a number of these operators likely provide viewing opportunities primarily for the coastal and nearshore populations of dolphins, particularly Atlantic bottlenose dolphins.

3.21 CULTURAL RESOURCES AT SEA

The potential cultural resources within each of the OPAREAs include prehistoric and historic resources (shipwrecks) as well as man-made obstructions. Prehistoric resources, in depths of less than approximately 100 m (328 ft) remain and may be considered a cultural resource (or archaeological sites).

It is anticipated that these sites would be buried under sediments that have accumulated over the centuries (i.e., they would be buried well below the affected environment associated with sonar training). Thus, it is anticipated that there would be no archaeological sites in the affected environment. The following discussion of cultural resources at sea relates only to shipwrecks within the Study Area.

3.21.1 Atlantic Ocean, Offshore of the Southeastern United States

The southeastern Atlantic coast contains the VACAPES OPAREA, CHPT OPAREA, and the JAX/CHAS OPAREA.

This area lies off the Delmarva Peninsula and extends southward to Cape Hatteras, North Carolina. Numerous barrier islands run along shore of the current U.S. mainland. Assateague, Chincoteague, and Kitty Hawk are well-known for historic settlements. Trade ships ran along the barriers islands, and many were lost from either running aground or during large storms and hurricanes. The area offshore of Virginia was very active for early European exploration and settlement during the late 1500s and early 1600s, and commercial shipping was widespread during the seventeenth century (MMS, 2006g). Most known shipwrecks in the VACAPES OPAREA are located near the coast, well landward of the shelf break. Approximately 159 shipwrecks are located in the VACAPES OPAREA.

NOAA's Automated Wreck and Obstruction Information System (AWOIS) was queried to determine the best representation of the potential for shipwrecks and obstructions within and adjacent to the VACAPES OPAREA (NOAA, 2007c).

CHPT OPAREA lies solely off the North Carolina coast. It is bounded by Cape Hatteras to the north, includes Pamlico Sound, and extends to Cape Lookout point. The area includes numerous barrier islands; thus, the propensity for a high distribution of shipwrecks is likely. The Outer Banks, as this string of islands are called, jut offshore of North Carolina in a manner that would have been unanticipated in early shipping times.

The first recorded shipwreck for this area took place in 1585 when one of John White's flagships, the *Tyger*, wrecked at Ocracoke Inlet. In the more than four centuries since then, historians estimate that over 1,000 ships have been lost along coastal North Carolina, earning the treacherous waters the nickname "The Graveyard of the Atlantic." The highest concentrations of shipwrecks are in the vicinity of Cape Hatteras, where the clash of cold northern currents and the northbound Gulf Stream forms the shallows of Diamond Shoals.

Many of the recent shipwrecks that have occurred in the area are marked on various navigational charts, and some are popular dive and fishing locations. Most of these known shipwrecks in the CHPT OPAREA are located near the coast, well landward of the shelf break. Approximately 104 known shipwrecks are located within the CHPT OPAREA. Notable shipwrecks include the Civil War era ironclad *USS Monitor*, and numerous World War II-era vessels belonging to both Allied and Axis forces. In fact, the area off the coast of Look Out Shoals was referred to at the time as “Torpedo Junction” because during the beginning of World War II German submarines (U-Boats) sank many U.S. and Allied vessels.

The *USS Monitor* lies in approximately 72 m (236 ft) of water and in 1975 was designated as the first U.S. Marine Sanctuary. Currently, the sanctuary is administered by NOAA and lies 25.75 km (13.9 NM) just south of Cape Hatteras. NOAA’s AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions within and adjacent to the CHPT OPAREA (NOAA, 2007c).

The JAX/CHASN OPAREA extends from just south of Charleston, South Carolina, to Cape Canaveral, Florida, and encompasses the entire Georgia Bight. The Georgia Bight contains numerous barrier islands called the “Sea Islands” and runs the length of the coast from Charleston to Cumberland Island, Georgia, lessening as this stretch reaches Cape Canaveral. The Georgia Bight differs from the above-mentioned OPAREAS in that it has the highest tides of the southeastern United States. These tides are semi-diurnal, with an average fluctuation of 2.4 to 3.4 m (7.9 ft to 11.2 ft). Since such large volumes of water are exchanged, preservation for shipwrecks in this area remains low. However, NOAA has established a marine sanctuary, located at the 20-m (65.6-ft) bathymetry line that does encompass one archaeological (and paleontology) site.

Most of the known shipwrecks in the JAX/CHASN OPAREA are located near the coast, well landward of the shelf break. Shipwrecks in the Atlantic, off the Georgia-Florida coast, were often the result of natural causes such as severe weather. Determining spatial patterns for shipwrecks in the Atlantic has not been a very productive task. Furthermore, these patterns tend to vary due to wind strength and direction and current shears. It is clear that most deep-water shipwrecks were due to hurricanes (Garrison et al., 1989). Literature indicates that less than 2 percent of pre-twentieth century ships and less than 10 percent of all ships reported lost in the Atlantic between 1500 and 1945 have known locations (Garrison et al., 1989). Ships have been lost since the beginning of Spanish exploration until the modern age of shipping and commerce.

There are several known shipwrecks from the Civil War (1860–1865). The *CSS Georgia* and the *USS Water Witch* are two such known ships that were used to guard harbor entrances and channels. The *CSS Georgia* was a Confederate ship that sat 4.8 km (2.6 NM) south of Savannah. This ship was used to guard the city by keeping Union forces at bay (USACE, 2006). The *USS Water Witch*, which was stationed in Ossabaw Sound, was captured by Confederate forces in 1864. Excavations occur periodically on these ships. Additionally, according to NOAA records, a number of shipwrecks lie in Cumberland Sound and the channel along Kings Bay Naval Submarine Base. Some of these wrecks have been investigated; however, at present, it is not know whether any of these qualify for eligibility listing on the National Register of Historic Places—it is only known that they do exist. These are the Caroline, Raptor, Twilight, and Sparta vessels.

NOAA's AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions within and adjacent to the JAX/CHASN OPAREA (NOAA, 2007c).

3.21.2 Atlantic Ocean, Offshore of the Northeastern United States

The northeastern Atlantic coast contains the Boston OPAREA, the Narragansett OPAREA, and the Atlantic City OPAREA.

The northern portion of the MAB, Georges Bank, and the Gulf of Maine contain numerous shipwrecks. Merchantman (freighters/tankers), ships-of-war, passenger ships, submarines, and fishing vessels have been sunk, lost, or run aground. Natural activities and features have played important roles in creating submerged cultural resources; those include powerful currents, such as the Labrador Current; winds (including cold fronts); rough seas (gales, hurricanes, blizzards); coastal topography (e.g., Cape Cod and Vineyard Sound); and shallow water and sandbars (Isles of Shoals, Nantucket Shoals). Not to be omitted are wars and battles that have resulted in more than 10,000 documented shipwrecks that occurred in the Boston OPAREA, the Narragansett OPAREA, and the Atlantic City OPAREA from 1500 to 1999. The Revolutionary War and the War of 1812 contributed to numerous ship losses. Specifically, World Wars I and II used submarine warfare, which resulted in numerous cargo ships being destroyed. The approximate numbers of shipwrecks found in state waters are astronomical: Maine (1,400); Massachusetts (5,300); Rhode Island (1,200); New York (1,550); and New Jersey (2,100).

The undulating coastline and large number of coastal islands associated with Maine and Massachusetts have been a factor in the loss of many vessels. For example, 74 shipwrecks documented from 1717 to 1914 were sunk along the eastern shore of Cape Cod, from Nantucket Sound to the mouth of Cape Cod Bay. The majority of the shipwrecks off Rhode Island, New York, and New Jersey can be attributed to the heavy coastal ship traffic and the associated higher frequency of wrecks attributed to onboard fires, collisions, nautical equipment breakdowns, or being torpedoed by German submarines. Some of the well-known wrecks in the vicinity of the Study Area include the *USS Squalus* off Portsmouth, New Hampshire; the *Portland,* which sank during the "Portland Gale" in the fall of 1898 in what is now Stellwagen Bank National Marine Sanctuary; and the Italian luxury liner *Andrea Doria* (1956) and tanker *Argo Merchant* (1976), both of which sank off Nantucket Island, Massachusetts.

NOAA's AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions within and adjacent to the northeastern OPAREAs (NOAA, 2007c).

3.21.3 Eastern Gulf of Mexico

The Eastern Gulf of Mexico OPAREA contains the Key West, Panama City, and Pensacola, Florida OPAREAs. A study was performed by Coastal Environments, Inc. (1977) that mapped the locations of known shipwrecks. A literature search of both shipwrecks and reported ship losses was combined with factors that are known to affect ship loss (reefs, straits, approaches to seaports, and storms). The results were used to determine areas that may have a high probability for shipwrecks. Although this study focused on the Gulf of Mexico, it is now well-known that shipwrecks tend to be clustered around navigational hazards and port entrances. During the

1960s, the U.S. National Park Service, or NPS began to investigate shipwrecks and document their conditions and locations.

Although most historic archaeological resources in the Gulf of Mexico are shipwrecks, other types of historic sites (such as the Ship Shoal Lighthouse) exist. A literature search for reported ship losses and known shipwrecks was conducted as part of an archaeological resources baseline study for the northern Gulf of Mexico. This study indicated that less than 2 percent of pre-twentieth century ships reported lost in the Gulf, and less than 10 percent of all ships reported lost between 1500 and 1945, have known locations (110 out of 1,589). Thus, little is known about the locations of historic shipwrecks in the Gulf of Mexico (MMS, 2006g).

In 1989 Texas A&M University completed a study for the MMS and identified over 4,000 potential shipwreck locations within the Gulf of Mexico. The MMS completed another study in 2003 and identified over 2,100 potential shipwreck locations in federal waters (shipwreck sites known to lie in state waters were not included in this database) (MMS, 2006g). The location coordinates are known for only 191 of the 1,202 shipwrecks off the coast of Florida, with the majority having occurred in the last two centuries. Known shipwrecks are often marked on various navigational charts, and some are popular dive and fishing locations.

Within the Florida Keys NMS, a trail of historic shipwrecks is scattered along the treacherous coral reefs and buried in the sandy shallows a few miles off the Florida Keys. There are many reasons these ships lie broken on the bottom including an inability to accurately determine position, inaccurate charts, lack of navigational aids (lighthouses and buoys), unpredictable currents, lack of wind, storms, and human error. The nine sites on the Shipwreck Trail represent three broad periods of the Keys maritime history: European Colonial, American, and Modern. These nine shipwreck sites are the City of Washington, the Benwood, the Duane, the Eagle, the San Pedro, the Adelaide Baker, the Thunderbolt, the North America, and the Amesbury (NOAA, 2007f).

NOAA's AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions in the eastern Gulf of Mexico (NOAA, 2007c).

3.21.4 Western Gulf of Mexico

The western Gulf of Mexico contains the Corpus Christi, Texas OPAREA. As stated previously, the locations of all shipwrecks in the Gulf of Mexico are not known. However, a study was completed to determine the factors involved in the preservation of shipwrecks in the Gulf of Mexico. It was determined that, due to differences in sedimentation rates across the north-central Gulf, it is expected that preservation potential in the eastern part of this area (off Mississippi and Alabama) will be higher than the preservation potential in the western part (off Louisiana) (MMS, 2006g). However, this does not include the Texas coast, where well-known shipwrecks have been discovered and excavated within recent years.

The *Belle* is one of the most important shipwrecks ever discovered in North America. The excavation, conducted in a cofferdam in Matagorda Bay, lies just to the north of Corpus Christi, Texas. The excavation lasted almost a year and produced an amazing array of finds, including the hull of the ship, three bronze cannons, thousands of glass beads, bronze hawk bells, pottery, and even the skeleton of a crew member. The 1 million artifacts represent a kit for building a seventeenth-century European colony in the New World (Texas Historic Commission [THC], 2007). The *Belle* was one of La Salle's ships used for exploration and colonization of the region.

NOAA's AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions within the western Gulf of Mexico (NOAA, 2007c).

4. ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This chapter discusses the potential environmental effects associated with the use of active sonar technology and the improved extended echo ranging (IEER) system during Atlantic Fleet active sonar training (AFAST) activities and research, development, test, and evaluation (RDT&E) and active sonar maintenance activities. For the purposes of this document, training and RDT&E activities involving active sonar and the IEER system are collectively referred to as "active sonar activities."

Environmental resources identified and described in Chapter 3 are presented and analyzed in this chapter using the same order. However, this chapter delineates between United States (U.S.) territorial waters (shoreline to 22 kilometers [km], or 12 nautical miles [NM]) and non-territorial waters (seaward of 22 km [12 NM]) for the purposes of applying the appropriate regulation (i.e., National Environmental Policy Act of 1969 [NEPA] or Executive Order [EO] 12114) followed to analyze the potential environmental effects. Specifically, text related to *territorial waters* is printed in italic type.

Proposed mitigation measures have been developed to minimize any potential environmental effects; Chapter 5 details these measures. In addition, Chapter 6 provides an assessment of the cumulative impacts discussed here in Chapter 4.

4.2 SCIENTIFIC AND ANALYTICAL BASIS FOR DETERMINING SIGNIFICANCE

In determining the potential environmental consequences, an approach was established to differentiate between significant and nonsignificant effects. This approach involved using either documented regulatory criteria or the best scientific information available at the time of analysis. Further, the extent of significance was evaluated using the context (e.g., short- versus long-term; territorial versus non-territorial) of the Proposed Action and the intensity (severity) of the potential effect. The introductory paragraph of each subsection explains the methodology used in the respective analysis.

4.3 MARINE HABITAT

This section will analyze the potential effects to sediment quality, water quality, and existing marine debris with regards to expended components listed in Table 4-1.

4.3.1 Contaminated Sediment

This section analyzes the potential effects to sediment quality as a result of unrecovered sonobuoys, torpedo components, ADCs, and EMATTs. Scuttled sonobuoy seawater batteries on the ocean floor are expected to have negligible adverse effects to the sediments, because electrodes are largely exhausted during operations and residual constituent dissolution will occur more slowly than the releases from activated seawater batteries. In addition, corrosion and colonization of encrusting marine organisms on the sonobuoy housing would reduce leaching rates. Therefore, this section focuses on sonobuoy, ADC, and EMATT batteries, as well as Otto Fuel II (OF II) combustion byproducts. This section will not analyze XBTs since they do not have batteries and, therefore, do not have the potential to affect sediments. Other unrecovered components associated with sonobuoys, torpedoes, ADCs, and EMATTs are not analyzed since they do not contain chemicals or metals that could potentially affect sediments.

Since the bottom types within territorial and non-territorial waters along the East Coast and Gulf of Mexico are similar, potential effects were considered to be the same for all OPAREAs without regard to territorial or non-territorial waters.

4.3.1.1 Sonobuoys

AFAST activities and RDT&E activities involving scuttled sonobuoys will occur within and adjacent to all OPAREAs in the AFAST Study Area. Residual metals associated with scuttled sonobuoys on the ocean floor represent a potential source of contamination to sediments. Sediments act as a reservoir for metals that are attracted to particulate organic carbon and, as such, may be available as a source of chronic stress to the benthic community.

A recent battery study involved a comprehensive survey of 775 aquatic Aid to Navigation (AToN) sites in California. After finding only 37 stations with expended batteries, the U.S. Coast Guard selected eight locations to represent potentially impaired habitats. Ten site sediment samples and a minimum of four background sediment samples were generally collected at each AToN location. The sediment samples were collected from a depth of 0 to 10 cm (0 to 4 in) and adjacent to or within 15 m (50 ft) of each battery location. Sediments were analyzed for all metal constituents in the subject batteries. Metals were either below National Oceanic and Atmospheric Administration (NOAA) screening levels or consistent with background levels for all but two sites. At one site, copper levels were elevated; at the other site, mercury and cadmium were elevated. A repeat survey at the high-mercury site failed to detect risk-bearing concentrations. Because the statistical analysis in the sampling strategy targeted the worst-case scenario, it was determined that, while batteries may have contributed risks at these two sites, no further investigation was required. This study did yield data where lead concentrations were between the NOAA effects range low (ERL) and effects range median (ERM), but all levels of lead were less than the levels from reference AToN sites without battery power. Neither of the AToN studies included evaluations of factors that mediate risks; hence, both present very conservative assessments. Factors that are generally understood to reduce risks associated with contaminated sediments include acid-volatile sulfide concentrations and organic carbon; both act to reduce the bioavailability of metals (EPA, 2001).

An earlier battery study for mostly zinc-mercury batteries was conducted with similar findings for four separate sites. Borener and Maugham (1998) reported case study investigations for Chesapeake Bay, Tampa Bay, Tennessee River, and Puget Sound including a wide range of AtoN types and environments. The study also involved laboratory analyses (e.g., leachate rate studies). The field studies at each location included analytical data for 10 samples per AToN station, with each representing 126 m^2. Bioaccumulation data were also obtained, generally from sessile (permanently attached) organisms on the batteries.

Table 4-1. Expended Materials

Device	Description	Expended Materials	Number Expended per Year
Sonobuoys	A sonobuoy is an expendable device used for the detection of underwater acoustical energy and for conducting vertical water column temperature measurements. There are three basic types of standard range sonobuoys: passive, active, and XBTs. Sonobuoys are launched from aircraft and ships and XBTs are launched from aircraft, ships, and submarines. Following deployment, sonobuoys descend to specified depths and transmit data measurements to a surface unit via an electrical suspension cable or radio frequency signal. A float containing a wire antenna is inflated and goes to the surface from the depth at which the buoy is deployed (27 or 122 m [90 or 400 ft]). Approximately one-sixth of the buoys used would be at a depth of 122 m (400 ft), and five-sixths would be at 27 m (90 ft). The signals can be relayed from this point and depths to a receiving station located on an aircraft or ship or at a land-based communications facility. Sonobuoys are cylindrical devices about 12.5 cm (4.9 in) in diameter and 91 cm (36 in) in length, weighing from 6 to 18 kg (14 to 39 lbs). At water impact, a seawater battery activates and deployment initiates. The parachute assembly (aircraft only) is jettisoned and sinks away from the unit, while a float containing an antenna is inflated. The subsurface assembly descends to a selected depth, and the sonobuoy case falls away and sea anchors deploy to stabilize the hydrophone (underwater microphone). The operating life of the seawater battery is eight hours, after which the sonobuoy scuttles itself and sinks to the ocean bottom.	• Parachute assembly (12-18 inch diameter nylon chute) and nylon cord • Lead chloride, cuprous thiocyanate, or silver chloride batteries, Lithium batteries, or Lithium iron disulfide thermal batteries (XBT does not contain a battery) • Plastic casing • Metal clips • Nylon strap • Electrical wiring	• Listening sonobuoys: 27,500 • Tonal sonobuoys: 5,853 • Explosive source sonobuoys: 872 • Receiver sonobuoys: 308
MK–46/54 Lightweight Torpedoes	MK-46 is a deep-diving, high-speed lightweight torpedo that is launched from helicopters, fixed-wing aircraft, and surface ships. It has an OTTO II fuel propulsion system and uses active acoustic homing. The MK-54 is launched similar to the MK-46. An exercise torpedo that actually "runs" is referred to as an "EXTORP." Only about 10% of the lightweight shots would be "runners." All MK-54 shots are "runners." The remaining shots are non-running "dummy" torpedo shapes called "REXTORPs." All torpedoes are recovered. A parachute assembly for aircraft-launched torpedoes is jettisoned and sinks.	• Protective nose cover • Suspension bands • Air stabilizer • Release wire • Propeller baffle • Steel-jacketed lead ballast weights • OTTO Fuel II	• 24 Torpedoes

Table 4-1. Expended Components Cont'd

Device	Description	Expended Materials	Number Expended per Year
MK-48 Torpedo	Heavy weight exercise torpedo about 580 cm (19 ft) in length and 53 cm (21 in) in diameter.	• Guidance wire (maximum of 0.1 cm [0.04 in] in diameter and composed of a very fine thin-gauge copper-cadmium core with a polyolefin coating); Up to 28 km (15 miles [mi]) of wire is deployed during a run • Flex hose (76 m [250 ft] long) • OTTO Fuel II	• 32 Torpedoes
ADC	Typically cylinder-shaped about 102 to 280 cm (40 to 110 in) in length, 8 to 15 cm (3 to 6 in) in diameter, and weighing between 3 and 57 kg (7 and 125 lbs).	• Lithium sulfur dioxide battery • Metal casing • Wires	• 225 ADCs
EMATT	Approximate shape of 12 by 91 cm (5 by 36 in) with a weight of 10 kg (21 lbs)	• Parachute assembly (12-18 inch diameter nylon chute) and nylon cord • Lithium sulfur dioxide battery • Metal casing • Metal clips • Nylon strap • Electrical wiring	• 725 EMATTs

ADC = acoustic device countermeasures; EMATT = expendable mobile acoustic training target; XBT = expendable bathythermograph; m = meter; ft = feet, cm = centimeters; in = inches; kg = kilograms; lbs = pounds

In addition, a U.S. Coast Guard document entitled "Aids to Navigation (AtoN) Battery Release Reporting Requirements" found that lead and other metals from batteries associated with AtoN sites represented levels that were less than reportable quantities under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 103(a) (U.S. Coast Guard, 1994). Since sonobuoy batteries are smaller and retain little metal after use, no reportable quantities should be present in sea floor deposits.

Furthermore, an update to the 1996 Environmental Assessment for the Canadian Forces Maritime Experimental and Test Ranges (CFMETR) near Nanoose, British Columbia, was completed in 2005 by Environmental Sciences Group, Royal Military College of Canada. This document analyzed chemical effects associated with expendable components from activities involving sonobuoys, torpedoes, EMATTs, and ADCs (ESG, 2005). Specifically, the analysis focused on lead, copper, lithium, and Otto fuel. The document stated that metal contaminants were most likely to concentrate in fine-grained particulate matter, especially when smaller than 63 μm. The findings of the EA demonstrated that CFMETR operations did not cause a measurable effect on sediment quality (ESG, 2005).

Given the mobility characteristics for the most soluble battery constituent, lead chloride, and the extensive studies conducted by the U.S. Coast Guard, there is low potential for substantial accumulation of contaminant in sediments. *Therefore, there will be no significant impact to sediments from sonobuoy batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to sediments from sonobuoy batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.1.2 Torpedoes

Releases of Otto Fuel II combustion byproducts will be diluted and dispersed in the water column due to flowing ocean currents. The potential effects of these chemical releases will be similar to those described for water quality (refer to Section 4.3.3. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. This is further substantiated by the results of the CFMETR EA, which determined that Otto fuel would not cause a measurable effect on sediment quality (ESG, 2005).

Upon completion of an MK-46 EXTORP run, two steel-jacketed lead ballast weights are released to lighten the torpedo, allowing it to rise to the surface for recovery. Each ballast weighs 16.8 kg (37 lbs) and sinks rapidly to the bottom. In addition to the ballasted MK-46 EXTORPs, MK-46 REXTORPs launched from P-3s also must be ballasted for safety purposes. Ballast weights for these REXTORPs are similarly released to allow for missile recovery. Ballasting the MK-46 REXTORP for P-3 use requires six ballasts, totaling 82 kg (180 lbs) of lead. In areas of soft bottom, ballasts would be buried quickly in the sediments.

The EPA saltwater quality standard for lead is 8.1 µg/L continuous and 210 µg/L maximum (EPA, 2006). Lead is a minor constituent of seawater, with a background concentration of 0.02 to 0.4 µg/L (Kennish, 2001).

The metallic lead of the ballast weights is unlikely to mobilize into the sediment or water as lead ions for three reasons. First, the lead is jacketed with steel, which means that the surface of the lead would not be exposed directly to the actions of seawater. Second, even if the lead were exposed, the general bottom conditions of slightly basic and low oxygen content (i.e., a reducing environment) would prohibit the lead from ionizing. In addition, only a small percentage of lead is soluble in seawater. Finally, in soft-bottom areas, the lead weights would be buried due to the velocity of their impact with the bottom. Sediments are generally anoxic and thus no lead would be ionized (DON, 1996a). Studies at other ranges have shown the impact of lead ballasts to be minimal, as they are buried deep in sediments where they are not biologically available (Environmental Sciences Group, 2005). There would be no cumulative effects from the lead ballasts due to the low probability of mobilization.

Therefore, there will be no significant impact to sediments from Otto Fuel II combustion byproducts in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to sediments from OF II combustion byproducts in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.1.3 Acoustic Device Countermeasures

Lithium sulfur dioxide battery cells power ADCs. The chemical reactions of the lithium sulfur dioxide batteries will be highly localized and short-lived, and the ocean currents will greatly diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. This is further substantiated by the results of the CFMETR EA, which determined that lithium in batteries would not cause a measurable effect on sediment quality (ESG, 2005). *Therefore, there will be no significant impact to sediments from ADC batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to sediments from ADC batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.1.4 Expendable Mobile Acoustic Training Target

Lithium sulfur dioxide battery cells also power EMATTs. The chemical reactions of the lithium sulfur dioxide batteries will be highly localized and short-lived, and the ocean currents will greatly diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. This is further substantiated by the results of the CFMETR EA, which determined that lithium in batteries would not cause a measurable effect on sediment quality (ESG, 2005). *Therefore, there will be no significant impact to sediments from EMATT batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to sediments from EMATT batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.2 Marine Debris

This section will analyze whether expending active sonar activity components into the Study Area will adversely contribute to the marine habitat. Refer to Sections 4.4, 4.5, and 4.8 for an analysis of potential entanglement effects to marine mammals, sea turtles, and seabirds from expended materials.

4.3.2.1 Sonobuoys

A sonobuoy is approximately 13 centimeters (cm) (5 inches [in]) in diameter, 1 meter (m) (3 feet [ft]) long, and weighs between 6 and 18 kilograms (kg) (14 and 39 pounds [lb]), depending on the type. In addition, aircraft-launched sonobuoys deploy a nylon parachute of varying sizes, ranging from 0.15 to 0.35 square meters (m^2) (1.6 to 3.8 square feet [ft^2]). The shroud lines range from 0.30 to 0.53 m (12 to 21 in) in length and are made of either cotton polyester with a 13.6-kg (30-lb) breaking strength or nylon with a 45.4-kg (100-lb) breaking strength. All parachutes are weighted with a 0.06-kg (2-ounce) steel material weight, which causes the parachute to sink from the surface within 15 minutes. At water impact, the parachute assembly, battery, and sonobuoy will sink to the ocean floor where they will be buried into its soft sediments or land on the hardbottom where they will eventually be colonized by marine organisms and degrade over time. These components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor. However, the active sonar activities using sonobuoys will not likely occur in the exact same location each time. Additionally, the materials will not likely settle in the same vicinity due to ocean currents.

Therefore, there will be no significant impact to marine habitat from scuttled sonobuoys or their expended components in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to marine habitat from scuttled sonobuoys or their expended components in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.2.2 Torpedoes

The MK-48 will be used during active sonar activities. These devices are approximately 580 cm (19 ft) long and 53 cm (21 in) in diameter). The guidance wire is a maximum of 0.11 cm (0.043 in) in diameter and composed of a very fine thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 19 kg (42 lb) and can be broken by hand. Up to 28 km (15 miles [mi]) of wire is deployed during a run, which will sink to the sea floor at a rate of 0.15 meters per second (m/sec) (0.5 feet per second [ft/sec]). The flex hose protects the guidance wire and prevents it from forming loops as it leaves the tube.

An assortment of air launch accessories, all of which consist of non-hazardous materials, would be expended into the marine environment during air launching of MK-46 or MK-54 torpedoes, which are lightweight torpedoes. Depending on the type of launch craft used, MK-46 launch accessories may be comprised of a protective nose cover, suspension bands, air stabilizer, release wire, and propeller baffle (DON, 1996). MK-54 air launch accessories may be comprised of a nose cap, suspension bands, air stabilizer, sway brace pad, arming wire, and fahnstock clip (DON, 1996a).

Upon completion of an MK-46 EXTORP run, two steel-jacketed lead ballast weights are released to lighten the torpedo, allowing it to rise to the surface for recovery. Each ballast weighs 16.8 kg (37 lbs) and sinks rapidly to the bottom. In addition to the ballasted MK-46 EXTORPs, MK-46 REXTORPs launched from maritime patrol aircraft (MPA) must also be ballasted for safety purposes. Ballast weights for these REXTORPs are similarly released to allow for missile recovery. Ballasting the MK-46 REXTORP for MPA use requires six ballasts, totaling 82 kg (180 lbs) of lead.

The small amount of material will be spread over a relatively large area. This expended material will settle to the ocean bottom and will be covered by sediments over time. Due to the small size and low density of materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor. However, the TORPEX activities will not likely occur in the exact same location each time. Additionally, due to ocean current, the materials will not likely settle in the same vicinity. *Therefore, there will be no significant effect to marine habitat from expended torpedo components in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine habitat from expended torpedo components in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.2.3 Acoustic Device Countermeasures

ADCs are approximately 102 to 280 cm (40 to 110 in) in length and 8 to 15 cm (3 to 6 in) in diameter, and they weigh between 3 and 57 kg (7 and 125 lb). ADCs are approximately the same size as sonobuoys. Once expended, ADCs and their associated batteries will sink to the ocean floor throughout the AFAST Study Area and will be covered with sediments over time. The small amount of expended material will be spread over a relatively large area. Due to the small size and low density of the materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor, but due to ocean currents, the materials will not likely settle in the same vicinity. *Therefore, there will be no significant impact to marine habitat from expended ADCs or their components in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine habitat from expended ADCs or their components in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.2.4 Expendable Mobile Acoustic Training Target

EMATTs are approximately 12 by 91 cm (5 by 36 in) and weigh approximately 10 kg (21 lb). EMATTs are much smaller than sonobuoys and ADCs. EMATTs, their batteries, parachutes, and other components will scuttle and sink to the ocean floor throughout the AFAST Study Area and will be covered by sediments over time. In addition, the small amount of expended material will be spread over a relatively large area. Due to the small size and low density of the materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor, but due to ocean currents, the materials will not likely settle in the same vicinity. *Therefore, there will be no significant impact to marine habitat from expended EMATTs or their components in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine habitat from expended EMATTs or their components in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3 Water Quality

This section analyzes the potential effects to water quality from sonobuoy, ADC, and EMATT batteries; explosive source sonobuoys (AN/SSQ-110A), and Otto Fuel II combustion byproducts associated with torpedoes. This section does not analyze XBTs since they do not use batteries.

4.3.3.1 Sonobuoys

The analysis provided in this section focuses on potential effects to water quality as a result of expended sonobuoy components. The approach used to evaluate the potential effects associated with seawater batteries included comparing the expected concentrations of potentially toxic battery constituents with EPA water quality criteria that have been established for the protection of aquatic life (EPA, 2006) or the best available literature values that established conservative toxicity thresholds. In accordance with EPA guidance, the concentrations are expressed as dissolved metal, which is also consistent with the ionic form that would be released from active batteries. The EPA recommends application of the acute and chronic limits as 1-hour (hr) and 4-day means, respectively (Table 4-2). Either limit cannot be exceeded more than once every 3 years on the average.

Table 4-2. Threshold Values for Safe Exposure to Selected Metals

Metal	Acute Criteria (µg/L, 24-hr exposure)	Chronic (µg/L, 4-hr mean exposure)
Lead	210	8.1
Silver	1.9	NA
Copper	4.8	3.1
Lithium[1]	6,000	NA

NA = no chronic value is available; µg/L = micrograms per liter; hr = hour
Note: EPA aquatic life criteria unless otherwise stated.
1. No EPA criteria available; values shown are based on literature (Kszos et al., 2003).

Sonobuoys consist of two main sections, a surface unit that contains the seawater battery and a metal subsurface unit. The seawater battery becomes energized following contact with the water and once submerged can hold approximately 164 milliliters (mL) of seawater. The batteries provide power to the sonobuoy electronics. Depending on the design of the sonobuoy, the seawater battery can have an operating life of up to 8 hours. Sonobuoy seawater battery electrodes are typically lead chloride, cuprous thiocyanide, or silver chloride. Lithium batteries are used to power subsurface units. Hydrogen gas is generated from the electrochemical reactions that occur within the battery compartment.

Of particular concern for water quality are the activated seawater batteries, as they release lead (Pb), silver (Ag), and copper (Cu) ions that are freely dissolved in the water column. Other constituents, including nickel-plated steel housing, lead solder, copper wire, and lead shot used for ballast, will theoretically pose lesser risks to the aquatic environment relative to the seawater batteries (Naval Facilities Engineering Command [NAVFAC], 1993). Most of these components are coated with plastic to reduce corrosion, providing an effective barrier to water exchange. On the housing, corrosion and colonization of encrusting marine organisms reduce leaching rates.

Scuttled sonobuoys on the ocean floor are expected to have negligible adverse effects on water quality, because electrodes are largely exhausted during operations and residual constituent dissolution will occur more slowly than the releases from activated seawater batteries. Therefore, this subsection describes the potential effects of batteries and residual explosive material on marine water quality in and surrounding the sonobuoy operation area. Because the types of sonobuoys and their corresponding battery components will likely vary over the course of the AFAST exercises, the present characterization evaluates the most likely chemical constituents (i.e., those associated with Directional Command-Activated Sonobuoy System (DICASS) 62D and 62E, and the explosive source sonobuoy [(AN/SSQ-110A)]) but should generally be applicable to other sonobuoys. A report prepared by Naval Facilities Engineering Command (NAVFAC) Southwest Division as part of the Quality Assurance Program for training in the use of sonobuoys in San Clemente, California (NAVFAC 1993), provides useful background for the assessment. Data presented in that report have been applied in evaluating chemical exposures associated with seawater battery functions**.**

Furthermore, an update to the 1996 Environmental Assessment for the Canadian Forces Maritime Experimental and Test Ranges (CFMETR) near Nanoose, British Columbia, was completed in 2005 by Environmental Sciences Group, Royal Military College of Canada. This document analyzed chemical effects associated with expendable components from activities involving sonobuoys, torpedoes, EMATTs, and ADCs (ESG, 2005). Specifically, the analysis focused on lead, copper, lithium, and Otto fuel. The document stated that metal contaminants were most likely to concentrate in fine-grained particulate matter, especially when smaller than 63 μm. The findings of the EA demonstrated that CFMETR operations did not cause a measurable effect on water quality (ESG, 2005).

In addition, water column effects on contaminant dispersal are dominated by physical mixing and diffusion properties and tend to be variable with both time and location. Few published studies have been performed on the water column in the area. As the volume of water in the AFAST Study Area is large, the contamination concentration would be very dilute and difficult to detect.

4.3.3.2 Sonobuoy Seawater Batteries

The approach used to evaluate effects associated with seawater batteries involved comparing the expected concentrations of potentially toxic battery constituents with EPA water quality criteria that have been established for the protection of aquatic life (EPA, 2006) or the best available literature values that established conservative toxicity thresholds (Table 4-3).

As stated previously, this assessment applies the findings from a study reported by NAVFAC (1993, Appendix D) in a sonobuoy training document developed for activities at San Clemente, California. The study involved a laboratory experiment where activated seawater batteries were held in a 64-liter (L) (17-gallon) seawater bath for 8 hours to provide an empirical estimate of expected leach rates for metals of concern. Water column concentrations of metals at the end of the exposure can be used to derive average leaching rates and can then be interpreted in the context of minimum current velocities to estimate maximum field exposures.

The exposure scenario applied in the NAVFAC report represents reasonable and conservative assumptions that have been retained for this analysis. It is assumed that only one seawater battery will occupy the test volume within its 8-hour operating life span. No vertical turbulence is applied, and the horizontal ocean current flow is set at 5 centimeters per second (cm/sec) (2 inches per second [in/sec]). For comparison, the weakest current reported in Section 3 for the North Atlantic is about 5 cm/sec(2 in/sec). Hence, the NAVFAC assumption represents a highly conservative dilution scenario relative to the selected location.

The sonobuoy battery experiment employed lead chloride batteries over an 8-hour period. The concentration of lead at the end of the exposure in the 64-L (17-gallon) bath was 0.2 milligrams per liter (mg/L) (NAVFAC, 1993 [Appendix D]). Hence, the total amount of lead leached from the battery was 0.2 milligrams (mg) × 64 L = 12.8 mg. As shown in the table below, the per-hour rate is then 1.6 milligrams per hour (mg/hr), and the milligrams-per-second rate is 0.000444 milligrams per second (mg/sec). Applying a highly conservative model wherein all of the lead released in a single second is contained within 1 mL, the concentration is 0.4 mg/L. Considering each milliliter as a discrete parcel, a reasonable dilution model for a current velocity of 5 cm/sec (2 in/sec) assumes that the contaminated section is diluted by a factor of 2 per second. As such, the concentration released from the battery is diluted to 0.2 mg/L or 200 micrograms per liter (µg/L), in 2 seconds, which is less than the acute criteria of 210 µg/L, a criteria applied as a 24-hr mean (Table 4-2). Likewise, assuming the exponential factor of two dilutions, the concentration is less than the chronic limit (8.1 µg/L) in 7 seconds. Therefore, lead chloride batteries will not result in significant degradation to marine water quality. Refer to Table 4-3 for description and summary of the calculations performed to determine potential effects from scuttled lead chloride batteries.

Table 4-3. Calculations to Characterize Maximum Lead Exposure Concentrations

Description of Calculation	Operation	Result
Total amount of lead leached from the battery	0.2 mg/L × 64 L =	12.8 mg/8 hr
Per-hour rate	12.8 mg/8 hrs =	1.6 mg/hr
Per-second rate	1.6/hr/(60 min/hr × 60 sec/min) =	0.000444 mg/sec
Concentration into 1 mL	0.000444 mg/mL × 100) mL/L =	0.4 mg/L
2-second dilution	0.4/2 =	0.2 mg/L or 200 µg/L

hr = hours; µg/L = micrograms per liter; mg = milligram; mL = milliliter; L = liter

Lead chloride, with a dissociation constant (K_{sp}) of 1.0×10^{-4} is more soluble than other metals used in seawater batteries (e.g., silver chloride $K_{sp} = 1.56 \times 10^{-10}$ and copper thiocyanate $K_{sp} = 1.64 \times 10^{-11}$) (International Union of Pure and Applied Chemistry [IUPAC], 2006). The relatively large differences in the propensity of lead ions (Pb^{+2}) to solubilize relative to copper (Cu^{+2}) and silver (Ag^{+}) assures that potential effects from batteries employing silver chloride or copper thiocyanate are substantially lower than those for the lead chloride battery. While the copper thiocyanate battery also has the potential to release cyanide, a material often toxic to the marine environment, thiocyanate is tightly bound and can form a salt or bind to bottom sediments. Therefore, the risk associated with thiocyanate is very low.

As such, there will be no significant impact to water quality from seawater batteries associated with scuttled sonobuoys in territorial waters with the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to water quality from seawater batteries associated with scuttled sonobuoys in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.2.1 Lithium Batteries

Lithium batteries are used in DICASS sonobuoys but not in the explosive source sonobuoy (AN/SSQ-110A). These batteries are contained within a metal casing housing sulfur dioxide, lithium metal, carbon, acetonitrile, and lithium bromide. During battery operation, the lithium reacts with the sulfur dioxide to form lithium dithionite. As with the seawater batteries, the reaction proceeds almost to completion once the cell is activated and only a small amount of reactants remain when the battery life terminates. In addition, the outside metal case can become encrusted from seawater processes, thus slowing the rate of further corrosion. Furthermore, a study conducted by Kszos et al. (2003) demonstrated that sodium ions mitigate the toxicity of lithium to sensitive aquatic species. Fathead minnows (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*) were unaffected by lithium concentrations as high as 6 mg/L in the presence of tolerated concentrations of sodium. Hence, it is expected that in the marine environment where sodium concentrations are at least an order of magnitude higher than tolerance limits for the tested freshwater species, lithium would be essentially nontoxic. Because of these factors, it has been determined that lithium batteries do not result in significant degradation to marine water quality.

Therefore, there will be no significant impact to water quality from lithium batteries associated with scuttled sonobuoys in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to water quality from lithium batteries associated with scuttled sonobuoys in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.2.2 Thermal Batteries

The AN/SSQ-62D and E DICASS have been improved with the replacement of the standard lithium battery with a lithium iron disulfide thermal battery. An important component of the thermal battery is a hermetically sealed casing. The casing is Series 300 welded stainless steel .7- to 2.54-mm (0.03- to 0.1-in) thickness and is resistant to the battery electrolytes.

The electrochemical system in the thermal battery includes an iron disulfide cathode and a lithium alloy anode. In addition, the electrolyte mixture includes chloride, bromide, and iodide salts of lithium and potassium. This mixture is inert and nonconductive until the battery is activated. Upon activation, the mixture becomes molten and highly conductive, allowing the cathode to interact efficiently with the anode. The thermal source is a mixture of iron powder and potassium perchlorate. Ignition of the thermal source supplies the energy to melt the electrolyte, initiating conductivity. The active life of thermal batteries (approximately 1 hour) is less than that afforded by other sonobuoy batteries, but product development to extend its capacity to longer operation is ongoing.

Material safety data sheets were developed by the current supplier of thermal batteries to the Navy (Eagle-Picher Industries, Joplin, Missouri). While Eagle-Picher's thermal batteries are technically exempt from the Hazard Communication Standard (29 Code of Federal Regulations [CFR] 1910.1200), or the "Right-to-Know Rule," because they do not "… release, or otherwise result in exposure to, a hazardous chemical under normal conditions of use" (Clarke, 1993), the company provides product information to ensure informed use (http://kauai.hawaii.edu/msds/files/cky/ckygg.html; Dharmesh Bhakta, personal communication). These sources state that during normal operation of a thermal battery, the greatest risk is from heat dissipated to the outer case (sufficient to cause severe burns under nonaquatic conditions). Also, thermal batteries should be treated as any other "live" source of electric power, in that they can cause electric shock. Due to the heat transmitted by thermal batteries, thermal shock or death would be expected for aquatic life exposed within close proximity of the battery unit unless it was contained within the sonobuoy housing. The thermal battery is located inside the transducer vessel of the sonobuoy and, hence, high temperature exposures should be minimized. In the case of extreme degradation of the battery housing on the sea floor, risks from thermal batteries would be similar to those from lithium batteries (i.e., negligible) but less because the iron alloy is less soluble.

Therefore, there will be no significant impact to water quality from thermal batteries associated with scuttled sonobuoys in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to water quality from thermal batteries associated with scuttled sonobuoys in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.3 Effects of Explosive Source Sonobuoys (AN/SSQ-110A)

Under water, the explosive reaction is relatively complete due to the higher-pressure conditions relative to air explosions. The concerns for the assessment discussed in this section are potential effects on water quality associated from the explosion byproducts. The acoustic effects associated with impulsive sound are addressed later in this chapter.

The explosive source sonobuoy (AN/SSQ-110A) is composed of two sections, an active (explosive) section and a passive section. The upper section is called the "control buoy" and is similar to the upper electronics package of the DICASS (AN/SSQ-62) sonobuoy. The lower section consists of two signal underwater sound (SUS) explosive payloads of Class A explosive weighing 1.9 kg (4.2 lb) each. The arming and firing mechanism is hydrostatically armed and detonated. Once in the water, the SUS charges explode, creating a loud acoustic signal. The explosive package consists largely of cyclotetramethylenetetranitramine (HLX) (90 percent research department explosive [RDX]) and small amounts (less than 0.3 g) of plastic-bonded molding powder (plastic bonded explosive [PBXN] PBXN 5 and hexanitrostilbene [HNS–IV], a detonator component).

The explosion creates an air bubble. Many of these gaseous byproducts travel within this bubble to the water surface and escape into the atmosphere. A small amount of the gas, however, dissolves into the water column. The product with greatest potential to result in toxicity is hydrogen fluoride compounds. These compounds are a reaction product associated with the booster charge that incorporates a Viton® fluoropolymer binder formulation to stabilize the highly explosive nitramines in HLX. The hydrogen fluoride is either produced directly in the explosion or from hydrolysis of another product. Explosive products were estimated using the Cheetah 4 computational program, and principal products are summarized in Table 4-4.

Table 4-4. Cheetah 4 Calculations of Detonation Product Weights

Explosive Products	C-J state (g/charge)	Ambient (g/charge)
Hydrogen fluoride compounds (HxFx)	24.6 (1.23%)	12.5 (0.63%)
Nitrogen (N_2)	634	675
Carbon dioxide (CO_2)	669	565
Water (H_2O)	211	332
Ammonia (H_3N)	61	13.4
Formic acid (CH_2O_2)	156	1.7
Ethylene (C_2H_6)	84.6	2.1

C-J state = initial detonation state; g = grams of detonation product
Note: Assumed a 2-kg [4.4-lb] explosive charge with a 3.7 to 0.5 ratio of HLX to booster

The United States has not produced any formal evaluation of risk to aquatic life from hydrogen fluorides; however, the European Union Committee for evaluation and control of the risks of existing substances has recommended risk-based benchmarks (Committee on Toxicity, Ecotoxicity and the Environment [CSTEE], 2000). Based on laboratory studies with freshwater species, they provide a probable no effect concentration (PNEC) of 0.9 and 0.4 mg/L for hard and soft water, respectively. These values are apparently close to background levels measured in many natural water bodies. Characterization of natural exposure levels and effects in saltwater are needed to provide further basis for the assessment of risks in marine systems. Only a small percentage (0.63 percent) of the available hydrogen fluoride explosive product is expected to become solubilized prior to reaching the surface and the rapid dilution that would occur upon mixture with ambient water. As such, it is unlikely that the explosive reactions associated with sonobuoys scuttling will contribute contaminant risks to the aquatic community.

Therefore, there will be no significant impact to water quality from explosion residuals associated with the explosive source sonobuoy (AN/SSQ-110A) in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to water quality from explosive residuals associated with the explosive source sonobuoy (AN/SSQ-110A) batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.4 Torpedoes

During exercises involving the firing of torpedoes, Otto Fuel II combustion byproducts could be released into the marine environment.

Otto Fuel II is used to power torpedoes. The fuel is combusted in the torpedo engine and the combustion byproducts are exhausted into the torpedo wake, which is extremely turbulent and causes rapid mixing and diffusion. These combustion byproducts include carbon dioxide, carbon monoxide, water, hydrogen gas, nitrogen gas, ammonia, hydrogen cyanide (HCN), and nitrogen oxides (Qadir et al., 1994). All of the byproducts, with the exception of hydrogen cyanide, are below the EPA water quality criteria. The concentration of hydrogen cyanide exceeds the 1-hour recommended value; however, hydrogen cyanide is highly soluble in seawater and dilutes below the EPA criterion within 6.3 m (20.7 ft) of the torpedo. *Therefore, there will be no significant impact to water quality from Otto Fuel II combustion byproducts in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to water quality from Otto Fuel II combustion byproducts in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

The exercise head section of the MK-46 and MK-54 torpedo is fitted with a dye container, which is filled with an estimated 109 g (3.7 oz) of sodium fluorescein dye (DON, 1996a). At the end of the torpedo exercise, the dye discharges into the seawater to enhance the visibility and facilitate the recovery of the torpedo. Sodium fluorescein dye is easily visible in very dilute solutions. The dye is commonly used to trace the flow of water and poses no harm to water quality or aquatic life at the concentrations that will occur during exercise torpedo operations. *Therefore, there will be no significant effect to water quality from torpedo sodium fluorescein dye in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to water quality from torpedo sodium fluorescein dye in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

MK-46, MK-54, and MK-48 torpedoes contain potentially hazardous or harmful (non-propulsion-related) components and materials. Only very small quantities of these materials, however, are contained in each torpedo. During normal exercise operations, the torpedo is sealed and is recovered at the end of a run; therefore, none of the potentially hazardous or harmful materials would be released to the marine environment. Potentially hazardous or harmful materials could be released on impact with a target or the sea floor. However, since the guidance system of the torpedo is programmed for target and bottom avoidance, the chance of an accidental release is remote. Further, since the amounts of potentially hazardous and harmful materials contained in each torpedo are very small, upon accidental release the materials would rapidly diffuse in the water column. *Therefore, there will be no significant impact to water quality from torpedo components and materials in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to water quality from torpedo components and materials in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.5 Acoustic Device Countermeasures

The lithium in the lithium sulfur dioxide batteries reacts with the sulfur dioxide to form soluble hydrogen gas and lithium dithionite. The hydrogen gas eventually enters the atmosphere and the lithium hydroxide dissociates, forming lithium ions and hydroxide ions. The hydroxide is neutralized by the hydronium formed from hydrolysis of the acidic sulfur dioxide, ultimately forming water. Sulfur dioxide, a gas that is highly soluble in water, is the major reactive component in the battery. The sulfur dioxide ionizes in the water, forming bisulfite (HSO_3) that is easily oxidized to sulfate in the slightly alkaline environment of the ocean. Sulfur is present as sulfate in large quantities (i.e., 885 mg/L) in the ocean. *Therefore, there will be no significant impact to water quality from ADC batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to water quality from ADC batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.6 Expendable Mobile Acoustic Training Target

As with ADCs, EMATTs also use lithium sulfur dioxide batteries; as such, the analysis and conclusion discussed previously applies. *Therefore, there will be no significant impact to water quality from EMATT batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to water quality from EMATT batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.4 MARINE MAMMALS

Forty-three marine mammal species, including whales, dolphins, seals, and manatees, have possible or confirmed occurrence along the East Coast or in the Gulf of Mexico. Marine mammals with possible occurrences along the north and south Atlantic coasts and within the Gulf of Mexico are provided in Section 3.6. An explanation of how marine resource assessments (MRAs) use a particular convention to describe marine mammal occurrence throughout each OPAREA is also provided in Chapter 3.

This section evaluates potential direct and indirect effects to marine mammals as a result of exposure to in-water sound. Specifically, a quantitative analysis was used to determine the potential impacts to marine mammals associated with the use of active sonar, in addition to the explosive source sonobuoy (AN/SSQ-110A).

4.4.1 Acoustic Systems Analyzed

Table 4-5 presents all of the acoustic systems used during Atlantic Fleet active sonar activities. As stated previously, systems that are typically operated at frequencies greater than 200 kHz were not analyzed. Note that some systems were found to have similar acoustic output parameters (i.e., frequency, power, deflection angles). For these systems, the system with the larger acoustic footprint was modeled which is representative of all similar systems.

4.4.2 Analytical Framework for Assessing Marine Mammal Response to Active Sonar

Marine mammals respond to various types of man-made sounds introduced in the ocean environment. Responses are typically subtle and can include shorter surfacings, shorter dives, fewer blows per surfacing, longer intervals between blows (breaths), ceasing or increasing vocalizations, shortening or lengthening vocalizations, and changing frequency or intensity of vocalizations (National Research Council of the National Academies [NRC], 2005). However, it is not known how these responses relate to significant effects (e.g., long-term effects or population consequences) (NRC, 2005). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. The Navy enlisted the expertise of the National Marine Fisheries Service (NMFS) as the cooperating agency in the preparation of this environmental impact statement/overseas environmental impact statement (EIS/OEIS).

Table 4-5. Acoustic Systems Analyzed

Systems that were Analyzed			
System	***Frequency***	***Associated Platform***	***System Description***
AN/SQS-53	MF	DDG and CG hull-mounted sonar	Utilized 70% in search mode and 30% track mode
AN/AQS-13 or AN/AQS-22	MF	Helicopter dipping sonar	AN/AQS-22: 10 pings/dip, 30 seconds between pings)- also used to represent AN/AQS-13
AN/SSQ-110A Sonobuoy	Impulsive	Helicopter and MPA deployed	Contains two 4.1 lb charges
AN/SQQ-32	HF	MCM over the side system	Used during MIW training events detect, classify, and localize bottom and moored mines
AN/BQS-15	HF	Submarine navigational sonar	Only used when entering and leaving port
AN/SQS-56	MF	FFG hull-mounted sonar	Utilized 70% in search mode and 30% track mode
MK-48 Torpedo	HF	Submarine fired exercise torpedo	Active for 15 min per torpedo run
MK-46 or MK-54 Torpedo	HF	Surface ship and aircraft fired exercise torpedo	MK-46: 15 min per torpedo run, modeling also used to represent MK-54
AN/SLQ-25 (NIXIE)	MF	DDG, CG, and FFG towed array	20 mins per use
AN/SQS-53 and AN/SQS-56 (Kingfisher)	MF	DDG, CG, and FFG hull-mounted sonar (object detection)	only modeled AN/SQS-53 Kingfisher, used to represent AN/SQS-56
AN/BQQ-10	MF	Submarine hull-mounted sonar	2 pings per hour
Tonal sonobuoy (DICASS) (AN/SSQ-62)	MF	Helicopter and MPA deployed	12 pings, 30 secs between pings
ADC	MF	Submarine fired countermeasure	20 mins , MK-3 modeling also used to represent all ADCs
Submarine fired countermeasure	MF	Submarine fired countermeasure	20 mins per use

ADC – Acoustic Device Countermeasure; CG – Guided Missile Cruiser; DDG – Guided Missile Destroyer; DICASS – Directional Command-Activated Sonobuoy System; FFG – Fast Frigate; HF – High-Frequency; MF – Mid-Frequency; MPA – Maritime Patrol Aircraft EMATT – Expendable Mobile Acoustic Training Target

In estimating the potential for marine mammals to be exposed to an acoustic source, the following actions were completed:

- Evaluated potential effects within the context of existing and current regulations, thresholds, and criteria.
- Identified all acoustic sources that will be used during active sonar activities.
- Identified the location, season, and duration of the action to determine which marine mammal species are likely to be present.
- Determined the estimated number of marine mammals (i.e., density) of each species that will likely be present in the respective OPAREAs during active sonar activities.

- Applied the applicable acoustic threshold criteria to the predicted sound exposures from the proposed activity. The results of this effort were then evaluated to determine whether the predicted sound exposures from the acoustic model might be considered harassment.
- Considered potential harassment within the context of the affected marine mammal population, stock, and species to assess potential population viability. Particular focus on recruitment and survival are provided to analyze whether the effects of the action can be considered to have negligible effects to species' populations.

The following flow chart (Figure 4-1) is a representation of the general analytical framework utilized in applying the specific thresholds discussed in this section. The framework presented in the flow chart is organized from left to right and is compartmentalized according to the phenomena that occur within each. These include the physics of sound propagation (Physics), the potential physiological processes associated with sound exposure (Physiology), the potential behavioral processes that might be affected as a function of sound exposure (Behavior), and the immediate effects these changes may have on functions the animal is engaged in at the time of exposure (Life Function – Proximate). These compartmentalized effects are extended to longer-term life functions (Life Function – Ultimate) and into population and species effects. Throughout the flow chart, dotted and solid lines are used to connect related events. Solid lines designate those effects that "will" happen; dotted lines designate those that "might" happen but must be considered (including those hypothesized to occur but for which there is no direct evidence).

Some boxes contained within the flow chart are colored according to how they relate to the definitions of harassment under the Marine Mammal Protection Act (MMPA). Red boxes correspond to events that are injurious. By prior ruling and usage, these events would be considered as Level A harassment under the MMPA. Yellow boxes correspond to events that have the potential to qualify as Level B harassment under the MMPA. Based on prior ruling, the specific instance of TTS is considered as Level B harassment. Boxes that are shaded from red to yellow have the potential for injury and behavioral disturbance.

The analytical framework outlined within the flow chart acknowledges that physiological responses must always precede behavioral responses (i.e., there can be no behavioral response without first some physiological effect of the sound) and an organization where each functional block only occurs once and all relevant inputs/outputs flow to/from a single instance.

4.4.2.1 Physics

Starting with a sound source, the attenuation of an emitted sound due to propagation loss is determined. Uniform animal distribution is overlaid onto the calculated sound fields to assess if animals are physically present at sufficient received sound levels to be considered "exposed" to the sound. If the animal is determined to be exposed, two possible scenarios must be considered with respect to the animal's physiology– effects on the auditory system and effects on non-auditory system tissues. These are not independent pathways and both must be considered since the same sound could affect both auditory and non-auditory tissues. Note that the model does not

1

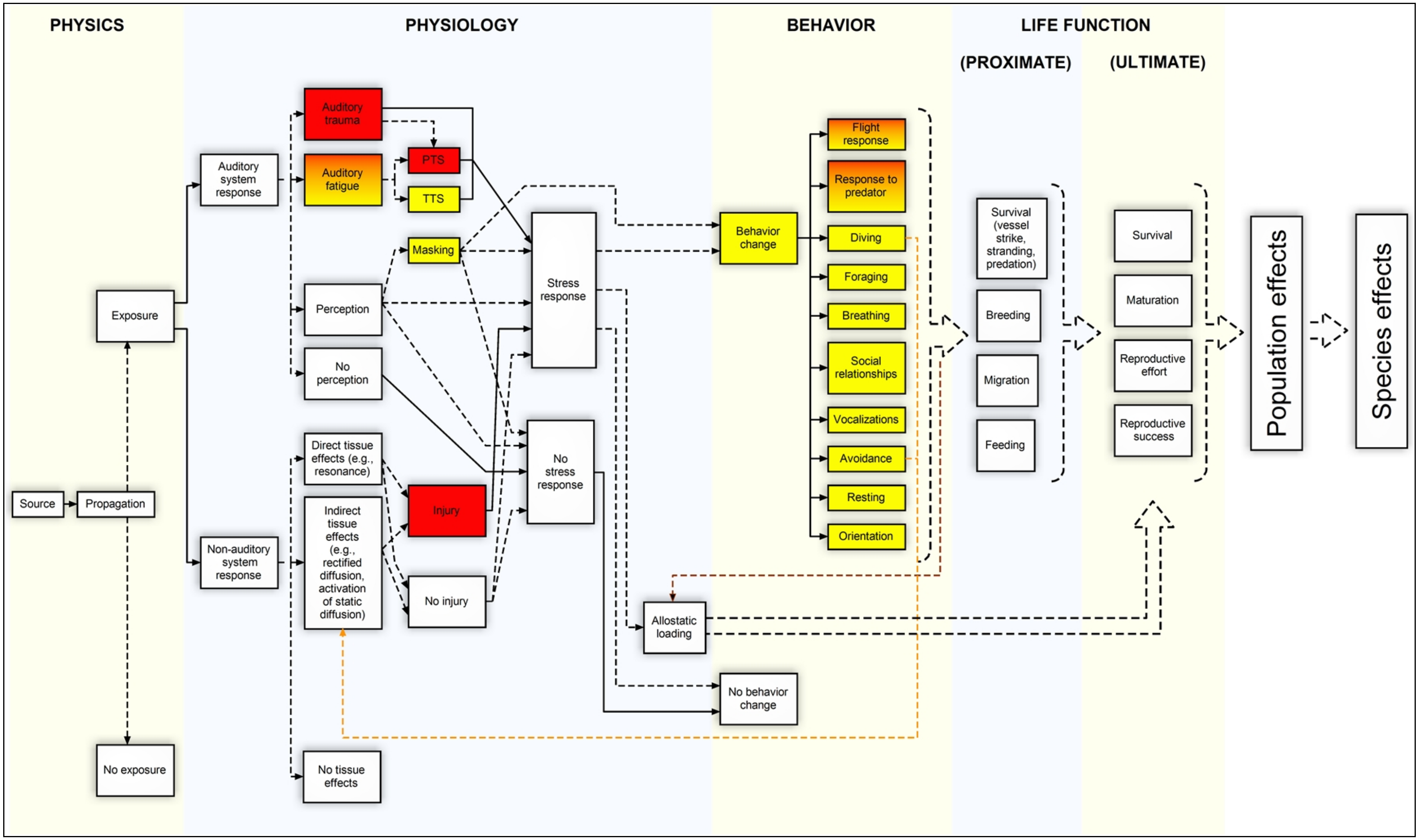

Figure 4-1. Analytical Framework Flow Chart

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account for any animal response; rather the animals are considered stationary, accumulating energy until the threshold is tripped.

4.4.2.2 Physiology

Potential impacts to the auditory system are assessed by considering the characteristics of the received sound (e.g., amplitude, frequency, duration) and the sensitivity of the exposed animals. Some of these assessments can be numerically based (e.g., TTS, permanent threshold shift [PTS], perception). Others will be necessarily qualitative, due to lack of information, or will need to be extrapolated from other species for which information exists.

Potential physiological responses to the sound exposure are ranked in descending order, with the most severe impact (auditory trauma) occurring at the top and the least severe impact occurring at the bottom (the sound is not perceived).

1. Auditory trauma represents direct mechanical injury to hearing related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory trauma is always injurious but could be temporary and not result in PTS. Auditory trauma is always assumed to result in a stress response.

2. Auditory fatigue refers to a loss of hearing sensitivity after sound stimulation. The loss of sensitivity persists after, sometimes long after, the cessation of the sound. The mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic exhaustion of the hair cells and cochlear tissues. The features of the exposure (e.g., amplitude, frequency, duration, temporal pattern) and the individual animal's susceptibility would determine the severity of fatigue and whether the effects were temporary (TTS) or permanent (PTS). Auditory fatigue (PTS or TTS) is always assumed to result in a stress response.

3. Sounds with sufficient amplitude and duration to be detected among the background ambient noise are considered to be perceived. This category includes sounds from the threshold of audibility through the normal dynamic range of hearing (i.e., not capable of producing fatigue). To determine whether an animal perceives the sound, the received level, frequency, and duration of the sound are compared to what is known of the species' hearing sensitivity.

   Since audible sounds may interfere with an animal's ability to detect other sounds at the same time, perceived sounds have the potential to result in auditory masking. Unlike auditory fatigue, which always results in a stress response because the sensory tissues are being stimulated beyond their normal physiological range, masking may or may not result in a stress response, depending on the degree and duration of the masking effect. Masking may also result in a unique circumstance where an animal's ability to detect other sounds is compromised without the animal's knowledge. This could conceivably result in sensory impairment and subsequent behavior change; in this case, the change in behavior is the *lack of a response* that would normally be made if sensory impairment did not occur. For this reason, masking also may lead directly to behavior change without first causing a stress response.

The features of perceived sound (e.g., amplitude, duration, temporal pattern) are also used to judge whether the sound exposure is capable of producing a stress response. Factors to consider in this decision include the probability of the animal being naïve or experienced with the sound (i.e., what are the known/unknown consequences of the exposure).

4. The received level is not of sufficient amplitude, frequency, and duration to be perceptible by the animal. By extension, this does not result in a stress response (not perceived).

Potential impacts to tissues other than those related to the auditory system are assessed by considering the characteristics of the sound (e.g., amplitude, frequency, duration) and the known or estimated response characteristics of nonauditory tissues. Some of these assessments can be numerically based (e.g., exposure required for rectified diffusion). Others will be necessarily qualitative, due to lack of information. Each of the potential responses may or may not result in a stress response.

1. Direct tissue effects – Direct tissue responses to sound stimulation may range from tissue shearing (injury) to mechanical vibration with no resulting injury. Any tissue injury would produce a stress response, whereas noninjurious stimulation may or may not.
2. Indirect tissue effects – Based on the amplitude, frequency, and duration of the sound, it must be assessed whether exposure is sufficient to indirectly affect tissues. For example, the hypothesis that rectified diffusion occurs is based on the idea that bubbles that naturally exist in biological tissues can be stimulated to grow by an acoustic field. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage occurs (injury); (2) bubbles develop to the extent that a complement immune response is triggered or nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury); or (3) the bubbles are cleared by the lung without negative consequence to the animal. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based on what is known about the specific process involved.
3. No tissue effects – The received sound is insufficient to cause either direct (mechanical) or indirect effects to tissues. No stress response occurs.

4.4.2.3 The Stress Response

The acoustic source is considered a potential stressor if, by its action on the animal, via auditory or nonauditory means, it may produce a stress response in the animal. The term “stress” has taken on an ambiguous meaning in the scientific literature, but with respect to Figure 4-1 and the later discussions of allostasis and allostatic loading, the stress response will refer to an increase in energetic expenditure that results from exposure to the stressor and which is predominantly characterized by either the stimulation of the sympathetic nervous system (SNS) or the hypothalamic-pituitary-adrenal (HPA) axis (Reeder and Kramer, 2005). The SNS response to a stressor is immediate and acute and is characterized by the release of the catecholamine neurohormones norepinephrine and epinephrine (i.e., adrenaline). These hormones produce elevations in the heart and respiration rate, increase awareness, and increase the availability of glucose and lipids for energy. The HPA response is ultimately defined by increases in the secretion of the glucocorticoid steroid hormones, predominantly cortisol in mammals. The amount of increase in circulating glucocorticoids above baseline may be an indicator of the overall severity of a stress response (Hennessy et al., 1979). Each component of the stress response is variable in time; e.g., adrenalines are released nearly immediately and are used or cleared by the system quickly, whereas cortisol levels may take long periods of time to return to baseline.

The presence and magnitude of a stress response in an animal depends on a number of factors. These include the animal's life history stage (e.g., neonate, juvenile, adult), the environmental conditions, reproductive or developmental state, and experience with the stressor. Not only will these factors be subject to individual variation, but they will also vary within an individual over time. In considering potential stress responses of marine mammals to acoustic stressors, each of these should be considered. For example, is the acoustic stressor in an area where animals engage in breeding activity? Are animals in the region resident and likely to have experience with the stressor (i.e., repeated exposures)? Is the region a foraging ground or are the animals passing through as transients? What is the ratio of young (naïve) to old (experienced) animals in the population? It is unlikely that all such questions can be answered from empirical data; however, they should be addressed in any qualitative assessment of a potential stress response as based on the available literature.

The stress response may or may not result in a behavioral change**,** depending on the characteristics of the exposed animal. However, provided a stress response occurs, we assume that some contribution is made to the animal's allostatic load. Allostasis is the ability of an animal to maintain stability through change by adjusting its physiology in response to both predictable and unpredictable events (McEwen and Wingfield, 2003). The same hormones associated with the stress response vary naturally throughout an animal's life, providing support for particular life history events (e.g., pregnancy) and predictable environmental conditions (e.g., seasonal changes). The allostatic load is the cumulative cost of allostasis incurred by an animal and is generally characterized with respect to an animal's energetic expenditure. Perturbations to an animal that may occur with the presence of a stressor, either biological (e.g., predator) or anthropogenic (e.g., construction), can contribute to the allostatic load (Wingfield, 2003). Additional costs are cumulative and additions to the allostatic load over time may contribute to reductions in the probability of achieving ultimate life history functions (e.g., survival, maturation, reproductive effort and success) by producing pathophysiological states. The contribution to the allostatic load from a stressor requires estimating the magnitude and duration of the stress response, as well as any secondary contributions that might result from a change in behavior.

If the acoustic source does not produce tissue effects, is not perceived by the animal, or does not produce a stress response by any other means, Figure 4-1 assumes that the exposure does not contribute to the allostatic load. Additionally, without a stress response or auditory masking, it is assumed that there can be no behavioral change. Conversely, any immediate effect of exposure that produces an injury (i.e., red boxes on the flow chart in Figure 4-1) is assumed to also produce a stress response and contribute to the allostatic load.

4.4.2.4 Behavior

Acute stress responses may or may not cause a behavioral reaction. However, all changes in behavior are expected to result from an acute stress response. This expectation is based on the idea that some sort of physiological trigger must exist to change any behavior that is already being performed. The exception to this rule is the case of masking. The presence of a masking sound may not produce a stress response, but may interfere with the animal's ability to detect and discriminate biologically relevant signals. The inability to detect and discriminate biologically relevant signals hinders the potential for normal behavioral responses to auditory cues and is thus considered a behavioral change.

Numerous behavioral changes can occur as a result of stress response, and Figure 4-1 lists only those that might be considered the most common types of response for a marine animal. For each potential behavioral change, the magnitude in the change and the severity of the response needs to be estimated. Certain conditions, such as stampeding (i.e., flight response) or a response to a predator, might have a probability of resulting in injury. For example, a flight response, if significant enough, could produce a stranding event. Under the MMPA, such an event would be considered a Level A harassment. Each altered behavior may also have the potential to disrupt biologically significant events (e.g., breeding or nursing) and may need to be qualified as Level B harassment. All behavioral disruptions have the potential to contribute to the allostatic load. This secondary potential is signified by the feedback from the collective behaviors to allostatic loading.

Special considerations are given to the potential for avoidance and disrupted diving patterns. Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation. Although hypothetical in nature, the potential process is currently popular and hotly debated.

4.4.2.5 Life Function

4.4.2.5.1 Proximate Life Functions

Proximate life history functions are the functions that the animal is engaged in at the time of acoustic exposure. The disruption of these functions, and the magnitude of the disruption, is something that must be considered in determining how the ultimate life history functions are affected. Consideration of the magnitude of the effect to each of the proximate life history functions is dependent upon the life stage of the animal. For example, an animal on a breeding ground which is sexually immature will suffer relatively little consequence to disruption of breeding behavior when compared to an actively displaying adult of prime reproductive age.

4.4.2.5.2 Ultimate Life Functions

The ultimate life functions are those that enable an animal to contribute to the population (or stock, or species, etc.). The impact to ultimate life functions will depend on the nature and magnitude of the perturbation to proximate life history functions. Depending on the severity of the response to the stressor, acute perturbations may have nominal to profound impacts on ultimate life functions. For example, unit-level use of sonar by a vessel transiting through an area that is utilized for foraging, but not for breeding, may disrupt feeding by exposed animals for a brief period of time. Because of the brevity of the perturbation, the impact to ultimate life functions may be negligible. By contrast, weekly training over a period of years may have a more substantial impact because the stressor is chronic. Assessment of the magnitude of the stress response from the chronic perturbation would require an understanding of how and whether animals acclimate to a specific, repeated stressor and whether chronic elevations in the stress response (e.g., cortisol levels) produce fitness deficits.

The proximate life functions are loosely ordered in decreasing severity of impact. Mortality (survival) has an immediate effect, in that no future reproductive success is feasible and there is no further addition to the population resulting from reproduction. Severe injuries may also lead to reduced survivorship (longevity) and prolonged alterations in behavior. The latter may further affect an animal's overall reproductive success and reproductive effort. Disruptions of breeding have an immediate impact on reproductive effort and may impact reproductive success. The magnitude of the effect will depend on the duration of the disruption and the type of behavior change that was provoked. Disruptions to feeding and migration can affect all of the ultimate life functions; however, the impacts to reproductive effort and success are not likely to be as severe or immediate as those incurred by mortality and breeding disruptions.

4.4.2.6 Application of the Framework

For each species in the region of a proposed action, the density and occurrence of the species in the region relative to the timing of the proposed action should be determined. The probability of exposing an individual will be based on the density of the animals at the time of the action and the acoustic propagation loss. Based upon the calculated exposure levels for the individuals, or proportions of the population, an assessment for auditory and nonauditory responses should be made. Based on the available literature on the bioacoustics, physiology, dive behavior, and ecology of the species, Figure 4-1 should be used to assess the potential impact of the exposure to the population and species.

4.4.3 Regulatory Framework

The Marine Mammal Protection Act (MMPA) prohibits the unauthorized harassment of marine mammals and provides the regulatory processes for authorization for any such harassment that might occur incidental to an otherwise lawful activity.

The regulatory framework for estimating potential acoustic effects from AFAST activities on marine mammal species makes use of the methodology that was developed in cooperation with NOAA for the Navy's 2005 Draft *Overseas Environmental Impact Statement/Environmental Impact Statement, Undersea Warfare Training Range (OEIS/EIS)* (DON, 2005a). Via response comment letter to Undersea Warfare Training Range (USWTR) received from NMFS 30 January 2006, NMFS concurred with the use of energy flux density level (EL) for the determination of physiological effects to marine mammals. Therefore, this methodology was used to estimate the annual exposure of marine mammals that may be exposed to Level A harassment (sound level threshold of 215 dB or above) or Level B harassment (sound levels below 215 dB down to 195 dB B) as a result of temporary, recoverable physiological effects.

In addition, the approach for estimating potential acoustic effects from AFAST activities on marine mammals makes use of the comments received on the Navy's Draft *Overseas Environmental Impact Statement/Environmental Impact Statement, Undersea Warfare Training Range (OEIS/EIS)* (DON, 2005a) and the *2006 Supplement to the 2002 Rim of the Pacific Programmatic Environmental Assessment* (DON, 2006g). NMFS and other commenters recommended the use of an alternate methodology to evaluate when sound exposures might result in behavioral effects without corresponding physiological effects (sound levels below the 195-dB threshold). As a result of these comments, this assessment used a dose-function approach to evaluate the potential for behavioral effects.

A number of Navy actions and NMFS rulings have helped to qualify possible activities deemed as "harassment" under the MMPA. As stated previously, "harassment" under the MMPA includes both potential injury (Level A) and disruptions of natural behavioral patterns to a point where they are abandoned or significantly altered (Level B). The acoustic effects analysis and exposure calculations are based on the following premises:

- Harassment that may result from Navy operations is unintentional and incidental to those operations.
- This EIS/OEIS uses an unambiguous definition of injury as defined in the *Undersea Warfare Training Range Draft OEIS/DEIS* (DON, 2005a) and in previous rulings (NOAA, 2001, 2002a): injury occurs when any biological tissue is damaged or lost as a result of the action.
- Behavioral disruption might result in subsequent injury, and injury may cause a subsequent behavioral disruption, so Level A and Level B harassment categories can overlap and are not necessarily mutually exclusive. However, based on prior ruling (NOAA, 2001, 2006c), this EIS/OEIS assumes that Level A and B do not overlap.
- An individual animal predicted to experience simultaneous multiple injuries, multiple disruptions, or both is counted as a single take (see NOAA, 2001, 2006c). An animal whose behavior is disrupted by an injury has already been counted as a Level A harassment and will not also be counted as a Level B harassment.
- The acoustic effects analysis is based on primary exposures to the action. Secondary or indirect effects, such as susceptibility to predation following injury and injury resulting from disrupted behavior may not be readily determined unless directly observed, or the risk of occurrence concluded from previous well-documented examples. Consideration of secondary effects would result in some Level A harassment being considered Level B harassment, and vice versa, since much injury (Level A harassment) has the potential to disrupt behavior (Level B harassment), and much temporary physiological or behavioral disruption (Level B) could be conjectured to have the potential for injury (Level A). Consideration of secondary effects would lead to circular definitions of harassment.
- Animals are uniformly distributed and remain stationary during the active sonar events; therefore, the model does not account for any animal response.

4.4.4 Integration of Regulatory and Biological Frameworks

This section presents a biological framework within which potential effects can be categorized and then related to the existing regulatory framework of injury (Level A) and behavioral disruption (Level B). The information presented in the subsections below was used to develop specific numerical exposure thresholds and dose-function estimations. Exposure thresholds were combined with sound propagation models and species distribution data to estimate the potential exposures.

4.4.4.1 Physiological and Behavioral Effects

Sound exposure may affect multiple biological traits of a marine animal; however, the MMPA as amended directs which traits should be used when determining effects. Effects that address injury are considered Level A harassment under MMPA. Effects that address behavioral disruption are considered Level B harassment under MMPA.

The biological framework discussed here is structured according to potential physiological and behavioral effects resulting from sound exposure. The range of effects may then be assessed to determine which qualify as injury or behavioral disturbance under MMPA regulations. Physiology and behavior are chosen over other biological traits because:

- They are consistent with regulatory statements defining harassment by injury and harassment by disturbance.
- They are components of other biological traits that may be relevant.
- They are a more sensitive and immediate indicator of effect.

For example, ecology is not used as the basis of the framework because the ecology of an animal is dependent on the interaction of an animal with the environment. The animal's interaction with the environment is driven both by its physiological function and its behavior, and an ecological effect may not be observable over short periods of observation. Ecological information is considered in the analysis of the effects to individual species.

A "physiological effect" is defined here as one in which the "normal" physiological function of the animal is altered in response to sound exposure. Physiological function is any of a collection of processes ranging from biochemical reactions to mechanical interaction and operation of organs and tissues within an animal. Physiological effects may range from the most significant of effects (i.e., mortality and serious injury) to lesser effects that define the lower end of the physiological effects range, such as the noninjurious distortion of auditory tissues. This latter physiological effect is important to the integration of the biological and regulatory frameworks and receives additional attention in later sections.

A "behavioral effect" is one in which the "normal" behavior or patterns of behavior of an animal are overtly disrupted in response to an acoustic exposure. Examples of behaviors of concern can be derived from the harassment definitions in the MMPA and the Endangered Species Act (ESA).

In this EIS/OEIS, the term "normal" is used to qualify distinctions between physiological and behavioral effects. Its use follows the convention of normal daily variation in physiological and behavioral function without the influence of anthropogenic (e.g., man-made) acoustic sources. As a result, this AFAST EIS/OEIS uses the following definitions:

- A physiological effect is a variation in an animal's physiology that results from an anthropogenic acoustic exposure and exceeds the normal daily variation in physiological function.
- A behavioral effect is a variation in an animal's behavior or behavior patterns that results from an anthropogenic acoustic exposure and exceeds the normal daily variation in behavior but arises through normal physiological process (i.e., it occurs without an accompanying physiological effect).
- The definitions of physiological effect and behavioral effect used here are specific to this document and should not be confused with wider definitions applied to the field of biology.

It is reasonable to expect some physiological effects to result in subsequent behavioral effects. For example, a marine mammal that suffers a severe injury may be expected to alter diving or foraging to the degree that its variation in these behaviors is outside that which is considered normal for the species. If a physiological effect is accompanied by a behavioral effect, the overall effect is characterized as a physiological effect; physiological effects take precedence over behavioral effects with regard to their ordering. This approach provides the most conservative ordering of effects with respect to severity, provides a rational approach to dealing with the overlap of the definitions, and avoids circular arguments.

The severity of physiological effects generally decreases with decreasing sound exposure and/or increasing distance from the sound source. The same generalization does not consistently hold for behavioral effects, because they do not depend solely on the received sound level. Behavioral responses also depend on an animal's learned responses, innate response tendencies, motivational state, the pattern of the sound exposure, and the context in which the sound is presented. However, to provide a tractable approach to predicting acoustic effects that is relevant to the terms of behavioral disruption described in the MMPA, it is assumed here that the severities of behavioral effects also decrease with decreasing sound exposure and/or increasing distance from the sound source. Figure 4-2 shows the relationship between severity of effects, source distance, and exposure level, as defined in this EIS/OEIS.

4.4.4.2 MMPA Level A and Level B Harassment

Categorizing potential effects as either physiological or behavioral allows correlation of the effects to the harassment definitions. For military readiness activities, Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury, as defined in previous rulings (NOAA, 2001, 2002a), is the destruction or loss of biological tissue. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of

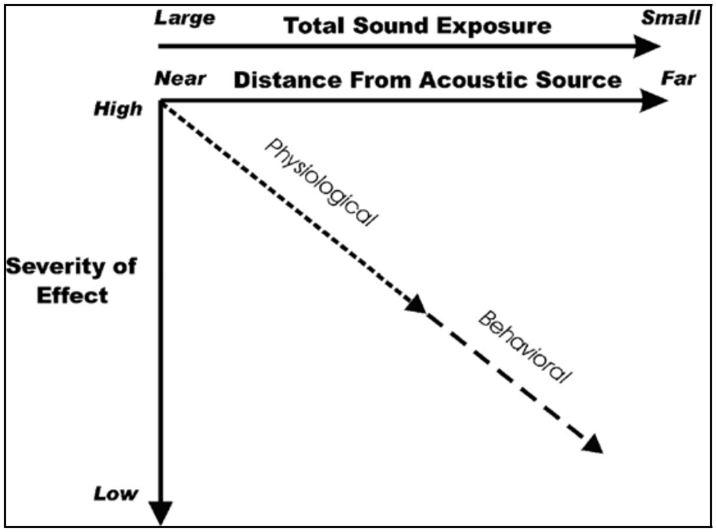

Figure 4-2. Relationship Between Severity of Effects, Source Distance, and Exposure Level

the intact tissue. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury. Therefore, this AFAST EIS/OEIS assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings (NOAA, 2001), all injuries (slight to severe) are considered Level A harassment.

Public Law (PL) 108-136 (2004) amended the MMPA definitions of Level B harassment for military readiness activities, which applies to this action. For military readiness activities, Level B harassment is defined as “any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered.” Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause Level B harassment.

For example, some physiological effects can occur that are noninjurious but that can potentially disrupt the behavior of a marine mammal. These include temporary distortions in sensory tissue that alter physiological function but are fully recoverable without the requirement for tissue replacement or regeneration. For example, an animal that experiences a temporary reduction in hearing sensitivity suffers no injury to its auditory system but may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction. This lack of response qualifies as a temporary disruption of normal behavioral patterns—the animal is impeded from responding in a normal manner to an acoustic stimulus.

The harassment status of slight behavior disruption has been addressed in workshops, previous actions, and rulings (NOAA, 1999, 2001; DON, 2001b). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic activity does not qualify as Level B harassment. A more general conclusion, that Level B harassment occurs only when there is "a potential for a significant behavioral change or response in a biologically important behavior or activity," is found in recent rulings (NOAA, 2002a).

Although the temporary lack of response discussed above may not result in abandonment or significant alteration of natural behavioral patterns, the acoustic effect inputs used in the acoustic model assume that temporary hearing impairment (slight to severe) is considered Level B harassment. These conclusions and definitions, including the 2004 amendments to the definitions of harassment, were considered in the context of the proposed AFAST activities in developing conservative thresholds for behavioral disruptions. As a result, the actual incidental harassment of marine mammals associated with this action may be less than that calculated.

4.4.4.3 MMPA Exposure Zones

Two acoustic modeling approaches are used to account for both physiological and behavioral effects to marine mammals. This subsection on exposure zones is specific to the modeling of total energy. When using a threshold of accumulated energy, the volumes of ocean in which Level A and Level B harassment are predicted to occur are called "exposure zones." As a conservative estimate, all marine mammals predicted to be in a exposure zone are considered exposed to accumulated sound levels that may result in harassment within the applicable Level A or Level B harassment categories. Figure 4-3 illustrates exposure zones extending from a hypothetical, directional sound source.

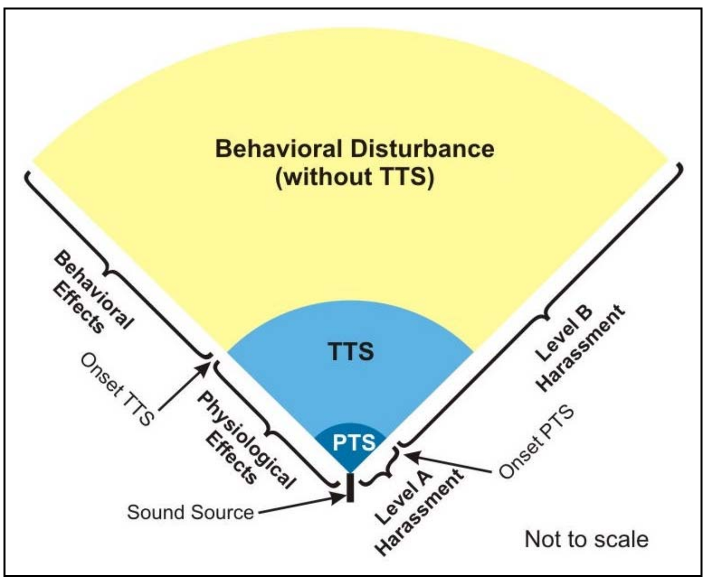

Figure 4-3. Exposure Zones Extending From a Hypothetical, Directional Sound Source
(This figure is not to scale and is intended to illustrate the general relationships between exposure zones and does not represent the sizes or shapes of the actual harassment zones)

The Level A exposure zone extends from the source out to the distance and exposure at which the slightest amount of injury is predicted to occur. The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the Level A exposure zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure takes into account all more serious injuries by inclusion within the Level A exposure zone.

The Level B exposure zone begins just beyond the point of slightest injury and extends outward from that point to include all animals that may possibly experience Level B harassment. Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs but without destruction or loss of that tissue. The animals predicted to be in this exposure zone are assumed to experience Level B harassment by virtue of temporary impairment of sensory function (i.e., altered physiological function) that can disrupt behavior.

4.4.4.4 Auditory Tissues as Indicators of Physiological Effects

Exposure to continuous sound may cause a variety of physiological effects in mammals. For example, exposure to very high sound levels may affect the function of the visual system, vestibular system, and internal organs (Ward, 1997). Exposure to high-intensity, continuous sounds of sufficient duration may cause injury to the lungs and intestines (e.g., Dalecki et al., 2002). Sudden, intense sounds may elicit a "startle" response and may be followed by an orienting reflex (Ward, 1997; Jansen, 1998). The primary physiological effects of sound, however, are on the auditory system (Ward, 1997).

The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the middle ears to fluids within the inner ear, except in cetaceans. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to overstimulation by sound exposure (Yost, 1994).

Very high sound levels may rupture the eardrum or damage the small bones in the middle ear (Yost, 1994). Lower level exposures of sufficient duration may cause permanent or temporary hearing loss; such an effect is called a noise-induced threshold shift, or simply a threshold shift (TS) (Miller, 1974). A TS may be either temporary (TTS) or permanent (PTS). PTS does not equal permanent hearing loss; more correctly, it is a permanent loss of hearing sensitivity, usually over a subset of the animal's hearing range. Similarly, TTS is a temporary hearing sensitivity loss, usually over a subset of the animal's hearing range. Still lower levels of sound may result in auditory masking, which may interfere with an animal's ability to hear other concurrent sounds.

Because the tissues of the ear appear to be the most susceptible to the physiological effects of sound and TSs tend to occur at lower exposures than other, more serious auditory effects, PTS and TTS are used here as the biological indicators of physiological effects. TTS is the first indication of physiological noninjurious change and is not physical injury. The remainder of this section is, therefore, focused on TSs, including PTSs and TTSs. Since masking (without a resulting TS) is not associated with abnormal physiological function, it is not considered a physiological effect for purposes of this assessment but rather a potential behavioral effect.

4.4.4.4.1 Noise-Induced Threshold Shifts

The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy lead to approximately equal effects (Ward, 1997). For intermittent sounds, less TS occurs than from a continuous exposure with the same energy (i.e., some recovery will occur between exposures) (Kryter et al., 1966; Ward, 1997).

The magnitude of a TS normally decreases with the amount of time post-exposure (Miller, 1974). The amount of TS just after exposure is called the "initial TS." If the TS activity returns to zero (the threshold returns to the pre-exposure value), the TS is a TTS. Since the amount of TTS depends on the time postexposure, it is common to use a subscript to indicate the time in minutes after exposure (Quaranta et al., 1998). For example, TTS_2 means a TTS measured 2 minutes after exposure. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. Figure 4-4 shows two hypothetical TSs: one that completely recovers (i.e., a TTS) and one that does not completely recover, leaving some PTS.

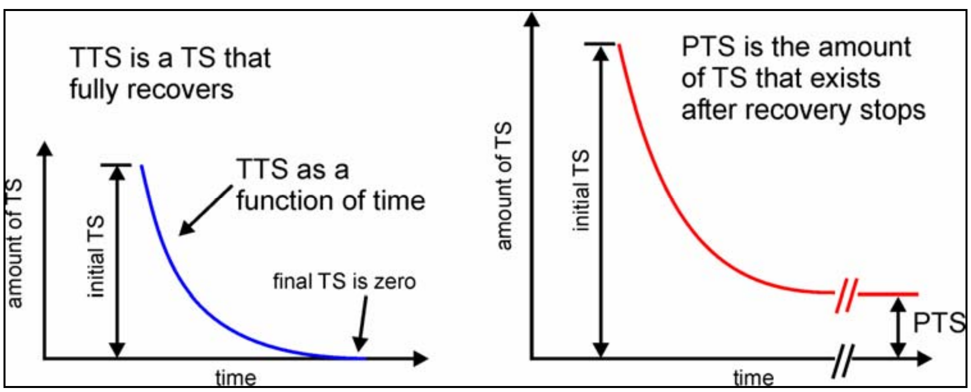

Figure 4-4. Hypothetical Temporary and Permanent Threshold Shifts

4.4.4.4.2 PTS, TTS, and Exposure Zones

PTS is nonrecoverable and therefore, qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. The smallest amount of PTS (onset-PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset-PTS is used to define the outer limit of the Level A exposure zone.

TTS is recoverable and, as in recent rulings (NOAA, 2001; 2002a), is considered to result from the temporary, noninjurious distortion of hearing-related tissues. In the AFAST Study Area, the smallest measurable amount of TTS (onset-TTS) is taken as the best indicator for slight temporary sensory impairment. Because it is considered noninjurious, the acoustic exposure associated with onset-TTS is used to define the outer limit of the portion of the Level B exposure zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it. Therefore, in this EIS/OEIS, the potential for TTS is considered as a Level B harassment that is mediated by physiological effects upon the auditory system.

4.4.4.5 ESA Harm and Harassment

The Navy entered into an ESA Section 7 consultation with NMFS for AFAST activities on 23 July 2007. A component of NMFS assessment is the conduct of an exposure analysis, which relies in part on the results of the acoustic models prepared based on the MMPA evaluations, as described previously. The ESA does not define harassment, nor has NMFS defined the term, pursuant to the ESA, through regulation.

4.4.4.6 Summary

The volumes of ocean in which Level A and Level B harassment are predicted to occur are described as exposure zones. The exposure zone for Level A harassment extends from the source out to the distance and exposure where onset-PTS is predicted to occur. The exposure zone for Level B harassment begins just beyond the point of onset-PTS and extends outward to the distance and exposure where no (biologically significant) behavioral disruption is expected to occur. The exposure zone for Level B harassment includes both behavioral effects and physiological effects and includes the region in which TTS is predicted to occur.

4.4.5 Criteria and Thresholds for Physiological Effects (Active Sonar)

This section presents the effect criteria and thresholds for physiological effects of sound leading to injury and behavioral disturbance as a result of sensory impairment. The tissues of the ear are the most susceptible to physiological effects of underwater sound. PTS and TTS were determined to be the most appropriate biological indicators of physiological effects that equate to the onset of injury (Level A harassment) and behavioral disturbance (Level B harassment), respectively. This section focuses on criteria and thresholds to predict PTS and TTS in marine mammals.

The most appropriate information from which to develop PTS/TTS criteria for marine mammals is experimental measurements of PTS and TTS from marine mammal species of interest. TTS data exist for several marine mammal species and may be used to develop meaningful TTS criteria and thresholds. PTS data do not exist for marine mammals and are unlikely to be obtained. Therefore, PTS criteria must be developed from TTS criteria and estimates of the relationship between TTS and PTS.

This section begins with a review of the existing marine mammal TTS data. The review is followed by a discussion of the relationship between TTS and PTS. The specific criteria and thresholds for TTS and PTS used in this EIS/OEIS are then presented. This is followed by discussions of sound energy flux density level (EL), the relationship between EL and SPL, and the use of SPL and EL in previous environmental compliance documents.

4.4.5.1 Energy Flux Density Level and Sound Pressure Level

EL is a measure of the sound energy flow per unit area expressed in dB. EL is stated in dB decibels referenced to 1 micro Pascal squared second (dB re 1 µPa^2-s) for underwater sound and dB re 20 µPa^2-s for airborne sound.

SPL is a measure of the root-mean square, or "effective," sound pressure in decibels. SPL is expressed in dB re 1 µPa for underwater sound and dB re 20 µPa for airborne sound.

4.4.5.2 TTS in Marine Mammals

A number of investigators have measured TTS in marine mammals. These studies measured hearing thresholds in trained marine mammals before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset TTS levels—exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (e.g., Schlundt et al., 2000). The existing marine mammal TTS data are summarized below.

Schlundt et al. **(2000)** reported the results of TTS experiments conducted with bottlenose dolphins and white whales exposed to one second tones. This paper also includes a re-analysis of preliminary TTS data released in a technical report by Ridgway et al. (1997). At frequencies of 3, 10, and 20 kilohertz (kHz), SPLs necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB re 1 µPa (EL = 192 to 201 dB re 1 µPa^2-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 µPa and 195 dB re 1 µPa^2-s, respectively. The sound exposure stimuli (tones) and relatively large number of test subjects (five dolphins and two white whales) make the Schlundt et al. (2000) data the most directly relevant TTS information for the scenarios described in this EIS/OEIS.

Finneran et al. (2001, 2003, 2005) described TTS experiments conducted with bottlenose dolphins exposed to 3-kHz tones for durations of 1, 2, 4, and 8 seconds. Small amounts of TTS (3 to 6 dB) were observed in one dolphin after exposure to ELs between 190 and 204 dB re 1 µPa^2-s. These results were consistent with the data of Schlundt et al. (2000) and showed that the Schlundt et al. (2000) data were not significantly affected by the masking sound used. These results also confirmed that, for tones with different durations, the amount of TTS is best correlated with the exposure EL rather than the exposure SPL.

Nachtigall et al. (2003a, 2004) measured TTS in a bottlenose dolphin exposed to octave-band sound centered at 7.5 kHz. Nachtigall et al. (2003a) reported TTSs of about 11 dB measured 10 to 15 minutes after exposure to 30 to 50 minutes of sound with SPL 179 dB re 1 µPa (EL about 213 dB re µPa^2-s). No TTS was observed after exposure to the same sound at 165 and 171 dB re 1 µPa. Nachtigall et al. (2004) reported TTSs of around 4 to 8 dB 5 minutes after exposure to 30 to 50 minutes of sound with SPL 160 dB re 1 µPa (EL about 193 to 195 dB re 1 µPa^2-s). The difference in results was attributed to faster post-exposure threshold measurement—TTS may have recovered before being detected by Nachtigall et al. (2003a). These studies showed that, for long-duration exposures, lower sound pressures are required to induce TTS than are required for short-duration tones. These data also confirmed that, for the cetaceans studied, EL is the most appropriate predictor for onset-TTS.

Finneran et al. (2000, 2002) conducted TTS experiments with dolphins and white whales exposed to impulsive sounds similar to those produced by distant underwater explosions and seismic waterguns. These studies showed that, for very short-duration impulsive sounds, higher sound pressures were required to induce TTS than for longer-duration tones.

Kastak et al. (1999, 2005) conducted TTS experiments with three species of pinnipeds, California sea lion, northern elephant seal, and a Pacific harbor seal exposed to continuous underwater sounds at levels of 80 and 95 dB Sensation Level (SL) at 2.5 and 3.5 kHz for up to 50 minutes. Mean TTS shifts of up to 12.2 dB occurred, with the harbor seals showing the largest shift of 28.1 dB. Increasing the sound duration had a greater effect on TTS than increasing the sound level from 80 to 95 dB.

Figure 4-5 shows the existing TTS data for cetaceans (dolphins and white whales). Individual exposures are shown in terms of SPL versus exposure duration (upper panel) and EL versus exposure duration (lower panel). Exposures that produced TTS are shown as filled symbols. Exposures that did not produce TTS are represented by open symbols. The squares and triangles represent impulsive test results from Finneran et al., 2000 and 2002, respectively. The circles show the 3-, 10-, and 20-kHz data from Schlundt et al. (2000) and the results of Finneran et al. (2003). The inverted triangle represents data from Nachtigall et al. (2004). Figure 4-5 illustrates that the effects of the different sound exposures depend on the SPL and duration. As the duration decreases, higher SPLs are required to cause TTS. In contrast, the ELs required for TTS do not show the same type of variation with exposure duration.

The solid line in the upper panel of Figure 4-5 has a slope of -3 dB per doubling of time. This line passes through the point where the SPL is 195 dB re 1 µPa and the exposure duration is 1 second. Since EL = SPL + $10\log_{10}$(duration), doubling the duration *increases* the EL by 3 dB. Subtracting 3 dB from the SPL *decreases* the EL by 3 dB. The line with a slope of -3 dB per doubling of time, represents an *equal energy line*—all points on the line have the same EL, which is, in this case, 195 dB re 1 μPa^2-s. This line appears in the lower panel as a horizontal line at 195 dB re 1 μPa^2-s. The equal energy line at 195 dB re 1 μPa^2-s fits the tonal and sound data (i.e., the nonimpulsive data) very well, despite differences in exposure duration, SPL, experimental methods, and subjects.

In summary, the existing marine mammal TTS data show that, for the species studied and sounds (nonexplosive) of interest, the following is true:

- The growth and recovery of TTS are comparable to those in land mammals. This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward, 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Ward, 1997).

- SPL by itself is not a good predictor of onset-TTS, since the amount of TTS depends on both SPL and duration.

- Exposure EL is correlated with the amount of TTS and is a good predictor for onset-TTS for single, continuous exposures with different durations. This agrees with human TTS data presented by Ward et al. (1958, 1959). An EL of 195 dB re 1 µPa^2-s is the most appropriate predictor for onset-TTS from a single, continuous exposure

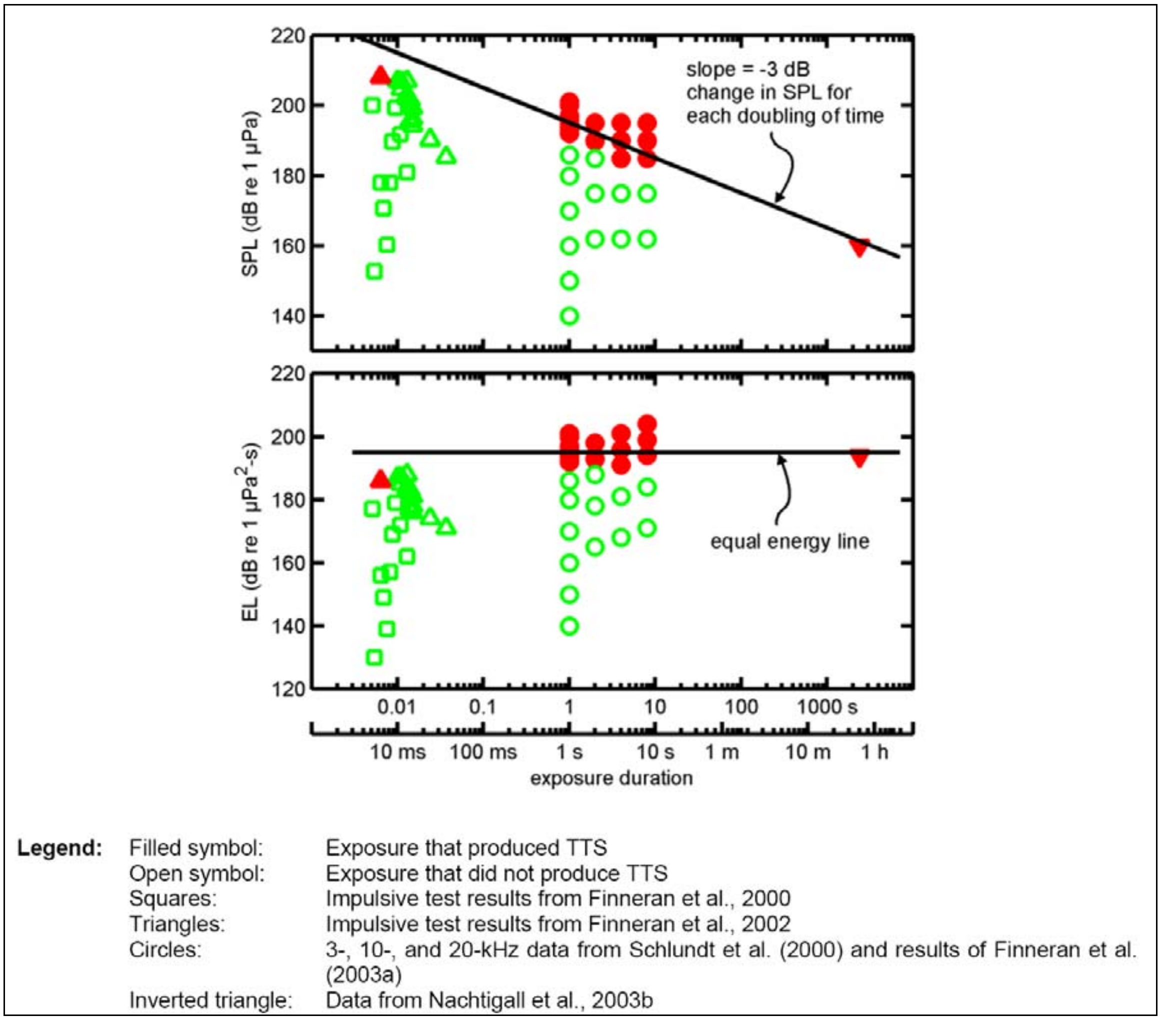

Figure 4-5. Existing TTS Data for Cetaceans

4.4.5.3 Relationship Between TTS and PTS

Since marine mammal PTS data do not exist, onset-PTS levels for these animals must be estimated using TTS data and relationships between TTS and PTS. Much of the early human TTS work was directed toward relating TTS_2 after 8 hours of sound exposure to the amount of PTS that would exist after years of similar daily exposures (e.g., Kryter et al., 1966). Although it is now acknowledged that susceptibility to PTS cannot be reliably predicted from TTS measurements, TTS data do provide insight into the amount of TS that may be induced without a PTS. Experimental studies of the growth of TTS may also be used to relate changes in exposure level to changes in the amount of TTS induced. Onset-PTS exposure levels may therefore be predicted by:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS that, again, may be induced without PTS. This is equivalent to estimating the growth rate of TTS—how much additional TTS is produced by an increase in exposure level.

Experimentally induced TTSs in marine mammals have generally been limited to around 2 to 10 dB, well below TSs that result in some PTS. Experiments with terrestrial mammals have used much larger TSs and provide more guidance on how high a TS may rise before some PTS results. Early human TTS studies reported complete recovery of TTSs as high as 50 dB after exposure to broadband sound (Ward, 1960; Ward et al., 1958, 1959). Ward et al. (1959) also reported slower recovery times when TTS_2 approached and exceeded 50 dB, suggesting that 50 dB of TTS_2 may represent a "critical" TTS. Miller et al. (1963) found PTS in cats after exposures that were only slightly longer in duration than those causing 40 dB of TTS. Kryter et al. (1966) stated: "A TTS_2 that approaches or exceeds 40 dB can be taken as a signal that danger to hearing is imminent." These data indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS.

The small amounts of TTS produced in marine mammal studies also limit the applicability of these data to estimates of the growth rate of TTS. Fortunately, data do exist for the growth of TTS in terrestrial mammals. For moderate exposure durations (a few minutes to hours), TTS_2 varies with the logarithm of exposure time (Ward et al., 1958, 1959; Quaranta et al., 1998). For shorter exposure durations, the growth of TTS with exposure time appears to be less rapid (Miller, 1974; Keeler, 1976). For very long duration exposures, increasing the exposure time may fail to produce any additional TTS, a condition known as asymptotic threshold shift (Saunders et al., 1977; Mills et al., 1979).

Ward et al. (1958 and 1959) provided detailed information on the growth of TTS in humans. Ward et al. presented the amount of TTS measured after exposure to specific SPLs and durations of broadband sound. Since the relationship between EL, SPL, and duration is known, these same data could be presented in terms of the amount of TTS produced by exposures with different ELs. Figure 4-6 shows results from Ward et al. (1958 and 1959) plotted as the amount of TTS_2 versus the exposure EL. The data in Figure 4-6(a) are from broadband (75 hertz [Hz] to 10 kHz) sound exposures with durations of 12 to 102 minutes (Ward et al., 1958). The symbols represent mean TTS_2 for 13 individuals exposed to continuous sound. The solid line is a linear regression fit to all but the two data points at the lowest exposure EL. The experimental data are fit well by the regression line (R2 = 0.95). These data are important for two reasons: (1) they confirm that the amount of TTS is correlated with the exposure EL; and (2) the slope of the line allows one to estimate the additional amount of TTS produced by an increase in exposure. For example, the slope of the line in Figure 4-6 is approximately 1.5 dB TTS_2 per dB of EL. This means that each additional dB of EL produces 1.5 dB of additional TTS_2.

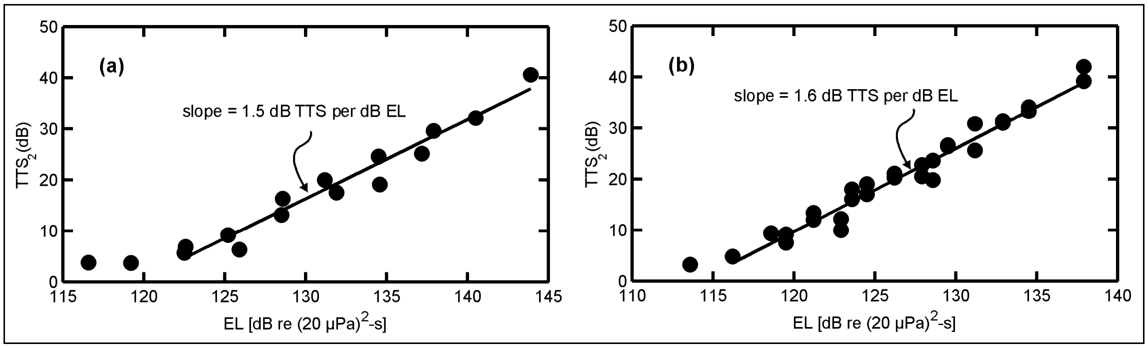

Figure 4-6. Growth of TTS Versus the Exposure EL
(from Ward et al. [1958, 1959])

The data in Figure 4-6(b) are from octave-band sound exposures (2.4 to 4.8 kHz) with durations of 12 to 102 minutes (Ward et al., 1959). The symbols represent mean TTS for 13 individuals exposed to continuous sound. The linear regression was fit to all but the two data points at the lowest-exposure EL. The results are similar to those shown in Figure 4-6(a). The slope of the regression line fit to the mean TTS data was 1.6 dB TTS_2/dB EL. A similar procedure was carried out for the remaining data from Ward et al. (1959), with comparable results. Regression lines fit to the TTS versus EL data had slopes ranging from 0.76 to 1.6 dB TTS_2/dB EL, depending on the frequencies of the sound exposure and hearing test.

An estimate of 1.6 dB TTS_2 per dB increase in exposure EL is the upper range of values from Ward et al. (1958 and 1959) and gives the most conservative estimate—it predicts a larger amount of TTS from the same exposure compared to the lines with smaller slopes. The difference between onset-TTS (6 dB) and the upper limit of TTS before PTS (40 dB) is 34 dB. To move from onset-TTS to onset-PTS, therefore, requires an increase in EL of 34 dB divided by 1.6 dB/dB, or approximately 21 dB. An estimate of 20 dB between exposures sufficient to cause onset-TTS and those capable of causing onset-PTS is a reasonable approximation. To summarize:

- In the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:
- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the growth rate of TTS, (i.e., determining how much additional TTS is produced by an increase in exposure level).
- A variety of terrestrial mammal data sources point toward 40 dB as a reasonable estimate of the largest amount of TS that may be induced without PTS. A conservative estimate is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.

- Data from Ward et al. (1958 and 1959) reveal a linear relationship between TTS2 and exposure EL. A 1.6 dB TTS2 per dB increase in EL is a conservative estimate of how much additional TTS is produced by an increase in exposure level for continuous-type sounds.
- There is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB). The additional exposure above onset-TTS that is required to reach PTS is therefore 34 dB divided by 1.6 dB/dB, or approximately 21 dB.
- Exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. This number is used as a conservative simplification of the 21 dB number derived above.

4.4.5.4 Threshold Levels for Harassment From Physiological Effects

For this specified action, sound exposure thresholds for TTS and PTS are as presented in the following box:

195 dB re 1 µPa^2-s received EL for TTS
215 dB re 1 µPa^2-s received EL for PTS

Marine mammals predicted to receive a sound exposure with EL of 215 dB re 1 µPa^2-s or greater are assumed to experience PTS and are counted as Level A harassment exposures. Marine mammals predicted to receive a sound exposure with EL greater than or equal to 195 dB re 1 µPa^2-s but less than 215 dB re 1 µPa^2-s are assumed to experience TTS and are counted as Level B harassment exposures.

The TTS threshold is primarily based on the cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The mean exposure EL required to produce onset-TTS in these tests was 195 dB re 1 µPa^2-s. This result is corroborated by the short-duration tone data of Finneran et al. (2000, and 2003) and the long-duration sound data from Nachtigall et al. (2003a, 2004). Together, these data demonstrate that TTS in cetaceans is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 µPa^2-s.

The PTS threshold is based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959).

4.4.5.5 Use of EL for Physiological Effect Thresholds

Effect thresholds are expressed in terms of total received EL. Energy flux density is a measure of the flow of sound energy through an area. Marine and terrestrial mammal data show that, for continuous sounds of interest, TTS and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The EL for each individual ping is calculated using the following equation:

$$EL = SPL + 10\log_{10}(\text{duration})$$

The EL includes both the ping SPL and duration. Longer-duration pings and/or higher-SPL pings will have a higher EL.

If an animal is exposed to multiple pings, the energy flux density in each individual ping is summed to calculate the total EL. Since mammalian TS data show less effect from intermittent exposures compared to continuous exposures with the same energy (Ward, 1997), basing the effect thresholds on the total received EL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the effect of a particular exposure. Therefore, estimates are conservative because recovery is not taken into account—intermittent exposures are considered comparable to continuous exposures.

The total EL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total EL and determine whether the received EL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 µPa and duration = 1 second.
- A single ping with SPL = 192 dB re 1 µPa and duration = 2 seconds.
- Two pings with SPL = 192 dB re 1 µPa and duration = 1 second.
- Two pings with SPL = 189 dB re 1 µPa and duration = 2 seconds.

4.4.5.6 Comparison to Surveillance Towed Array Sensor System Low-Frequency Active Risk Functions

The physiological effect thresholds described in this EIS/OEIS should not be confused with criteria and thresholds used for the Navy's Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) sonar. SURTASS LFA features pings lasting many tens of seconds. The sonars of concern for use during AFAST activities emit pings lasting a few seconds at most. SURTASS LFA risk functions were expressed in terms of the received "single ping equivalent" SPL. Physiological effect thresholds in this EIS/OEIS are expressed in terms of the total received EL. The SURTASS LFA risk function parameters cannot be directly compared to the effect thresholds used in the AFAST EIS/OEIS. Comparisons must take into account the differences in ping duration, number of pings received, and method of accumulating effects over multiple pings.

4.4.5.7 Previous Use of EL for Physiological Effects

Energy measures have been used as a part of dual criteria for cetacean auditory effects in shock trials, which only involve impulsive-type sounds (DON, 1998 and 2001b). These actions used

192 dB re 1 µPa^2-s as a reference point to derive a TTS threshold in terms of EL. A second TTS threshold, based on peak pressure, was also used. If either threshold was exceeded, effect was assumed.

The 192 dB re 1 µPa^2-s reference point differs from the threshold of 195 dB re 1 µPa^2-s used in this document. The 192 dB re 1 µPa^2-s value was based on the minimum observed by Ridgway et al. (1997) and Schlundt et al. (2000) during TTS measurements with bottlenose dolphins exposed to one second tones. At the time, no impulsive test data for marine mammals were available and the one second tonal data were considered to be the best available. The minimum value of the observed range of 192 to 201 dB re 1 µPa^2-s was used to protect against misinterpretation of the sparse data set available. The 192 dB re 1 µPa^2-s value was reduced to 182 dB re 1 µPa^2-s to accommodate the potential effects of pressure peaks in impulsive waveforms.

The additional data now available for onset-TTS in small cetaceans confirm the original range of values and increase confidence in it (Finneran et al., 2001 and 2003; Nachtigall et al., 2003a and 2004). The acoustical analyses uses the more complete data available and the mean value of the entire Schlundt et al. (2000) data set (195 dB re 1 µPa^2-s), instead of the minimum of 192 dB re 1 µPa^2-s. From the standpoint of statistical sampling and prediction theory, the mean is the most appropriate predictor—the "best unbiased estimator"—of the EL at which onset-TTS should occur; predicting the number of exposures in future actions relies (in part) on using the EL at which onset-TTS will most likely occur. When that EL is applied over many pings in each of many sonar exercises, that value will provide the most accurate prediction of the actual number of exposures by onset-TTS over all of those exercises. Use of the minimum value would overestimate the number of exposures because many animals counted would not have experienced onset-TTS. Further, no logical limiting minimum value of the distribution would be obtained from continued successive testing. Continued testing and use of the minimum would produce more and more erroneous estimates.

4.4.5.8 Summary of Criteria and Thresholds for Physiological Effects

PTS and TTS are used as the criteria for physiological effects resulting in injury (Level A harassment) and disturbance (Level B harassment), respectively. Sound exposure thresholds for TTS and PTS are 195 dB re 1 µPa^2-s received EL for TTS and 215 dB re 1 µPa^2-s received EL for PTS. The TTS threshold is primarily based on cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The PTS threshold is based on a 20-dB increase in exposure EL over that required for onset-TTS. The 20-dB value is based on extrapolations from terrestrial mammal data indicating that PTS occurs at 40 dB or more of TS and that TS growth occurring at a rate of approximately 1.6 dB/dB increases in exposure EL.

4.4.6 Criteria and Thresholds for Behavioral Effects (Active Sonar)

This section presents the effect criterion and threshold for behavioral effects of sound leading to behavioral disturbance without accompanying physiological effects. Since TTS is used as the biological indicator for a physiological effect leading to behavioral disturbance, the behavioral effects discussed in this section may be thought of as behavioral disturbance occurring at exposure levels below those causing TTS.

4.4.6.1 History of Assessing Potential Harassment from Behavioral Effects

PTS and TTS are used as the criteria for physiological effects resulting in injury (Level A harassment) and disturbance (Level B harassment), respectively. Sound exposure thresholds for TTS and PTS are 195 dB re 1 μPa^2-s received EL for TTS and 215 dB re 1 μPa^2-s received EL for PTS. The TTS threshold is primarily based on cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The PTS threshold is based on a 20-dB increase in exposure EL over that required for onset-TTS. The 20-dB value is based on extrapolations from terrestrial mammal data indicating that PTS occurs at 40 dB or more of TS and that TS growth occurring at a rate of approximately 1.6 dB/dB increases in exposure EL.

Behavioral observations of trained cetaceans exposed to intense underwater sound under controlled circumstances are an important data set in evaluating and developing a criterion and threshold for behavioral effects of sound. These behavioral response data are an important foundation for the scientific basis of the Navy's prior threshold of onset behavioral effects because of the: (1) finer control over acoustic conditions; (2) greater quality and confidence in recorded sound exposures; and (3) the exposure stimuli closely match those of interest for the mid-frequency active sonar used during AFAST activities. Since no comparable controlled exposure data for wild animals exist, or are likely to be obtained in the near-term, the relationship between the behavioral results reported by Finneran and Schlundt (2004) and wild animals is not known. Although experienced, trained subjects may tolerate higher sound levels than inexperienced animals; it is also possible that prior experiences and resultant expectations may have made some trained subjects less tolerant of sound exposures. However, in response to USWTR comments, potential differences between trained subjects and wild animals were considered by the Navy in conjunction with NMFS in the Navy's application for harassment authorization for RIMPAC 2006. At that time, NMFS recommended the Navy include analysis of this threshold based on NMFS' evaluation of behavioral observations of marine mammals under controlled conditions, plus NMFS' interpretation of two additional studies on reactions to vessel sound (Nowacek et al., 2004) and analysis for the U.S.S. Shoup event (NMFS, 2005c).

For that exercise, a conservative threshold for effect was derived compared to the regulatory definition of harassment, and the Navy agreed to the use of the 173 dB re 1 μPa^2-s threshold for the RIMPAC incidental harassment authorization (IHA) request. Rationale for using energy flux density for evaluation of behavioral effects included:

- EL effect exposures account for both the exposure SPL and duration. Both SPL and duration of exposure affect behavioral responses to sound, so a behavioral effect threshold based on EL accounts for exposure duration.
- EL takes into account the effects of multiple pings. Effect thresholds based on SPL predict the same effect regardless of the number of received sounds. Previous actions using SPL-based criteria included implicit methods to account for multiple pings, such as the single-ping equivalent used in the surveillance towed array sensor system low frequency active (SURTASS LFA) (DON, 2001a).

- EL allows a rational ordering of behavioral effects with physiological effects. The effect thresholds for physiological effects are stated in terms of EL because experimental data described above showed that the observed effects (TTS and PTS) are correlated best with the sound energy, not the SPL. Using EL for behavioral effects allows the behavioral and physiological effects to be placed on a single exposure scale, with behavioral effects occurring at lower exposures than physiological effects.

Subsequent to issuance of the RIMPAC IHA, additional public comments were received and considered. Based on this input, the Navy continued to coordinate with NMFS to determine whether an alternate approach to energy flux density could be used to evaluate when a marine mammal may behaviorally be affected by mid-frequency sonar sound exposures. Coordination between the Navy and NMFS produced the adoption of dose function for evaluation of behavioral effects. The dose function approach for evaluating behavioral effects is described below and fully considers the controlled, tonal sound exposure data, in addition to comments received from regulatory agencies, the scientific community and the public regarding concerns with the use of EL for evaluating the effects of sound on wild animals.

4.4.6.2 Defining MMPA Level B Behavioral Harassment Using Risk Function

In the Hawaii Range Complex Draft EIS, the Navy presented a dose methodology to assess MMPA Level B behavioral harassment from the effects of mid-frequency active sonar on marine mammals. Based on comments received from the public and regulator on the Draft EIS, Navy now presents a more concise mathematical representation of a risk assessment to define behavioral harassment under the MMPA. This Draft EIS explains the approach for assessing MMPA Level B behavioral harassment from the effects of MFA sonar on marine mammals using the mathematical function previously presented in the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) EIS (DON, 2001) and relied on in Supplemental SURTASS LFA EIS (DON, 2007) with input parameters modified for MFA sonar.

4.4.6.3 Summary of Potential Behavioral Effects of MFA Sonar

Based on the evidence available, marine animals are likely to exhibit any of a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonar transmissions. Potential behavioral responses include, but are not limited to:

- They will try to avoid exposure or continued exposure,
- They will experience behavioral disturbance (including distress or disruption of social or foraging activity),
- They will habituate to the sound,
- They will become sensitized to the sound, or
- They will not respond.

In experimental trials with trained marine mammals exposed to mid-frequency tones, behavioral changes typically involved what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests (Schlundt et al., 2000; Finneran et al., 2002). Bottlenose dolphins exposed to 1-second intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa rms and beluga whales did so at received levels of 180 to 196 dB and above. Test animals sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al., 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al., 1997; Schlundt et al., 2000).

Existing studies of behavioral effects of human-made sounds in marine environments remain inconclusive, partly because many of those studies have lacked adequate controls, applied only to certain kinds of exposures (which are often different from the exposures being analyzed), and had limited ability to detect behavioral changes that may be significant to the biology of the animals that were being observed. These studies are further complicated by the wide variety of behavioral responses marine mammals exhibit and the fact that those responses can vary significantly by species, individuals, and the context of an exposure. In some circumstances, some individuals will continue normal behavioral activities in the presence of high levels of human-made noise. In other circumstances, the same individual or other individuals may avoid an acoustic source at much lower received levels (Richardson et al., 1995, Wartzok et al., 2003). These differences within and between individuals appear to result from a complex interaction of experience, motivation, and learning that are difficult to quantify and predict.

Acoustic exposures can also result in noise induced reduction in hearing sensitivity that is a function of the interactions of several factors, including individual hearing sensitivity and exposure amplitude, exposure duration, frequency, and other variables that have not been studied extensively (e.g., kurtosis, temporal pattern, directionality). Reduction of hearing sensitivity is referred to as a "threshold shift." The extent and duration of threshold shift depends on a combination of several acoustic features and is specific to particular species. A shift in hearing sensitivity may be temporary (temporary threshold shift or TTS) or it may be permanent (permanent threshold shift or PTS) depending on how the frequency, amplitude and duration of the exposure combine to produce damage and if that change is reversible.

Several "mass stranding" events – strandings that involve two or more individuals of the same species (excluding a single cow-calf pair) - that have occurred over the past two decades have been associated with naval operations, seismic surveys, and other anthropogenic activities that introduced sound into the marine environment. Sonar exposure has been identified as a contributing cause of/factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira, Spain in 2000; and the Canary Islands in 2002 and 2004 (Advisory Committee Report, 2006). In these circumstances, exposure to acoustic energy has been considered an indirect cause of the death of marine mammals (Cox et al., 2006).

4.4.6.4 Methodology for Applying Risk Function

To assess the potential effects on marine mammals from active sonar used during training activities, the Navy together with the National Marine Fisheries Service (NMFS) first investigated a series of mathematical models and methodologies that estimate the number of times individuals of the different species of marine mammal might be exposed to MFA sonar at different received levels. These effects analyses assumed that the potential consequences of exposure to MFA sonar on individual animals would be a function of the intensity (measured in both sound pressure level (dB re 1 µPa) and frequency), duration, and how often the animal was exposed to the mid-frequency transmissions. These exposure analyses assume that MFA sonar poses no risk (i.e., does not constitute harassment) to marine mammals if they are exposed to sound pressure levels from the MFA sonar below some basement value. It may be possible active sonar could have various indirect, adverse effects on marine mammals; however, the Navy and NMFS did not identify situations where this concern might apply.

The second step of the assessment procedure requires the Navy and NMFS to identify how marine mammals are likely to respond when and if they are exposed to active sonar. Marine mammals can experience a variety of responses to sound including sensory impairment (permanent and temporary threshold shifts and acoustic masking), physiological responses (particular stress responses), behavioral responses, social responses that might result in reducing the fitness of individual marine mammals, and social responses that won't result in reducing the fitness of individual marine mammals.

In the past, the Navy and NMFS have used "acoustic thresholds" to identify the number of marine mammals that might experience hearing sensitivity shifts or behavioral harassment upon being exposed to mid-frequency active sonar (see Figure 4.7 left panel). These acoustic 'thresholds" have been represented by either sound exposure level (related to sound energy, abbreviated as SEL), sound pressure level (abbreviated as SPL), or other metrics such as peak pressure level and acoustic impulse (not considered for sonar in this document). The general approach has been to apply these threshold functions such that a marine mammal is counted as behaviorally harassed or experiencing hearing a sensitivity shift (depending on which threshold) when exposed to received sound levels above the threshold and not counted as behaviorally harassed or experiencing hearing a sensitivity shift when exposed to received levels below that threshold. For example, previous Navy EISs, environmental assessments, permit applications, and a NMFS MMPA authorization used 195 dB re 1 μPa^2-s as the energy threshold level (i.e., SEL) for temporary hearing degradation for cetaceans. If the transmitted sonar accumulated energy received by a whale was above 195 dB re 1 μPa^2-s, then the animal was considered to have experienced a temporary shift in the sensitivity of its hearing. If the received accumulated energy level was below 195 dB re 1 μPa^2-s, then the animal was not treated as having experienced a temporary loss in the sensitivity of its hearing.

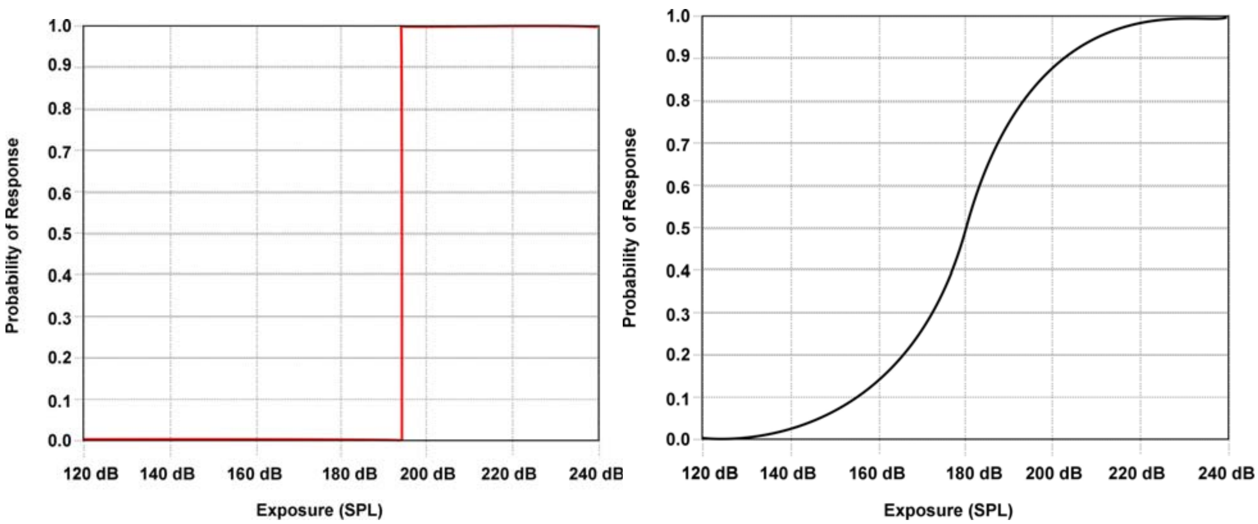

Figure 4-7. Typical Step Function and Typical Risk Continuum Function

The left panel in Figure 4-7 illustrates a typical step-function or threshold that might also relate a sonar exposure to the probability of a response. As this figure illustrates, acoustic thresholds the Navy and NMFS used in the past assumed that every marine mammal above a particular received level (for example, to the right of the red vertical line in the figure) would exhibit identical responses to a sonar exposure. This assumed that the responses of marine mammals would not be affected by differences in acoustic conditions, differences between species and populations, differences in gender, age, reproductive status, social behavior, or the prior experience of the individuals.

Both the Navy and NMFS agree that the studies of marine mammals in the wild and in experimental settings do not support these assumptions — different species of marine mammals and different individuals of the same species respond differently to sonar exposure. Additionally, there are specific geographic conditions that dictate the response of marine mammals to sonar that suggest that different populations may respond differently to sonar exposure. Further, studies of animal physiology suggest that gender, age, reproductive status, and social behavior, among other variables, probably affect how marine mammals respond to sonar exposures. However, neither agency previously had the data necessary to implement alternatives to discrete acoustic thresholds.

Over the past several years, the Navy and the NMFS have worked on developing a MFA sonar acoustic risk function to replace the acoustic thresholds used in the past to estimate the probability of marine mammals being behaviorally harassed by received levels of MFA sonar. The Navy and NMFS will continue to use acoustic thresholds to estimate the probability of temporary or permanent threshold shifts and for behavioral responses to explosives (multiple detonations) using SEL as the appropriate metric. Unlike acoustic thresholds, acoustic risk continuum functions (which are also called "exposure-response functions," "dose-response functions," or "stress-response functions" in other risk assessment contexts) assume that the probability of a response depends first on the "dose" (in this case, the received level of sound) and that the probability of a response increases as the "dose" increases. It is important to note that the probabilities associated with acoustic risk functions do not represent an individual's probability of responding. Rather, the probabilities identify the proportion of an exposed population that is likely to respond to an exposure.

The right panel in Figure 4-7 illustrates a typical acoustic risk function that might relate an exposure, as received sound pressure level in decibels referenced to 1 microPascal (1 µPa), to the probability of a response (proportion of population or density). As the exposed receive level increases in this figure, the probability increases as well but the relationship between an exposure and a response is "linear" only in the center of the curve (that is, unit increases in exposure would produce unit increases in the probability of a response only in the center of a risk function curve). In the "tails" of an acoustic risk function curve, unit increases in exposure produce smaller increases in the probability. Using the illustration as an example, increasing an exposure from 190 dB SPL to 200 dB SPL would have greater effect on the probability than increasing an exposure from 160 dB SPL to 170 dB SPL or from 210 dB SPL to 220 dB SPL (the upper and lower "tails" of the risk function, respectively). Based on observations of various animals, including humans, the relationship represented by an acoustic risk function is a more robust predictor of the probable behavioral responses of marine mammals to sonar and other acoustic sources.

The Navy and NMFS have used the acoustic risk function to estimate the probable responses of marine mammals to acoustic exposures for other training and research programs. Examples of previous application include the Navy FEISs on the Surveillance Towed Array Sonar System – Low Frequency Active (SURTASS-LFA) (DON, 2001); the North Pacific Acoustic Laboratory (NPAL) experiments conducted off the Island of Kaua'i (ONR, 2001), and the Supplemental EIS for SURTASS LFA (DON, 2007).

The Navy and NMFS will use two metrics to estimate the number of marine mammals that might be "taken" by Level B harassment as defined by the MMPA during training exercises. The agencies will use acoustic risk functions with the metric of sound pressure level (dB re 1 µPa) to estimate the number of marine mammals that might be "taken" by MMPA Level B behavioral harassment as a result of being exposed to MFA sonar. The agencies will continue to use acoustic thresholds ("step-functions") with the metric of sound exposure level (dB re 1 μPa^2-s) to estimate the number of marine mammals that might be "taken" through sensory impairment (i.e., PTS and TTS) as a result of being exposed to mid-frequency active sonar and to estimate the number of marine mammals that might be "taken" during exercises that use explosives for MMPA Level A harassment and Level B TTS harassment (for example, sinking exercises).

Although the Navy has not used acoustic risk functions in previous MFA sonar assessments of the potential effects of MFA sonar on marine mammals, risk functions are not new concepts for risk assessments. Common elements are contained in the process used for developing criteria for air, water, radiation, and ambient noise and for assessing the effects of sources of air, water, and noise pollution. The Environmental Protection Agency uses dose-functions to develop water quality criteria and to regulate pesticide applications (EPA 1998); the Nuclear Regulatory Commission uses dose-functions to estimate the consequences of radiation exposures (see NRC 1997 and 10 CFR 20.1201); the Centers for Disease Control and Prevention and the Food and

Drug Administration use dose-functions as part of their assessment methods (for example, see Centers for Disease Control and Prevention, 2003, FDA and others 2001); and the Occupational Safety and Health Administration uses dose-functions to assess the potential effects of noise and chemicals in occupational environments on the health of people working in those environments (for examples, see Federal Register 61:56746-56856, 1996; Federal Register 71:10099-10385, 2006).

4.4.6.4.1 Harbor Porpoises

The information currently available regarding these inshore species that inhabit shallow and coastal waters suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (e.g. Kastelein *et al*., 2000; Kastelein *et al.*, 2005; Kastelein *et al*., 2006) and wild harbor porpoises (e.g. Johnston, 2002) responded to sound (e.g. acoustic harassment devices (AHDs), acoustic deterrent devices (ADDs), or other non-pulsed sound sources) is very low (e.g. ~120 dB SPL), although the biological significance of the disturbance is uncertain. Therefore, Navy will not use the risk function curve as presented but will apply a step function threshold of 120 dB SPL to estimate take of harbor porpoises (i.e., assumes that all harbor porpoises exposed to 120 dB or higher MFAS will respond in a way NMFS considers behavioral harassment).

4.4.6.4.2 Risk Function Adapted from Feller (1968)

The particular acoustic risk function the Navy and NMFS developed for this DEIS estimates behavioral responses that NMFS would classify as harassment for the purposes of the Marine Mammal Protection Act given exposure to specific received levels of MFA sonar. To define the appropriate mathematical function and applicable input parameters for the MFA risk function, NMFS and Navy considered several different means of assessing the probability of marine mammal responses to MFA sonar for the purposes of quantifying behavioral harassment from military readiness activities. The process resulted in two proposed functions that relate to acoustic "doses" (i.e. MFA exposures) to the probability of significant behavioral responses. As the regulating agency, NMFS reviewed the two proposed functions and presented the two methodologies to six scientists (both within and outside the federal government) for an independent, initial review for which would be the most applicable, scientifically valid MFA risk assessment function/approach. For the final determination, NMFS Office of Protected Resources considered the independent scientific reviews, the fact that the underlying data are limited, and past NMFS' rulings for a risk function in the SURTASS LFA FEIS (Federal Register (FR) 67:48145-48154, 2002; FR 72: 46846-46893, 2007) regarding which mathematical approach and input parameters to incorporate to determine the risk for MMPA Level B behavioral harassment from MFA sonar. Based on NMFS' guidance (NMFS, 2008), the Navy is implementing the mathematical function adapted from the solution in Feller (1968) as defined in the SURTASS LFA FOEIS/EIS (DON, 2001), and relied on in the Supplemental SURTASS LFA EIS (DON, 2007) for the probability of MFA sonar risk for MMPA Level B behavioral harassment with input parameters modified by NMFS for MFA sonar for mysticetes, odontocetes (except harbor porpoises), and pinnipeds.

In order to represent a probability of risk, the function should have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution functions (CDF's). In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in DON (2001), the mathematical function below is adapted from the solution in Feller (1968).

$$R = \frac{1 - \left(\frac{L - B}{K} \right)^{-A}}{1 - \left(\frac{L - B}{K} \right)^{-2A}}$$

Where: R = risk (0 to 1.0);
L = Receive Level (RL) in dB;
B = basement RL in dB; (120 dB)
K = the RL increment above basement in dB at which there is 50 percent risk;
A = risk transition sharpness parameter (10)

In order to use this function, the values of the three parameters (B, K, and A) need to be established. The values used in this DEIS analysis are based on three sources of data: temporary threshold shift experiments conducted at SPAWAR Systems Center and documented in Finneran, et al (2001, 2003, 2004 and 2005); reconstruction of sound fields produced by the USS Shoup associated with the behavioral responses of killer whales observed in Haro Strait and documented in DOC, 2005; DON, 2003; and Fromm, 2004a, 2004b; and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al, 2004. The input parameters, as defined by NMFS, are based on the best available science at this time.

4.4.6.5 Data Sources Used for Risk Function

There is widespread consensus that cetacean response to MFA sound signals needs to be better defined using controlled experiments. Navy is contributing to an ongoing behavioral response study in the Bahamas that is anticipated to provide some initial information on beaked whales, the species identified as the most sensitive to MFA sonar. NOAA Fisheries is leading this international effort with scientists from various academic institutions and research organizations to conduct studies on how marine mammals respond to underwater sound exposures.

Until additional data is available, NMFS and the Navy have determined that the following three datasets are most applicable for the direct use in the development of risk function parameters to describe what portion of a population exposed to specific levels of MFA sonar will respond in a manner that NMFS would classify as harassment. These datasets represent the only known data that specifically relate altered behavioral responses to exposure to MFA sound sources.

<u>Data from Controlled Experiments:</u> Most of the observations of the behavioral responses of toothed whales resulted from a series of controlled experiments conducted by researchers at the SPAWAR System Center facility in San Diego, CA (Finneran *et al*. 2000; Finneran *et al*. 2002, Finneran *et al*. 2004; Schlundt *et al*. 2000).

1. Finneran and Schlundt (2004) examined behavioral observations recorded by the trainers or test coordinators during the Schlundt *et al*. (2000) and Finneran *et al*. (2001, 2003, 2005) experiments featuring 1-second tones. These included observations from 193 exposure sessions (fatiguing stimulus level > 141 dB re 1µPa) conducted by Schlundt *et al*. (2000) and 21 exposure sessions conducted by Finneran *et al*. (2001, 2003, 2005). The observations were made during exposures to sound sources at 0.4 kHz, 3 kHz, 10 kHz, 20 kHz, and 75 kHz. The TTS experiments that supported Finneran and Schlundt (2004) are further explained below:

    a. Schlundt *et al*. (2000) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at SSC San Diego with 1-second tones. Schlundt *et al*. (2000) reported eight individual TTS experiments. Fatiguing stimuli durations were 1-second; exposure frequencies were 0.4 kHz, 3 kHz, 10 kHz, 20 kHz and 75 kHz. The experiments were conducted in San Diego Bay. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise. Schlundt *et al*. (2000) reported that "behavioral alterations," or deviations from the behaviors the animals being tested had been trained to exhibit, occurred as the animals were exposed to increasing fatiguing stimulus levels.

    b. Finneran *et al*. (2001, 2003, 2005) conducted TTS experiments using tones at 3 kHz. The test method was similar to that of Schlundt *et al*. (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 µPa/Hz), and no masking noise was used. Two separate experiments were conducted using 1-second tones. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB re 1 µPa were randomly presented.

    <u>Data from Studies of Baleen (Mysticetes) Whale Responses</u>: The only Mysticete data available resulted from a field experiments in which baleen whales (mysticetes) were exposed to a range frequency sound sources from 120 Hz to 4500 Hz (Nowacek *et al*. 2004). An alert stimuli, with a mid-frequency component, was the only portion of the study used to support the risk function input parameters.

2. Nowacek *et al*. (2004) document observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components. To assess risk factors involved in ship strikes, a multi-sensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the

social sounds of conspecifics and a signal designed to alert the whales. The alert signal was 18-minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60% duty cycle and consisted of: 1) alternating 1-sec pure tones at 500 Hz and 850 Hz; 2) a 2-sec logarithmic down-sweep from 4500 Hz to 500 Hz; and 3) a pair of low (1500 Hz)-high (2000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. The purpose of the alert signal was a) to provoke an action from the whales auditory system with disharmonic signals that cover the whales estimated hearing range; b) to maximize the signal to noise ratio (obtain the largest difference between background noise) and c) to provide localization cues for the whale. Five out of six whales reacted the most strongly to the signal designed to elicit such behavior. Receive levels ranged from 133 to 148 dB re 1μPa.

<u>Reconstructed Sound Field from Observations in the Wild:</u> In May 2003, killer whales (*Orcinus orca*) were observed exhibiting behavioral responses while the USS SHOUP was engaged in MFA sonar operations in the Haro Strait in the vicinity of Puget Sound, Washington. Although these observations were made in an uncontrolled environment, the sound field that may have been associated with the sonar operations had to be estimated, and the behavioral observations were reported for groups of whales, not individual whales, the observations associated with the USS SHOUP provide the only data set available of the behavioral responses of wild, non-captive animal upon exposure to the AN/SQS-53 mid-frequency sonar.

3. DOC (2005); DON (2003); Fromm (2004a, 2004b) documented reconstruction of sound fields produced by the USS SHOUP associated with the behavioral response of killer whales observed in Haro Strait. Observations from this reconstruction included an approximate closest approach time which was correlated to a reconstructed estimate of receive level to an unknown exact whale location ranging from 150 to 180 dB, with a mean value of 169.3 dB.

4.4.6.6 Input Parameters for the Risk Function

The values of <u>B</u>, <u>K</u>, and <u>A</u> need to be specified in order to utilize the risk function defined previously. The risk continuum function approximates the dose-response function in a manner analogous to pharmacological risk assessment (DON 2001, Appendix D). In this case, the risk function is combined with the distribution of sound exposure levels to estimate aggregate impact on an exposed population.

4.4.6.7 Basement Value for Risk – The <u>B</u> Parameter

The <u>B</u> parameter defines the basement value for risk, below which the risk is so low that calculations are impractical. This 120 dB level is taken as the estimate received level (RL) below which the risk of significant change in a biologically important behavior approaches zero for the MFA sonar risk assessment. This level is based on a broad overview of the levels at which multiple species have been reported responding to a variety of sound sources, both mid-frequency and other, was recommended by the peer-reviewers, and has been used in other publications. The Navy recognizes that for actual risk of changes in behavior to be zero, the signal-to-noise ratio of the animal must also be zero. However, the present convention of ending the risk calculation at 120 dB for MFA sonar has a negligible impact on the subsequent calculations, because the risk function does not attain appreciable values at received levels that low.

4.4.6.8 Risk Transition – The A Parameter

The A parameter controls how rapidly risk transitions from low to high values with increasing receive level. As A increases, the slope of the risk function increases. For very large values of A, the risk function can approximate a threshold response or step function. NMFS has recommended that Navy use A=10 as the value for odontocetes (except harbor porpoises), and pinnipeds (Figure 4-8) (NMFS, 2008). This is the same value of A that was used for the SURTASS LFA analysis. Based on NMFS' recommendation, Navy will use a value of A=8 for mysticetes to allow for greater consideration of potential harassment at the lower received levels based on Novacek *et al*, 2004 (Figure 4-9).

4.4.6.9 The K Parameter

NMFS and the Navy used the mean of the following values to define the midpoint of the function: (1) the mean of the lowest receive levels at which each individual responded with altered behavior to 3 kHz tones in the SSC dataset (185.3 dB SPL); (2) the estimated mean received level value of 169.3 dB produced by the reconstruction of the USS SHOUP incident in which killer whales exposed to MFA sonar (range modeled possible received levels: 150 – 180 dB); and (3) the mean of the 5 received levels at which Nowacek *et al.* (2004) observed significantly altered responses of right whales to the alert stimuli than to the control is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of K is the difference between the value of B (120 dB SPL) and the 50% value of 165 dB SPL; therefore, K=45.

4.4.6.10 Risk Function Equation/Curves Used for MFA Sonar Behavioral Analysis

The mathematical function used to predict MMPA Level B behavioral harassment is adapted from the solution in Feller (1968) as used in DON (2001) and shown below.

$$R = \frac{1-\left(\frac{L-B}{K}\right)^{-A}}{1-\left(\frac{L-B}{K}\right)^{-2A}}$$

Where: R = risk (0 – 1.0);
L = RL in dB;
B = basement RL in dB; (120 dB)
K = the RL increment above basement in dB at which there is 50 percent risk;
A = risk transition sharpness parameter (10)

The input parameters for the MFA sonar risk function were defined by NMFS Office of Protected Resources (NMFS, 2008). Figure 4-8 is the curve resulting from the risk function input parameter for odontocetes (except harbor porpoises) and pinnipeds. Figure 4-9 is the curve resulting from the risk function input parameters for mysticetes.

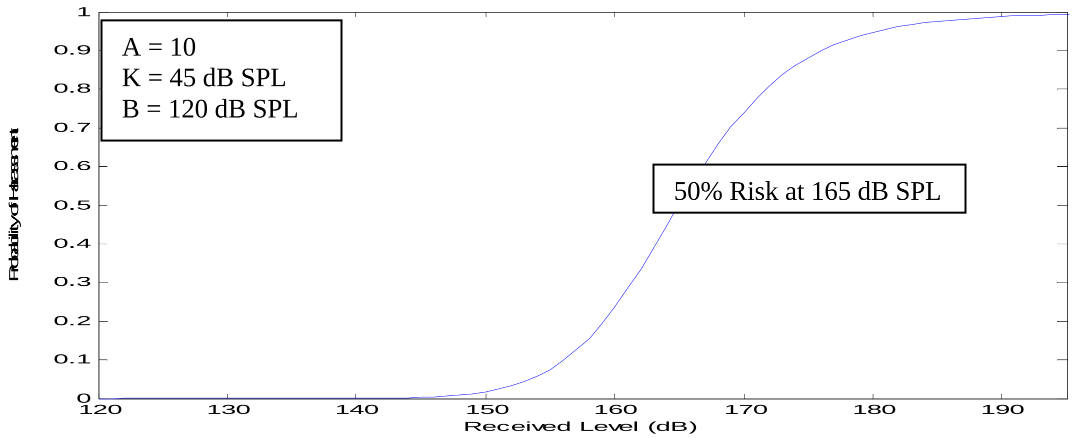

Figure 4-8. Risk Function Curve for Odontocetes (toothed whales except harbor porpoises) and Pinnipeds

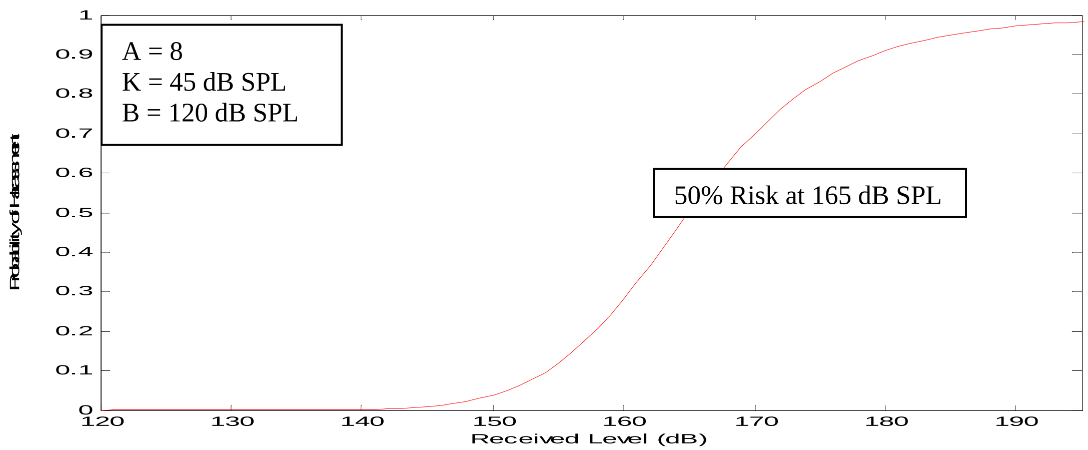

Figure 4-9. Risk Function Curve for Mysticetes (Baleen Whales)

The values obtained by applying this risk function represent the proportion of the exposed population that is likely to behaviorally respond in a manner that NMFS would classify as behavioral harassment.

4.4.7 Criteria and Thresholds for Small Explosives

Criteria and thresholds for estimating the exposures from a single explosive activity on marine mammals were established for the Seawolf Submarine Shock Test Final Environmental Impact Statement (FEIS) ("Seawolf") and subsequently used in the USS Winston S. Churchill (DDG-81) Ship Shock FEIS ("Churchill") (DON, 1998 and 2001b). NMFS adopted these criteria and thresholds in its final rule on unintentional taking of marine animals occurring incidental to the shock testing (NOAA, 1998). In addition, this section reflects a revised acoustic criterion for small underwater explosions (i.e., 23 pounds per square inch [psi] instead of previous acoustic criteria of 12 psi for peak pressure over all exposures), which is based on an incidental harassment authorization (IHA) issued to the U.S. Air Force (NOAA, 2006c).

4.4.7.1 Criteria and Thresholds for Injurious Physiological Effects

The approach to risk assessment for impulsive sound in the water was derived from the Seawolf/Churchill approach. Churchill used three criteria: eardrum rupture (i.e., tympanic-membrane [TM] rupture), onset of extensive lung injury, and onset of slight lung injury. The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM); this is stated in terms of an EL value of 1.17 inch pounds per square inch (in-lb/in^2) (about 205 dB re 1 µPa^2-s). This recognizes that TM rupture is not necessarily a serious or life-threatening injury, but it is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten [1998] indicates a 30 percent incidence of PTS at the same threshold).

The criteria for mortality is the onset of extensive lung injury. For small mammals, the threshold is given in terms of the Goertner modified positive impulse, indexed to 30.5 pounds per square inch-millisecond (psi-ms). For medium and large mammals, the threshold is 73.9 and 111.7 psi-ms, respectively. In this assessment, all cetaceans were analyzed using the threshold for small mammals for extensive lung injury. The results of the analysis, therefore, are conservative.

The threshold for onset of slight lung injury was calculated for a calf dolphin (12.2 kg [27 lbs]) and an adult dolphin (174 kg [384 lbs]); it is given in terms of the Goertner modified positive impulse, indexed to 13 psi-ms and 32 psi-ms respectively. In this assessment, all cetaceans were analyzed using the threshold for a calf dolphin for onset slight lung injury. The results of the analysis, therefore, are conservative.

4.4.7.2 Criteria and Thresholds for Noninjurious Physiological Effects

The Churchill criterion for non-injurious harassment is TTS, which is a slight, recoverable loss of hearing sensitivity (DON, 2001b). In this case, there are two thresholds, one for energy and one for peak pressure.

4.4.7.3 TTS Energy Threshold

The TTS energy threshold is a 182 dB re 1 µPa^2-s maximum energy flux density level in any 1/3-octave band at frequencies above 0.1 kHz for toothed whales and in any 1/3-octave band above 0.010 kHz for baleen whales. For large explosives, the latter limits at 0.01 and 0.1 kHz make a difference in the range estimates. NMFS has defined large explosives in prior rulemaking as greater than 907 kg (2,000 lbs) Net Explosive Weight (NEW) (NMFS, 2006b). The Navy has defined small explosives as less than 680 kg (1,500 lbs) NEW per directive. For small explosives, the spectrum of the shot arrival is broad and there is essentially no difference in effects ranges for the two classes of animals.

4.4.7.4 TTS Peak Pressure Threshold

The TTS peak pressure threshold applies to all cetacean species and is stated in terms of peak pressure at 23 psi, which is based on an IHA issued to the Air Force for a similar action (NOAA, 2006d). This threshold is derived from the Churchill threshold. However, peak pressure and energy scale at different rates with charge weight, so that ranges based on the peak-pressure threshold are much greater than those for the energy metric when charge weights are small—even when source and animal are away from the surface. In order to more accurately estimate TTS for smaller shots while preserving the safety feature provided by the peak pressure threshold, the peak pressure threshold was appropriately scaled for small detonations. This scaling is based on the similitude formulas (e.g., Urick, 1983) used in virtually all compliance documents for short ranges. Further, the peak-pressure threshold for marine mammal TTS for explosives offers a safety margin for a source or an animal near the ocean surface.

4.4.7.5 Criteria and Thresholds for Behavioral Effects

Behavioral modification (sub-TTS) is only applied to successive detonations. For single detonations, behavioral disturbance is likely to be limited to a short-lived startle reaction; therefore, use of the TTS criterion is considered sufficient protection.

4.4.8 Summary of Criteria and Thresholds

Table 4-6 summarizes the effects, criteria, and thresholds used in the assessment to determine potential physiological effects from active sonar.

Tables 4-7 and 4-8 summarize the SPL risk-function parameters for behavioral response to active sonar.

Table 4-9 summarizes the effects, criteria, and thresholds used in the assessment for small explosives (explosive source sonobuoy [AN/SSQ-110A]).

Table 4-6. Effects, Criteria, and Thresholds for Active Sonar

Effect	Criteria	Threshold (dB 1 µPa^2-s)	MMPA Effect
Physiological	PTS	215	Level A harassment
Physiological	TTS	195	Level B harassment

dB 1 µPa^2-s = decibel referenced to 1 micropascal squared second; PTS = Permanent Threshold Shift; TTS = Temporary Threshold Shift

Table 4-7. SPL Risk-Function Parameters for Behavioral Response to Active Sonar

Animals	Risk-Function Mean (SPL)	Risk Transition Parameter	Basement Receive Level
Odontocetes (except harbor porpoises) and Pinnipeds	165 dB	10	120 dB
Mysticetes	165 dB	8	120 dB

dB = decibel

Table 4-8. Behavioral Response to Active Sonar (Harbor Porpoise)

Animals	Effect	Receive Level
Harbor Porpoise	Behavioral	Greater than 120 dB SPL re 1 μPa

dB = decibel; SPL re 1 μPa = sound pressure level referenced to 1 micropascal

Table 4-9. Effects, Criteria, and Thresholds for Small Explosives

Effect	Criteria	Metric	Threshold	MMPA Effect
Physiological	Onset extensive lung injury	Goertner modified positive impulse	30.5 psi-ms	Mortality
Physiological	50 percent TM rupture	Energy flux density	1.17 in-lb/in^2 (about 205 dB re 1 μPa^2-s)	Level A Harassment
Physiological	Onset slight lung injury	Goertner modified positive impulse	indexed to 13 psi-ms	Level A Harassment
Physiological	TTS for baleen whales	Greatest energy flux density level in any 1/3-octave band above 10 Hz - for total energy over all exposures	182 dB re 1 μPa^2-s	Level B Harassment
Physiological	TTS for toothed whales and sea turtles	Greatest energy flux density level in any 1/3-octave band above 100 Hz - for total energy over all exposures	182 dB re 1 μPa^2-s	Level B Harassment
Physiological	TTS	Peak pressure over all exposures	23 psi	Level B Harassment

dB 1 μPa^2-s = decibel referenced to 1 micropascal squared second; Hz = hertz; psi-ms = pounds per square inch-millisecond; TM = tympanic membrane; TTS = temporary threshold shift

4.4.9 Acoustic Effects Analysis

Potential acoustic sources to be modeled for the AFAST EIS were examined with regard to their source characteristics in order to determine whether they should be included in the marine mammal acoustic impact analysis. Systems with an operating frequency greater than 200 kHz were not analyzed, as these signals attenuate rapidly during propagation (30 dB/km or more signal spreading losses), resulting in very short propagation distances. In addition, such frequencies are outside the known hearing range of most marine mammals. Although there are no direct data on auditory thresholds for any mysticete species, anatomical evidence strongly suggests that their inner ears are well adapted for low-frequency hearing. (Richardson et al., 1995; Ketten, 1998) Filter-bank models of the humpback whale's ear have been developed from anatomical features and optimization techniques (Houser et al., 2001). The results suggest that humpbacks are sensitive to frequencies between 40 Hz and 16 kHz, but best sensitivity is likely to occur between 100 Hz and 8 kHz.

Most available information on cetacean hearing pertains to odontocetes, which commonly have good functional hearing between 200 Hz and 100 kHz, although individual species may have functional ultrasonic hearing to nearly 200 kHz (Richardson et al., 1995). Some of the species with ultrasonic hearing are *Kogia* to 150 kHz (Ridgway and Carder, 2001), striped dolphins 160 kHz (Kastelein et al., 2003), and harbor porpoise, 180 kHz (Kastelein et al., 2002a). In all cases these frequencies represent the upper limit of capability with their best frequency range considerably below that. In pinnipeds, the animals with the highest-frequency hearing are phocid seals; their functional high-frequency limit is around 60 kHz (Terhune, 1988; Richardson, 1995).

To summarize, marine mammals as a group have functional hearing ranges of 10 Hz to 200 kHz, with their best sensitivities well below that level. Because sources operating at 200 kHz or higher attenuate rapidly and are at or outside the upper frequency limit of even the ultrasonic species of marine mammals, further consideration and modeling of these higher frequency acoustic sources are not warranted.

4.4.9.1 Active Sonar

The analysis occurred in five broad steps. An overview of each step is provided below.

1. Each source emission is modeled according to the particular operating mode of the sonar. See Table H-1 for a description of sources modeled. The "effective" energy source and sound pressure level is computed by integrating over the bandwidth of the source, scaling by the pulse length, and adjusting for gains due to source directivity. The location of the source at the time of each emission must also be specified.
2. For the relevant environmental acoustic parameters, transmission loss (TL) estimates are computed, sampling the water column over the appropriate depth and range intervals. TL data are sampled at the typical depth(s) of the source and at the nominal frequency of the source. If the source is relatively broadband, an average over several frequency samples may be appropriate.
3. The accumulated energy and maximum received sound pressure level within the waters in which the sonar is operating is sampled over a volumetric grid. At each grid point, the received sound from each source emission is modeled as the effective energy source and sound pressure level reduced by the appropriate propagation loss from the location of the source at the time of the emission to that grid point.
4. For energy criteria, the zone of influence (ZOI) for a given threshold (that is, the volume for which the accumulated energy level exceeds the threshold) is estimated by summing the incremental volumes represented by each grid point for which the accumulated energy flux density exceeds that threshold. For the sound pressure level, the maximum received sound pressure level is compared to the appropriate dose response function for

the marine mammal group and source frequency of interest. The percentage of animals likely to respond corresponding to the maximum received level is found, and the volume of the grid point is multiplied by that percentage to find the adjusted volume. Those adjusted volumes are summed across all grid points to find the overall ZOI.

5. The number of animals exposed to any given acoustic threshold is estimated by multiplying the animal densities by the effect area (derived from the effect volume). This calculation assumes that the animals are evenly distributed throughout the grid.

Acoustic propagation and mammal population data are analyzed by season. The analysis estimated the sound exposure for marine mammals produced by each active source type independently. Results from each acoustic source were added on a per-training exercise basis and then activities were summed to annual totals.

The relevant measure of potential physiological effects to marine mammals due to sonar training is the modeled accumulated (summed over all source emissions) energy flux density level received by the animal over the duration of the activity. To calculate the estimated exposures using EL, the seasonal exposure zones generated during the acoustic modeling are multiplied by the average density of each species per season by OPAREA. Behavioral effects below the 195 dB EL threshold were modeled using the dose function.

4.4.9.2 Small Explosives (Explosive Source Sonobuoy [AN/SSQ-110A])

The impact of explosive sources on marine wildlife is measured by three different metrics, each with its own threshold(s). The energy metric, peak one-third octave, is treated in similar fashion as the energy metric used for the active sonars, including the summation of energy if there are multiple source emissions. The other two, peak pressure and positive impulse, are not accumulated; rather, the maximum levels are stored.

4.4.9.2.1 Peak One-Third Octave Energy Metric

The computation of impact volumes for the energy metric follows closely the approach taken to model the energy metric for the active sonars. The only significant difference is that energy flux density is sampled at several frequencies in one-third-octave bands and only the peak one-third-octave level is accumulated.

4.4.9.2.2 Peak Pressure Metric

The peak pressure metric is a simple, straightforward calculation. At each range/animal depth combination, transmission ratio modified by the source level in a one-octave band and beam pattern is averaged across frequency on an eigenray-by-eigenray basis. This averaged transmission ratio (normalized by the broadband source level) is then compared across all eigenrays with the maximum designated as the peak arrival. Peak pressure at that range/animal depth combination is then simply the product of:

- The square root of the averaged transmission ratio of the peak arrival,

- The peak pressure at a range of 1 m, and
- The similitude correction.

If the peak pressure for a given grid point is greater than the specified threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

4.4.9.2.3 Modified Positive Impulse Metric

The modeling of positive impulse follows the work of Goertner. The modified positive impulse threshold is unique among the various injury and harassment metrics in that it is a function of depth and the animal weight. To be conservative, the Navy will assume the animal weight is that of a calf dolphin, with an average mass of 12.2 kg (27 lb).

Although the thresholds are a function of depth and animal weight, sometimes they are summarized as their value at the sea surface for a typical calf dolphin (with an average mass of 12.2 kg [27 lb]). For the onset of slight lung injury, the threshold at the surface is approximately 13 psi ms; for the onset of extensive lung hemorrhaging (1 percent mortality), the threshold at the surface is approximately 31 psi-ms.

4.4.10 Acoustic Effects Results for Marine Mammals

4.4.10.1 Species with Possible Occurrence but Not Modeled

Exposure numbers for four species occurring within the AFAST Study Area could not be calculated due to the lack of appropriate data needed to generate density estimates. However, potential effects to these species were qualitatively analyzed. These four species include the following:

- Blue whale
- White-beaked dolphin
- Hooded seal
- Harp seal

Exposure numbers for the manatees occurring in the southeast could not be calculated due to the lack of acoustic exposure criteria and lack of available density information. In addition, three species have no density estimate since their occurrence is considered extralimital throughout the AFAST Study Area. Therefore, these species have a functional density of zero; therefore, no potential effects are predicted. These species include the following:

- Beluga whale
- Ringed seal
- Walrus

4.4.10.2 Model Results for Acoustic Sources

When analyzing the results of the acoustic effects modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data and to the acoustic model, which in turn, leads to an overestimation (i.e., conservative estimate) of the total exposures to marine mammals. Specifically, the modeling results are conservative for the following reasons:

- Acoustic footprints for sonar sources near land are not reduced to account for the land mass where marine mammals would not occur.
- Acoustic footprints for sonar sources are added independently and, therefore, do not account for overlap they would have with other sonar systems used during the same active sonar activity. As a consequence, the calculated acoustic footprint is larger than the actual acoustic footprint.
- Acoustic exposures do not reflect implementation of mitigation measures, such as reducing sonar source levels when marine mammals are present.
- In this analysis, the acoustic footprint is assumed to extend from the water surface to the ocean bottom. In reality, the acoustic footprint radiates from the source like a bubble, and a marine animal may be outside this region.
- Marine mammal densities were averaged across specific active sonar activity areas and, therefore, are evenly distributed without consideration for animal grouping or patchiness.
- Harbor porpoise and sei whale densities are unavailable for certain areas due to the lack of sightings (resulting from low densities). In this analysis, areas of unknown densities were overestimated because they were projected from areas of higher densities.

Annual exposure estimates for the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3 are presented in Tables 4-10 and 4-25. Exposures numbers were rounded to “1” if the result was equal to or greater than 0.5. Even though an exposure number may have rounded to “0” in an individual analysis area, when summed with all other results for other analysis areas within the AFAST Study Area, an exposure of “1” is possible.

Table 4-10. Estimated Marine Mammal Exposures From ULT, RDT&E, and Maintenance Active Sonar Activities Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0*	35	0	0	0*	13	0	0	3	189	0	0	0*	231	0	0	0	0
Humpback whale**	0	0	3	519	0	0	3	613	0	0*	10	2120	0	0	0*	1478	0	0	0	0
Minke whale	0	0	0	27	0	0	0	32	0	0	1	113	0	0	0	393	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0*	2070	0	0	0	0
Fin whale**	0	0	1	65	0	0	0	0	0	0	0	0	0	0	0*	1283	0	0	0	0
Sperm whale**	0	0*	23	4688	0	0	1	332	0	0	6	1552	0	0	1	6442	0	0	0*	38
Kogia spp.	0	0	4	544	0	0	5	649	0	0	14	2277	0	0	0	1031	0	0	0	26
Beaked whale	0	0	5	523	0	0	2	250	0	0	7	945	0	0	0	815	0	0	0	6
Rough-toothed dolphin	0	0	2	259	0	0	2	308	0	0	7	1082	0	0	0	487	0	0	0	188
Bottlenose dolphin	0	2	261	47505	0	3	358	71169	0	17	2954	400187	0	0	3	37834	0	0	14	7828
Pantropical spotted dolphin	0	1	80	11991	0	1	100	14287	0	2	317	50155	0	0	1	22553	0	0	11	4455
Atlantic spotted dolphin	0	7	884	138986	0	2	483	23553	0	6	1991	111824	0	0	2	27389	0	0	2	6267
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1734
Clymene dolphin	0	0	38	5729	0	0	48	6826	0	1	151	23962	0	0	1	10775	0	0	7	1084
Striped dolphin	0	5	545	116150	0	0	0	61	0	0	0	0	0	1	15	232341	0	0	0	318
Common dolphin	0	3	689	52953	0	0	1	57	0	0	0	0	0	1	12	106105	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
Risso's dolphin	0	0	63	10537	0	0	55	8467	0	2	288	58422	0	0	3	39245	0	0	1	151
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	34165	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	216
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Pilot whales	0	1	101	19848	0	1	56	13593	0	3	327	81754	0	0	4	34233	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	149
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	285124	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	37535	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	69320	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-11. Estimated Marine Mammal Exposures From Coordinated ULT Active Sonar Activities Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0*	2	0	0	0*	1	0	0	2	56	0	0	0	1	0	0	0	0
Humpback whale**	0	0	1	24	0	0	1	33	0	0	7	459	0	0	0	5	0	0	0	0
Minke whale	0	0	0	1	0	0	0	2	0	0	0	25	0	0	0	1	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
Fin whale**	0	0	0*	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
Sperm whale**	0	0	4	195	0	0	0*	14	0	0	4	284	0	0	0	23	0	0	0	2
Kogia spp.	0	0	1	24	0	0	1	33	0	0	10	470	0	0	0	4	0	0	0	1
Beaked whale	0	0	1	46	0	0	0	20	0	0	5	306	0	0	0	3	0	0	0	0
Rough-toothed dolphin	0	0	0	11	0	0	0	16	0	0	5	223	0	0	0	2	0	0	0	120
Bottlenose dolphin	0	0	47	2020	0	0	64	3378	0	10	2055	85392	0	0	0	136	0	0	2	3423
Pantropical spotted dolphin	0	0	14	519	0	0	18	728	0	1	220	10355	0	0	0	81	0	0	2	153
Atlantic spotted dolphin	0	1	159	6215	0	0	88	1923	0	3	1393	30979	0	0	0	98	0	0	0	1908
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55
Clymene dolphin	0	0	7	248	0	0	9	348	0	1	105	4947	0	0	0	39	0	0	1	119
Striped dolphin	0	1	98	4853	0	0	0	3	0	0	0	0	0	0	0	835	0	0	0	7
Common dolphin	0	0	125	3061	0	0	0	5	0	0	0	0	0	0	0	381	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Risso's dolphin	0	0	11	466	0	0	10	427	0	1	200	11833	0	0	0	141	0	0	0	11
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pilot whales	0	0	18	833	0	0	10	615	0	2	226	15702	0	0	0	123	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1008	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	135	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	249	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-12. Estimated Marine Mammal Exposures From Strike Group Active Sonar Exercises Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0*	1	0	0	0*	5	0	0	0	14	0	0	0	0	0	0	0	0
Humpback whale**	0	0	1	37	0	0	3	218	0	0	5	404	0	0	0	0	0	0	0	0
Minke whale	0	0	0	2	0	0	0	12	0	0	0	22	0	0	0	0	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fin whale**	0	0	0*	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperm whale**	0	0*	9	412	0	0	2	123	0	0*	7	393	0	0	0	0	0	0	5	345
Kogia spp.	0	0	1	37	0	0	5	218	0	0	7	412	0	0	0	0	0	0	5	318
Beaked whale	0	0	2	77	0	0	3	135	0	0	7	370	0	0	0	0	0	0	2	150
Rough-toothed dolphin	0	0	0	18	0	0	2	104	0	0	4	196	0	0	0	0	0	0	10	685
Bottlenose dolphin	0	1	108	4593	0	3	379	20185	0	7	1129	58611	0	0	0	0	0	1	240	12085
Pantropical spotted dolphin	0	0	21	821	0	1	104	4799	0	1	164	9076	0	0	0	0	0	5	684	46916
Atlantic spotted dolphin	0	2	305	12451	0	1	337	7767	0	1	374	8475	0	0	0	0	0	1	154	4986
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	290	19659
Clymene dolphin	0	0	10	392	0	0	50	2293	0	1	78	4336	0	0	0	0	0	1	106	7271
Striped dolphin	0	1	199	9047	0	0	0	26	0	0	0	0	0	0	0	0	0	0	58	3987
Common dolphin	0	1	159	4758	0	0	1	19	0	0	0	0	0	0	0	0	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	304
Risso's dolphin	0	0	21	876	0	0	54	2517	0	1	155	9427	0	0	0	0	0	0	20	1361
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	1446
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	208
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	435
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	56
Pilot whales	0	0	41	1789	0	1	69	4052	0	2	252	15851	0	0	0	0	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	1000
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-13. Estimated Marine Mammal Exposures from ULT, RDT&E, Maintenance, Coordinated ULT, and Strike Group Active Sonar Activities Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	1	38	0	0	1	19	0	0	5	259	0	0	0*	232	0	0	0	0
Humpback whale**	0	0	4	581	0	0*	7	865	0	0*	23	2983	0	0	0*	1483	0	0	0	0
Minke whale	0	0	0	30	0	0	0	46	0	0	1	160	0	0	0	394	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0*	2078	0	0	0	0
Fin whale**	0	0	1	75	0	0	0	0	0	0	0	0	0	0	0*	1287	0	0	0	0
Sperm whale**	0	0*	36	5296	0	0	4	470	0	0	17	2229	0	0	1	6465	0	0	5	386
Kogia spp.	0	0	5	605	0	0	10	899	0	0*	32	3159	0	0	0	1035	0	0	5	345
Beaked whale	0	0	8	646	0	0	5	405	0	0	19	1621	0	0	0	818	0	0	2	156
Rough-toothed dolphin	0	0	3	288	0	0	5	427	0	0	15	1501	0	0	0	488	0	0	10	994
Bottlenose dolphin	0	3	416	54118	0	7	801	94732	0	34	6137	544190	0	0	3	37970	0	1	256	23337
Pantropical spotted dolphin	0	1	116	13330	0	2	223	19815	0	5	701	69586	0	0	1	22635	0	5	696	51524
Atlantic spotted dolphin	0	10	1349	157652	0	3	908	33243	0	10	3759	151279	0	0	2	27488	0	1	156	13162
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	291	21447
Clymene dolphin	0	0	55	6369	0	1	106	9467	0	2	335	33245	0	0	1	10814	0	1	114	8474
Striped dolphin	0	7	842	130050	0	0	1	90	0	0	0	0	0	1	15	233176	0	0	58	4312
Common dolphin	0	4	972	60771	0	0	3	82	0	0	0	0	0	1	12	106486	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	354
Risso's dolphin	0	1	96	11879	0	1	119	11411	0	5	643	79682	0	0	3	39386	0	0	21	1524
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	34288	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	1685
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	242
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	507
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	65
Pilot whales	0	1	160	22469	0	1	135	18260	0	7	805	113307	0	0	4	34356	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	1166
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	286132	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	37670	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	69569	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-14. Estimated Marine Mammal Exposures From ULT, RDT&E, and Maintenance Active Sonar Activities Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0*	26	0	0	0	1	0	0	1	127	0	0	0*	5	0	0	0	0
Humpback whale**	0	0	2	521	0	0	2	669	0	0*	7	2276	0	0	0*	1509	0	0	0	0
Minke whale	0	0	0	27	0	0	0	35	0	0	0	120	0	0	0	81	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0*	1638	0	0	0	0
Fin whale**	0	0	1	70	0	0	0	0	0	0	0	0	0	0	0*	593	0	0	0	0
Sperm whale**	0	0*	17	3495	0	0	2	429	0	0	3	783	0	0	1	4510	0	0	0*	32
Kogia spp.	0	0	3	548	0	0	3	709	0	0	10	2450	0	0	0	1330	0	0	0	25
Beaked whale	0	0	2	241	0	0	1	78	0	0	4	539	0	0	0	274	0	0	0	4
Rough-toothed dolphin	0	0	1	260	0	0	2	337	0	0	5	1165	0	0	0	632	0	0	0	155
Bottlenose dolphin	0	3	388	74794	0	2	262	53965	0	7	845	198757	0	0	4	57358	0	0	13	4484
Pantropical spotted dolphin	0	1	63	12068	0	1	73	15617	0	2	228	53983	0	0	2	29308	0	0	12	4039
Atlantic spotted dolphin	0	5	517	102106	0	1	159	20918	0	4	666	123014	0	0	3	38981	0	0	2	2047
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1125
Clymene dolphin	0	0	30	5766	0	0	35	7461	0	1	109	25791	0	0	1	14002	0	0	7	1030
Striped dolphin	0	1	89	10913	0	0	0	23	0	0	0	0	0	2	23	411722	0	0	0	284
Common dolphin	0	5	964	92860	0	0	0	1	0	0	0	0	0	1	19	216659	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43
Risso's dolphin	0	0	26	3641	0	0	5	921	0	2	204	48766	0	0	3	36849	0	0	0	126
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	205
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Pilot whales	0	1	116	22699	0	0	34	8247	0	2	244	59243	0	0	4	30028	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	142
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	177079	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-15. Estimated Marine Mammal Exposures From Coordinated ULT Active Sonar Activities Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0	1	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0
Humpback whale**	0	0	0*	23	0	0	0*	33	0	0	5	459	0	0	0	5	0	0	0	0
Minke whale	0	0	0	1	0	0	0	2	0	0	0	25	0	0	0	0	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Fin whale**	0	0	0*	5	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Sperm whale**	0	0	3	148	0	0	0*	18	0	0	2	150	0	0	0	16	0	0	0	2
Kogia spp.	0	0	1	23	0	0	1	32	0	0	7	471	0	0	0	5	0	0	0	1
Beaked whale	0	0	0	22	0	0	0	6	0	0	3	177	0	0	0	1	0	0	0	0
Rough-toothed dolphin	0	0	0	11	0	0	0	15	0	0	3	224	0	0	0	2	0	0	0	120
Bottlenose dolphin	0	0	70	3156	0	0	47	2528	0	4	582	36102	0	0	0	206	0	0	2	3423
Pantropical spotted dolphin	0	0	11	499	0	0	13	714	0	1	158	10385	0	0	0	105	0	0	2	167
Atlantic spotted dolphin	0	1	93	4304	0	0	29	1120	0	2	461	22520	0	0	0	140	0	0	0	1908
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55
Clymene dolphin	0	0	5	239	0	0	6	341	0	1	75	4961	0	0	0	50	0	0	1	119
Striped dolphin	0	0	16	526	0	0	0	1	0	0	0	0	0	0	0	1480	0	0	0	7
Common dolphin	0	1	174	4872	0	0	0	0	0	0	0	0	0	0	0	779	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Risso's dolphin	0	0	5	169	0	0	1	43	0	1	141	9531	0	0	0	132	0	0	0	11
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pilot whales	0	0	21	965	0	0	6	372	0	1	169	11508	0	0	0	108	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	637	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-16. Estimated Marine Mammal Exposures From Strike Group Active Sonar Exercises Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0	1	0	0	0	0	0	0	0*	24	0	0	0	0	0	0	0	0
Humpback whale**	0	0	0*	23	0	0	3	218	0	0	5	459	0	0	0	5	0	0	0	0
Minke whale	0	0	0	1	0	0	0	12	0	0	0	25	0	0	0	0	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Fin whale**	0	0	0*	5	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Sperm whale**	0	0	3	148	0	0	3	152	0	0	2	150	0	0	0	16	0	0	4	287
Kogia spp.	0	0	1	23	0	0	4	217	0	0	7	471	0	0	0	5	0	0	5	352
Beaked whale	0	0	0	22	0	0	1	31	0	0	3	177	0	0	0	1	0	0	2	151
Rough-toothed dolphin	0	0	0	11	0	0	2	103	0	0	3	224	0	0	0	2	0	0	12	804
Bottlenose dolphin	0	0	70	3156	0	2	274	13531	0	4	582	36102	0	0	0	206	0	1	110	7464
Pantropical spotted dolphin	0	0	11	499	0	1	93	4788	0	1	158	10385	0	0	0	105	0	5	734	50005
Atlantic spotted dolphin	0	1	93	4304	0	1	194	6876	0	2	461	22520	0	0	0	140	0	0	58	3949
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	145	9822
Clymene dolphin	0	0	5	239	0	0	44	2287	0	1	75	4961	0	0	0	50	0	1	105	7170
Striped dolphin	0	0	16	526	0	0	0	10	0	0	0	0	0	0	0	1480	0	0	46	3161
Common dolphin	0	1	174	4872	0	0	0	0	0	0	0	0	0	0	0	779	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	300
Risso's dolphin	0	0	5	169	0	0	7	334	0	1	141	9531	0	0	0	132	0	0	17	1145
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	1426
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	205
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	429
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	55
Pilot whales	0	0	21	965	0	0	34	1972	0	1	169	11508	0	0	0	108	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	987
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	637	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-17. Estimated Marine Mammal Exposures From ULT, RDT&E, Maintenance, Coordinated ULT, and Strike Group Active Sonar Activities Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0*	28	0	0	0	1	0	0	1	175	0	0	0*	5	0	0	0	0
Humpback whale**	0	0	3	568	0	0*	6	920	0	0*	18	3194	0	0	0*	1520	0	0	0	0
Minke whale	0	0	0	29	0	0	0	48	0	0	1	171	0	0	0	81	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0*	1650	0	0	0	0
Fin whale**	0	0	1	80	0	0	0	0	0	0	0	0	0	0	0*	597	0	0	0	0
Sperm whale**	0	0*	23	3792	0	0*	5	599	0	0*	8	1082	0	0	1	4543	0	0	4	321
Kogia spp.	0	0	4	593	0	0	8	959	0	0	25	3393	0	0	0	1340	0	0	5	379
Beaked whale	0	0	3	284	0	0	1	115	0	0	10	892	0	0	0	276	0	0	2	155
Rough-toothed dolphin	0	0	2	282	0	0	4	456	0	0	12	1613	0	0	0	637	0	0	12	1080
Bottlenose dolphin	0	4	527	81106	0	5	583	70024	0	15	2008	270962	0	0	4	57770	0	1	125	15371
Pantropical spotted dolphin	0	1	86	13067	0	1	179	21119	0	5	544	74752	0	0	2	29519	0	5	748	54211
Atlantic spotted dolphin	0	6	703	110715	0	2	382	28914	0	8	1588	168055	0	0	3	39262	0	1	60	7904
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	145	11002
Clymene dolphin	0	0	41	6243	0	1	85	10090	0	2	260	35713	0	0	1	14103	0	1	114	8319
Striped dolphin	0	1	122	11965	0	0	0	34	0	0	0	0	0	2	23	414682	0	0	46	3452
Common dolphin	0	6	1313	102603	0	0	0	1	0	0	0	0	0	1	19	218216	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	348
Risso's dolphin	0	0	35	3980	0	0	13	1298	0	4	487	67828	0	0	3	37114	0	0	17	1282
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	1654
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	238
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	498
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	64
Pilot whales	0	1	158	24629	0	1	75	10591	0	5	582	82259	0	0	4	30243	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	1145
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	178352	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	20	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-18. Estimated Marine Mammal Exposures From ULT, RDT&E, and Maintenance Active Sonar Activities Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0*	26	0	0	0	1	0	0	1	128	0	0	0*	5	0	0	0	0
Humpback whale**	0	0	2	521	0	0	2	669	0	0*	8	2343	0	0	0*	1509	0	0	0	0
Minke whale	0	0	0	27	0	0	0	35	0	0	0	125	0	0	0	81	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0*	1638	0	0	0	0
Fin whale**	0	0	1	69	0	0	0	0	0	0	0	0	0	0.0	0*	593	0	0	0	0
Sperm whale**	0	0*	16	3278	0	0	2	423	0	1	3	847	0	1	1	4510	0	0	0*	32
Kogia spp.	0	0	3	548	0	0	3	709	0	0	11	2536	0	0	0	1330	0	0	0	25
Beaked whale	0	0	2	205	0	0	1	77	0	0	4	496	0	0	0	274	0	0	0	4
Rough-toothed dolphin	0	0	1	260	0	0	2	337	0	0	5	1205	0	0	0	632	0	0	0	155
Bottlenose dolphin	0	3	341	65089	0	3	279	59173	0	9	1049	239908	0	0	4	57358	0	0	13	4484
Pantropical spotted dolphin	0	1	63	12068	0	1	73	15617	0	2	238	55870	0	0	2	29308	0	0	12	4039
Atlantic spotted dolphin	0	5	511	100665	0	1	159	20852	0	4	689	128494	0	0	3	38981	0	0	2	2047
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1125
Clymene dolphin	0	0	30	5766	0	0	35	7461	0	1	114	26692	0	0	1	14002	0	0	7	1030
Striped dolphin	0	1	92	11489	0	0	0	23	0	0	0	0	0	2	23	411722	0	0	0	284
Common dolphin	0	5	906	80819	0	0	0	1	0	0	0	0	0	1	19	216659	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43
Risso's dolphin	0	0	26	3836	0	0	14	3482	0	2	250	59747	0	0	3	36849	0	0	0	126
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	205
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Pilot whales	0	1	105	20086	0	0	35	8414	0	3	285	68518	0	0	4	30028	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	142
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	177079	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	20	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-19. Estimated Marine Mammal Exposures From Coordinated ULT Active Sonar Activities Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0	1	0	0	0	0	0	0	0*	24	0	0	0	0	0	0	0	0
Humpback whale**	0	0	0*	23	0	0	0*	33	0	0	5	475	0	0	0	5	0	0	0	0
Minke whale	0	0	0	1	0	0	0	2	0	0	0	26	0	0	0	0	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Fin whale**	0	0	0*	5	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Sperm whale**	0	0	3	138	0	0	0*	18	0	0	2	162	0	0	0	16	0	0	0	2
Kogia spp.	0	0	1	23	0	0	1	32	0	0	7	490	0	0	0	5	0	0	0	1
Beaked whale	0	0	0	16	0	0	0	6	0	0	3	164	0	0	0	1	0	0	0	0
Rough-toothed dolphin	0	0	0	11	0	0	0	15	0	0	4	233	0	0	0	2	0	0	0	120
Bottlenose dolphin	0	0	61	2737	0	0	50	2764	0	5	724	44821	0	0	0	206	0	0	2	3423
Pantropical spotted dolphin	0	0	11	499	0	0	13	714	0	1	165	10801	0	0	0	105	0	0	2	167
Atlantic spotted dolphin	0	1	92	4242	0	0	29	1117	0	2	478	23620	0	0	0	140	0	0	0	1908
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55
Clymene dolphin	0	0	5	239	0	0	6	341	0	1	79	5160	0	0	0	50	0	0	1	119
Striped dolphin	0	0	17	551	0	0	0	1	0	0	0	0	0	0	0	1480	0	0	0	7
Common dolphin	0	1	164	4352	0	0	0	0	0	0	0	0	0	0	0	779	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Risso's dolphin	0	0	5	178	0	0	2	159	0	1	173	11718	0	0	0	132	0	0	0	11
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pilot whales	0	0	19	849	0	0	6	379	0	2	197	13387	0	0	0	108	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	637	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-20. Estimated Marine Mammal Exposures From Strike Group Active Sonar Exercises Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0	0*	0	0	0	0*	0	0	0*	11	0	0	0	0	0	0	0	0
Humpback whale**	0	0	1	36	0	0	3	218	0	0	5	421	0	0	0	0	0	0	0	0
Minke whale	0	0	0	2	0	0	0	12	0	0	0	23	0	0	0	0	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fin whale**	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperm whale**	0	0	6	275	0	0	3	151	0	0	3	209	0	0	0	0	0	0	4	287
Kogia spp.	0	0	1	36	0	0	4	217	0	0	7	435	0	0	0	0	0	0	5	352
Beaked whale	0	0	1	28	0	0	1	30	0	0	3	160	0	0	0	0	0	0	2	151
Rough-toothed dolphin	0	0	0	17	0	0	2	103	0	0	3	207	0	0	0	0	0	0	12	804
Bottlenose dolphin	0	1	132	5668	0	2	291	14749	0	4	529	30614	0	0	0	0	0	1	110	7464
Pantropical spotted dolphin	0	0	16	789	0	1	93	4788	0	1	159	9574	0	0	0	0	0	5	734	50005
Atlantic spotted dolphin	0	1	206	8949	0	1	194	6861	0	1	261	11980	0	0	0	0	0	0	58	3949
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	145	9822
Clymene dolphin	0	0	8	377	0	0	44	2287	0	1	76	4574	0	0	0	0	0	1	105	7170
Striped dolphin	0	0	19	838	0	0	0	10	0	0	0	0	0	0	0	0	0	0	46	3161
Common dolphin	0	1	107	4573	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	300
Risso's dolphin	0	0	6	284	0	0	15	933	0	1	134	8317	0	0	0	0	0	0	17	1145
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	1426
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	205
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	429
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	55
Pilot whales	0	0	38	1660	0	0	35	2011	0	1	180	11149	0	0	0	0	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	987
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-21. Estimated Marine Mammal Exposures From ULT, RDT&E, Maintenance, Coordinated ULT, and Strike Group Active Sonar Activities Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	321	0	0*	27	0	0	0	1	0	0	1	163	0	0	0*	5	0	0	0	0
Humpback whale**	0	0	3	581	0	0*	6	920	0	0*	18	3240	0	0	0*	1515	0	0	0	0
Minke whale	0	0	0	30	0	0	0	48	0	0	1	174	0	0	0	81	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0*	1644	0	0	0	0
Fin whale**	0	0	1	76	0	0	0	0	0	0	0	0	0	0	0*	595	0	0	0	0
Sperm whale**	0	0*	25	3691	0	0*	5	591	0	1	9	1219	0	1	1	4527	0	0	4	321
Kogia spp.	0	0	4	606	0	0	8	959	0	0	25	3461	0	0	0	1335	0	0	5	379
Beaked whale	0	0	3	249	0	0	1	113	0	0	9	820	0	0	0	275	0	0	2	155
Rough-toothed dolphin	0	0	2	288	0	0	4	456	0	0	12	1645	0	0	0	635	0	0	12	1080
Bottlenose dolphin	0	4	534	73494	0	5	621	76686	0	18	2302	315343	0	0	4	57564	0	1	125	15371
Pantropical spotted dolphin	0	1	91	13356	0	1	179	21119	0	5	562	76245	0	0	2	29414	0	5	748	54211
Atlantic spotted dolphin	0	7	808	113856	0	2	382	28830	0	8	1428	164095	0	0	3	39121	0	1	60	7904
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	145	11002
Clymene dolphin	0	0	43	6381	0	1	85	10090	0	2	268	36426	0	0	1	14053	0	1	114	8319
Striped dolphin	0	1	128	12878	0	0	0	34	0	0	0	0	0	2	23	413202	0	0	46	3452
Common dolphin	0	6	1177	89744	0	0	0	1	0	0	0	0	0	1	19	217438	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	348
Risso's dolphin	0	0	38	4298	0	0	31	4575	0	5	558	79782	0	0	3	36981	0	0	17	1282
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	1654
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	238
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	498
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	64
Pilot whales	0	1	162	22594	0	1	76	10804	0	6	661	93054	0	0	4	30136	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	1145
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	177715	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	20	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-22. Estimated Marine Mammal Exposures From ULT, RDT&E, and Maintenance Active Sonar Activities Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0*	35	0	0	0*	13	0	0	2	206	0	0	0*	153	0	0	0	0
Humpback whale**	0	0	3	516	0	0	3	621	0	0*	10	2151	0	0	0*	1348	0	0	0	0
Minke whale	0	0	0	27	0	0	0	33	0	0	1	115	0	0	0	521	0	0	0	0
Bryde’s whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0*	1422	0	0	0	0
Fin whale**	0	0	1	46	0	0	0	0	0	0	0	0	0	0	0*	967	0	0	0	0
Sperm whale**	0	0*	13	2871	0	0	1	324	0	0*	6	1552	0	0	1	6053	0	0	0*	31
Kogia spp.	0	0	4	543	0	0	4	657	0	0	14	2314	0	0	0	984	0	0	0	27
Beaked whale	0	0	4	449	0	0	2	271	0	0	7	945	0	0	0	230	0	0	0	1
Rough-toothed dolphin	0	0	2	258	0	0	2	312	0	0	7	1100	0	0	0	464	0	0	0	135
Bottlenose dolphin	0	1	116	22674	0	3	286	59086	0	16	2249	378889	0	0	2	30049	0	0	13	8168
Pantropical spotted dolphin	0	1	78	11967	0	1	97	14480	0	2	303	50982	0	0	1	21509	0	0	10	3847
Atlantic spotted dolphin	0	4	503	90655	0	1	377	17400	0	6	1941	130195	0	0	1	12110	0	0	2	5996
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1773
Clymene dolphin	0	0	38	5717	0	0	46	6918	0	1	145	24357	0	0	1	10276	0	0	7	1058
Striped dolphin	0	2	253	57612	0	0	0	61	0	0	0	0	0	1	13	190963	0	0	0	426
Common dolphin	0	1	295	14431	0	0	1	41	0	0	0	0	0	1	14	127989	0	0	0	0
Fraser’s dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44
Risso’s dolphin	0	0	37	6012	0	0	65	9726	0	2	293	59465	0	0	3	35907	0	0	0	176
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	44891	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	210
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Pilot whales	0	1	67	14123	0	1	44	11572	0	3	328	81873	0	0	4	33103	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	146
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	457442	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	37872	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	84695	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a “may affect” for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-23. Estimated Marine Mammal Exposures From Coordinated ULT Active Sonar Activities Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0*	2	0	0	0*	1	0	0	2	57	0	0	0	1	0	0	0	0
Humpback whale**	0	0	0*	24	0	0	1	34	0	0	7	462	0	0	0	5	0	0	0	0
Minke whale	0	0	0	1	0	0	0	2	0	0	0	26	0	0	0	2	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
Fin whale**	0	0	0*	4	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Sperm whale**	0	0	2	119	0	0	0*	14	0	0	4	284	0	0	0	22	0	0	0	2
***Kogia* spp.**	0	0	1	23	0	0	1	33	0	0	10	473	0	0	0	4	0	0	0	1
Beaked whale	0	0	1	38	0	0	0	21	0	0	5	306	0	0	0	1	0	0	0	0
Rough-toothed dolphin	0	0	0	11	0	0	0	16	0	0	5	225	0	0	0	2	0	0	0	120
Bottlenose dolphin	0	0	21	945	0	0	51	2800	0	9	1560	76919	0	0	0	108	0	0	2	3418
Pantropical spotted dolphin	0	0	14	517	0	0	17	732	0	1	211	10412	0	0	0	77	0	0	2	146
Atlantic spotted dolphin	0	1	91	3921	0	0	68	1474	0	4	1358	33921	0	0	0	43	0	0	0	1908
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55
Clymene dolphin	0	0	7	247	0	0	8	350	0	1	101	4975	0	0	0	37	0	0	1	118
Striped dolphin	0	0	45	2420	0	0	0	3	0	0	0	0	0	0	0	687	0	0	0	7
Common dolphin	0	0	54	1052	0	0	0	4	0	0	0	0	0	0	0	460	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Risso's dolphin	0	0	7	271	0	0	12	499	0	1	203	12050	0	0	0	129	0	0	0	10
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	161	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pilot whales	0	0	12	586	0	0	8	520	0	2	226	15727	0	0	0	119	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1618	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	136	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	305	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-24. Estimated Marine Mammal Exposures From Strike Group Active Sonar Exercises Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	0*	1	0	0	0*	4	0	0	0*	14	0	0	0	0	0	0	0	0
Humpback whale**	0	0	1	37	0	0	3	219	0	0	5	404	0	0	0	0	0	0	0	0
Minke whale	0	0	0	2	0	0	0	12	0	0	0	22	0	0	0	0	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fin whale**	0	0	0*	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperm whale**	0	0	5	228	0	0	2	121	0	0*	7	393	0	0	0	0	0	0	4	249
Kogia spp.	0	0	1	37	0	0	5	218	0	0	7	412	0	0	0	0	0	0	5	351
Beaked whale	0	0	1	60	0	0	3	143	0	0	7	370	0	0	0	0	0	0	0	25
Rough-toothed dolphin	0	0	0	18	0	0	2	104	0	0	3	196	0	0	0	0	0	0	3	172
Bottlenose dolphin	0	0	46	2083	0	2	301	16693	0	7	1001	56526	0	0	0	0	0	2	270	15428
Pantropical spotted dolphin	0	0	20	817	0	1	101	4812	0	1	162	9087	0	0	0	0	0	4	622	42190
Atlantic spotted dolphin	0	1	185	8166	0	1	256	5594	0	1	365	9138	0	0	0	0	0	0	122	4833
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	290	19575
Clymene dolphin	0	0	10	390	0	0	48	2299	0	1	77	4341	0	0	0	0	0	1	105	7157
Striped dolphin	0	1	69	3428	0	0	0	26	0	0	0	0	0	0	0	0	0	1	80	5436
Common dolphin	0	0	52	1136	0	0	1	14	0	0	0	0	0	0	0	0	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	299
Risso's dolphin	0	0	11	468	0	0	61	2865	0	1	155	9478	0	0	0	0	0	0	27	1814
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	1423
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	205
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	428
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	55
Pilot whales	0	0	26	1199	0	0	56	3475	0	2	252	15856	0	0	0	0	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	985
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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Table 4-25. Estimated Marine Mammal Exposures From ULT, RDT&E, Maintenance, Coordinated ULT, and Strike Group Active Sonar Activities Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function	Mortality	PTS	TTS	Dose-Function
North Atlantic right whale**	0	0	1	39	0	0	0	19	0	0	5	278	0	0	0*	154	0	0	0	0
Humpback whale**	0	0	4	578	0	0*	7	873	0	0*	22	3017	0	0	0*	1353	0	0	0	0
Minke whale	0	0	0	30	0	0	0	46	0	0	1	162	0	0	0	523	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
Sei whale**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0*	1428	0	0	0	0
Fin whale**	0	0	1	53	0	0	0	0	0	0	0	0	0	0	0*	970	0	0	0	0
Sperm whale**	0	0*	20	3218	0	0	4	459	0	0*	17	2229	0	0	1	6074	0	0	4	282
Kogia spp.	0	0	5	604	0	0	10	909	0	0	31	3199	0	0	0	987	0	0	5	379
Beaked whale	0	0	6	547	0	0	5	435	0	0	19	1621	0	0	0	231	0	0	0	26
Rough-toothed dolphin	0	0	2	287	0	0	5	432	0	0	15	1520	0	0	0	466	0	0	3	427
Bottlenose dolphin	0	1	184	25701	0	6	638	78579	0	31	4810	512333	0	0	2	30157	0	2	285	27014
Pantropical spotted dolphin	0	1	113	13300	0	2	216	20024	0	5	675	70481	0	0	1	21587	0	5	634	46183
Atlantic spotted dolphin	0	6	778	102742	0	2	701	24468	0	11	3664	173254	0	0	1	12153	0	1	125	12738
Spinner dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	290	21402
Clymene dolphin	0	0	54	6354	0	1	103	9566	0	2	323	33673	0	0	1	10313	0	1	114	8333
Striped dolphin	0	3	367	63460	0	0	1	90	0	0	0	0	0	1	13	191649	0	1	80	5869
Common dolphin	0	1	400	16619	0	0	2	59	0	0	0	0	0	1	14	128449	0	0	0	0
Fraser's dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	349
Risso's dolphin	0	0	55	6750	0	1	138	13090	0	5	652	80992	0	0	3	36036	0	0	27	2001
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	45052	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	1657
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	238
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	498
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	64
Pilot whales	0	1	105	15908	0	1	108	15567	0	7	806	113456	0	0	4	33221	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	1147
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	459060	0	0	0	0
Gray Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	38008	0	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	84999	0	0	0	0

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.

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4.4.11 Summary of Potential Acoustic Effects by Marine Mammal Species

The acoustic analysis model is good at producing rough estimates of marine species physiological effects and behavioral reactions, but should not be relied upon solely as final assessment of the effects to marine mammals. A qualitative analysis of oceanographic and habitat conditions is also an important consideration in the overall marine mammal analysis. Oceanographic features and conditions often determine primary productivity, which drives prey availability and therefore the distribution of marine mammals.

When querying the data from the marine mammal density and acoustic footprint databases, large buffer areas around the training areas are applied; this can hide small geographic differences in the alternatives within the model (e.g. Alternative 3 versus the No Action Alternative) that still may provide significant environmental differences.

Additionally, marine species density models are based on the best available science, but are often compiled from small datasets and are only as good as the limited survey information used to build the models. Single hotspots in the density databases can be an artifact of a single data point, and can drive the density estimate for an entire area beyond what is probable or realistic.

Quantitative analysis alone should not be relied upon for a complete assessment of the alternatives presented in this AFAST Draft EIS/OEIS, although the quantitative acoustic analysis can help to inform the decision making process.

4.4.11.1 Potential Effects to ESA-Listed Species

4.4.11.1.1 North Atlantic Right Whale

Acoustic analysis indicates that up to 555 North Atlantic right whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 210 under Alternative 1, 197 under Alternative 2, and 495 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no right whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to right whales.

Lookouts will likely detect a group of North Atlantic right whales out to 914 m (1,000 yd) given their large size (Leatherwood and Reeves, 1982), surface behavior, pronounced blow, and mean group size of approximately three animals. The probability of trackline detection in Beaufort Sea States of 6 or less is 0.90 or 90 percent (Barlow, 2003). Implementation of mitigation measures and probability of detecting a large North Atlantic right whale reduce the likelihood of exposure and potential effects. Thus, the number of North Atlantic right whale exposures indicated by the acoustic analysis is likely a conservative overestimate of actual exposures. Additionally, even though the right whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

No tests on North Atlantic right whale hearing have been conducted although a right whale audiogram has been constructed using a mathematical model based on the internal structure of the ear. The predicted audiogram indicates hearing sensitivity to frequencies from 15 Hz to 20 kHz, with maximum relative sensitivity between 20 Hz and 2 kHz (Ketten, 1998).

The Navy considered potential effects to stocks based on the best abundance estimate for each stock of marine mammal species, as published in the stock assessment report (SAR) by NMFS. Approximately 350 individuals, including about 70 mature females, are thought to occur in the western North Atlantic (Kraus et al., 2005). The most recent stock assessment report states that in a review of the photo-id recapture database for October 2005, 306 individually recognized whales were known to be alive during 2001 (Waring et al., 2007). This number represents a minimum population size, and no abundance estimate with an associated coefficient of variation has been calculated for this population (Waring et al., 2007). Right whales are not expected to occur in the Gulf of Mexico.

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

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

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

(3) Cape Cod and Massachusetts Bays

In the southeast North Atlantic right whale critical habitat, activities could include object detection/navigational sonar training and maintenance activities for surface ships and submarines while entering/exiting ports located in Kings Bay, Georgia, and Mayport, Florida. In addition, helicopter dipping sonar would occur off of Mayport, Florida in the established training areas within the right whale critical habitat. In the northeast North Atlantic right whale critical habitat, a limited number of TORPEXs would be conducted in August, September, and October per the Navy consultation with NMFS.

Based on best available science the Navy concludes that exposures to North Atlantic right whales due to AFAST activities would result in short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to North Atlantic right whales.

In accordance with NEPA, there will be no significant impact to North Atlantic right whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to North Atlantic right whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect North Atlantic right whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.11.1.2 Humpback Whale

Acoustic analysis indicates that up to 5,946 humpback whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 6,229 under Alternative 1, 6,283 under Alternative 2, and 5,854 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no humpback whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to humpback whales.

Lookouts would likely detect humpback whales at the surface because of their large size (up to 16 m [53 ft]) (Leatherwood and Reeves, 1982), and pronounced vertical blow. Thus, the number of humpback whale exposures indicated by the acoustic analysis is likely a conservative overestimate of actual exposures. Additionally, even though the humpback whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

No tests on humpback whale hearing have been made although a humpback whale audiogram has been constructed using a mathematical model based on the internal structure of the ear. The predicted audiogram indicates sensitivity to frequencies from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 and 6 kHz. Recent information on the songs of humpback whales suggests that their hearing may extend to frequencies of at least 24 kHz and source levels of 151-173 dB re 1μPa (Au et al., 2006). A single study suggested that humpback whales responded to mid frequency sonar (3.1-3.6 kHz re 1 μPa^2-s) sound (Maybaum, 1989), however the hand-held sonar system used had a sound artifact below 1,000 Hz which apparently caused a response to the control playback (a blank tape) and may have confounded the results from the treatment (i.e., the humpback whale may have responded to the low frequency artifact rather than the mid-frequency sonar sound).

The Navy considered potential effects to stocks based on the best available data for each stock of marine mammal species. Humpback whales in the North Atlantic are thought to belong to five different feeding stocks: Gulf of Maine, Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, and Iceland. Previously, the North Atlantic humpback whale population was treated as a single stock for management purposes (Waring *et al.* 1999). However, based upon the strong regional fidelity by individual whales the Gulf of Maine has been reclassified as a separate feeding stock (Waring et al., 2007). Recent genetic analyses have also found significant differences in mtDNA haplotype frequencies among whales sampled in four western feeding areas, including the Gulf of Maine (Palsbøll et al., 2001). As a result, the International Whaling Commission acknowledged the evidence for treating the Gulf of Maine as a separate stock for the purpose of management (IWC, 2002). The current best estimate of population size for humpback whales in the North Atlantic, including the Gulf of Maine Stock, is 11,570 individuals (Waring et al., 2007). The best abundance estimate for the Gulf of Maine humpback stock is 902 individuals (Waring et al., 2007). During the winter, most of the North Atlantic population of humpback whales is believed to migrate south to calving grounds in the West Indies region

(Whitehead and Moore, 1982; Smith et al., 1999; Stevick et al., 2003). During this time individuals from the various feeding stocks mix through migration routes as well as on the feeding grounds. Additionally, there has been an increasing occurrence of humpbacks, which appear to be primarily juveniles, during the winter along the U.S. Atlantic coast from Florida north to Virginia (Clapham et al., 1993; Swingle et al., 1993; Wiley et al., 1995; Laerm et al., 1997). Although the population composition of the mid-Atlantic is apparently dominated by Gulf of Maine whales, the lack of recent photographic effort in Newfoundland makes it likely that other feeding stocks may be under-represented in the photo identification matching data (Waring et al., 2007). Although the majority of acoustic exposures in the Northeast are likely to be from the Gulf of Maine feeding stock, the mixing of multiple stocks through the migratory season suggests that exposures in the Mid-Atlantic and Southeast are likely spread across all of the North Atlantic populations. Sufficient data to estimate the percentage of exposures to each stock is currently not available.

Based on best available science the Navy concludes that exposures to humpback whales due to AFAST activities would result in short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to humpback whales.

In accordance with NEPA, there will be no significant impact to humpback whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to humpback whales from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect humpback whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.11.1.3 Sei Whale

Acoustic analysis indicates that up to 2,078 sei whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 1,650 under Alternative 1, 1,644 under Alternative 2, and 1,428 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no sei whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to sei whales.

Lookouts would likely detect sei whales at the surface because they have high likelihood of detection (0.90 in Beaufort Sea States of 6 or less; Barlow, 2003). Sei whales generally form groups of three animals or more, have a pronounced vertical blow, and are large animals. Thus, the number of sei whale exposures indicated by the acoustic analysis is likely a conservative overestimate of actual exposures. Additionally, even though the sei whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

The Navy considered potential effects to stocks based on the best available data for each stock of marine mammal species. Sei whales in the North Atlantic belong to three stocks: Nova Scotia, Iceland-Denmark Strait, and Northeast Atlantic (Perry et al., 1999). The Nova Scotia Stock occurs in U.S. Atlantic waters (Waring et al., 2007). Prior to 1999, the North Atlantic humpback whale population was identified as the western North Atlantic Stock for management purposes (Waring et al., 2005). The boundaries of the Nova Scotian stock of sei whales include the continental shelf waters of the northeastern United States and extends northeastward to the south of Newfoundland (Waring et al., 1999). NMFS adopted the boundaries based on the proposed International Whaling Commission stock definition, which extends from the East Coast to Cape Breton, Nova Scotia, and east to longitude 42 ^{o} W (Warring et al., 1999). There are no recent abundance estimates for the Nova Scotia stock (Waring et al., 2007). Sufficient data to estimate the percentage of exposures to the stock is currently not available.

Based on best available science the Navy concludes that exposures to sei whales due to AFAST activities would result in short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to sei whales.

In accordance with NEPA, there will be no significant impact to sei whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to sei whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect sei whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.11.1.4 Fin Whale

Acoustic analysis indicates that up to 1,364 fin whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 678 under Alternative 1, 672 under Alternative 2, and 1,025 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no fin whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to fin whales.

Lookouts would likely detect a group of fin whales at the surface because they have a high likelihood of detection (0.90 in Beaufort Sea States of 6 or less; Barlow, 2003). Additionally, even though the fin whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Fin whales are currently considered as a single stock in the western North Atlantic. The best abundance estimate for the Western North Atlantic stock of fin whales is 2,814 (Waring et al., 2007). The population is likely to be larger than the best estimate because as Waring et al. (2007) note dive times are extended for fin whales and the incorporation of a dive correction factor brings the estimate to 5,000 to 6,000 fin whales in the waters of the U.S. Atlantic (CETAP, 1982; Kenney et al., 1997). Fin whales are not expected to occur in the Gulf of Mexico.

Based on best available science the Navy concludes that exposures to the western North Atlantic fin whale stock due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to fin whales.

In accordance with NEPA, there will be no significant impact to fin whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to fin whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect fin whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.11.1.5 Blue Whale

Acoustic analysis is not available for blue whales due to the lack of abundance and density data for North Atlantic populations. Population estimates are available only for the Gulf of St. Lawrence area (off eastern Canada), where 308 individuals have been catalogued. This number is considered to be the minimum population estimate for the western North Atlantic stock. The entire population may total only in the hundreds, but no conclusive data exist to confirm or refute this estimate.

Blue whales occur primarily in deep offshore water, with occasional sightings on the continental shelf. This species is considered to occur only occasionally in the U.S. EEZ, and the northeastern EEZ may represent the southern limit of blue whale feeding grounds. There are a few records of blue whale occurrence in the Atlantic OPAREAs, and only two reliable records in the GOMEX.

An undetermined number of blue whales could be exposed to sound levels likely to result in Level B harassment. Based on the presumed relatively small population and low number of recorded sightings in the OPAREAs, the number of potential exposures is probably low. No exposure of individuals to sound levels likely to result in Level A harassment is expected. No mortality due to explosive sonobuoys is expected. Lookouts would likely detect blue whales at the surface. Additionally, even though blue whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

Based on best available science the Navy concludes that exposures to blue whales due to AFAST activities would result in short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to blue whales.

In accordance with NEPA, there will be no significant impact to blue whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to blue whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.
In accordance with the ESA, the Navy finds the AFAST activities may affect blue whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.11.1.6 Sperm Whale

Acoustic analysis indicates that up to 14,908 sperm whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 10,377 under Alternative 1, 10,392 under Alternative 2, and 12,307under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to one sperm whale may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, zero under Alternative 1, two under Alternative 2, and zero under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to sperm whales.

Lookouts would likely detect a group of sperm whales at the surface because they have a high likelihood of detection (0.87 in Beaufort Sea States of 6 or less; Barlow, 2003) given their large size (up to 17 m [56 ft]) (Leatherwood and Reeves, 1982), pronounced blow (large and angled), and mean group size (approximately seven animals). Additionally, even though the sperm whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

No direct tests on sperm whale hearing have been made, although the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high frequency to ultrasonic frequency sounds. Behavioral observations have been made whereby during playback experiments off the Canary Islands, André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André et al., 1997).

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Sperm whales are currently considered as a single stock in the western North Atlantic. NMFS provisionally considers the sperm whale population in the northern GOMEX, the Gulf of Mexico stock, distinct from the U.S. Atlantic stock (Waring et al., 2006). Genetic analyses, coda vocalizations, and population structure support this (Jochens et al., 2006). Stock structure for sperm whales in the North Atlantic is not known (Dufault et al., 1999). The best abundance estimate for sperm whales for the western North Atlantic is 4,804, with a minimum population estimate of 3,539 animals. The current best abundance estimate for sperm whales in the northern GOMEX is 1,349 individuals (Mullin and Fulling, 2004).

Based on best available science the Navy concludes that exposures to the western North Atlantic and Gulf of Mexico sperm whale stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to sperm whales.

In accordance with NEPA, there will be no significant impact to sperm whales *from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. Further, in accordance with EO 12114, there will be no significant harm to sperm whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect sperm whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.11.1.7 Manatee

With the exception of maintenance and ship object detection/navigational sonar training, no active sonar activity would be conducted within Florida manatee habitat. The manatee is considered to be an inshore species, with most sightings occurring in warm freshwater, estuarine, and extremely nearshore coastal waters. During winter, manatees are largely restricted to peninsular Florida in the Gulf of Mexico and to Florida and southeastern Georgia in the Atlantic Ocean. Distribution expands northward and eastward in warmer months. Exposure numbers for the manatees occurring in the southeast could not be calculated due to the lack of acoustic exposure criteria and lack of available density information.

Behavioral data on two animals indicate an underwater hearing range of approximately 0.4 to 46 kHz, with best sensitivity between 16 and 18 kHz (Gerstein et al., 1999), while earlier electrophysiological studies indicated best sensitivity from 1 to 1.5 kHz (Bullock et al., 1982). Therefore, it appears that manatees have the capability of hearing active sonar. In one study, manatees were shown to react to the sound from approaching or passing boats by moving into deeper waters or increasing swimming speed (Nowacek et al., 2004). By extension, manatees could react to active sonar; however, there is no evidence to suggest the reaction would likely disturb the manatee to a point where their behaviors are abandoned or significantly altered. Specifically, manatees did not respond to sound at levels of 10 to 80 kHz produced by a pinger every 4 seconds for 300 milliseconds (Bowles et al., 2001). The pings' energy was predominantly in the 10 to 40 kHz range (the mid to high portion of manatee hearing). The level of sound was approximately 130 dB re 1 μPa.

Additionally, Hubbs-SeaWorld Research Institute (HSWRI) initially tested a manatee detection device based on sonar (Bowles, et al., 2004). In addition to conducting sonar reflectivity, the experiments also included a behavioral response study. Experiments were conducted with 10 kHz pings, whereby the sound level was increased by 10 dB from 130 dB to 180 dB or until the researchers observed distress. Rapid swimming, thrashing of the body or paddle, and spinning while swimming indicated distress. Researchers found that manatees detected the 10 kHz pings and approached the transducer cage when the sonar was turned on initially. However, none of the responses indicated that the manatees responded with intense avoidance or distress. The authors concluded that manatees do not exhibit strong startle responses or an aggressive nature towards acoustic stimuli, which differs from experiments conducted on cetaceans and pinnipeds (Bowles, et al., 2004).

Based on best available science manatees would hear mid-frequency and high-frequency sonar, but would not likely show a strong reaction or be disturbed from their normal range of behaviors. Additionally, limited active sonar activities would take place in the vicinity of manatee habitat. *Therefore, in accordance with NEPA, there will be no significant impact to manatees from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.*

In accordance with the ESA, the Navy finds the AFAST activities will have no effect on manatees.

4.4.11.2 Estimated Exposures for Non-ESA-Listed Species

4.4.11.2.1 Minke Whale

Acoustic analysis indicates that up to 632 minke whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 332 under Alternative 1, 335 under Alternative 2, and 763 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no minke whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to minke whales.

Lookouts would likely detect a group of minke whales at the surface given their large size (up to 8 m [27 ft]), pronounced blow, and breaching behavior (Barlow, 2003). Additionally, even though the minke whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. There are four recognized populations in the North Atlantic Ocean: Canadian East Coast, West Greenland, Central North Atlantic, and Northeastern North Atlantic (Donovan, 1991; Waring et al., 2007). Minke whales off the eastern United States are considered to be part of the Canadian East Coast stock which inhabits the area from the eastern half of the Davis Strait to 45ºW and south to the Gulf of Mexico (Waring et al., 2007). The best available abundance estimate for minke whales from the Canadian East Coast stock is 2,998 animals (Waring et al., 2007). The minke whale is not expected in the Gulf of Mexico.

Based on best available science the Navy concludes that exposures to the Canadian East Coast minke whale stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to minke whales.

In accordance with NEPA, there will be no significant impact to minke whales *from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. Further, in accordance with EO 12114, there will be no significant harm to minke whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.2 Bryde's Whale

Acoustic analysis indicates that up to 27 Bryde's whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 26 under Alternative 1, 26 under Alternative 2, and 26 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no Bryde's whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Bryde's whales.

Lookouts would likely detect a group of Bryde's whales at the surface because they have a high likelihood of detection (0.87 in Beaufort Sea States of 6 or less; Barlow, 2003; 2006) given their large size (up to 14 m [46 ft]) and pronounced blow. Additionally, even though the Bryde's whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Bryde's whales are not expected in U.S. waters of the western North Atlantic. Bryde's whales are currently considered as a single, separate stock in the northern Gulf of Mexico. It has been suggested that the Bryde's whales found in the GOMEX may represent a resident stock (Schmidly, 1981), but there is no information on stock differentiation (Waring et al., 2006). The best abundance estimate for Bryde's whales within the northern Gulf of Mexico is 40, with a minimum population size estimate of 25 whales (Waring et al., 2006).

Based on best available science the Navy concludes that exposures to the northern Gulf of Mexico Bryde's whale stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Bryde's whales.

In accordance with NEPA, there will be no significant impact to Bryde's whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Bryde's whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.3 Pygmy and Dwarf Sperm Whales

Acoustic analysis indicates that up to 6,095 pygmy and dwarf sperm whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 6,706 under Alternative 1, 6,783 under Alternative 2, and 6,129 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no pygmy or dwarf sperm whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to pygmy or dwarf sperm whales.

Lookouts would likely detect a group of pygmy and dwarf sperm whales at the surface because of their large size (up to 14 m [46 ft]) and behavior of resting at the surface (Leatherwood and Reeves, 1982). Additionally, even though the pygmy and dwarf sperm whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimates presented in the stock assessment reports published by NMFS. There is currently no information to differentiate Atlantic stock(s) (Waring et al., 2007). The best abundance estimate for both species combined in the western North Atlantic is 395 individuals (Waring et al., 2007). Species-level abundance estimates cannot be calculated due to uncertainty of species identification at sea (Waring et al., 2007). There is currently no information to differentiate the Northern GOMEX stock from the Atlantic stock(s) (Waring et al., 2006). For pygmy and dwarf sperm whales in the Northern Gulf of Mexico, the best abundance estimate is 742 animals with a minimum population of 584 (Waring et al., 2006). A separate abundance estimate for the pygmy sperm whale or the dwarf sperm whale cannot be calculated due to uncertainty of species identification at sea (Waring et al., 2006).

Based on best available science the Navy concludes that exposures to the northern Gulf of Mexico pygmy and dwarf sperm whale stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to pygmy and dwarf sperm whales.

In accordance with NEPA, there will be no significant impact to pygmy and dwarf sperm whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to pygmy and dwarf sperm whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.4 Beaked Whales (various species)

Acoustic analysis indicates that up to 3,680 beaked whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 1,739 under Alternative 1, 1,627 under Alternative 2, and 2,890 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no beaked whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to beaked whales.

Most beaked whale species are difficult to identify to the species level at sea; therefore, much of the available characterization for beaked whales is to genus level only *(Ziphius* and *Mesoplodon* species). Four species of *Mesoplodon*are found in the in the northwest Atlantic. These include True's beaked whale, *Mesoplodon mirus*; Gervais' beaked whale, *M. europaeus*; Blainville's beaked whale, *M.densirostris*; and Sowerby's beaked whale, *M. bidens*. Stock structure for each species is unknown (Waring et al., 2004).

The best abundance estimate for Cuvier's beaked whales in the northern Gulf of Mexico is 95 individuals. The minimum population estimate for the northern Gulf of Mexico is 65 Cuvier's beaked whales (Waring et al., 2006). The total number of Cuvier's beaked whales off the eastern U.S. and Canadian Atlantic coast is unknown, but there have been several estimates of an undifferentiated grouping of beaked whales that includes both *Ziphius* and *Mesoplodon* species. The best abundance estimate for undifferentiated beaked whales (*Ziphius* and *Mesoplodon* species) in the Western North Atlantic is 3,513, with a minimum population estimate of 2,154 (Waring et al., 2006). It is not possible to determine the minimum population estimate of only Cuvier's beaked whales.

Identification of *Mesoplodon* to species in the Gulf of Mexico is very difficult, and in many cases, *Mesoplodon* and Cuvier's beaked whale (*Ziphius cavirostris*) cannot be distinguished; therefore, sightings of beaked whales (Family Ziphiidae) are identified as *Mesoplodon* sp., Cuvier's beaked whale, or unidentified Ziphiidae. The best abundance estimate for *Mesoplodon* species in the northern Gulf of Mexico is 106 animals. The minimum population estimate for *Mesoplodon* species in the northern Gulf of Mexico is 76 individuals (Waring et al., 2006). Present data are insufficient to calculate minimum population estimates for all *Mesoplodon* species in the western North Atlantic. The total number of northern bottlenose whales off the East Coast is unknown.

In general, the Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the SAR by NMFS. Because many beaked whales are difficult to differentiate at sea, density estimates are only available for beaked whales as a group. It is possible to make some broad inferences about effects to individual species based on their generally accepted abundance estimates in each region but it is important to keep in mind the difficulty in identifying most individuals beyond the genus level.

Based on best available science the Navy concludes that exposures to beaked whales due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to beaked whales.

In accordance with NEPA, there will be no significant impact to beaked whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to beaked whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.5 Rough-Toothed Dolphin

Acoustic analysis indicates that up to 3,731 rough-toothed dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 3,400,under Alternative 1, 4,133 under Alternative 2, and 3,156 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no rough-toothed dolphins will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to rough-toothed dolphins.

Lookouts would likely detect a group of rough-toothed dolphins at the surface because of their high probability of detection (0.76 in Beaufort Sea States of 6 or less; Barlow, 2006) given their frequent surfacing and mean group sizes (14.8 animals). Implementation of mitigation measures and probability of detecting large groups of rough-toothed dolphins reduce the likelihood of exposure. Thus, rough-toothed dolphin exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimates presented in the stock assessment reports published by NMFS. There is no information on stock differentiation for the western North Atlantic stock of this species and no abundance estimates are available for rough-toothed dolphins here. The best abundance estimate for rough-toothed dolphins is 2,223 in the northern Gulf of Mexico (Fulling et al., 2003; Mullin and Fulling, 2004; Waring et al., 2006) with a minimum population estimate of 1,595 rough-toothed animals.

Based on best available science the Navy concludes that exposures to rough-toothed dolphins due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to rough-toothed dolphins.

In accordance with NEPA, there will be no significant impact to rough-toothed dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to rough-toothed dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.6 Bottlenose Dolphin

Acoustic analysis indicates that up to 761,961bottlenose dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 498,478 under Alternative 1, 542,043 under Alternative 2, and 679,704 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to 46 bottlenose dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, 26 under Alternative 1, 28 under Alternative 2, and 41 under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to bottlenose dolphins.

Bottlenose dolphins tend to have relatively short dives and given their frequent surfacing, lookouts would be more likely detect a group of bottlenose dolphins at the surface. The probability of detecting groups of bottlenose dolphins and the subsequent implementation of mitigation measures would reduce the likelihood of exposures, especially at very close ranges that would potentially cause Level A harassment and especially. Thus, the number of bottlenose dolphin exposures indicated by the acoustic analysis is likely a conservative over-estimate of actual exposures.

The Navy considered potential effects to stocks based on the best available data for each stock of marine mammal species. A number of stocks exist for the bottlenose dolphin in the western North Atlantic and the northern Gulf of Mexico. Therefore, the assessment focuses on the stocks that occur within the area for AFAST activities that have the potential to overlap the species' distributions.

For the western North Atlantic, these stocks include both the coastal and offshore stocks. The best estimate for the western North Atlantic coastal stock of bottlenose dolphins is 15,620 and the best estimate for the western North Atlantic offshore stock of bottlenose dolphins is 81,588 (Waring et al., 2007). Torres et al. (2003) found a statistically significant break in the distribution of the morphotypes at 34 km (18 NM) from shore based upon the genetic analysis of tissue samples collected in nearshore and offshore waters. The offshore morphotype was found exclusively seaward of 34 km (18 NM) and in waters deeper than 34 m (18 NM). Within 7.5 km (4 NM) of shore, all animals were of the coastal morphotype. More recently, offshore morphotype animals have been sampled as close as 7.3 km (4 NM) from shore in water depths of 13 m (43 ft) (Garrison et al., 2003). Due to the apparent mixing of the coastal and offshore stocks of bottlenose dolphins along the Atlantic coast it is impossible to estimate the percentage of each stock potentially exposed to sonar from AFAST. The general distribution of AFAST training activities suggests that the majority of estimated exposures to bottlenose dolphins will be to the offshore stock, however some small proportion of exposures will likely apply to the coastal stock as well.

In the northern GOMEX, the stocks of concern include the continental shelf and oceanic stocks. The continental shelf stock is thought to overlap with both the oceanic stock as well as coastal stocks in some areas (Waring et al., 2007); however, the coastal stock is generally limited to less than 20 m (66 ft) water depths and therefore is not expected to be exposed to sonar from AFAST. The best abundance estimate for the continental shelf stock is 25,320 (Waring et al., 2007). The estimated abundance for bottlenose dolphins in oceanic waters, pooled from 1996 to 2001, is 2,239 (Mullin and Fulling, 2004). The oceanic stock is provisionally defined for bottlenose dolphins inhabiting waters greater than 200 m (656 ft) (Waring et al., 2007). While the two stocks may overlap to some degree the Navy estimates, based on the distribution of AFAST activities, that most of the predicted exposures will occur to the oceanic stock with the few remaining exposures applying to the continental stock.

Based on best available science the Navy concludes that exposures to both Atlantic and Gulf of Mexico bottlenose dolphins due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to bottlenose dolphins.

In accordance with NEPA, there will be no significant impact to bottlenose dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to bottlenose dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.7 Pantropical Spotted Dolphins

Acoustic analysis indicates that up to 178,628 pantropical spotted dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 194,227 under Alternative 1, 195,925 under Alternative 2, and 173,214 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to 12 pantropical spotted dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action

Alternative, 12 under Alternative 1, 13 under Alternative 2, and 12 under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to pantropical spotted dolphins.

Given their frequent surfacing and large group size encompassing hundreds of animals (Leatherwood and Reeves, 1982), mean group size of 60.0 animals and probability of trackline detection of 1.00 in Beaufort Sea States of 6 or less (Barlow, 2006), lookouts would likely detect a group of pantropical spotted dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of pantropical spotted dolphins reduce the likelihood of exposure. Thus, the estimated number of pantropical spotted dolphins experiencing harassment may be fewer than previously stated.

No direct measures of hearing ability are available for pantropical spotted dolphins, but ear anatomy has been studied and indicates that this species should be adapted to hear the lower range of ultrasonic frequencies (less than 100 kHz).

In general, the Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment report by NMFS. In the western North Atlantic, the best abundance estimate for pantropical spotted dolphins is 4,439 with a minimum population estimate of 3,010 animals (Waring et al., 2006). The best abundance estimate for pantropical spotted dolphins in the northern Gulf of Mexico is 91,321, with a minimum population of 79,879 dolphins (Waring et al., 2006).

Based on best available science the Navy concludes that exposures to pantropical spotted dolphins due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to pantropical spotted dolphins.

In accordance with NEPA, there will be no significant impact to pantropical spotted dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to pantropical spotted dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.8 Atlantic Spotted Dolphin

Acoustic analysis indicates that up to 388,997 Atlantic spotted dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 357,586 under Alternative 1, 356,486 under Alternative 2, and 330,623 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to 24 Atlantic spotted dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, 17 under Alternative 1, 17 under Alternative 2, and 20 under Alternative 3.

Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Atlantic spotted dolphins.

Lookouts would likely detect a group of pantropical spotted dolphins at the surface because of their high probability of detection (1.00 in Beaufort Sea States of 6 or less; Barlow, 2006) given their frequent surfacing and large group size encompassing hundreds of animals (Leatherwood and Reeves, 1982). Implementation of mitigation measures and probability of detecting large groups of Atlantic spotted dolphins reduce the likelihood of exposure. Thus, the estimated number of Atlantic spotted dolphins experiencing harassment may be fewer than previously stated.

In general, the Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the SAR by NMFS. In the North Atlantic, the best abundance estimate for Atlantic spotted dolphins is 50,978, with a minimum population estimate (based on the combined offshore and coastal abundance estimates) of 36,235 (Waring et al., 2006). The best abundance estimate for Atlantic spotted dolphins in the northern Gulf of Mexico is 30,947, with a minimum population estimate of 24,752 dolphins (Waring et al., 2006).

Based on best available science the Navy concludes that exposures to Atlantic spotted dolphins due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Atlantic spotted dolphins.

In accordance with NEPA, there will be no significant impact to Atlantic spotted dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Atlantic spotted dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.9 Spinner Dolphin

Acoustic analysis indicates that up to 21,738 spinner dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 11,147 under Alternative 1, 11,147 under Alternative 2, and 21,692 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to two spinner dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, one under Alternative 1,one under Alternative 2, and two under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to spinner dolphins.

Lookouts would likely detect a group of spinner dolphins at the surface because of their high probability of detection (1.00 in Beaufort Sea States of 6 or less; Barlow, 2006) given their frequent surfacing, aerobatics, and large mean group size of 31.7 animals. Implementation of mitigation measures and probability of detecting large groups of spinner dolphins reduce the likelihood of exposure. Thus, spinner dolphin exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment report by NMFS. No best estimate is currently available for the western North Atlantic stock of spinner dolphins. Stock structure in the western North Atlantic is unknown (Waring et al., 2007). The best abundance estimate for spinner dolphins in the northern Gulf of Mexico is 11,971, with a minimum population of 6,990 spinner dolphins (Waring et al., 2006).

Based on best available science the Navy concludes that exposures to the northern Gulf of Mexico spinner dolphin stock due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to spinner dolphins.

In accordance with NEPA, there will be no significant impact to spinner dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to spinner dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.10 Clymene Dolphin

Acoustic analysis indicates that up to 68,980 Clymene dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 74,968 under Alternative 1, 75,779 under Alternative 2, and 68,834 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to four Clymene dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, four under Alternative 1, four under Alternative 2, and four under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Clymene dolphins.

Given their gregarious behavior and potentially large group size of up to several hundred or even thousands of animals (Jefferson, 2006), it is likely that lookouts would detect a group of Clymene dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of Clymene dolphins reduce the likelihood of exposure. Thus, Clymene dolphin exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Clymene dolphins are currently considered as a single stock in the western North Atlantic; the northern

Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks (Waring et al., 2007). The best abundance estimate for Clymene dolphins in the western North Atlantic is 6,086 animals, with a minimum population estimate of 3,132 Clymene dolphins (Waring et al., 2007). The best abundance estimate of Clymene dolphins in the northern Gulf of Mexico is 17,355, with a minimum population estimate of 10,528 dolphins (Waring et al., 2007).

Based on the best available science the Navy concludes that exposures to both Northwest Atlantic and Gulf of Mexico Clymene dolphin stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Clymene dolphins.

In accordance with NEPA, there will be no significant impact to Clymene dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Clymene dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.11 Striped Dolphin

Acoustic analysis indicates that up to 368,544 striped dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 430,325 under Alternative 1, 429,764 under Alternative 2, and 261,529 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to nine striped dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, three under Alternative 1, three under Alternative 2, and five under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to striped dolphins.

Given their gregarious behavior and large group size of up to several hundred or even thousands of animals (Baird et al., 1993), it is likely that lookouts would detect a group of striped dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of striped dolphins reduce the likelihood of exposure. Thus, striped dolphin exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Striped dolphins are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks. The best abundance estimate for striped dolphins in the western North Atlantic is 94,462 animals, with a minimum population estimate of 68,558 striped dolphins (Waring et al., 2006). The best abundance estimate of striped dolphins in the northern Gulf of Mexico is 6,505, with a minimum population estimate of 4,599 dolphins (Waring et al., 2005).

Based on the best available science the Navy concludes that exposures to both Northwest Atlantic and Gulf of Mexico striped dolphin stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to striped dolphins.

In accordance with NEPA, there will be no significant impact to striped dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to striped dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.12 Common Dolphin

Acoustic analysis indicates that up to 168,325 common dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 322,152 under Alternative 1, 308,378 under Alternative 2, and 145,543 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to five common dolphin may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, eight under Alternative 1, seven under Alternative 2, and two under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to common dolphin.

Given their gregarious behavior and large group size of up to thousands of animals (Jefferson et al. 1993), it is likely that lookouts would detect a group of common dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of common dolphins reduce the likelihood of exposure. Thus, common dolphin exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Currently, there is no conclusive information available for western North Atlantic common dolphin stock structure (Waring et al., 2007). The best abundance estimate for common dolphins in the western North Atlantic is 120,743 animals, with a minimum population estimate of 99,975 common dolphins (Waring et al., 200).

Based on the best available science the Navy concludes that exposures to Northwest Atlantic common dolphins due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to common dolphins.

In accordance with NEPA, there will be no significant impact to common dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to common dolphin from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.13 Fraser's Dolphin

Acoustic analysis indicates that up to 359 Fraser's dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 353 under Alternative 1, 353 under Alternative 2, and 353 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no Fraser's dolphins will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Fraser's dolphins.

Given their typical aggregations in large, fast-moving groups of up to several hundred animals (Jefferson and Leatherwood, 1994; Reeves et al., 1999b; Gannier, 2000), it is likely that lookouts would detect a group of Fraser's dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of Fraser's dolphins reduce the likelihood of exposure. Thus, Fraser's dolphin exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Fraser's dolphins are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. No abundance estimate of Fraser's dolphins in the western North Atlantic is available (Waring et al., 2007). The best abundance estimate of Fraser's dolphins in the northern Gulf of Mexico is 726, with a minimum population estimate of 427 dolphins (Mullin and Fulling, 2004; Waring et al., 2006).

Based on the best available science the Navy concludes that exposures to both Northwest Atlantic and Gulf of Mexico Fraser's dolphin stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Fraser's dolphins.

In accordance with NEPA, there will be no significant impact to Fraser's dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to

Fraser's dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.14 Risso's Dolphin

Acoustic analysis indicates that up to 144,764 Risso's dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 112,056 under Alternative 1, 127,564 under Alternative 2, and 139,743 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to seven Risso's dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, five under Alternative 1, six under Alternative 2, and seven under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Risso's dolphins.

Given their frequent surfacing and large group size of up to several hundred animals (Leatherwood and Reeves, 1982), it is likely that lookouts would detect a group of Risso's dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of Risso's dolphins reduce the likelihood of exposure. Thus, Risso's dolphin exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Risso's dolphins are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. The best abundance estimate for Risso's dolphins in the western North Atlantic is 20,479, with a minimum population estimate of 12,920 animals (Waring et al., 2007). The best estimate of abundance for Risso's dolphins in the northern Gulf of Mexico is 2,169, with a minimum population estimate of 1,668 Risso's dolphins (Waring et al., 2006).

Based on best available science the Navy concludes that exposures to both Northwest Atlantic and Gulf of Mexico Risso's dolphin stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Risso's dolphins.

In accordance with NEPA, there will be no significant impact to Risso's dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Risso's dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.15 Atlantic White-Sided Dolphin

Acoustic analysis indicates that up to 34,290 Atlantic white-sided dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 110 under Alternative 1, 110 under Alternative 2, and 45,054 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no Atlantic white-sided dolphins will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Atlantic white-sided dolphins.

Group size of Atlantic white-sided dolphins ranges from a few to a few hundred individuals and seems to vary geographically; the typical average group size is about 50 animals (CETAP, 1982; Weinrich et al., 2001; Perrin et al., 2002). Given their typical group size and level of surface activity, it is likely that lookouts would detect a group of Atlantic white-sided dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of white-sided dolphins reduce the likelihood of exposure. Thus, Atlantic white-sided dolphin exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Three stock units have been suggested for the Atlantic white-sided dolphin in the western North Atlantic: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea (Palka et al., 1997; Waring et al., 2004). However, recent mitochondrial DNA analysis indicates that no definite stock structure exists (Amaral et al., 2001). The best abundance estimate for Atlantic white-sided dolphins in the western North Atlantic is 51,640 animals, with a minimum population estimate of 37,904 dolphins (Waring et al., 2007). Atlantic white-sided dolphins are not expected to occur in the northern Gulf of Mexico.

Based on best available science the Navy concludes that exposures to Atlantic white-sided dolphin stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Risso’s dolphins.

In accordance with NEPA, there will be no significant impact to Atlantic white-sided dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Atlantic white-sided dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.16 Atlantic White-Beaked Dolphin

Acoustic analysis is not available for white-beaked dolphins due to the lack of abundance and density data. Although older population estimates are available for portions of this species' range, NMFS' Stock Assessment Reports conclude that data are insufficient to calculate a minimum population estimate in the U.S. EEZ. There are believed to be separate stocks in the eastern and western North Atlantic Ocean.

This species is typically found only in cold-temperate and sub-arctic waters in the North Atlantic. In the western North Atlantic, white-beaked dolphins occur from eastern Greenland and Davis Strait to southern New England. They are generally found in the northern portion of this range between spring and late fall, apparently wintering in the southern portion. Off the northeastern United States, white-beaked dolphin sightings are concentrated in the western Gulf of Maine and around Cape Cod. Prior to the 1970s, this species was found primarily over the continental shelf. However, since then, their distribution has shifted to waters over the continental slope.

An undetermined number of white-beaked dolphins could be exposed to sound levels likely to result in Level B harassment. Based on their northerly distribution, the number of potential exposures is probably low. No exposure of individuals to sound levels likely to result in Level A harassment is expected. No mortality due to explosive sonobuoys is expected. Group size of up to 30 white-beaked dolphins is common, but groups of several hundred or thousands of animals have been recorded. This species is also typically active at the surface (Perrin et al., 2002). Therefore, lookouts would likely detect white-beaked dolphins at the surface, thus reducing the likelihood of exposure.

Based on best available science the Navy concludes that exposures to white-beaked dolphins due to AFAST activities would result in short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to white-beaked dolphins.

In accordance with NEPA, there will be no significant impact to white-beaked dolphins from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to white-beaked dolphins from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.17 Melon-Headed Whale

Acoustic analysis indicates that up to 1,708 melon-headed whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 1,677 under Alternative 1, 1,677 under Alternative 2, and 1,680 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no melon-headed whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to melon-headed whales.

Melon-headed whales are typically found in large groups of between 150 and 1,500 individuals (Perryman et al., 1994; Gannier, 2002), although Watkins et al. (1997) described smaller groups of 10 to 14 individuals. These animals often log at the water's surface in large schools composed of subgroups. Given their large body size, gregarious behavior, and large group size, it is likely that lookouts would detect a group of melon-headed whales at the surface. Implementation of mitigation measures and probability of detecting large groups of melon-headed whales reduce the likelihood of exposure. Thus, melon-headed whale exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Melon-headed whales are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks. There are no abundance estimates for melon-headed whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for melon-headed whales in the northern Gulf of Mexico is 3,451 individuals, with a minimum population estimate of 2,238 (Mullin and Fulling, 2004; Waring et al., 2006).

Based on best available science the Navy concludes that exposures to melon-headed whale stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to melon-headed whales.

In accordance with NEPA, there will be no significant impact to melon-headed whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to melon-headed whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.18 Pygmy Killer Whale

Acoustic analysis indicates that up to 245 pygmy killer whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 241 under Alternative 1, 241 under Alternative 2, and 241 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no pygmy killer whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to pygmy killer whales.

Pygmy killer whales are typically found in groups of up to 50 individuals (Perrin et al., 2002). Given their large body size, gregarious behavior, and group size, it is likely that lookouts would detect a group of pygmy killer whales at the surface. Implementation of mitigation measures and probability of detecting groups of pygmy killer whales reduce the likelihood of exposure. Thus, pygmy killer whale exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Pygmy killer whales are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks. There is no estimate of abundances for pygmy killer whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for pygmy killer whales in the northern Gulf of Mexico is 408 individuals, with a minimum population estimate of 256 (Mullin and Fulling, 2004; Waring et al., 2006).

Based on best available science the Navy concludes that exposures to pygmy killer whale stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to pygmy killer whales.

In accordance with NEPA, there will be no significant impact to pygmy killer whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to pygmy killer whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.19 False Killer Whale

Acoustic analysis indicates that up to 514 false killer whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 504 under Alternative 1, 504 under Alternative 2, and 505 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no false killer whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to false killer whales.

False killer whales may occur in groups as large as 1,000 individuals (Cummings and Fish, 1971), although groups of less than 100 are most common. Given their large body size, gregarious behavior, and group size, it is likely that lookouts would detect a group of false killer whales at the surface. Implementation of mitigation measures and probability of detecting large groups of false killer whales reduce the likelihood of exposure. Thus, false killer whale exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. NMFS does not include false killer whales among those species having populations or stocks in the Western North Atlantic. False killer whales are currently considered as a single stock in the northern Gulf of Mexico. There is no estimate of abundances for false killer whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for false killer whales in the northern Gulf of Mexico is 1,038 individuals, with a minimum population estimate of 606 (Mullin and Fulling, 2004; Waring et al., 2006).

Based on best available science the Navy concludes that exposures to false killer whale stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to false killer whales.

In accordance with NEPA, there will be no significant impact to false killer whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to false killer whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.20 Killer Whale

Acoustic analysis indicates that up to 66 killer whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 65 under Alternative 1, 65 under Alternative 2, and 65 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no killer whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to killer whales.

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Killer whale group size appears to vary geographically, and ranges from 10 to 40 individuals (Katona et al., 1988; O'Sullivan and Mullin, 1997). Given their large body size, gregarious behavior, and group size, it is likely that lookouts would detect a group of killer whales at the surface. Implementation of mitigation measures and probability of detecting groups of killer whales reduce the likelihood of exposure. Thus, killer whale exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. There are no estimates of abundance for killer whales in the western North Atlantic (Waring et al., 2007). Killer whales are currently considered as a single stock in the northern Gulf of Mexico. The best estimate of abundance for killer whales in the northern Gulf of Mexico is 133 individuals, with a minimum population estimate of 90 (Mullin and Fulling, 2004; Waring et al., 2006).

Based on best available science the Navy concludes that exposures to killer whale stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to killer whales.

In accordance with NEPA, there will be no significant impact to killer whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to killer whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.21 Long-Finned and Short-Finned Pilot Whales

Acoustic analysis indicates that up to 190,679 long-finned and short-finned pilot whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 149,701 under Alternative 1, 158,651 under Alternative 2, and 180,339 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to ten long-finned and short-finned pilot whales may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, eight under Alternative 1, eight under Alternative 2, and ten under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to long-finned and short-finned pilot whales.

Pilot whale group size typically ranges from several to several hundred individuals (Jefferson et al., 1993). Given their large body size, gregarious behavior, and group size, it is likely that lookouts would detect a group of pilot whales at the surface. Implementation of mitigation measures and probability of detecting groups of pilot whales reduce the likelihood of exposure. Thus, pilot whale exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Pilot whales occur in both the western North Atlantic and northern Gulf of Mexico. Short-finned pilot whales occur in both water bodies, while long-finned pilot whales occur only in the North Atlantic. Fullard et al. (2000) proposed a stock structure for long-finned pilot whales in the North Atlantic that was correlated with sea-surface temperature. This involved a cold-water population west of the Labrador and North Atlantic current and a warm-water population that extended across the North Atlantic in the warmer water of the Gulf Stream. There is no information regarding genetic differentiation within the western North Atlantic stock (Waring et al., 2004). Short-finned pilot whales are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks. The best estimate of abundance for pilot whales (combined short-finned and long-finned) in the western North Atlantic is 31,139 individuals, with a minimum population estimate of 24,866 (Waring et al., 2007). The best estimate of abundance for the short-finned pilot whale in the northern Gulf of Mexico is 2,388 individuals, with a minimum population estimate of 1,628 (Mullin and Fulling, 2004; Waring et al., 2006).

Based on best available science the Navy concludes that exposures to pilot whale stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to pilot whales

In accordance with NEPA, there will be no significant impact to long-finned and short-finned pilot whales from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to long-finned and short-finned pilot whales from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.22 Harbor Porpoise

Acoustic analysis indicates that up to 286,132 harbor porpoises may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 28 under Alternative 1 and Alternative 2, and 459,061 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no harbor porpoises will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to harbor porpoises.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Harbor porpoises do not occur in the Gulf of Mexico. There are four proposed separate populations of harbor porpoises in the western North Atlantic: Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland, and Greenland (Gaskin, 1992). During summer, harbor porpoises are concentrated in the Gulf of Maine/Bay of Fundy region, generally in waters less than 150 m (492 ft) deep (Kraus et al., 1983; Palka, 1995a, b). During fall and spring, they are widely dispersed from New Jersey to Maine, with lower densities farther north and south. At this time, they occur from the coastline to deeper waters (greater than 1800 m [5,905 ft]) (Westgate et al., 1998). During winter, intermediate densities of harbor porpoises occur in waters off New Jersey to North Carolina, with lower densities off New York to New Brunswick, Canada. There does not appear to be coordinated migration or a specific migratory route to and from the Bay of Fundy region. The best abundance estimate for the Gulf of Maine/Bay of Fundy stock of harbor porpoises is 89,700 individuals, with a minimum population estimate of 74,695 (Waring et al., 2004). The best estimate of abundance for harbor porpoises in the northern Gulf of Mexico is 2,169, with a minimum population estimate of 1,668 harbor porpoises (Waring et al., 2006).

Based on best available science the Navy concludes that exposures to harbor porpoise stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to harbor porpoises.

In accordance with NEPA, there will be no significant impact to harbor porpoises from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to harbor porpoises from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.23 Hooded Seal

The best abundance estimate for hooded seals in the western North Atlantic Ocean is 592,100, with a minimum population estimate of 512,000. Present data are insufficient to calculate the minimum population estimate in U.S. waters. Acoustic analysis was not conducted for AFAST activities. Although individual hooded seals may travel far outside their typical range and have been sighted as far south as Puerto Rico and the Virgin Islands, they generally occur in the Atlantic region of the Arctic Ocean and in high latitudes of the North Atlantic near the outer edge of the pack ice. Hooded seals occur with regularity only in the Northeast OPAREA (from northern Maine to southern Delaware), primarily during winter. Sightings off the northeastern United States have generally increased in recent years. An undetermined number of hooded seals could be exposed to sound levels likely to result in Level B harassment. However, because on their distribution, the relative number of potential exposures is probably low. No exposure of individuals to sound levels likely to result in Level A harassment is expected. No mortality due to explosive sonobuoys (AN/SSQ-110A) is expected.

Based on best available science the Navy concludes that exposures to hooded seals due to AFAST activities would result in short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to hooded seals.

In accordance with NEPA, there will be no significant impact to hooded seals from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to hooded seals from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.24 Harp Seal

The best abundance estimate for harp seals in the western North Atlantic Ocean is 5.9 million, with a minimum population estimate of 5.3 million. Present data are insufficient to calculate the minimum population estimate in U.S. waters. Acoustic analysis was not conducted for AFAST activities. Harp seals are closely associated with pack ice of the North Atlantic and Arctic

Oceans, from Newfoundland and the Gulf of St. Lawrence to northern Russia. Most of the western North Atlantic harp seals congregate off the east coast of Newfoundland-Labrador to pup and breed; the remainder gather near the Magdalen Islands in the Gulf of St. Lawrence. This species undergoes extensive spring and fall migrations to and from summer feeding and pupping grounds in sub-arctic and arctic waters.

The number of sightings and strandings of harp seals off the northeastern United States has been increasing, particularly in winter and early spring when the western North Atlantic stock is at its southernmost distribution point. They may occur in the Northeast OPAREA, from the northern coast of Maine to the southern coast of Delaware during winter and spring, and from the southern coast of Maine to Long Island during fall. An undetermined number of harp seals could be exposed to sound levels likely to result in Level B harassment. This species' northerly distribution would result in relatively fewer exposures. No exposure of individuals to sound levels likely to result in Level A harassment is expected. No mortality due to explosive sonobuoys is expected.

Based on best available science the Navy concludes that exposures to harp seals due to AFAST activities would result in short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to harp seals.

In accordance with NEPA, there will be no significant impact to harp seals from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to harp seals from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.25 Gray Seals

Acoustic analysis indicates that up to 37,673 gray seals may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 178,363 under Alternative 1, 177,727 under Alternative 2, and 38,011 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to one gray seal may be exposed to levels of sound likely to result in Level A harassment under Alternative 1 and one under Alternative 2. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to gray seals.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Gray seals do not occur in the Gulf of Mexico. There are at least three populations of gray seals in the North Atlantic Ocean: eastern North Atlantic, western North Atlantic, and Baltic (Boskovic et al., 1996). The western North Atlantic stock is equivalent to the eastern Canada breeding population (Waring et al., 2007). There are two breeding concentrations in eastern Canada: one at Sable

Island and the other on the pack ice in the Gulf of St. Lawrence. These two breeding groups are treated as separate populations for management purposes (Mohn and Bowen, 1996). Current estimates of the gray seal population in the western North Atlantic are not available, but in 1995 there were an estimated 195,000 individuals (DFO, 2003a). The herd on Sable Island is thought to be growing and may have more than doubled in number, but the Gulf of St. Lawrence population has changed little (DFO, 2003a). Present data are insufficient to calculate the minimum population estimate for U.S. waters (Baraff and Loughlin, 2000; Waring et al., 2004). A minimum of 1,000 pups were born in the northeastern United States during 2002 (Wood et al., 2003).

Based on best available science the Navy concludes that exposures to gray seal stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to gray seals.

In accordance with NEPA, there will be no significant impact to gray seals from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to gray seals from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11.2.26 Harbor Seals

Acoustic analysis indicates that up to 69,572 harbor seals may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 21 under Alternative 1, 21 under Alternative 2, and 85,003 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to four harbor seals may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, one under Alternative 1, zero under Alternative 2, and four under Alternative 3. Modeling of the explosive sonobuoys (AN/SSQ-110A) predicts no potential for mortality to the harbor seal. Implementation of mitigation measures would reduce the likelihood of exposure. Thus, harbor seal exposure indicated by the acoustic analysis is likely a conservative overestimate of actual exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Harbor seals do not occur in the Gulf of Mexico. Five species of harbor seals are recognized; *Phoca vitulina concolor* is the western North Atlantic subspecies (Rice, 1998). Currently, harbor seals that occur along the coast of the eastern United States and Canada are considered to be a single population (Waring et al., 2007). The best abundance estimate for harbor seals in the western North Atlantic is 99,340, with a minimum population estimate of 91,546 animals (Waring et al., 2007).

Based on best available science the Navy concludes that exposures to harbor seal stocks due to AFAST activities would result in only short-term effects to most individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to harbor seals.

In accordance with NEPA, there will be no significant impact to harbor seals from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to harbor seals from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.12 Other Potential Acoustic Effects to Marine Mammals

4.4.12.1 Ship Noise

Increased number of ships operating in the area will result in increased sound from vessel traffic. Marine mammals react to vessel-generated sounds in a variety of ways. Some respond negatively by retreating or engaging in antagonistic responses while other animals ignore the stimulus altogether (Watkins, 1986; Terhune and Verboom, 1999).

Most studies have ascertained the short-term response to vessel sound and vessel traffic (Watkins, et al., 1981; Baker, et al., 1983; Magalhães, et al., 2002); however, the long-term implications of ship sound on marine mammals is largely unknown (NMFS, 2007a).

Anthropogenic sound has increased in the marine environment over the past 50 years (NRC Richardson, et al., 1995; 2003). This sound increase can be attributed to increases in vessel traffic as well as sound from marine dredging and construction, oil and gas drilling, geophysical surveys, sonar, and underwater explosions (Richardson, et al., 1995).

Given the current ambient sound levels in the marine environment, the amount of sound contributed by the use of Navy vessels in the proposed exercises is very low. It is anticipated that any marine mammals exposed may exhibit only short-term reactions and would not suffer any long-term consequences from ship sound.

4.4.12.2 Acoustically Mediated Bubble Growth

One suggested cause of injury to marine mammals is rectified diffusion, which is the process of increasing the size of a bubble by exposing it to a sound field (Crum and Mao, 1996). This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with a gas, such as nitrogen, which makes up approximately 78 percent of air (remainder of air is about 21 percent oxygen with some carbon dioxide). Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). Deeper and longer dives of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater supersaturation (Houser et al., 2001). Conversely, studies have shown that marine mammal lung structure (both pinnipeds and cetaceans) facilitates collapse of the lungs at depths below approximately 50 m (162 ft) (Kooyman et al., 1970). Collapse of the lungs would force air into the non-air-exchanging areas of the lungs (into the bronchioles away from the alveoli), thus significantly decreasing nitrogen diffusion into the body. Deep-diving pinnipeds such as the northern elephant (*Mirounga angustirostris*) and Weddell seals (*Leptonychotes weddellii*) typically exhale before long deep dives, further reducing air volume in the lungs (Kooyman et al., 1970). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration of sonar pings will be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario, the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size.

4.4.12.3 Decompression Sickness

Another hypothesis suggests that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al., 2003). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Cox et al. (2006), with experts in the field of marine mammal behavior, diving, physiology, respiration physiology, pathology, anatomy, and bioacoustics considered this to be a plausible hypothesis that requires further investigation. Conversely, Fahlman et al. (2006) suggested that diving bradycardia (reduction in heart rate and circulation to the tissues), lung collapse, and slow ascent rates would reduce nitrogen uptake and thus reduce the risk of decompression sickness by 50 percent in models of marine mammals. Zimmer and Tyack (2007) suggest that beaked whales avoid sonar sound by swimming deeper than 25 m and shallower than the depth of alveolar collapse. This avoidance mechanism continues until the sound no longer creates the response or the animal enters shallow water where it can no longer dive in this pattern. The evidence would support decompression sickness and is consistent with previous studies on avoidance, for example with ship noise (Zimmer and Tyack, 2007). Recent information on the diving profiles of Cuvier's (*Ziphius cavirostris*) and Blainvilles's (*Mesoplodon densirostris*) beaked whales (Baird et al., 2006) and in the Ligurian Sea in Italy (Tyack et al., 2006) showed that while these species do dive deeply (regularly exceed depths of 800 meters) and for long periods (48-68 minutes), they have significantly slower ascent rates than descent rates. This fits well with Fahlman et al. (2006) model of deep and long duration divers that would have slower ascent rates to reduce nitrogen saturation and reduce the risk of decompression sickness. Therefore, if nitrogen saturation remains low, then a rapid ascent in response to sonar should not cause decompression sickness. Currently it is not known if beaked whales rapidly ascend in response to sonar or other disturbances. It may be that deep diving animals would be better protected diving to depth to avoid predators, such as killer whales, rather then ascending to the surface where they may be more susceptible to predators.

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann, 2004; Evans and Miller, 2004). To date, ELs predicted to cause *in vivo* bubble formation within diving cetaceans have not been evaluated (NOAA, 2002b). Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al., 2003), there is no conclusive evidence of this and complicating factors are associated with introduction of gas into the venous system during necropsy. Because evidence supporting it is debatable, no marine mammals addressed in this EIS/OEIS are given special treatment due to the possibility for acoustically mediated bubble growth. Beaked whales are, however, assessed differently from other species to account for factors that may have contributed to prior beaked whale strandings as set out in the previous section.

4.4.12.4 Resonance

Another suggested cause of injury in marine mammals is air cavity resonance due to sonar exposure. Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration—the particular frequency at which the object vibrates most readily. The size and geometry of an air cavity determine the frequency at which the cavity will resonate. Displacement of the cavity boundaries during resonance has been suggested as a cause of injury. Large displacements have the potential to tear tissues that surround the air space (for example, lung tissue).

Understanding resonant frequencies and the susceptibility of marine mammal air cavities to resonance is important in determining whether certain sonars have the potential to affect different cavities in different species. In 2002, NMFS convened a panel of government and private scientists to address this issue (NOAA, 2002b). They modeled and evaluated the likelihood that U.S. Navy mid-frequency active sonar caused resonance effects in beaked whales that eventually led to their stranding (Department of Commerce and DON, 2001). The conclusions of that group were that resonance in air-filled structures the frequencies at which resonance were predicted to occur were below the frequencies utilized by the sonar systems employed. Furthermore, air cavity vibrations due to the resonance effect were not considered to be of sufficient amplitude to cause tissue damage. The AFAST EIS/OEIS assumes that similar phenomenon will not be problematic in other cetacean species.

4.4.12.5 Likelihood of Prolonged Exposure

ASW activities would not result in prolonged exposure because the vessels are constantly moving, and the flow of the activity when training occurs reduces the potential for prolonged exposure. The implementation of the protective measures described in Section 5 would further reduce the likelihood of any prolonged exposure.

4.4.12.6 Likelihood of Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with an animal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by a second sound at similar frequencies and at similar or higher levels. If the second sound were artificial, it could be potentially harassing if it disrupted hearing-related behavior such as communications or echolocation. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure.

Historically, principal masking concerns have been with prevailing background noise levels from natural and man-made sources (for example, Richardson et al., 1995). Dominant examples of the latter are the accumulated sound from merchant ships and sound of seismic surveys. Both cover a wide frequency band and are long in duration.

The majority of proposed AFAST activities are away from harbors or heavily traveled shipping lanes. The loudest mid-frequency underwater sounds in the Proposed Action area are those produced by hull-mounted mid-frequency active tactical sonar. The sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal and frequency domains. In particular, the pulse lengths are short, the duty cycle low, and these hull-mounted mid-frequency active tactical sonars transmit within a narrow band of frequencies (typically less than one-third octave). For the reasons outlined above, the chance of sonar operations causing masking effects is considered negligible.

4.4.12.7 Potential for Long-Term Effects

Some AFAST training activities will be conducted in the same general areas, so marine mammal populations could be exposed to repeated activities over time. However, as described earlier, the acoustic analyses assume that short-term noninjurious SELs predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. Application of this criterion assumes an effect even though it is highly unlikely that all behavioral disruptions or instances of TTS will result in long-term significant effects.

4.4.12.8 Sound in the Water From In-Air Sound

Sound originating in air can be transmitted through the air-sea boundary and can be perceived underwater. The use of low-flying helicopters during some missions could potentially expose marine animals to air-generated sound. To calculate possible received levels of sound by marine species, direct in-water measurements of sound generated by MH-60 helicopters from Navy tests were used (DON, 1999). From these measurements, decibel levels were modeled based on various helicopter altitudes and water depths.

During these tests, an MH-60 flew over calibrated sonobuoys (receiver depth at 122 m [400 ft] at altitudes ranging from 75 to 1,500 m (246 to about 5,000 ft). The resulting underwater sound spectrum levels fell from 80 dB at 0.010 kHz to 60 dB at 0.5 kHz and 30 dB at 5.0 kHz. The total intensity level was approximately 100 dB referenced to 1 micropascal squared second (dB re μPa^2-s). The sound source level at the helicopter was calculated to be approximately 150 dB re 1 μPa^2-s at 1 m (3.2 ft), which is equivalent to approximately 124 dBA at 1 m (3.2 ft).

Based on these measurements, decibel levels were modeled using various helicopter altitudes and water depths. Table 4-26 shows the received underwater sound levels generated by an MH-60 hovering at altitudes of 15 and 76 m (50 and 250 ft), which were the lower and upper altitudes of operation for the Navy tests (DON, 1999). Received levels were calculated for points directly below the aircraft. A water depth of 1 m (3.2 ft) was used as a conservative value to simulate the depth of a marine animal just under the surface. The received sound level would be lower at points farther away from the source (in depth and/or in range).

Table 4-26. Helicopter Sound in Water Total Intensity Levels (dB re 1 µPa^2 s)

Altitude	Source Level (at 1 m)	Depth = 1 m
15 m	150 dB	130 dB
76 m	150 dB	119 dB

dB = decibels; dB re 1 µPa^2-s = decibels referenced to 1 micropascal squared second; m = meters

As shown in Table 4-26, the maximum underwater sound level potentially experienced is expected to be approximately 130 dB re 1 µPa^2-s. Regulatory sound level criteria do not exist for nonprotected marine species; however, these decibel levels are below current threshold criteria for protected marine mammals. *Therefore, there will be no significant impact from in-air sound to marine mammals from helicopters over territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm from in-air sound to marine mammals from helicopters over non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.4.13 Potential Nonacoustic Effects to Marine Mammals

Non-acoustic effects analyzed in the AFAST EIS/OEIS included vessel strikes, entanglement from training materials, and water quality effects associated with expended sonobuoy batteries, explosive residuals, and torpedo sodium fluorescein dye. Marine mammals are also subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Most documented cases of entanglements occur when whales encounter the vertical lines of fixed fishing gear. Possible expended materials from AFAST activities include sonobuoys, torpedoes, and Acoustic Device Countermeasure (ADCs), and Expendable Mobile Acoustic Training Target (EMATTs).

4.4.13.1 Vessel Strikes

Ship strikes are known to affect large whales in the AFAST Study Area. The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., the sperm whale). In addition, some baleen whales, such as the North Atlantic right whale seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek et al., 2004). These species are primarily large, slow moving whales. Smaller marine mammals-for example, Atlantic bottlenose and Atlantic spotted dolphins-move quickly throughout the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

After reviewing historical records and computerized stranding databases for evidence of ship strikes involving baleen and sperm whales, Laist et al. (2001) found that accounts of large whale ship strikes involving motorized boats in the area date back to at least the late 1800s. Ship collisions remained infrequent until the 1950s, after which point they increased. Laist et al. (2001) report that both the number and speed of motorized vessels have increased over time for trans-Atlantic passenger services, which transit through the area. They concluded that most strikes occur over or near the continental shelf, that ship strikes likely have a negligible effect on the status of most whale populations, but that for small populations or segments of populations the impact of ship strikes may be significant.

Although ship strike mortalities may represent a small proportion of whale populations, Laist et al. (2001) also concluded that, when considered in combination with other human-related mortalities in the area (e.g., entanglement in fishing gear), these ship strikes may present a concern for whale populations.

Of 11 species known to be hit by ships, fin whales are struck most frequently; right whales, humpback whales, sperm whales, and gray whales are all hit commonly (Laist et al 2001). In some areas, one-third of all fin whale and right whale strandings appear to involve ship strikes. Sperm whales spend long periods (typically up to 10 minutes; Jacquet et al. 1998) "rafting" at the surface between deep dives. This could make them exceptionally vulnerable to ship strikes. Berzin (1972) noted that there were "many" reports of sperm whales of different age classes being struck by vessels, including passenger ships and tug boats. There were also instances in which sperm whales approached vessels too closely and were cut by the propellers (NMFS 2006b).

Accordingly, the Navy has adopted mitigation measures to reduce the potential for collisions with surfaced marine mammals (for more details refer to Chapter 5). These measures include the following:

- Using lookouts trained to detect all objects on the surface of the water, including marine mammals.
- Implementing reasonable and prudent actions to avoid the close interaction of Navy assets and marine mammals.
- Maneuvering to keep away from any observed marine mammal.

Navy shipboard lookouts (also referred to as "watchstanders") are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water. Navy lookouts undergo extensive training in order to qualify as a lookout. This training includes on-the-job instruction under the supervision of an experienced lookout, followed by completion of the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects).
The Navy includes marine species awareness as part of its training for its bridge lookout personnel on ships and submarines. Lookouts are trained how to look for marine species, and report sightings to the Officer of the Deck so that action may be taken to avoid the marine species or adjust the exercise to minimize effects to the species. Marine Species Awareness Training was updated in 2006, and the additional training materials are now included as required training for Navy ship and submarine lookouts. Additionally, all Commanding Officers and Executive Officers of units involved in training exercises are required to undergo marine species awareness training. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information to aid in avoiding interactions with marine species.

Additionally, the Navy implements additional mitigation measures to protect North Atlantic right whales. The east coast is a principal migratory corridor for North Atlantic right whales that travel between the calving/nursery areas in the Southeastern United States and feeding grounds in the northeast United States and Canada. Transit to the Study Area from mid-Atlantic ports requires Navy vessels to cross the migratory route of North Atlantic right whales. Southward right whale migration generally occurs from mid- to late November, although some right whales may arrive off the Florida coast in early November and stay into late March (Kraus et al., 1993). The northbound migration generally takes place between January and late March. Data indicate that during the spring and fall migration, right whales typically occur in shallow water immediately adjacent to the coast, with over half the sightings (63.8 percent) occurring within 18.5 km (10 NM), and 94.1 percent reported within 55 km (30 NM) of the coast.

Given the low abundance of North Atlantic right whales relative to other species, the frequency of occurrence of vessel collisions to right whales suggests that the threat of ship strikes is proportionally greater to this species (Jensen and Silber, 2004). Therefore, in 2004, NMFS proposed a right whale vessel collision reduction strategy to consider the establishment of operational measures for the shipping industry to reduce the potential for large vessel collisions with North Atlantic right whales while transiting to and from mid-Atlantic ports during right whale migratory periods. Recent studies of right whales have shown that these whales tend to lack a response to the sounds of oncoming vessels (Nowacek et al., 2004). Although Navy vessel traffic generally represents only 2 to 3 percent of overall large vessel traffic, based on this biological characteristic and the presence of critical Navy ports along the whales' mid-Atlantic migratory corridor, the Navy was the first federal agency to proactively adopt additional mitigation measures for transits in the vicinity of mid-Atlantic ports during right whale migration. 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.

Specifically, the Navy has unilaterally adopted the following measures:

- During months of expected Atlantic Ocean right whale occurrence, Navy vessels will practice increased vigilance with respect to avoidance of vessel-whale interactions along the mid-Atlantic coast, including transits to and from any mid-Atlantic ports.
- All surface units transiting within 56 kilometers (km) (30 Nautical Miles [NM]) of the coast in the mid-Atlantic will ensure at least two lookouts are posted, including at least one that has completed required marine mammal awareness training.
- Navy vessels will avoid knowingly approaching any whale head on and will maneuver to keep at least 460 meters (m) (1,500 feet [ft]) away from any observed whale, consistent with vessel safety.

These measures are similar to vessel transit procedures in place since 1997 for Navy vessels in the vicinity of designated right whale critical habitat in the southeastern United States. Based on the implementation of Navy mitigation measures, especially during times of anticipated right whale occurrence, and the relatively low density of Navy ships in the Study Area the likelihood that a vessel collision would occur is very low. *Therefore, there will be no significant impact to marine mammals from vessel interactions during AFAST training exercises within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to marine mammals resulting from vessel interactions during AFAST training exercises in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. AFAST training with respect to vessel strikes may affect ESA-listed marine mammal species. The Navy is consulting with NMFS in accordance with the MMPA and ESA.

4.4.13.2 Entanglement

Marine mammals are subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Most documented cases of entanglements occur when whales encounter the vertical lines of fixed fishing gear. Possible expended materials from AFAST activities include sonobuoys, torpedoes, ADCs, and EMATTs (Table 4-1). Specifically, during torpedo exercises, guidance wires and flex hoses are expended. Moreover, sonobuoy and EMATT parachutes are also expended during AFAST activities. This section analyzes the potential effects of expended materials on marine mammals.

4.4.13.2.1 Parachutes

Aircraft-launched sonobuoys, torpedoes, and air deployed EMATTs use nylon parachutes of varying sizes. At water impact, the parachute assembly is expended, and it sinks away from the exercise sonobuoy or torpedo. The parachute assembly will potentially be at the surface for a short time before sinking to the sea floor. Entanglement and the eventual drowning of a marine mammal in a parachute assembly will be unlikely, since the parachute will have to land directly on an animal, or an animal will have to swim into it before it sinks. The potential for a marine mammal to encounter an expended parachute is extremely low, given the generally low probability of a marine mammal being in the immediate location of deployment, especially given the mitigation measures outlined in Chapter 5.

All of the material is negatively buoyant and will sink to the ocean floor. Many of the components are metallic and will sink rapidly. For instance, IEER system parachutes are weighted with metal clips that assist in their quick decent to the sea floor. The expended material will accumulate on the ocean floor and will be covered by sediments over time, thereby remaining on the ocean floor and reducing the potential for entanglement. This accrual of material is not expected to cause an increased potential for marine mammal entanglement. If bottom currents are present, the canopy may billow (bulge) and pose an entanglement threat to marine animals with bottom-feeding habits; however, the probability of a marine mammal encountering a parachute assembly on the sea floor and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely.

Some ingestion of plastics by marine mammals is known to occur. Humpback whales have been speculated to feed on the ocean floor on Stellwagen Bank, in water depths less than 40 m (131 ft). In this area, it is hypothesized that humpbacks either directly touch the bottom or come close enough to it in order to stir up sand lance, a preferred prey (Hain et al., 1995). Right whales have also been suggested to feed near the ocean floor in the Great South Channel on copepods that migrate to deep waters during the day (Baumgartner and Wenzel, 2005). The prey items for each of these species are much smaller in size than the materials that will be expended during an exercise utilizing torpedoes or sonobuoys. The parachutes used are large in comparison with marine animal’s normal food items and are very difficult to ingest. Due to the larger size of the expended materials, ingestion is not expected by these bottom or near-bottom feeding species.

The overall possibility of marine mammals ingesting parachute fabric or becoming entangled in cable assemblies is very remote. *Therefore, there will be no significant impact to marine mammals resulting from interactions with parachute assemblies during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to marine mammals resulting from interactions with parachute assemblies during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Parachutes associated with AFAST training may affect ESA-listed marine mammal species.

4.4.13.2.2 Torpedoes

There is a negligible risk that a marine mammal could be struck by a torpedo during ASW training activities. This conclusion is based on (1) review of torpedo design features, and (2) review of a large number of previous naval exercise ASW torpedo activities.

The acoustic homing programs of torpedoes are designed to detect either the mechanical sound signature of the submarine or active sonar returns from its metal hull with large internal air volume interface. The torpedoes are specifically designed to ignore false targets. As a result, their homing logic does not detect or recognize the relatively small air volume associated with the lungs of marine mammals. They do not detect or home to marine mammals.

The Navy has conducted exercise torpedo activities since 1968. At least 14,322 exercise torpedo runs have been conducted since 1968. There have been no recorded or reported instances of a marine species strike by an exercise torpedo. Every exercise torpedo activity is monitored acoustically by on-scene range personnel listening to range hydrophones positioned on the ocean floor in the immediate vicinity of the torpedo activity. After each torpedo run, the recovered exercise torpedo is thoroughly inspected for any damage. The torpedoes then go through an extensive production line refurbishment process for re-use. This production line has stringent quality control procedures to ensure that the torpedo will safely and effectively operate during its next run. Since these exercise torpedoes are frequently used against manned Navy submarines, this post activity inspection process is thorough and accurate. Inspection records and quality control documents are prepared for each torpedo run. This post exercise inspection is the basis that supports the conclusion of negligible risk of marine mammal strike. *Therefore, there will be no significant impact to marine mammals resulting from interactions with torpedoes during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to marine mammals resulting from interactions with torpedoes during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The probability of direct strike of torpedoes associated with AFAST training is negligible and therefore will have no effect on ESA-listed marine mammal species.

4.4.13.2.3 Torpedo Guidance Wires

Torpedoes are equipped with a single-strand guidance wire, which is laid behind the torpedo as it moves through the water. At the end of a torpedo run, the wire is released from the firing vessel and the torpedo to enable torpedo recovery. The wire sinks rapidly and settles on the ocean floor.

Guidance wires are expended with each exercise torpedo launched. Each year, about 254 exercise torpedoes will be used; therefore, the same number of control wires will be expended annually.

DON (1996) analyzed the potential entanglement effects of torpedo control wires on marine mammals. The Navy analysis concluded that the potential for entanglement effects will be low for the following reasons:

- The guidance wire is a very fine, thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 19 kg (42 lb) and can be broken by hand. With the exception of a change encounter with the guidance wire while it was sinking to the sea floor (at an estimate rate of 0.2 m [0.5 ft] per second), a marine animal would be vulnerable to entanglement only if its diving and feeding patterns place it in contact with the bottom.
- Heezen (as cited in DON, 1996) theorized that the entanglement of marine mammals with undersea cables was a direct result of the mammal coming into contact with loops in the cable (e.g., swimming through loops that then tightened around the mammal). The torpedo control wire is held stationary in the water column by drag forces as it is pulled from the torpedo in a relatively straight line until its length becomes sufficient for it to form a chain-like droop. When the wire is cut or broken, it is relatively straight and the physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the entanglement literatures.

Given the low potential probability of marine mammal entanglement with guidance wires, the potential for any harm or harassment to these species is extremely low. *Therefore, there will be no significant impact to marine mammals resulting from interactions with torpedo guidance wire during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to marine mammals resulting from interactions with torpedo guidance wire during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The torpedo guidance wires associated with AFAST activities will have no effect on ESA-listed marine mammal species.

4.4.13.2.4 Torpedo Flex Hoses

Improved flex hoses or strong flex hoses will be expended during torpedo exercises. DON (1996) analyzed the potential for the flex hoses to affect marine mammals. This analysis concluded that the potential entanglement effects to marine animals will be insignificant for reasons similar to those stated for the potential entanglement effects of control wires:

- Due to its weight, the flex hoses will rapidly sink to the bottom upon release. With the exception of a chance encounter with the flex hose while it was sinking to the sea floor, a marine animal would be vulnerable to entanglement only if its diving and feeding patterns placed it in contact with the bottom.

- Due to its stiffness, the 76.2 m (250 ft) long flex hose will not form loops that could entangle marine animals.

Therefore, there will be no significant impact to marine mammals resulting from interactions with torpedo flex hoses during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to marine mammals resulting from interactions with torpedo flex hoses during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The torpedo flex hoses associated with AFAST activities will have no effect on ESA-listed marine mammal species.

4.4.13.3 Direct Strikes

The Navy uses the EMATT and the MK-30 acoustic training targets (recovered), sonobuoys and exercise torpedoes during ASW sonar training exercises. The size of EMATTs, MK-30 targets, and sonobuoys (12 by 91 centimeters [cm] [5 by 36 inches (in)]), coupled with the low probability that an animal would occur at the immediate location of deployment and reconnaissance, provide little potential for a direct strike. Moreover, there is a negligible risk that a marine mammal could be struck by a torpedo during ASW training activities. The acoustic homing programs of torpedoes are designed to detect either the mechanical sound signature of the submarine or active sonar returns from its metal hull with large, internal air volume interface. Their homing logic does not detect or recognize the relatively small air volume associated with the lungs of marine mammals. Furthermore, the Navy has conducted exercise torpedo activities since 1968 and there have been no recorded or reported instances of a marine species strike by an exercise torpedo during the 14,322 exercise torpedo runs. Additionally, each torpedo obtains a thorough post-run inspection for damage. *Therefore, there will be no significant impact to marine mammals resulting from interactions with targets, sonobuoys or exercise torpedoes during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to marine mammals resulting from interactions with targets, sonobuoys, or exercise torpedoes during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The probability of direct strike of training target associated with AFAST training is negligible and therefore will have no effect on ESA-listed marine mammal species.

4.4.14 Potential for Mortality: Cetacean Stranding Activities

The history of Navy activities in the AFAST Study Area and analysis in this document indicate that military readiness activities are not expected to result in any sonar – induced mortalities to marine mammals. There are natural and manmade sources of mortality other than sonar and underwater detonation that may contribute to stranding events as discussed in Section 3.6.3 and described in detail in Appendix E, Cetacean Stranding Report. The actual cause of a particular stranding may not be immediately apparent when there is little evidence of physical trauma, especially in the case of disease or age-related mortalities. These events require careful scientific investigation by a collaborative team of subject matter experts to determine actual cause of death.

Given the frequency of naturally occurring marine mammal strandings (e.g., natural mortality), it is conceivable that a stranding could co-occur with a Navy exercise even though the stranding is actually unrelated to and not caused by Navy activities.

Evidence from five beaked whale strandings which have occurred over approximately a decade, suggests that the exposure of beaked whales to mid-frequency sonar in the presence of certain conditions (e.g., multiple units using tactical sonar, steep bathymetry, constricted channels, strong surface ducts, etc.) may result in strandings, potentially leading to mortality. Although these physical factors believed to contribute to the likelihood of beaked whale strandings are not present, in their aggregate, in the AFAST study area, scientific uncertainty exists regarding what other factors, or combination of factors, may contribute to beaked whale strandings.

In a letter from NMFS to Navy dated October 2006, NMFS indicated that Section 101(a)(5)(A) authorization is appropriate for mid-frequency active sonar activities because it allows NMFS to consider the potential for incidental mortality. NMFS' letter indicated; "because mid-frequency sonar has been implicated in several marine mammal stranding events including some involving serious injury and mortality, and because there is no scientific consensus regarding the causal link between sonar and stranding events, NMFS cannot conclude with certainty the degree to which mitigation measures would eliminate or reduce the potential for serious injury of mortality." Accordingly, the Navy's Letter of Authorization (LOA) request will request mortality authorization for the most commonly stranded non ESA-listed species present in the AFAST Study Area. This request will be made even though almost 40 years of conducting similar exercises without incident in the operating environments represented in the AFAST study area indicate that injury, strandings, and mortality are not expected to occur as a result of Navy activities. The Navy is requesting 10 serious injury or mortality takes for beaked whale species. This approach overestimates the potential effects to marine mammals associated with Navy sonar training in the AFAST Study Area, as no mortality or serious injury of any species is anticipated.

Neither NMFS nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of mid-frequency sonar during Navy exercises within the AFAST study area. However, by authorizing a very small number of mortalities for beaked whales, if a single individual of this species is found dead coincident with Navy activities, a potentially lengthy investigation of the cause(s) of the death would not unnecessarily interfere with Navy training exercises. Additionally, through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the unlikely event that a causal relationship were to be found between Navy activities and a future stranding.

4.5 SEA TURTLES

This section evaluates potential direct and indirect effects to sea turtles as a result of exposure to mid-frequency (1 to 10 kHz) and high-frequency (greater than 10 kHz) active sonar, and the explosive source sonobuoy (AN/SSQ-110). Five species of sea turtles (Atlantic loggerhead, Atlantic green, leatherback, hawksbill, and Kemp's ridley) occur in the Gulf of Mexico and North Atlantic. All species but the loggerhead are classified as endangered. The loggerhead is classified as threatened. Refer to Chapter for a more detailed description on the occurrence of sea turtle species within the North Atlantic and Gulf of Mexico.

The primary issue of concern is the potential for sonar and other sound to affect marine species, including sea turtles. Sea turtles do not have an auditory meatus or pinna that channels sound to the middle ear, nor do they have a specialized tympanum (eardrum). Instead, they have a cutaneous layer and underlying subcutaneous fatty layer that function as a tympanic membrane. The subcutaneous fatty layer receives and transmits sound to the extracolumella, 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.

In contrast to marine mammals, little is known about the role of sound and hearing in sea turtle survival and only rudimentary information is available about responses to anthropogenic noise. Sea turtles appear to be most sensitive to low frequencies; greatest sensitivities are 300 to 400 Hz for the green turtle (Ridgway et al., 1969) and around 250 Hz for juvenile loggerheads (Bartol et al., 1999). The effective hearing range for marine turtles is generally considered to be between 100 and 1000 Hz (Bartol et al., 1999; Lenhardt, 1994; Moein, 1994; Ridgway et al., 1969). Hearing thresholds below 100 Hz were found to increase rapidly (Lenhardt, 1994). Additionally, calculated in-water hearing thresholds at best frequencies (100 to 1000 Hz) appear to be high—160–200 dB re 1μPa (Lenhardt, 1994; Moein et al., 1995).

Sea turtle auditory capabilities and sensitivity is not well studied, though a few investigations suggest that it is limited to low-frequency bandwidths, 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 (Lenhardt et al., 1983). Ridgway et al. (1969) used aerial and mechanical stimulation to measure the cochlea in three specimens of green turtle, and concluded that they have a useful hearing span of perhaps 60-1,000 Hz, but hear best from about 200 Hz up to 700 Hz, with their sensitivity falling off considerably below 200 Hz. The maximum sensitivity for one animal was at 300 Hz, and for another was at 400 Hz. At the 400 Hz frequency, the turtle's hearing threshold was about 64 dB in air (approximately 126 dB in water). At 70 Hz, it was about 70 dB in air (approximately 132 dB in water). These values probably apply to all four of the hard-shell turtles (i.e., the green, loggerhead, hawksbill, and Kemp's ridley turtles). No audiometric data are available for the leatherback sea turtle, but based on other sea turtle hearing capabilities, they probably also hear best in the low frequencies. Lenhardt et al. (1983) also applied audio-frequency vibrations at 250 Hz and 500 Hz to the heads of loggerheads and Kemp's ridleys submerged in salt water to observe their behavior, measure the attenuation of the vibrations, and assess any neural-evoked response. These stimuli (250 Hz, 500 Hz) were chosen as representative of the lowest sensitivity area of marine turtle hearing (Wever, 1978). At the maximum upper limit of the vibratory delivery system, the turtles exhibited abrupt movements, slight retraction of the head, and extension of the limbs in the process of swimming. Lenhardt et al. (1983) concluded that bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving surfaces.

A recent study on the effects of airguns on sea turtle behavior also suggests that sea turtles are most likely to respond to low-frequency sounds (McCauley et al., 2000). The pressure level is measured at a standard reference point such as 1 meter with a reference pressure of 1 μPa at 1 m (i.e., re 1 μPa-m). 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 μPa at 1 m and 175 dB re 1 μPa, respectively (McCauley et al., 2000). The sea turtles' response was consistent: above a level of about 166 dB re 1 μPa, the turtles noticeably increased their swimming activity. Above 175 dB re 1 μPa, their behavior became more erratic, possibly indicating that the turtles were agitated (McCauley et al., 2000). Extrapolation from human and marine mammal data to turtles may be inappropriate given the morphological differences between the auditory systems of mammals and turtles. Currently it is believed that the range of maximum sensitivity for sea turtles is 0.1 to 0.8 kHz, with an upper limit of about 2.0 kHz (Lenhardt, 1994). Hearing below 0.08 kHz is less sensitive but still potentially usable to the animal. Green turtles are most sensitive to sounds between 0.2 and 0.7 kHz, with peak sensitivity at 0.3 to 0.4 kHz (Ridgway et al., 1997). They possess an overall hearing range of approximately 0.1 to 1.0 kHz (Ridgway et al., 1969). Juvenile loggerhead turtles hear sounds between 0.25 and 1.0 kHz and, therefore, often avoid these low frequency sounds (Bartol et al., 1999). Finally, sensitivity even within the optimal hearing range is apparently low—threshold detection levels in water are relatively high at 160 to 200 dB re 1 μPa-m (Lenhardt, 1994). Given the lack of audiometric information, the potential for temporary threshold shifts among leatherback turtles must be classified as unknown but would likely follow those of other sea turtles. In terms of sound emission, nesting leatherback turtles produce sounds in the 0.3 to 0.5 kHz range (Mrosovsky, 1972).

4.5.1 Mid-Frequency and High-Frequency Active Sonar

Any potential role of long-range acoustical perception in sea turtles has not been studied and is unclear at this time. The concept of sound masking is difficult, if not impossible, to apply to sea turtles. Although low-frequency hearing has not been studied in many sea turtle species, most of those that have been tested, exhibit low audiometric and behavioral sensitivity to low-frequency sound. It appears that if there were the potential for the mid frequency sonar to increase masking effects for any sea turtle species, it would be expected to be minimal. *Therefore, there will be no significant impact to sea turtles from active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to sea turtles from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities will have no effect on ESA-listed sea turtle species.

4.5.2 Explosive Source Sonobuoy (AN/SSQ-110A)

There is no documentation in the literature of PTS or TTS in sea turtles. However, it is assumed that acoustic exposure may elicit a physiological or behavioral response (startle) to detonations (NMFS, 1995b). Presumably the same broad categories of responses that were examined for marine mammals may also apply here to sea turtles. Few experiments have been conducted to attempt to quantify explosive exposures on turtles; and unfortunately, the methods of these experiments do not allow for their results to be analyzed (MCAS CHPT, 2001). Navy analysts have compared the injury levels reported by the best of these experiments to the injury levels that would be predicted using the modified Goertner method (Goertner, 1982). For this assessment, the Level A harassment/injury criteria for marine mammals, as established in the Churchill FEIS (DON, 2001a), is equated to ESA harm for turtles. In addition, the Level B harassment criteria for toothed whales are equated to ESA harassment for sea turtles. Table 4-27 shows the criteria used for sea turtles. Section 4.4.7 provides a more detailed explanation for each criteria level, metric, and threshold for small explosives (i.e., explosive source sonobuoy [AN/SSQ-110A]).

Table 4-27. Explosive Criteria Used for Estimating Sea Turtle Exposures

Harassment Level	Criteria	Metric	Threshold
Mortality	Onset extensive lung injury	Goertner modified positive impulse	30.5 psi-ms
Harm (MMPA Level A)	Onset slight lung injury/PTS	Goertner modified positive impulse	indexed to 13 psi-ms
Harassment (MMPA Level B)	TTS	Greatest energy flux density level in any 1/3-octave band above 100 Hz - for total energy over all exposures	182 dB re 1 µPa^2-s
Harassment (MMPA Level B)	TTS	Peak pressure over all exposures	23 psi

dB 1 µPa^2-s – decibel referenced to 1 micropascal squared second; Hz – hertz;
MMPA – Marine Mammal Protection Act; psi-ms = pounds per square inch-millisecond;
TM – tympanic membrane; TTS – temporary threshold shift

As shown in Tables 4-28 through 4-31, the analysis identified the potential for all sea turtles to be exposed to sound from AFAST activities involving the explosive source sonobuoy (AN/SSQ-110A).

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Table 4-28. Estimated Sea Turtle Acoustic Exposures from Explosive Source Sonobuoys (AN/SSQ-110A) Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States									Northeast			Gulf of Mexico		
	VACAPES OPAREA			CHPT OPAREA			JAX/CHASN OPAREA			Northeast OPAREA			GOMEX		
	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS
Loggerhead sea turtle	0	0*	0*	0	0*	0*	0	0*	1	0	0	0	0	0*	0*
Kemp's ridley sea turtle[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leatherback sea turtle	0	0	0*	0	0	0	0	0	0	0	0	0	0	0	0*
Hardshell sea turtles[2]	0	0	0*	0	0	0*	0	0*	0*	0	0	0	0	0*	0*

*Indicates an exposure greater than or equal to 0.05, therefore is considered a "may affect" for ESA listed species.
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.
2. This category includes green, hawksbill, and unidentified hardshell species for all regions. It also includes Kemp's ridley sea turtles in the Gulf of Mexico, and may include extralimital occurrences of olive ridley turtles along the Atlantic coast.

Table 4-29. Estimated Sea Turtle Acoustic Exposures from Explosive Source Sonobuoys (AN/SSQ-110A) Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States									Northeast			Gulf of Mexico		
	VACAPES OPAREA			CHPT OPAREA			JAX/CHASN OPAREA			Northeast OPAREA			GOMEX		
	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS
Loggerhead sea turtle	0	0*	0*	0	0*	0*	0*	1	3	0	0	0	0	0*	0*
Kemp's ridley sea turtle[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leatherback sea turtle	0	0	0*	0	0	0	0*	1	3	0	0	0	0	0	0
Hardshell sea turtles[2]	0	0	0*	0	0	0*	0	0*	2	0	0	0*	0	0*	0*

*Indicates an exposure greater than or equal to 0.05, therefore is considered a "may affect" for ESA listed species.
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.
2. This category includes green, hawksbill, and unidentified hardshell species for all regions. It also includes Kemp's ridley sea turtles in the Gulf of Mexico, and may include extralimital occurrences of olive ridley turtles along the Atlantic coast.

Table 4-30. Estimated Sea Turtle Acoustic Exposures from Explosive Source Sonobuoys (AN/SSQ-110A) Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States									Northeast			Gulf of Mexico		
	VACAPES OPAREA			CHPT OPAREA			JAX/CHASN OPAREA			Northeast OPAREA			GOMEX		
	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS
Loggerhead sea turtle	0	0*	0*	0	0*	0*	0*	1	2	0	0	0	0	0*	0*
Kemp's ridley sea turtle[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leatherback sea turtle	0	0	0*	0	0	0	0	0*	1	0	0	0	0	0	0
Hardshell sea turtles[2]	0	0	0*	0	0	0*	0	0*	2	0	0	0*	0	0*	0*

*Indicates an exposure greater than or equal to 0.05, therefore is considered a "may affect" for ESA listed species.
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.
2. This category includes green, hawksbill, and unidentified hardshell species for all regions. It also includes Kemp's ridley sea turtles in the Gulf of Mexico, and may include extralimital occurrences of olive ridley turtles along the Atlantic coast.

Table 4-31. Estimated Sea Turtle Acoustic Exposures from Explosive Source Sonobuoys (AN/SSQ-110A) Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States									Northeast			Gulf of Mexico		
	VACAPES OPAREA			CHPT OPAREA			JAX/CHASN OPAREA			Northeast OPAREA			GOMEX		
	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS
Loggerhead sea turtle	0	0*	0*	0	0*	0*	0	0*	1	0	0	0	0	0*	0*
Kemp's ridley sea turtle[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leatherback sea turtle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0*
Hardshell sea turtles[2]	0	0	0*	0	0	0*	0	0*	0	0	0	0	0	0*	0*

*Indicates an exposure greater than or equal to 0.05, therefore is considered a "may affect" for ESA listed species.
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.
2. This category includes green, hawksbill, and unidentified hardshell species for all regions. It also includes Kemp's ridley sea turtles in the Gulf of Mexico, and may include extralimital occurrences of olive ridley turtles along the Atlantic coast.

4.5.2.1 Loggerhead Sea Turtles

Acoustic analysis indicates that up to two loggerhead sea turtles may be exposed to levels of sound from explosive source sonobuoys likely to result in TTS under the No Action Alternative, four under Alternative 1, three under Alternative 2, and one under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that zero loggerhead sea turtles may be exposed to levels of sound from explosive source sonobuoys likely to result in PTS or onset slight lung injury under the No Action Alternative, one under Alternative 1, one under Alternative 2, and zero under Alternative 3. The exposure numbers for PTS under all Alternatives include no possible mortalities. The above numbers represent potential exposures based on modeling results specifically for loggerhead sea turtles. However, additional loggerhead turtles could be included in the hardshell sea turtle class of Tables 4-28 through 4-31, which includes unidentified hardshell turtles. Therefore, the total number of loggerheads harassed could be greater than the numbers identified above. Modeling of the explosive source sonobuoys predicts no mortality to loggerhead sea turtles.

Even though loggerhead sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual loggerhead sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual loggerhead sea turtles.

In accordance with NEPA, there will be no significant impact to loggerhead sea turtles from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to loggerhead sea turtles from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect loggerhead sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA.

4.5.2.2 Kemp's Ridley Sea Turtles

In the Atlantic Ocean, acoustic analysis indicates that no Kemp's ridley sea turtles will be exposed to levels of sound from explosive source sonobuoys likely to result in TTS under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Acoustic analysis indicates that no Kemp's ridley sea turtles will be exposed to levels of sound from explosive source sonobuoys likely to result in PTS or onset slight lung injury under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The above numbers represent potential exposures based on modeling results specifically for Kemp's ridley sea turtles in the Atlantic Ocean. However, additional Kemp's ridley turtles could be included in the hardshell sea turtle class of Tables 4-28 through 4-31, which includes unidentified hardshell turtles. Therefore, the total number of Kemp's ridleys harassed in the Atlantic could be greater than the numbers identified above.

In the Gulf of Mexico, acoustic modeling results are not available specifically for Kemp's ridley sea turtles because the number of sightings for this species was not sufficient to allow for spatial modeling. However, this species comprises an unknown portion of the unidentified hardshell sea turtle class for the GOMEX in Tables 4-28 through 4-31. Acoustic analysis indicates the potential for exposure of hardshell turtles (including Kemp's ridley sea turtles) to levels of sound from explosive source sonobuoys likely to result in TTS and PTS or onset slight lung injury. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Modeling of the explosive source sonobuoys predicts no mortality to hardshell turtles, and thus no mortality to the Kemp's ridley sea turtles in the Gulf of Mexico.

Even though Kemp's ridley sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual Kemp's ridley sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual Kemp's ridley sea turtles.

In accordance with NEPA, there will be no significant impact to Kemp's ridley sea turtles from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Kemp's ridley sea turtles from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect Kemp's ridley sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.5.2.3 Leatherback Sea Turtles

Acoustic analysis indicates that no leatherback sea turtles may be exposed to levels of sound from explosive source sonobuoys likely to result in TTS under the No Action Alternative, three under Alternative 1, two under Alternative 2, and none under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no leatherback sea turtles may be exposed to levels of sound from explosive source sonobuoys likely to result in PTS or onset slight lung injury under the No Action Alternative, one under Alternative 1, none under Alternative 2, and none under Alternative 3. The exposure numbers for PTS under all Alternatives includes no possible mortalities.

Even though leatherback sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual leatherback sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual leatherback sea turtles.

In accordance with NEPA, there will be no significant impact to leatherback sea turtles from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to leatherback sea turtles from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect leatherback sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.5.2.4 Atlantic Green Sea Turtles

Acoustic modeling results are not available specifically for Atlantic green sea turtles because the numbers of sightings for this species was not sufficient to allow for spatial modeling. However, this species comprises an unknown portion of the unidentified hardshell sea turtle class in Tables 4-28 through 4-31. Acoustic analysis indicates the potential for exposure of hardshell turtles (including green sea turtles) to levels of sound from explosive source sonobuoys likely to result in TTS and PTS or onset slight lung injury. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Modeling of the explosive source sonobuoys predicts no mortality to hardshell turtles, and thus no mortality to Atlantic green sea turtles.

Even though Atlantic green sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual green sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual green sea turtles.

In accordance with NEPA, there will be no significant impact to Atlantic green sea turtles from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to green turtles from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect Atlantic green sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA.

4.5.2.5 Hawksbill Sea Turtles

Acoustic modeling results are not available specifically for hawksbill sea turtles because the number of sightings for this species was not sufficient to allow for spatial modeling. However, this species comprises an unknown portion of the unidentified hardshell sea turtle class in Tables 4-28 through 4-31. Acoustic analysis indicates the potential for exposure of hardshell turtles (including hawksbill sea turtles) to levels of sound from explosive source sonobuoys likely to result in TTS and PTS or onset slight lung injury. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Modeling of the explosive source sonobuoys predicts no mortality to hardshell turtles, and thus mortality to hawksbill sea turtles.

Even though hawksbill sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual hawksbill turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual hawksbill sea turtles.

In accordance with NEPA, there will be no significant impact to hawksbill sea turtles from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to hawksbill sea turtles from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities may affect hawksbill sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA.

4.5.2.6 Olive Ridley Sea Turtles

Acoustic modeling results are not available specifically for olive ridley sea turtles. Although extremely rare in the North Atlantic Ocean, this species may comprise an unknown portion of the unidentified hardshell sea turtle class in Tables 4-28 through 4-31. Acoustic analysis indicates the potential for exposure of hardshell turtles (including olive ridley sea turtles) to levels of sound likely to result in TTS and PTS or onset slight lung injury. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Modeling of the explosive source sonobuoys predicts no mortality to hardshell turtles, and thus no potential for mortality to olive ridley sea turtles.

Even though olive ridley sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individuals or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual olive ridley sea turtles.

In accordance with NEPA, there will be no significant impact to olive ridley sea turtles from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to olive ridley sea turtles from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities, due to the extremely low probability of encountering an olive ridley sea turtle will have no effect on olive ridley sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.5.3 Potential Nonacoustic Effects to Sea Turtles

4.5.3.1 Vessel Strikes

Collisions with commercial and U.S. Navy ships can cause major wounds and may occasionally cause fatalities to sea turtles. In addition, sound from surface vessel traffic may cause behavioral responses of sea turtles.

Accordingly, the U.S. Navy has adopted standard operating procedures and mitigation measures to reduce the potential for collisions with surfaced marine mammals (for more details refer to Chapter 5). These mitigation measures include:

- Using lookouts trained to detect all objects on the surface of the water, including sea turtles.
- Implementing reasonable and prudent actions to avoid the close interaction of Navy assets and sea turtles.
- Maneuvering to keep away from any observed sea turtle.

Based on the implementation of appropriate mitigation measures, the likelihood that a ship strike will occur during AFAST activities is low. *Therefore, there will be no significant impact to loggerhead, green, leatherback, Kemp's ridley, hawksbill, or olive ridley sea turtles from vessel interactions during AFAST training exercises within territorial waters*. In addition, there will be no significant harm to loggerhead, green, leatherback, Kemp's ridley, hawksbill, or olive ridley sea turtles resulting from vessel interactions during AFAST training exercises in non-territorial waters. AFAST training exercises may affect loggerhead, green, leatherback, Kemp's ridley, and hawksbill sea turtles through vessel-strikes.

4.5.3.2 Expended Materials

Similar to marine mammals, sea turtles are subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Most documented cases of entanglements occur when whales encounter the vertical lines of fixed fishing gear. Possible expended materials from AFAST activities includes sonobuoys, torpedoes, and ADCs, and EMATTs (Table 4-1). Specifically, during torpedo exercises, guidance wires and flex hoses are expended. Moreover, sonobuoy and EMATT parachutes are also expended during AFAST activities. This section analyzes the potential effects of expended materials on marine species, including sea turtles.

4.5.3.2.1 Parachutes

Aircraft-launched sonobuoys, torpedoes, and EMATTs deploy nylon parachutes of varying sizes. At water impact, the parachute assembly is expended, and it sinks away from the exercise sonobuoy or torpedo. The parachute assembly will potentially be at the surface for a short time before sinking to the sea floor. Entanglement and the eventual drowning of a sea turtle in a parachute assembly will be unlikely, since the parachute will have to land directly on an animal, or an animal will have to swim into it before it sinks. The potential for a sea turtle to encounter an expended parachute is extremely low, given the generally low probability of a sea turtle being in the immediate location of deployment, especially given the mitigation measures outlined in Chapter 5.

All of the material is negatively buoyant and will sink to the ocean floor. Many of the components are metallic and will sink rapidly. The expended material will accumulate on the ocean floor and will be covered by sediments over time, thereby remaining on the ocean floor, reducing the potential for entanglement. This accrual of material is not expected to cause an increased potential for sea turtle entanglement. If bottom currents are present, the canopy may billow (bulge) and pose an entanglement threat to marine animals with bottom-feeding habits; however, the probability of a sea turtle encountering a parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely.

The overall possibility of sea turtles ingesting parachute fabric or becoming entangled in cable assemblies is very remote. *Therefore, there will be no significant impact to sea turtles resulting from interactions with parachute assemblies during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to sea turtles resulting from interactions with parachute assemblies during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. AFAST training activities with respect to parachute assemblies may affect ESA-listed sea turtles. Parachutes associated with AFAST training may affect ESA-listed sea turtle species.

4.5.3.2.2 Torpedoes

There is a negligible risk that a sea turtle could be struck by a torpedo during ASW training activities. This conclusion is based on (1) review of torpedo design features and (2) review of a large number of previous naval exercise ASW torpedo activities.

The acoustic homing programs of torpedoes are designed to detect either the mechanical sound signature of the submarine or active sonar returns from its metal hull with large internal air volume interface. The torpedoes are specifically designed to ignore false targets. As a result, their homing logic does not detect or recognize the relatively small air volume associated with the lungs of sea turtles. They do not detect or home to sea turtles.

The Navy has conducted exercise torpedo activities since 1968. At least 14,322 exercise torpedo runs have been conducted since 1968. There have been no recorded or reported instances of a marine species strike by an exercise torpedo. Every exercise torpedo activity is monitored acoustically by on-scene range personnel listening to range hydrophones positioned on the ocean floor in the immediate vicinity of the torpedo activity. After each torpedo run, the recovered exercise torpedo is thoroughly inspected for any damage. The torpedoes then go through an extensive production line refurbishment process for re-use. This production line has stringent quality control procedures to ensure that the torpedo will safely and effectively operate during its next run. Since these exercise torpedoes are frequently used against manned Navy submarines, this post-activity inspection process is thorough and accurate. Inspection records and quality control documents are prepared for each torpedo run. This post exercise inspection is the basis that supports the conclusion of negligible risk of sea turtle strike. *Therefore, there will be no significant impact to sea turtles resulting from interactions with torpedoes during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to sea turtles resulting from interactions with torpedoes during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The probability of direct strike of torpedoes associated with AFAST training is negligible and therefore will have no effect on ESA-listed sea turtle species.

4.5.3.2.3 Torpedo Guidance Wires

Torpedoes are equipped with a single-strand guidance wire, which is laid behind the torpedo as it moves through the water. At the end of a torpedo run, the wire is released from the firing vessel and the torpedo to enable torpedo recovery. The wire sinks rapidly and settles on the ocean floor. Guidance wires are expended with each exercise torpedo launched. Each year, about 254 exercise torpedoes will be used; therefore, the same number of control wires will be expended annually.

DON (1996) analyzed the potential entanglement effects of torpedo control wires on sea turtles. The Navy analysis concluded that the potential for entanglement effects will be low for the following reasons:

- The guidance wire is a very fine, thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 19 kg (42 lb) and can be broken by hand. With the exception of a change encounter with the guidance wire while it was sinking to the sea floor (at an estimate rate of 0.2 m [0.5 ft] per second), a marine animal would be vulnerable to entanglement only if its diving and feeding patterns place it in contact with the bottom.
- The torpedo control wire is held stationary in the water column by drag forces as it is pulled from the torpedo in a relatively straight line until its length becomes sufficient for it to form a chain-like droop. When the wire is cut or broken, it is relatively straight and the physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the entanglement literatures.

Given the low potential probability of sea turtles and sea turtle entanglement with control wires, the potential for any harm or harassment to these species is extremely low. *Therefore, there will be no significant impact to sea turtles resulting from interactions with torpedo guidance wire during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to sea turtles resulting from interactions with torpedo guidance wire during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. AFAST training activities with respect to the release of torpedo guidance wire may affect ESA-listed sea turtles. The torpedo guidance wires associated with AFAST activities will have no effect on ESA-listed sea turtle species.

4.5.3.2.4 Torpedo Flex Hoses

Improved flex hoses or strong flex hoses will be expended during torpedo exercises. DON (1996) analyzed the potential for the flex hoses to affect sea turtles. This analysis concluded that the potential entanglement effects to marine animals will be insignificant for reasons similar to those stated for the potential entanglement effects of control wires:

- Due to its weight, the flex hoses will rapidly sing to the bottom upon release. With the exception of a chance encounter with the flex hose while it was sinking to the sea floor, a marine animal would be vulnerable to entanglement only if its diving and feeding patterns placed it in contact with the bottom.
- Due to its stiffness, the 76.2-m-long (250-ft-long) flex hose will not form loops that could entangle marine animals.

Therefore, there will be no significant impact to sea turtles resulting from interactions with torpedo flex hoses during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to sea turtles resulting from interactions with torpedo flex hoses during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. AFAST training activities with respect to the release of torpedo flex hoses may affect ESA-listed sea turtles. The torpedo flex hoses associated with AFAST activities will have no effect on ESA-listed sea turtle species.

4.5.3.2.5 Direct Strikes

The Navy uses the EMATT and the MK-30 acoustic training targets (recovered) during ASW sonar training exercises. The potential for direct physical contact between an EMATT [12 by 91 cm (5 by 36 in) and a sea turtle, or for a direct strike from an MK-30 to a sea turtle, is extremely low given the generally low probability of occurrence of these animals at the immediate location of deployment and the reconnaissance procedures implemented prior to and during exercises. *Therefore, there will be no significant impact to sea turtles resulting from interactions with EMATTs or MK-30s during AFAST activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to sea turtles resulting from interactions with EMATTs or MK-30s during AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The probability of direct strike of training target associated with AFAST training is negligible and therefore will have no effect on ESA-listed marine mammal species.

4.6 ESSENTIAL FISH HABITAT

Essential Fish Habitat (EFH) includes hardbottom, softbottom, estuaries, reefs, wrecks, inshore areas, oyster reefs, vegetated bottom, and the water column. Effects to EFH could potentially result from either acoustic impacts, or from explosive forces and material introduced into the water column and sediments from explosive source sonobuoy (AN/SSQ-110A) and other activities. Acoustic effects would only apply to living organisms such as shell fish and coral.

Very little information is available regarding the hearing capability of marine invertebrates (NRC, 2003). However, no effects to these resources are anticipated from active sonar since acoustic transmissions are brief in nature. Marine plants are acoustically transparent. Therefore, no effects to EFH due to active sonar are anticipated.

Operation of the explosive source sonobuoy (AN/SSQ-110A) will result in explosive impulses. Such explosive forces could affect EFH by either disturbing the sea bottom or by physically impacting structures such as wrecks or reefs. However, explosive source sonobuoy (AN/SSQ-110A) detonations will occur in the water column, at a sufficient distance from the seafloor to avoid disturbance of bottom habitats. Activities will not occur in marine sanctuaries or near reefs. Known wrecks will be avoided, as will other areas of relief and structure. Therefore, effects to EFH resulting from alteration of structures in the water are not anticipated.

Effects to the water column and seafloor habitats could occur due to the explosive source sonobuoy (AN/SSQ-110A), torpedoes, ADCs, or EMATTs. Explosive source sonobuoys (AN/SSQ-110A) could affect water quality by the release of explosive byproducts, and could affect bottom habitats by release of chemicals (primarily from batteries) into the sediment. The sonobuoy explosive package consists primarily of HLX and small amounts of plastic-bonded molding powder. Explosions creates gaseous byproducts, many of which travel to the surface and escape into the atmosphere. A small amount of the gas, however, dissolves into the water column. Although several byproducts are produced, the products with greatest potential to result in toxicity are hydrogen fluoride compounds. However, as discussed in section 4.5.1.2, only a minute amount of these substances are expected to be introduced, and they would be rapidly diluted by water movement. It is therefore considered unlikely that the explosive reactions associated with sonobuoys will result in contamination to EFH.

Sonobuoys use various types of batteries to power different components. Typical batteries employed include seawater, lithium, and thermal batteries. Soluble battery constituents of potential concern that may be released into the water column or sediments include lead, silver, and copper. Several other constituents such as chloride, bromide, and lithium may be released as well. Several investigations into the potential effects of battery constituents on seawater and sediment conditions found acceptable levels of such substances (ESG, 2005; Kszos, 2003; EPA, 2001; Borener and Maughan, 1998; U.S. Coast Guard, 1994; NAVFAC, 1993). Little accumulation occurred in sediments, and mixing and diffusion resulted in low concentrations in the water column. Therefore, there are no significant impacts to EFH anticipated from sonobuoy batteries.

Otto Fuel II is used to propel torpedoes. The combustion byproducts of this fuel include carbon dioxide, carbon monoxide, water, hydrogen gas, nitrogen gas, ammonia, hydrogen cyanide (HCN), and nitrogen oxides. These substances are exhausted into the torpedo wake, which is extremely turbulent and causes rapid mixing and diffusion. All of the byproducts produced during torpedo use, with the exception of hydrogen cyanide, are below the EPA water quality criteria. The concentration of hydrogen cyanide exceeds the 1-hour recommended value; however, hydrogen cyanide is highly soluble in seawater and dilutes below the EPA criterion within 6.3 m (20.7 ft) of the torpedo. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. Therefore, there are no significant impacts to EFH anticipated from torpedo use.

Both ADCs and EMATTs are powered by lithium sulfur dioxide batteries. The final battery byproducts include lithium ions, hydroxide (which combines with hydronium to form water), and sulfate. All of these substances are considered benign in the marine environment. In addition, the chemical reactions of the batteries will be highly localized and short-lived, and ocean currents will diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. Therefore, there are no significant impacts to EFH anticipated from ADCs or EMATTs.

The proposed action will not reduce the quality and/or quantity of EFH, will not introduce significant contamination to the water column or bottom habitats, will not result in physical disruption of EFH, will not result in loss of prey, and will not reduce any species' fecundity. *Therefore, there will be no significant impact to EFH from active sonar or the explosive source sonobuoy (AN/SSQ-110A) or other systems in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no adverse impacts to EFH from active sonar or the explosive source sonobuoy (AN/SSQ-110A) or other systems in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.7 MARINE FISH

4.7.1 Mid-Frequency and High-Frequency Active Sonar

Hearing capability data only exists for fewer than 100 of the 27,000 species of fish (Hastings and Popper, 2005). Data collected to date suggests that the predominance of fish hearing for most species of fish occurs from 0.05 to 1.0 kHz (NRC, 2003). More specifically, studies indicate most marine fish are hearing generalists and have their best hearing sensitivity at or below 0.3 kHz (Popper, 2003). It has also been demonstrated that a few marine hearing specialists can detect sounds up to 4.0 kHz, while some can detect sounds above 120 kHz; however, a gap in the sensitivity exists from 3.2 kHz to 12.5 kHz for at least one of these species, the American shad (Dunning et al., 1992; Mann et al., 1998; Mann et al., 2001; Nestler et al., 2002; Popper and Carlson 1998; Ross et al., 1996). As stated previously, less than 1 percent of fish have been studied to obtain hearing capability data. Therefore, it is difficult to take the conclusions of limited studies and extend them to all fish in general terms. To be conservative, however, this analysis assumed that many marine hearing generalists could potentially detect mid- and high-frequency sonar.

Studies have shown that hearing generalists normally experience only minor or no hearing loss when exposed to continuous sound, but hearing specialists may be affected by sound exposure. Exposure to loud sound can result in significant threshold shifts in hearing specialists (Scholik and Yan, 2001; Smith et al., 2004a; Smith et al., 2004b). The only experiments having shown mortality in fish have been investigations on juvenile herring (*Clupea harengus*) when exposed to intense mid-frequency active sonar (Jørgensen et al., 2005; Sevaldsen and Kvadsheim, 2004). This is not to say, however, that any fish species, no matter what their hearing sensitivity, are not prone to injury as a result of exposure to mid-frequency active sonar. Individual juvenile fish with a swim bladder resonance in the frequency range of the operational sonars, and especially hearing specialists such as some clupeid species, may experience injury or mortality. The resonance frequency will depend on fish species, size and depth (McCartney and Stubbs, 1971; Løvik and Hovem, 1979). The swimbladder is a vital part of a system that amplifies vibrations that reach the fish's hearing organs, and at resonance the swimbladders may absorb much of the acoustic energy in the impinging sound wave (Sevaldsen and Kvadsheim, 2004). The resulting oscillations may cause mortality or harm the swimbladder itself or the auditory organs (Jørgensen et al., 2005). The physiological effect of sonars on adult fish is expected to be less than for juvenile fish because adult fish are in a more robust stage of development, the swim bladder frequencies will be outside the range of the frequency of mid-frequency active sonar, and adult fish have more ability to move from an unpleasant stimulus (Kvadsheim and Sevaldsen, 2005). In a follow-on study to their earlier work (2005) that showed mortality in herring due to mid-frequency active sonar, Kvadsheim et al. (2007) showed no reaction of herring to mid-frequency active sonar. The age class of herring in this more recent study was not described. Interestingly, herring did react to playbacks of killer whale feeding sounds covering the same frequency band.

Kvadsheim and Sevaldsen (2005) determined the effects to the Atlantic herring population are likely to be minor considering the natural mortality rate of juvenile fish and the limited exposure of the fish to the sound source (Jørgensen et al., 2005 The investigators point out that continuous wave (CW) transmissions at the frequency band corresponding to the swim bladder resonance escalate the effect to juvenile herring significantly and suggested frequencies, depending on fish length, for which Atlantic herring will most likely be affected by CW signals (Table 4-32). Still, in the area of investigation, the effect of CW transmission at 225 dB on the juvenile herring population was determined to be small (0.1 percent) compared to daily natural mortality (5 percent). While CW signals will be used in the Proposed Action, the most commonly used signals will be FM, the significant threshold for mortality for which was determined to be 180-190 dB (re 1 µPa) for juvenile herring (Kvadsheim and Sevaldsen, 2005).

Table 4-32. Frequency Bands Most Likely to Affect Juvenile Herring

Atlantic Herring Length	Effective Frequency Band
2.5 to 3 cm	3 to 6 kHz
3 to 4 cm	2 to 5 kHz
5 to 6 cm	1.5 to 3 kHz
6 to 10 cm	1 to 3 kHz

cm = centimeter; kHz = kilohertz

Frequency bands for which a juvenile herring are likely to be affected during the use of CW-sonar signals. The effective frequency band is defined based on the expected resonance frequencies of the swim bladder of the juvenile Atlantic herring, as estimated from the length of the fish using the empirical model of Lovik & Hoven (1979) +/- 1 kHz bandwidth (McCartney and Stubbs, 1971) (based on Kvadsheim and Sevaldsen, 2005).

In a study of the response of fishes to active sonar ranging from 1.6 to 4.0 kHz, Jørgensen et al. (2005) observed the behavior of four unrelated marine species, (saithe [*Pollachius virens*], spotted wolffish [*Anarhichas minor*], cod [*Gadus morhua*], and Atlantic herring [*Clupea* *harengus*]). Jørgensen et al. (2005) concluded that, of the species studied, herring might be the only species of concern due to its increased hearing ability. Juvenile herring responded with startle behaviors from sonar signals around 170 dB re 1 μPa, but resumed normal activity after the first few pulses. However, in tests with received levels around 180 to 189 dB re 1 μPa, juvenile herring exhibited startle behaviors followed by abnormal swimming. In addition, strong distress was evident during presentation of a series of 100 frequency modulated (FM) sonar pulses at around 180 dB re 1 μPa. The other species of juvenile fishes did not exhibit startle responses, or any other behavioral evidence, from the mid-frequency sonar pulses as expected for fishes with no known auditory specializations for reception of frequencies above 1.0 kHz. Investigators suggested limiting the use of sonar in the range of 1.0 to 2.0 kHz at maximal operational source levels (greater than 200 dB) in areas of known juvenile herring abundance, because juvenile herring have swim bladder resonance frequencies in this frequency band.

Ultrasound detecting clupeids (such as American shad, blueback herring, alewife) with distributions overlapping the AFAST Study Area may have similar reactions to mid-frequency active sonar (as found by Jørgensen et al., 2005 and Kvadsheim and Sevaldsen, 2005) because of their similarities in hearing sensitivity. River herring (blueback herring and alewife) are listed by NMFS as a species of concern and could become listed as endangered or threatened species when enough information becomes available to indicate a need for endangered or threatened listing.

In another experiment exposing fish to sonar, Popper et al. (2007) exposed rainbow trout, a fish sensitive to low frequencies, to high-intensity low-frequency sonar (215 dB re 1 μPa^2 170-320 Hz) with receive level for two experimental groups estimated at 193 dB for 324 or 648 seconds. Fish exhibited a slight behavioral reaction, and one group exhibited a 20-dB auditory threshold shift at one frequency. No direct mortality, morphological changes, or physical trauma was noted as a result of these exposures. The authors point out, however, that the experimental conditions represented an extreme worst-case example with longer than typical exposures for low-frequency sonar, use of a stationary source, and confined animals. These results, therefore, may not be reflective of expected real-world exposures from low-frequency sonar operations. While low-frequency sonar is not included in the Proposed Action, these results of low-frequency sonar effects on low-frequency sensitive rainbow trout are encouraging in that similar results may be found with mid-frequency sonar use when applied to mid-frequency sensitive fish. Still, extrapolating results should always be done with caution, especially considering that in Popper et al.'s (2007) experiment, rainbow trout of different groups had markedly different reactions to test conditions.

Studies have shown that low-frequency sound and ultrasound will alter the behavior of fish and can be used to deter fish away from potentially dangerous situations, such as turbine inlets of hydroelectric power plants (Knudsen et al., 1994). Stronger avoidance responses are exhibited from sounds in the infrasound range (0.005 to 0.010 kHz) rather than from 0.050 and 0.15 kHz sounds (Knudsen et al., 1992). In test pools, wild salmon will swim to a deeper section of the test pool, even if that deep section was near the sound source, when exposed to low-frequency sound. Ultrasound has been shown to cause some clupeid species to exhibit strong movement away from the sound source (Dunning et al., 1992; Mann et al., 1998; Ross et al., 1993), and it has also been observed to cause some clupeids to form tight schools (Mann et al., 1998; Nestler et al., 1992), which is a common defensive behavior (Astrup, 1999).

Culik et al. (2001) and Gearin et al. (2000) studied how sound may affect fish behavior by looking at the effects of mid-frequency sound produced from acoustic devices designed to deter marine mammals from gillnet fisheries. These devices generally produce sound in similar frequencies of mid-frequency active sonar devices. Gearin et al. (2000), studied adult sockeye salmon (*Oncorhynchus nerka*) and found that they exhibited an initial startle response, likely due to the placement of an inactive acoustic alarm (designed to deter harbor porpoises) in the test tank. The fish resumed their normal swimming pattern within 10 to 15 seconds. After 30 seconds, the fish approached the inactive alarm to within 30 cm (1 ft). The same experiment was conducted with the alarm active. The fish exhibited the same initial startle response from the insertion of the alarm into the tank; however, within 30 seconds, the fish were swimming within 30 cm (1 ft) of the active alarm. After five minutes of observation, the fish did not exhibit any reaction or behavior change except for the initial startle response (Gearin et al., 2000). This demonstrated that the alarm was either inaudible to the salmon, or the salmon were not disturbed by the mid-frequency sound (Gearin et al., 2000).

Wysocki and Ladich (2005) investigated the influence of sound exposure on the auditory sensitivity of two freshwater hearing specialists (goldfish [*Carassius auratus*] and lined Raphael catfish [*Platydoras costatus*]) and a freshwater hearing generalist (sunfish [*Lepomis gibbosus*]). Baseline thresholds showed greatest hearing sensitivity around 0.5 kHz in the goldfish and catfish and at 0.1 kHz in the sunfish. For the hearing specialists (goldfish and catfish), continuous white noise of 130 dB resulted in a significant threshold shift of 23 to 44 dB. In contrast, the auditory thresholds in the hearing generalist (sunfish) declined by 7 to 11 dB. It was concluded that acoustic communication and orientation of fishes, in particular of hearing specialists, may be limited by sound regimes in their environment. Studies have also found that hearing generalists normally experience only minor or no hearing loss when exposed to continuous sound, but that hearing specialists may be affected by sound exposure (e.g., acoustic communication might be restricted in noisy habitats) (Amoser and Ladich, 2003; Smith, et al., 2004a and 2004b).

The inability to hear ecologically important sounds due to the interference of other sounds ("masking") has implications for reduced fitness; potentially leaving fish vulnerable to predators, unable to locate prey, sense their acoustic environment, or unable to communicate acoustically (McCauley et al., 2003). Pressure to detect predators is likely a significant driving force in the development of hearing abilities. Gannon et al. (2005) showed that bottlenose dolphins (*Tursiops truncates*) move toward acoustic playbacks of the vocalization of Gulf toadfish (*Opsanus beta*). Thus, dolphin prey, such as Gulf toadfish, could be under selective pressure to detect dolphin acoustic signals and use this information to adjust mate advertisement calling (Remage-Healey et al., 2006). Bottlenose dolphins employ a variety of vocalizations during social communication and foraging, including high-frequency whistles (5 to 20 kHz), echolocation clicks (20 to 100 kHz) and low-frequency pops. Toadfish may be able to best detect the low-frequency pops since their auditory frequency encoding is most robust below 1.0 kHz, and they have shown reduced levels of calling when bottlenose dolphins approach (Remage-Healey et al., 2006). Silver perch have also been shown to decrease calls when exposed to playbacks of dolphin whistles mixed with other biological sounds (Luczkovich et al., 2000). Results of the Luczkovich et al. (2000) study, however, must be viewed with caution because of the lack of clarity of which sound elicited the silver perch response (Ramcharitar et al., 2006b).

Communication signals, which loud sounds have the potential to mask, are a necessary aspect of some species' ecology. The Sciaenids, which are primarily inshore fishes, are probably the most active sound producers among fish (Ramcharitar et al., 2001; Ramcharitar et al., 2006a). The frequency range of sciaenid sounds may span several kHz but the dominant frequency is generally between 0.1 and 1.0 kHz. Although there may be energy to higher frequencies in some species, the functional importance of these higher frequencies is unknown, and they may only be present as extraneous harmonics on the major frequency components in the sound (Ramcharitar et al., 2006a).

The ability to hear reproductive sound signals is necessary for population survival of some vocal fishes. The distance over which sound can be useful is often limited by the physics of sound travel underwater and therefore makes most reproductive sounds of limited use as an ecological cue over larger distances. Reproductive calls are often thought to be undetectable to fish within 20 m (66 ft) or less from the source, due to interactions with the surface and substrate (Mann and Lobel, 1997), although the detection distance will increase as water depth increases. Loud anthropogenic sounds may mask reproductive signals and therefore be detrimental to some fish populations.

Also vulnerable to masking is navigation by larval fish. There is indication that larvae of some species navigate to juvenile and adult habitat by listening for fish choruses (the sound signature emitted from reefs and actively produced by adult fishes and invertebrates [Higgs, 2005]) and other sounds indicative of a particular habitat. In a study of an Australian reef system, it was determined the sound signature emitted from fish choruses were between 0.8 and 1.6 kHz (Cato, 1978) and could be detected 5 to 8 km (3 to 4 NM) from the reef (McCauley and Cato, 2000). This bandwidth is well within the detectable bandwidth of adults and larvae of many species of reef fish (Fay, 1988; Kenyon, 1996; Myrberg, 1980).

Thus, studies have indicated that acoustic communication and orientation of fish may be restricted by sound regimes in their environment. However, most marine fish species are not expected to able to detect sounds in the mid-frequency range of the operational sonars used in the Proposed Action, and therefore, the sound sources do not have the potential to mask key environmental sounds. The few fish species that have been shown to be able to detect mid-frequencies do not have their best sensitivities in the range of the operational sonars. Additionally, vocal marine fish largely communicate below the range of mid-frequency levels used in the Proposed Action.

There is no information available that suggests that exposure to non-impulsive acoustic sources results in significant fish mortality on a population level. Mortality has been shown to occur in one species, a hearing specialist, however, the level of mortality was considered insignificant in light of natural daily mortality rates. Experiments have shown that exposure to loud sound can result in significant threshold shifts in certain fish that are classified as hearing specialists (but not those classified as hearing generalists). Threshold shifts are temporary, and considering the best available data, no data exist that demonstrate any long-term negative effects on marine fish from underwater sound associated with sonar activities. Further, while fish may respond behaviorally to mid-frequency sources, this behavioral modification is only expected to be brief and not biologically significant.

Based on the evaluation presented herein, the likelihood of significant effects to individual fish from active sonar is low. *Therefore, there will be no significant impact to fish populations as a result of active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to fish populations from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.7.2 Explosive Source Sonobuoy (AN/SSQ-110A)

In fisheries science, it has been found that if carefully deployed, explosives can serve to quantitatively sample small areas without greatly damaging the habitat structure (Continental Shelf, Inc., 2004). This is largely because lethal shock waves attenuate rapidly. Nonetheless, explosives are rarely used to sample fishes due to safety and public perception issues.

There currently is no set threshold for determining effects to fish from explosives other than mortality models. Fish that are located in the water column, in proximity to the source of detonation could be injured, killed, or disturbed by the impulsive sound and possibly temporarily leave the area. Continental Shelf Inc. (2004) presented a few generalities from studies conducted to determine effects associated with removal of offshore structures (e.g., oil rigs) in the Gulf of Mexico. Their findings revealed that at very close range, underwater explosions are lethal to most fish species regardless of size, shape, or internal anatomy. For most situations, cause of death in fishes has been massive organ and tissue damage and internal bleeding. At longer range, species with gas-filled swimbladders (e.g., snapper, cod, and striped bass) are more susceptible than those without swimbladders (e.g., flounders, eels). Studies also suggest that larger fishes are generally less susceptible to death or injury than small fishes. Moreover, elongated forms that are round in cross section are less at risk than deep-bodied forms; and orientation of fish relative to the shock wave may affect the extent of injury. Open water pelagic fish (e.g., mackerel) also seem to be less affected than reef fishes. The results of most studies are dependent upon specific biological, environmental, explosive, and data recording factors.

The huge variations in the fish population, including numbers, species, sizes, and orientation and range from the detonation point, make it very difficult to accurately predict mortalities at any specific site of detonation. Most fish species experience large number of natural mortalities especially during early life-stages, and therefore any small level of mortality caused by the AFAST activities involving the explosive source sonobuoy (AN/SSQ-110A) will most likely be insignificant to the population as a whole. *Therefore, there will be no significant impact to fish from the explosive source sonobuoy (AN/SSQ-110A) in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to fish from the explosive source sonobuoy (AN/SSQ-110A) in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.7.3 ESA-Listed Fish Species

The shortnose sturgeon, subadult and adult Gulf sturgeon, and the smalltooth sawfish are listed as endangered species. In addition, a critical habitat has been designated for the Gulf sturgeon. The shortnose sturgeon is a coastal/estuarine inhabitant and is not expected to be present within the Study Area. The Gulf sturgeon is not expected to be present in the Study Area since it is a coastal inhabitant and the AFAST Study Area is located outside the Gulf sturgeon's critical habitat. *In accordance with NEPA, there will be no significant impact to the endangered shortnose sturgeon, or subadult and adult Gulf sturgeon from AFAST activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.*

In accordance with the ESA, the Navy finds the AFAST activities will have no effect on the endangered shortnose sturgeon, or subadult and adult Gulf sturgeon. Gulf sturgeon critical habitat is largely restricted to estuarine and inshore areas (behind the barrier island system). One section of critical habitat, from approximately Pensacola to Cape San Blas, Florida, extends seaward of the barrier island system. However, this habitat is defined as only one nautical mile from shore. AFAST activities will not occur in these areas and are not expected to disturb bottom habitats or the water column. Gulf sturgeon critical habitat will not be destroyed or adversely modified.

The smalltooth sawfish is likely to be present within the Study Area near southwestern peninsular Florida. This portion of the Study Area would include activities involving the explosive source sonobuoy (AN/SSQ-110A). Recent surveys (1990 to 2002) have recorded over 533 sawfish sightings off southwest Florida (Charlotte Harbor to Cape Romano and Ten Thousand Islands), and 1,632 in Florida Bay and the Florida Keys. The Mote Marine Laboratory (MML) has established a Sawfish Encounter Database, which contained 593 verified encounters off Florida and adjacent waters as of April 2005 (Seitz and Poulakis, 2002; Poulakis and Seitz, 2004; Simpfendorfer and Wiley, 2005a). There is a positive correlation between the size, water depth, and distance from shore for this species. Smaller individuals typically utilize habitats close to shore (water less than 1m [3 ft] deep) in areas with inshore bars, mangroves, and seagrass beds possibly to avoid predation by sharks, while larger individuals inhabit deeper waters commonly greater than 70 m (230 ft) but as deep as 122 m (400 ft) (NMFS, 2003c; Poulakis and Seitz, 2004; Simpfendorfer, and Wiley 2005a; 2005b). However, recent tagging studies indicate that adults are only found in deeper waters occasionally and spend more time in shallow water than previously thought (Simpfendorfer and Wiley, 2005a). Therefore, since smaller individuals are found nearshore and larger individuals are only occasionally found in deeper water, it is unlikely that this species would be encountered during explosive source sonobuoy activities. In accordance with EO 12114, there will be no significant harm to smalltooth sawfish from AFAST activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST activities will have no effect on the smalltooth sawfish.

4.8 SEA BIRDS

4.8.1 Mid-Frequency and High-Frequency Active Sonar

It is expected the potential effects to seabirds from exposure to mid- and high-frequency active sonar during AFAST and RDT&E activities will be the same without regard to the respective OPAREA. Therefore, the sections have been combined and are only differentiated based on whether the animal is listed as a threatened or endangered species.

NMFS issued an Environmental Assessment in 2003 for the purpose of determining whether to issue a scientific research permit for "takes" by "level B harassment" in accordance with the Marine Mammal Protection Act of 1972 (MMPA). The proposed research activity consisted of exposing gray whales to low-powered, high-frequency active sonar while simultaneously recording their reaction to the sound (NMFS, 2003a). The operating frequency of the system proposed was greater than 20 kHz with a maximum source level at or less than 220 dB re 1μPa at 1 m in individual pulses less than one second for a duty cycle (time on over total time) of less than 10 percent (e.g., in an 8-hour day, maximum sonar use would be 48 minutes) (NMFS, 2003a). As part of the environmental documentation, seabirds were analyzed for potential effects associated with exposure to the active sonar. Little is known about the general hearing or underwater hearing capabilities of sea birds, but research suggests an in-air maximum auditory sensitivity between 1 and 5 kHz for most bird species (NMFS, 2003a). Although the potential hearing capability of seabirds was outside the proposed high-frequency of 20 kHz, it was concluded effects were unlikely even if some diving birds were able to hear the signal for the following reasons:

- There is no evidence seabirds use underwater sound.
- Seabirds spend a small fraction of time submerged.
- Seabirds could rapidly fly away from the area and disperse to other areas if disturbed.

Based on these conclusions, it is scientifically reasonable to extend these reasons to mid-frequency active sonar. While it is possible that seabirds are likely to hear some mid-frequency sounds in-air, there is no scientific evidence to suggest birds can hear these sounds underwater. In addition, little published literature exists on the effects of underwater sound to diving birds. A review of available articles indicates that the most extensive research has focused on pile-driving and seismic surveys. During these studies, airguns have not caused any harm and explosives have resulted in injury only when the seabirds occurred near the detonation (Turnpenny and Nedwell, 1994). In general, seabirds spend a short period of time underwater, and as stated in Section 3.10, seabirds rarely fully submerge themselves while feeding. If they do submerge themselves, they typically perform such activities for a short period of time. For example, the Northern gannet has the longest recorded dive depth and dive time of 15 m (49 ft) in 30 seconds (Mowbray, 2002). It is highly unlikely that a seabird would be exposed to active sonar while foraging due to the very short dive time. Thus, it is extremely unlikely that active sonar use would coincide with the dive of a seabird.

Therefore, there will be no significant impact to seabirds from active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to seabirds from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.8.2 Explosive Source Sonobuoy (AN/SSQ-110A)

As stated previously, seabirds spend a short period of time underwater and it is extremely unlikely that the detonation of the explosive source sonobuoy (AN/SSQ-110A) will coincide with the dive of a seabird. During studies conducted on pile-driving and seismic surveys, airguns were not found to have caused any harm. However, explosives have resulted in injury, but only when the seabirds occurred near the detonation (Turnpenny and Nedwell, 1994). *Therefore, there will be no significant impact to seabirds from the explosive source sonobuoy (AN/SSQ-110A) in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to seabirds from the explosive source sonobuoy (AN/SSQ-110A) in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.8.3 Threatened and Endangered Seabirds

As stated in Section 3.10.4, there are five threatened or endangered birds that may occur within the AFAST Study Area, which include the following:

- Bermuda petrel
- Brown pelican
- Least tern
- Roseate tern
- Piping plover

However, the Bermuda petrel will rarely occur along the East Coast, preferring to nest on islets off Bermuda. Moreover, the two terns and plover prefer beaches and sandbars, while the brown pelican prefers relatively undisturbed coastal islands. As such, no ESA-listed seabirds are anticipated to be near the AFAST Study Area.

Therefore, there will be no effect on threatened or endangered seabirds from active sonar under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.8.4 Entanglement

Similar to sea turtles, the potential exists for seabirds to become entangled in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Possible expended materials from AFAST and RDT&E activities are nylon parachutes of varying sizes. At water impact, the parachute assembly is expended and it sinks away from the exercise weapon or target. The parachute assembly will potentially be at the surface for a short time before sinking to the sea floor. Entanglement and the actual drowning of a seabird in a parachute assembly is unlikely, since the parachute would have to land directly on the animal, or a diving seabird would have to be diving exactly underneath the location of the sinking parachute. The potential for a seabird to encounter an expended parachute is extremely low, given the generally low probability of a seabird being in the immediate location of deployment. *Therefore, there will be no significant impact to seabirds from entanglement in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to seabirds from entanglement in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.9 MARINE INVERTEBRATES

This section discusses the potential effects of active sonar and the explosive source sonobuoy (AN/SSQ-110A) to marine invertebrates, including shell fish and corals.

4.9.1 Mid-Frequency and High-Frequency Active Sonar

According to the National Research Council of the National Academies (NRC, 2003), there is very little information available regarding the hearing capability of marine invertebrates. However, no effects to marine invertebrates are anticipated from active sonar since acoustic transmissions are brief in nature. *Therefore, there will be no significant impact to marine invertebrates as a result of active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine invertebrates from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.9.2 Explosive Source Sonobuoy (AN/SSQ-110A)

There is a huge variation in marine invertebrates, including numbers, species, sizes, and orientation and range from the detonation point, which makes it very difficult to accurately predict effects at any specific site of detonation.

Most invertebrates experience large number of natural mortalities especially since they are important foods for fish, reptiles, birds, and mammals. Any small level of mortality caused by the AFAST activities involving the explosive source sonobuoy (AN/SSQ-110A) will most likely not be significant to the population as a whole. In addition, the explosions associated with the explosive source sonobuoy (AN/SSQ-110A) will be occurring within the water column. Based on the small net explosive weight (NEW) of the explosive, it is not likely that the pressure wave associated with the detonation will reach the bottom, where the majority of invertebrates live. *Therefore, there will be no significant impact to marine invertebrates from the explosive source sonobuoy (AN/SSQ-110A) in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine invertebrates from the explosive source sonobuoy (AN/SSQ-110A) in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.10 MARINE PLANTS AND ALGAE

This section discusses the potential effects of active sonar and the explosive source sonobuoy (AN/SSQ-110A) to marine plants (seagrasses) and algae (*Sargassum*).

4.10.1 Mid-Frequency and High-Frequency Active Sonar

No effects to marine plants and algae are anticipated from active sonar because plants and algae are acoustically transparent. Moreover, ships and submarines will not be operating in the shallow waters where seagrass are present. In addition, *Sargassum* mats are easily identified and will be avoided wherever possible. *Therefore, there will be no significant impact to marine plants and algae as a result of active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine plants and algae from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.10.2 Explosive Source Sonobuoy (AN/SSQ-110A)

Explosive source sonobuoy (AN/SSQ-110A) detonations will occur within the water column. Moreover, *Sargassum* mats are easily identified and will be avoided wherever possible. *Therefore, there will be no significant impact to marine plants and algae as a result of explosive source sonobuoy (AN/SSQ-110A)activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine plants and algae from explosive source sonobuoy (AN/SSQ-110A) activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.11 NATIONAL MARINE SANCTUARIES

Under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3, the U.S. Navy will not conduct active sonar activities in the Stellwagen Bank, USS Monitor, Gray's Reef, Flower Garden, and Florida Keys National Marine Sanctuaries. Therefore, there would be no effect to the Stellwagen Bank, USS Monitor, Gray's Reef, Flower Garden, and Florida Keys National Marine Sanctuaries under Alternative 1, Alternative 2, or Alternative 3.

Under the No Action Alternative, the Navy could conduct active sonar activities; however, at the present time, the Navy does not conduct active sonar activities in the Stellwagen Bank, USS Monitor, Gray's Reef, Flower Garden, and Florida Keys National Marine Sanctuaries. If it is determined that an active sonar activity may occur in the Gray's Reef, Flower Garden, or Florida Keys National Marine Sanctuaries, naval activities will be carried out in a manner that avoids to the maximum extent practicable any adverse impacts on sanctuary resources and qualities. If necessary, the Navy would consult with the Director, Office of Ocean and Coastal Resource Management in accordance with 15 CFR 922. In addition, Stellwagen Bank and USS Monitor National Marine Sanctuary regulations specifically preclude the Navy from conducting operations in this area without first entering consultation. If it is determined that an active sonar activity or vessel transit may occur in the Stellwagen Bank or USS Monitor National Marine Sanctuaries the Navy would consult with the Director, Office of Ocean and Coastal Resource Management in accordance with 15 CFR 922. Therefore, there would be no effect to the Stellwagen Bank, USS Monitor, Gray's Reef, Flower Garden, and Florida Keys National Marine Sanctuaries under the No Action Alternative.

4.12 AIRSPACE MANAGEMENT

Changes to airspace can include the introduction of new or modification of existing activities occurring within an airspace area, change in aircraft density, or change in aircraft movements within an airspace area.

There will be no change to existing airspace configuration and scheduling of airspace and Notices to Airmen (NOTAMs) will be completed prior to the activity to ensure aircraft and pilot safety. *Thus, the Navy has determined there will be no effect to airspace management within the territorial portion of the AFAST Study Area from implementing the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no effect to airspace management within the non-territorial portion of the AFAST Study Area from implementing the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.13 ENERGY (WATER, WIND, OIL, AND GAS)

This section provides analysis for the potential of AFAST activities to affect water energy development, wind farms, as well as oil and gas exploration.

4.13.1 Atlantic Ocean, Offshore of the Southeastern United States

Currently, there is a development and improvement project for the infrastructure located offshore of Dania Beach, Florida, near Fort Lauderdale by Ocean Renewable Power Company (ORPC). Additional sites have been identified in Miami, Florida and West Palm Beach, Florida. However, all locations are located outside the AFAST Study Area.

The majority of the environmental effects associated with wave and tidal energy generation is unknown given its fairly recent advancement. The industry has identified some potential effects in environmental documentation and has conducted studies, for instance on fish (Davidson, 2007). The potential exists for turbine-generated energy to affect water currents, silt flows, and habitats, particularly along the shore. The projects initiated throughout the world recently have concluded that turbines turn slowly such that they do not change water flow and therefore, in turn do not affect water quality (Freeman, 2007). Furthermore, marine mammals and fish could avoid the blades given their slow movement. Additionally, some operations in other countries have installed rounded blades on their turbines to minimize injury to protected marine species (Freeman, 2007). The other identified potential adverse consequences include migratory fish effects and habitat impacts to fish and birds from the inability for tidal flushing to occur in coastal habitats (Andrews and Jelley, 2007). Scientists have identified economic factors in consideration of the development, which include survivability in violent storms, vulnerability of equipment, and the costs associated with construction, maintenance, and repair (Andrews and Jelley, 2007).

Along with the negative consequences, scientists have identified a number of benefits in the development of these types of alternative energy production in the ocean. These advantages include the movement to carbon-free energy and the development of additional flood protection in coastal areas (Andrews and Jelley, 2007).

There are currently no wind farms located along the southeast coast of the United States, nor are any proposed for future development. Moreover, no active gas or oil exploration leases exist in the Atlantic. Therefore, there will be no effect to water energy development, wind farms, or gas and oil exploration from AFAST activities off the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.13.2 Atlantic Ocean, Offshore of the Northeastern United States

Currently, Verdant Power operates the Roosevelt Island Tidal Energy Project in the East River near New York City. In addition, there is a proposed project off the coast of Eastport, Maine, as well as sites proposed for Piscataqua River (between Maine and New Hampshire); Merrimack River, Massachusetts; Amesbury, Massachusetts; and Indian River Inlet, Delaware. However, all of these locations are located outside the AFAST Study Area.

There are no existing wind farms, or gas or oil leases along the northeast coast of the United States. Therefore, there will be no effect to water energy development, wind farms, or gas and oil exploration from AFAST and RDT&E activities off the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.13.3 Eastern Gulf of Mexico

Currently, there are no existing or proposed water energy developments or wind farms in the eastern Gulf of Mexico. However, oil and gas drilling is occurring in non-territorial portions of the eastern Gulf of Mexico. The proposed AFAST activities do not include any increases in tempo over past activities or any changes in locations. The U.S. Navy has held exercises in the Gulf of Mexico previously and no significant effects to oil and gas drilling platforms have been documented. Therefore, there will be no effect to water energy development or wind farms from AFAST and RDT&E activities in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant effect to oil and gas drilling from AFAST and RDT&E activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.13.4 Western Gulf of Mexico

Currently, there are no existing water energy developments or wind farms in the western Gulf of Mexico. However, oil drilling is occurring in territorial and non-territorial portions of the western Gulf of Mexico. The proposed AFAST activities do not include any increases in tempo over past activities or any changes in locations. The U.S. Navy has held exercises in the Gulf of Mexico previously and no significant effects to oil and gas drilling platforms have been documented. Therefore, there will be no effect to water energy developments wind farms from AFAST and RDT&E activities in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. *There will be no significant impact to oil and gas drilling from AFAST and RDT&E activities in territorial waters off the eastern coast of Texas under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to oil and gas drilling from AFAST and RDT&E activities in non-territorial waters off the eastern coast of Texas under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.14 RECREATIONAL BOATING

This analysis examines the potential effect active sonar activities may have to recreational boating. Typical considerations include potential area closures to operators of personal watercraft. Specifically, a significant effect would occur if boaters were unable to take part in recreational activities due to public closures.

Under all three alternatives, various active sonar activities will occur within, adjacent, or seaward of existing OPAREAs. Since it is expected that potential conflicts with recreational boaters could occur under all three alternatives, the analysis was performed without regard to specific OPAREAs.

The Navy does not routinely close areas for active sonar activities. *Therefore, there will be no significant impacts to recreational boating from active sonar activities conducted in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to recreational boating from active sonar activities conducted in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.15 COMMERCIAL AND RECREATIONAL FISHING

This analysis examines the potential effect that active sonar activities may have to commercial and recreational fishing. Typical considerations include potential area closures to fishermen. Specifically, a significant effect would occur if boaters were unable to take part in recreational activities due to public closures.

Under all three alternatives, various active sonar activities will occur within, adjacent, or seaward of existing OPAREAs. Since commercial and recreational fishing provide a large economic output for certain states, including Florida, Texas, and North Carolina, the analysis was performed with regard to specific OPAREAs.

4.15.1 Atlantic Ocean, Offshore of the Southeastern United States

Recreational fishing primarily occurs along the coasts of the southern states ranging from Florida to Virginia. Catches and participation are generally increasing or stable in these regions for coastal and territorial waters while the quantity of fish caught, the amount of trips taken, and the number anglers participating are decreasing for federal waters.

Various organizations host recreational fishing tournaments during the year along the southeastern Atlantic coast from central Florida to Maryland. However, the majority of tournaments take place during the weekends followed by activities extending from the middle of the week to weekends and from Friday through Sunday. The majority of fishing takes place in areas near canyons and humps, including such places as Edisto Banks (Georgia to North Carolina), Washington Canyon (Virginia and Maryland), Poorman's Canyon (Virginia and Maryland), and Norfolk Canyon (Virginia). The U.S. Navy would avoid these areas under Alternative 1 and 2, and no effects to or changes related to tournament action have been documented for previous naval exercises (No Action Alternative).

The majority of commercial fish landings by weight and by value in the southeastern Atlantic coast, like recreational fishing activities there, occur in state waters. The only exception is for the value of fisheries in the Virginia area where 61 percent of the finances of commercial fishing come from federal waters. Otherwise, as much as 92 percent of the weight and 63 percent of the value of commercial fisheries arise from state waters in Virginia and North Carolina, respectively. In Florida, the percentage is 55 percent by weight and 60 percent by value. Thus, commercial fishing is more heavily tied to coastal areas where the U.S. Navy will not be training. Navy active sonar activities in state waters include sonar maintenance, navigational use, and other routine activities that the U.S. Navy will carry out going into and out of port or at the pier.

Furthermore, there are no significant effects to fish from the associated analysis presented in Section 4.7, Marine Fish.

Since there are no increases in tempo or intensity over past exercises and the majority of commercial and recreational fishing is connected with coastal areas, there will be no significant effect on this resource. *Therefore, there will be no significant impact to recreational or commercial fishing from active sonar activities conducted in territorial waters in the western Atlantic Ocean offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to recreational and commercial fishing from active sonar activities conducted in non-territorial waters in the western Atlantic Ocean offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.15.2 Atlantic Ocean, Offshore of the Northeastern United States

Commercial and recreational fishing occur within the various OPAREAs of the northeastern Atlantic coast. The potential exists for temporary disruptions to occur to recreational and commercial fishing within waters of the northeastern Atlantic coast. The majority of recreational fishing off of the northeastern Atlantic coast, including Maine, Massachusetts, and Rhode Island, takes place in state and territorial waters, where catch numbers and participation has increased. Activities have generally decreased in federal waters. For example, in Maine and in the Atlantic City OPAREA, catch has gone down in federal waters by 83 percent and 44 percent, respectively.

Sportfishing tournaments occur throughout the year from New Jersey to Maine. A large proportion of the activities take place during the weekend beginning on Friday and ending Saturday or Sunday; however, longer tournaments, which make up the majority of the activities along the northeastern Atlantic coast, begin either Wednesday or Thursday and/or extend through the following Monday or Tuesday. The majority of fishing takes place at hotspots like canyons and humps. The U.S. Navy would avoid these areas under Alternatives 1 and 2, and no effects to or changes related to tournament action have been documented for previous naval exercises (No Action Alternative).

The majority of commercial fish landings by value along the northeastern Atlantic coast are nearly equal for federal and state waters at 51 percent and 49 percent, respectively. However, up to 67 percent of the commercial landings by weight are caught in federal waters. Thus, the potential exists for conflicts to arise between commercial fisheries and active sonar activities because of the locations for active sonar training.

Furthermore, there are no significant effects to fish from the associated analysis presented in Section 4.7, Marine Fish.

Therefore, there will be no significant impact to recreational or commercial fishing from active sonar activities conducted in territorial waters in the western Atlantic Ocean offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to recreational and commercial fishing from active sonar activities conducted in non-territorial waters in the western Atlantic Ocean offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.15.3 Eastern Gulf of Mexico

In this area of the Gulf of Mexico, the number of participants in recreational fishing is increasing. Although catch is generally increasing throughout the region, the amount of landings is declining along the west coast of Florida. Sportfishermen take in the majority of landings from state waters.

Two large fishing tournaments are held each year in the eastern Gulf of Mexico. The Mobile Big Game Fishing Club Memorial Day Tournament is held in Orange Beach, Alabama, and the Bay Point Billfish Invitational Tournament in Panama City, Florida. These activities occur from Friday to Monday and from Friday to Sunday, respectively. The majority of fishing takes place on artificial reefs and hotspots such as like canyons and humps. The U.S. Navy would avoid these areas under Alternatives 1 and 2, and no effects to or changes related to tournament action have been documented for previous naval exercises (No Action Alternative).

Unlike the other regions discussed previously, commercial landings occur in offshore, federal waters. The commercial fishing industry lands nearly 59 percent and 70 percent of landings by weight and by value, respectively, in these waters. Furthermore, there are no significant effects to fish from the associated analysis presented in Section 4.7, Marine Fish.

Therefore, there will be no significant impact to recreational or commercial fishing from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there would be no significant harm to recreational and commercial fishing from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.15.4 Western Gulf of Mexico

Recreational fishing has decreased in Texas on investigation of the number of anglers participating in the sport. Like most other regions, the majority of recreational fishing takes place only a few miles from the coast.

Major fishing tournaments in the western Gulf of Mexico occur from Venice, Louisiana, to South Padre Island, Texas. The majority of the activities in the region generally run from the middle of the week through the weekend and the largest prizes encompass various billfishes. The majority of fishing takes place on artificial reefs and at hotspots like canyons and humps. The U.S. Navy would avoid these areas under Alternatives 1 and 2, and no effects to or changes related to tournament action have been documented for previous naval exercises (No Action Alternative).

The majority of commercial fishing activities in the western Gulf of Mexico encompass nearshore trawling for shrimp. Additional significant fishery operations target finfish and shellfish. Of the four largest ports in Texas, two are situated in east Texas, one is located in central Texas, and one exists in west Texas. The major fishery, shrimping, occurs in coastal, nearshore waters. Commercial landings occur in offshore, federal waters. Specifically, the commercial fishing industry lands nearly 59 percent and 70 percent of landings by weight and by value, respectively, in these waters. Furthermore, there are no significant effects to fish from the associated analysis presented in Section 4.7, Marine Fish.

Therefore, there will be no significant impact to recreational or commercial fishing from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to recreational and commercial fishing from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.16 COMMERCIAL SHIPPING

This section addresses potential effects to commercial shipping associated with the proposed active sonar training along the east coast and in the Gulf of Mexico. Typical considerations include location of shipping lanes in relation to Navy training, the amount of shipping activities, and the potential for disruption to the industry. Since commercial shipping is such an important industry, the analysis was performed with regard to specific OPAREAs.

4.16.1 Atlantic Ocean, Offshore of the Southeastern United States

Shipping routes exist throughout the nearshore and offshore waters of the southeastern United States The Virginia Capes (VACAPES) OPAREA encompasses seven major shipping lanes while only three lanes occur within the CHPT OPAREA. The Jacksonville/Charleston (JAX/CHASN) complex contains the highest amount of shipping channels with over 20 present there. Representative routes include the Atlantic-Puerto Rico Access and the Atlantic-Panama Access. The total area of shipping lanes within the southeastern United States is small compared with the amount of water available for training in this portion of Atlantic Ocean.

Past records of U.S. Navy training indicate no significant effects to commercial shipping have occurred. Furthermore, the Navy will avoid shipping vessels that transit through the Study Area. *Therefore, there will be no significant impact to commercial shipping from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to commercial shipping from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the southeastern United States with the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.16.2 Atlantic Ocean, Offshore of the Northeastern United States

Shipping lanes exist throughout the nearshore and offshore waters of the northeastern United States, although less concentrated as compared with the southeastern United States. About 15 shipping lanes exist in this region with the same representative routes as the northeastern United States, including the Atlantic-Puerto Rico Access and the Atlantic-Panama Access.

The ocean area for training by the U.S. Navy will be significantly more than the area encompassed by shipping routes. Additionally, no significant effects to commercial shipping have been documented from previous active sonar training. Furthermore, the Navy will avoid shipping vessels that transit through the Study Area. *Therefore, there will be no significant impact to commercial shipping from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to commercial shipping from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.16.3 Eastern Gulf of Mexico

Shipping lanes overlap with some portions of the active sonar areas in the eastern Gulf of Mexico. At least 20 major channels exist in this region. Representative shipping routes include the Gulf Deepwater Spine. The area of water available for active sonar training will encompass significantly more area than that of the shipping lanes in the eastern Gulf of Mexico. No significant effects have been documented on commercial shipping by the Navy exercises.

Furthermore, the Navy will avoid shipping vessels that transit through the active sonar areas. *Therefore, there will be no significant impact to commercial shipping from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to commercial shipping from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.16.4 Western Gulf of Mexico

MIW training will occur in areas where shipping lanes are present in the western Gulf of Mexico. Fifteen major channels exist off of the state of Texas. These lanes represent the Gulf-Panama Access and the Gulf-Deepwater Access; many of the channels include service routes for the energy exploration and offshore drilling industry. No significant effects to commercial shipping have been documented from previous Navy exercises, and the Proposed Action represents no increase in activity or change in locations.

Furthermore, the Navy will avoid shipping vessels that transit through the active sonar areas. *Therefore, there will be no significant impact to commercial shipping from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to commercial shipping from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.17 SCUBA DIVING

This section analyzes the potential effects (either adverse or beneficial) to scuba diving activities. Typical considerations include potential effects related to dive trips and to the safety of recreational divers. Since scuba diving is a popular recreational activity in coastal states, the analysis was performed with regard to specific geographic regions. The Professional Association of Diving Instructors (PADI) suggests that certified openwater divers limit their dives to 18 m (60 ft). More experienced divers are generally limited to 30 m (100 ft); in general, no recreational diver should exceed 40 m (130 ft) (PADI, 2006).

4.17.1 Atlantic Ocean, Offshore of the Southeastern United States

There are relatively few natural reefs in waters off the eastern United States and none north of Georgia's east coast, because corals require warm, tropic temperatures to thrive. Most coral reefs occur in shallow nearshore waters where the water remains relatively warm year-round. These reefs are popular destinations for recreational divers. The Navy will operate in accordance with EO 13089 to ensure avoidance of all identified coral reefs, which will result in no significant effects to divers on coral reefs. In addition, many popular dive sites are considered cultural resources (historic shipwrecks) will already be included in areas to avoid due to their status as a reef or cultural resource.

Since the locations of the popular diving spots are well documented and dive boats (typically well marked) and diver-down flags will be visible from the ships conducting the routine training, no interactions between recreational divers and Navy operations are likely to occur. In addition, The Naval Sea Systems Command Instruction (NAVSEAINST) 3150.2, "Safe Diving Distances from Transmitting Sonar," is the Navy's governing document for human divers in relation to mid-frequency active sonar systems. That instruction provides procedures for calculating safe distances from active sonars. Such procedures are derived from experimental and theoretical research conducted at the Naval Submarine Medical Research Laboratory and the Naval Experimental Diving Unit. Inputs to those procedures include diver dress, type of sonar, and distance from the sonar. The output is represented as a permissible exposure limits (i.e., how long the diver can safely stay at that exposure level). For example, a diver wearing a wetsuit without a hood has a permissible exposure limit of 71 minutes at a distance of 914 m (3,000 ft) from the AN/SQS-53 sonar. That same instruction advises that if the type of sonar is unknown, divers should start 914 m (3,000 ft) from the source and move closer (as needed) to the limits of diver comfort. If an interaction did occur, it is unlikely the active sonar activity would not be conducted close enough to a diver to trigger the permissible exposure limit.

Therefore, there will be no significant impact to scuba diving from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to scuba diving from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.17.2 Atlantic Ocean, Offshore of the Northeastern United States

Recreational diving activities within the western north Atlantic take place primarily at known diving sites. Unlike the southeastern United States where coral reefs exist from Georgia southward, the Northeast OPAREAs comprise mainly man-made artificial reefs and shipwrecks. As described in Section 3.19, known diving sites exist throughout each of the OPAREAs.

Federal (National Register of Historic Places) and state agencies (State Historic Preservation Officers) consider many of the identified shipwrecks as cultural resources. These shipwrecks will be avoided for their protection, thereby eliminating potential effects to divers on protected sites.

Possible interactions between U.S. Navy operations within the offshore areas and recreational scuba divers will be minimized because the locations of the popular diving spots are well documented and because dive boats (typically well marked) and diver-down flags will be visible from the ships conducting the routine training. Furthermore, most training activities will take place offshore at depths of 30.5 m (100 ft) or more; thus, it is highly unlikely that any interactions between recreational divers and training exercises will occur given that they will not be in close enough proximity to one another. If an interaction did occur, it is unlikely the active sonar activity would not be conducted close enough to a diver to trigger the permissible exposure limit.

No significant effects will occur to scuba diving because the U.S. Navy will avoid shipwrecks and depths of recreational divers are limited. *Therefore, there will be no significant impact to scuba diving from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to scuba diving from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.17.3 Eastern Gulf of Mexico

Recreational diving is a popular sport in the eastern Gulf of Mexico, where attractions include a number of artificial reefs and shipwrecks. Only small patches of coral exist in the eastern Gulf of Mexico with greater concentrations occurring in such areas as the Flower Garden Banks. These reefs are popular destinations for recreational divers. As previously mentioned, the Navy will operate in accordance with EO 13089 to ensure avoidance of all identified coral reefs, which will result in no significant effects to divers on coral reefs.

Additionally, some shipwrecks exist there, and certain state and federal agencies have deemed them cultural resources. Thus, many popular dive sites will be avoided by the Navy as they are either coral reefs or cultural resources. Furthermore, the locations of the popular diving spots have been well documented and dive boats (typically well marked) and diver-down flags will be visible from the ships conducting the routine training; thus, no adverse effects are anticipated to recreational divers. If an interaction did occur, it is unlikely the active sonar activity would not be conducted close enough to a diver to trigger the permissible exposure limit. Furthermore, the *Therefore, there will be no significant impact to scuba diving from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to scuba diving from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.17.4 Western Gulf of Mexico

Like the eastern Gulf of Mexico, the western portion also provides opportunities for recreational diving. As with the previous sections, coral reefs and shipwrecks will be avoided and dive boats and diver-down flags will be visible from ships conducting training. If an interaction did occur, it is unlikely the active sonar activity would not be conducted close enough to a diver to trigger the permissible exposure limit.

Therefore, there will be no significant impact to scuba diving from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to scuba diving from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.18 MARINE MAMMAL WATCHING

Marine mammal watching (whale watching), as defined in Section 3.20, includes the conduct of tours by boat, aircraft, or from land to view cetaceans. Whale watching is also considered a category of marine tourism that can include activities, formal or informal, where people view, swim with, or listen to any cetacean species. The cetacean species targeted during tours includes dolphins, whales, and porpoises. In the northeast, the industry focuses on the various whales summering in waters off of New England and include sightings of harbor porpoises while in the southeast and Gulf of Mexico, operators often target the Atlantic bottlenose dolphin. The following subsections look at whale watching in relation to the respective active sonar areas.

4.18.1 Atlantic Ocean, Offshore of the Southeastern United States

Whale watching in this region occurs within a few miles of shore and rarely in federal waters. Based on the distribution and abundance of the various marine mammal species and the location of these popular ports for whale watching, the most commonly viewed cetaceans in the southeastern Atlantic coast portion of the AFAST Study Area include coastal and nearshore populations of Atlantic bottlenose dolphins and for humpback whales (Hoyt, 2001).

Whale watching targets primarily bottlenose dolphins along the southeastern Atlantic coast and generally extends from April through November. Operations occur in areas where concentrations of coastal and nearshore populations of dolphins are abundant. Tours typically last from one to two hours in such hotspots for dolphin watching as the Virginia Beach, Virginia; Nags Head, North Carolina; and Hilton Head Island, South Carolina. Thus, the potential for interactions between the U.S. Navy and dolphin-watch activities to occur will exist primarily during one-half of each year and will take place on a short duration given the time-limited characteristics of typical dolphin cruises. Furthermore, dolphin-watch activities will generally occur in coastal waters, where only a few AFAST activities will occur.

Therefore, there will be no significant impact to whale watching from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to whale watching from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.18.2 Atlantic Ocean, Offshore of the Northeastern United States

Whale watching occurs within a few miles of shore and rarely in federal waters. The most commonly viewed cetaceans in the northeastern Atlantic coast include humpback whales, fin whales, right whales, minke whales, sei whales, Atlantic white-sided dolphins, and harbor porpoises (Hoyt, 2007).

The height of whale watching in New England generally occurs from April through October. Thus, the potential for effects to the industry will exist primarily during late spring through early fall. Tours range typically from three to six hours in length, with an average duration of three and one-half to four hours (Whale and Dolphin Conservation Society [WDCS], 2007).

Therefore, there will be no significant impact to whale watching from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to whale watching from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.18.3 Eastern Gulf of Mexico

Naval activities in the eastern Gulf of Mexico will occur seaward of the shelf break in federal waters. Whale watching occurs within a few miles of shore and rarely in federal waters. The most commonly viewed cetaceans in this portion of the Gulf of Mexico include Atlantic bottlenose dolphins, Atlantic spotted dolphins, and sperm whales (Hoyt, 2001).

Within the eastern Gulf of Mexico, tours generally last from one and a quarter to three and one-half hours, with average trip durations of two hours. Thus, the potential for effects to the industry will be low given that trips generally occur close to shore and their duration is generally limited to less than four hours.

Therefore, there will be no significant impact to whale watching from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to whale watching from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.18.4 Western Gulf of Mexico

Whale watching occurs within a few miles of shore and rarely in federal waters. Similar to the eastern/central Gulf of Mexico, the most commonly viewed cetaceans in the western Gulf of Mexico includes Atlantic bottlenose dolphins, Atlantic spotted dolphins, and sperm whales (Hoyt, 2001).

Similar to whale watching along the southeastern Atlantic coast and in the eastern/central Gulf of Mexico, tours generally target coastal and nearshore populations of dolphins. These trips generally last between one and two hours. Thus, potential effects from active sonar activities on the dolphin-watch industry in the western Gulf of Mexico will be minimal since wildlife trips generally occur close to shore, unlike training exercises, and their duration is generally limited to less than two hours.

Therefore, there will be no significant impact to whale watching from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to whale watching from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.19 CULTURAL RESOURCES AT SEA

Potential cultural resources within the AFAST Study Area include prehistoric and historic resources (predominately shipwrecks) as well as man-made obstructions. Prehistoric resources, in depths of less than approximately 100 m (328 ft) may be cultural resources (or archaeological sites) that remain from Pre-Paleo or Paleoindian habitations prior to the last ice age, when sea levels were much lower (Pleistocene Era which occurred prior to 10,000 before present [B.P.]. However, these sites will be buried under deep layers of sediments that have accumulated over the centuries; thus, they will not be affected by AFAST or RDT&E activities.

In addition, sonar is not expected to affect cultural resources, especially since the explosions associated with the explosive source sonobuoy (AN/SSQ-110A) will occur within the water column and will not reach the ocean floor. Therefore, this section will focus on the potential effects that expended materials associated with the sonobuoys and torpedoes will have on cultural resources (shipwrecks). Since cultural resources are unique to specific geographic regions, the analysis was conducted with regard to each OPAREA. Potential effects are expected to be the same under the No Action Alternative, Alternative 1, and Alternative 2; thus, alternatives are combined for discussion purposes.

4.19.1 Atlantic Ocean, Offshore of the Southeastern United States

Known shipwrecks are located within and adjacent to the VACAPES, CHPT, and JAX/CHASN OPAREAs. Many details, including latitudes and longitudes, of submerged wrecks and obstruction in coastal waters of the United States are cataloged in the Automated Wreck and Obstruction Information System (AWOIS). As discussed in Section 4.3, the small size and low density of expended materials will not cause effects to the sediment stability on the ocean bottom. In addition, the Navy will avoid all known cultural resources; however, if effects to cultural resources are anticipated, consultation with the applicable agencies, including the State Historic Preservation Officer (SHPO) will be initiated as required by law. *Therefore, there will be no significant impact to cultural resources from active sonar activities conducted in territorial waters in the western north Atlantic, offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to cultural resources from active sonar activities conducted in non-territorial waters in the western north Atlantic, offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.19.2 Atlantic Ocean, Offshore of the Northeastern United States

No known cultural resources lie within the northeastern OPAREAs. *Therefore there will be no impact to cultural resources from active sonar activities conducted in territorial waters in the western north Atlantic, offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to cultural resources from active sonar activities conducted in non-territorial waters in the western north Atlantic, offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.19.3 Eastern Gulf of Mexico

Known shipwrecks are located in the eastern Gulf of Mexico. Many details, including latitudes and longitudes, of submerged wrecks and obstruction in coastal waters of the United States are cataloged in the AWOIS. As discussed in Section 4.3, the small size and low density of expended materials will not cause effects to the sediment stability on the ocean bottom. In addition, the Navy will avoid all known cultural resources; however, if effects to cultural resources are anticipated, consultation with the applicable agencies, including the SHPO will be initiated as required by law. *Therefore, there will be no significant impact to cultural resources from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to cultural resources from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.19.4 Western Gulf of Mexico

Many known shipwrecks lie offshore of the Texas coast, particularly along Padre Island, Matagorda Bay, and Corpus Christi Bay. Many details, including latitudes and longitudes, of submerged wrecks and obstruction in coastal waters of the United States are cataloged in the AWOIS. As discussed in Section 4.3, the small size and low density of expended materials will not cause effects to the sediment stability on the ocean bottom. In addition, the Navy will avoid all known cultural resources; however, if effects to cultural resources are anticipated, consultation with the applicable agencies, including the SHPO will be initiated as required by law. *Therefore, there will be no significant impact to cultural resources from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to cultural resources from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.20 COASTAL ZONE CONSISTENCY DETERMINATION

The Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. § 1451 "*et seq*".) was enacted to protect coastal resources from growing demands associated with commercial, residential, recreational and industrial uses. The CZMA allows coastal states to develop a Coastal Zone Management Plan (CZMP) whereby they designate permissible land and water use within the state's coastal zone. States then have the opportunity to review and comment on federal agency activities that could affect the state's coastal zone or its resources.

Federal agency activities potentially affecting a state's coastal zone must be consistent, to the maximum extent practicable, with the enforceable policies of the state's coastal management program. Enforceable policies of a state's coastal management plan generally consist of existing state statutes and codes that have been combined to comprise the CZMP. Typically, a state's CZMP will focus on the protection of physical, biological, and socioeconomic resources.

Review of federal agency activities is conducted through the submittal of either a Consistency Determination or a Negative Determination. A federal agency shall submit a Consistency Determination when it determines that its activity may have either a direct or an indirect effect on a state's coastal zone or resources. In accordance with 15 CFR § 930.39, the consistency determination shall include a brief statement indicating whether the proposed activity will be undertaken in a manner consistent to the maximum extent practicable with the enforceable policies of the management program and should be based upon an evaluation of the relevant enforceable policies of the management program.

Pursuant to 15 CFR § 930.41, the state has 60 days from the receipt of the Consistency Determination in which to concur with or object to the Consistency Determination, or to request an extension under 15 CFR § 930.41(b). Federal agencies shall approve one request for an extension period of 15 days or less.

A federal agency may submit a Negative Determination to a coastal state when the federal agency has determined that its activities would not have an effect on the state's coastal zone or its resources or when conducting the same or similar activities for which Consistency Determinations have been prepared in the past. Pursuant to 15 CFR § 930.35 the state has 60 days to review a federal agency's Negative Determination. States are not required to concur with a Negative Determination, and if the federal agency has not received a response from the state by the 60^{th} day of submittal, it may proceed with its action. However, within the 60-day review period, a state agency may request, and the federal agency shall approve, one request for an extension period of 15 days or less.

In accordance with the CZMA, the U.S. Navy has reviewed the enforceable policies of each state's CZMP located within the study area. Based on the limitations discussed in Section 2.6, the enforceable policies of each state's CZMP, and pursuant to 15 CFR § 930.39, the U.S. Navy has prepared Consistency Determinations for the states of Connecticut, Florida, Georgia, Texas, and Virginia. Appendix F contains the U.S. Navy's Consistency Determinations associated with the Proposed Action. Additionally, the U.S. Navy will prepare Negative Determinations pursuant to 15 CFR § 930.35 for the states of Alabama, Delaware, Louisiana, Maine, Maryland, Massachusetts, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, and South Carolina.

4.21 ENVIRONMENTAL JUSTICE AND RISKS TO CHILDREN

The Council on Environmental Quality's (CEQ's) Environmental Justice Guidance under NEPA (1997) identifies factors that are to be considered to the extent practicable when determining whether environmental effects to minority populations and low-income populations are disproportionately high and adverse. These factors include whether there is or will be an effect on the natural or physical environment that significantly (as delineated in NEPA) and adversely affect a minority population, low-income population, or Indian tribe. The "significance" language is specific to NEPA and not part of the Executive orders. Such effects may include ecological, cultural, human health, economic, or social effects when those effects are interrelated to effects to the natural or physical environment. Other factors to be considered if significant and adverse effects are projected include: (1) whether they will appreciably exceed those same effects to the general population or other appropriate comparison group, and (2) whether these populations have been affected by cumulative or multiple exposures from environmental hazards.

The methods to conduct the effects analysis for environmental justice included a review of conclusions for resources discussed in this chapter. If significant effects were identified or if the identified effects considered were disproportionately high and adverse for the purposes of the environmental justice analysis (i.e., effects that exceeded an accepted threshold or standard and will potentially affect the public), an evaluation would have been conducted to determine if further analysis was needed to determine if effects could disproportionately fall on minority populations or low-income populations. No significant impacts to geology, water quality, marine habitat, airspace management, cultural resources, and socioeconomics within territorial or non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, the active sonar activities that are described in this EIS/OEIS are not new and do not involve significant changes in systems, tempo, or intensity from past events. *Therefore, implementation of the proposed action would not pose disproportionate high or adverse effects to minority or low-income populations, or environmental health and safety risks to children.*

4.22 UNAVOIDABLE ADVERSE IMPACTS

There would be no adverse effects as a result of implementation of the Proposed Action within territorial waters. Potential effects would be limited to exposure of marine mammals (endangered and threatened, and non-endangered and threatened) to underwater sound associated with active sonar and the explosive source sonobuoy (AN/SSQ-110A). In addition, endangered sea turtles and the endangered smalltooth sawfish may be exposed to underwater sound from the explosive source sonobuoy (AN/SSQ-110A). The Navy is consulting with NMFS in accordance with the MMPA and Section 7 of the ESA.

4.23 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND THE ENHANCEMENT OF LONG-TERM PRODUCTIVITY

There would be no effects that would adversely affect the long-term productivity of implementing the Proposed Action within the territorial waters. There would be some short-term effects to the environment; however, they would be brief and localized

4.24 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Implementation of the Proposed Action would irretrievably commit the use of nonrenewable resources such as fuel, materials, and human labor. Destruction of submerged cultural or historical resources would also be considered an irretrievable commitment because these resources are irreplaceable. However, the Navy avoids these areas, which makes the potential interaction with cultural or historical resources very unlikely.

The Proposed Action would inevitably require the use of some nonrenewable resources. However, the action is not expected to result in the destruction or degradation of environmental resources to the point that their use is appreciably limited presently or in the future. The Navy, through operational constraints and mitigation measures, would minimize the irreversible and irretrievable commitment of resources present within the operating area.

5. MITIGATION MEASURES

Effective training dictates that ship, submarine, and aircraft participants utilize their sensors to their optimum capabilities as required by mission. The Department of the Navy (DON) recognizes that such use has the potential to cause behavioral disruption of some marine mammal species in the vicinity of training, as discussed in Chapter 4. This chapter presents the Navy's mitigation measures that would be implemented as part of the proposed action to protect marine mammals and federally listed species during active sonar training activities (Section 5.1), use of explosive source sonobuoys (AN/SSQ-110A) (Section 5.2), and associated with vessel transit and right whales (Section 5.3). It should be noted that several of these mitigation measures align with mitigation measures for unit-level training that the Navy has had in place since 2004. In addition, the Navy coordinated with the National Marine Fisheries Service (NMFS) to further develop measures for protection of marine mammals during the period of the National Defense Exemption. Those mitigations for mid-frequency active sonar are detailed below. This chapter also presents a discussion of other measures that have been considered and rejected because they either: (1) are not feasible, (2) present a safety concern, (3) provide no known or ambiguous protective benefit; or (4) impact the effectiveness of the required military readiness activity.

In order to make the findings necessary to issue the Marine Mammal Protection Act (MMPA) authorization, it may be necessary for NMFS to require additional mitigation or monitoring measures beyond those addressed in this Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). These could include measures considered, but eliminated, in this Draft EIS/OEIS, or measures yet to be developed. In addition to commenting on this Draft EIS/OEIS, the public will have an opportunity to provide information to NMFS through the MMPA process, both during the comment period following NMFS' Notice of Receipt of the application for a Letter of Authorization (LOA), and during the comment period following NMFS' publication of the proposed rule. NMFS may propose additional mitigation or monitoring measures in the proposed rule. Any measures not considered in the Draft EIS/OEIS, but required through the MMPA process, would require evaluation in accordance with the National Environmental Policy Act of 1969 (NEPA). The final suite of measures developed as a result of the MMPA LOA process would be identified and analyzed in the Final EIS/OEIS.

For the purposes of the ESA section 7 consultation, the mitigation measures proposed here may be considered by NMFS as beneficial actions taken by the Federal agency or applicant (50 CFR 402.14[g][8]). If required to satisfy requirements of the Endangered Species Act, NMFS may develop an additional set of measures contained in Reasonable and Prudent Alternatives, Reasonable and Prudent Measures, or Conservation Recommendations in any Biological Opinion issued for this Proposed Action.

5.1 MITIGATION MEASURES RELATED TO ACOUSTIC EFFECTS

Effective training dictates that ship, submarine, and aircraft participants use their sensors and exercise weapons (i.e., torpedoes) to their optimum capabilities. The Navy recognizes that such use may cause behavioral disruption of some marine mammal species (as outlined in Chapter 4) in the Study Area and is therefore seeking a Biological Opinion and incidental take statement from NMFS. This chapter describes the Navy's proposed mitigation measures that would be implemented to protect marine mammals during the proposed active sonar activities.

The typical ranges, or distances, from the most powerful and common active sonar sources used in Atlantic Fleet Active Sonar Training (AFAST) to received sound energy levels associated with TTS and PTS are shown in Table 5-1. In addition, the range to effects for explosive source sonobuoys (AN/SSQ-110A) are shown in Table 5-2. Due to spreading loss, sound attenuates logarithmically from the source, so the area in which an animal could be exposed to potential injury (PTS) is small. Because the most powerful sources would typically be used in deep water and the range to effect is limited, spherical spreading is assumed for 195 decibels referenced to 1 micro-Pascal squared second (dB re 1µPa^2-s) and above. Also, due to the limited ranges, interactions with the bottom or surface ducts are rarely an issue.

Table 5-1. Range to Effects for Active Sonar

Sonar Source	215 dB re 1 µPa2-s received EL (PTS)	195 dB re 1 µPa2-s received EL (TTS)
AN/SQS-53	10 m	100-300 m
AN/SQS-56 or AN/AQS-22	5 m	30-60 m
DICASS sonobuoy	never in a realistic operating environment	3-6 m

Table 5-2. Range to Effects for Explosive Source Sonobuoys (AN/SSQ-110A)

Explosive Source	30.5 psi-ms impulse pressure (Morality)	205 dB re 1 µPa^2-s received EL in total spectrum (PTS)	23 psi (TTS)
AN/SSQ-110A	14 – 44 meters	27 – 77 meters	118 – 196 meters

5.1.1 Personnel Training

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

Marine mammal mitigation training for those who participate in the active sonar activities is a key element of the mitigation measures. The goal of this training is twofold: (1) that active sonar operators understand the details of the mitigation measures and be competent to carry out the mitigation measures, and (2) that key personnel onboard Navy platforms exercising in the various Navy Operating Areas (OPAREAs) understand the mitigation measures and 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 (ASW) operations include searching for submarine periscopes would be trained in marine mammal spotting. These personnel would also be trained on the details of the mitigation measures specific to both their platform and that of the surface combatants with which they are operating.

- **Sonar personnel on ships, submarines, and ASW aircraft –** Sonar operators aboard ships, submarines, and aircraft who are participating in AFAST exercises would be trained in the details of the mitigation measures relative to their platform. Training would also target the specific actions to be taken if a marine mammal is observed.

5.1.2 Procedures

The following procedures would be implemented to maximize the ability of operators to recognize instances when marine mammals are in the vicinity.

5.1.2.1 General Maritime Mitigation Measures: Personnel Training

- All lookouts aboard platforms involved in ASW training activities would review NMFS-approved MSAT material prior to using sonar.
- All Commanding Officers, Executive Officers, and officers standing watch on the bridge would have reviewed the MSAT material prior to a training activity that employs the use of sonar.
- Navy lookouts would undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command Manual [NAVEDTRA] 12968-B).
- Lookout training would include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts would complete the PQS program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts from inclusion in previous measures as long as supervisors monitor their progress and performance.

- Lookouts would be trained to quickly and effectively communicate within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

5.1.2.2 General Maritime Mitigation measures: Lookout and Watchstander Responsibilities

- On the bridge of surface ships, there would always be at least three personnel on watch whose duties include observing the water surface around the vessel.
- In addition to the three personnel on watch, all surface ships participating in ASW exercises would have at least two additional personnel on watch at all times during the exercises.
- Personnel on lookout and officers on watch on the bridge would have at least one set of binoculars available for each person to aid in the detection of marine mammals.
- On surface vessels equipped with mid-frequency active sonar, pedestal-mounted "Big Eye" (20 x 110) binoculars will be present and will be maintained in good working order to assist in the detection of marine mammals near the vessel.
- Personnel on lookout would follow visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).
- Surface lookouts would scan the water from the ship to the horizon and be responsible for all contacts in their sector. In searching the assigned sector, the lookout would always start at the forward part of the sector and search aft (toward the back). To search and scan, the lookout would hold the binoculars steady so the horizon is in the top third of the field of vision and direct their eyes just below the horizon. The lookout would scan for approximately five seconds in as many small steps as possible across the field seen through the binoculars. They would search the entire sector through the binoculars in approximately five-degree steps, pausing between steps for approximately five seconds to scan the field of view. At the end of the sector search, the glasses would be lowered to allow the eyes to rest for a few seconds, and then the lookout would search back across the sector with the naked eye.
- After sunset and prior to sunrise, lookouts would employ Night Lookout Techniques in accordance with the Lookout Training Handbook.
- At night, lookouts would not sweep the horizon with their eyes, because eyes do not see well when they are moving. Lookouts would scan the horizon in a series of movements that would allow their eyes to come to periodic rests as they scan the sector. When visually searching at night, they would look a little to one side and out of the corners of their eyes, paying attention to the things on the outer edges of their field of vision.
- Personnel on lookout would be responsible for informing the Officer of the Deck of all objects or anomalies sighted in the water (regardless of the distance from the vessel), since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may indicate a threat to the vessel and its crew or the presence of a marine species that may need to be avoided, as warranted.

5.1.2.3 Operating Procedures

- Commanding Officers would make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible, consistent with the safety of the ship.
- All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) would monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action. The Navy can detect sounds within the human hearing range due to an operator listening to the incoming sounds. Passive acoustic detection systems are used during all ASW activities.
- Units shall use training lookouts to survey for marine mammals and sea turtles prior to commencement and during the use of active sonar.
- During operations involving sonar, personnel would use all available sensor and optical systems (such as night vision goggles to aid in the detection of marine mammals).
- Navy aircraft participating in exercises at sea would conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.
- Aircraft with deployed sonobuoys would use only the passive capability of sonobuoys when marine mammals are detected within 183 meters (m) (200 yards [yd]) of the sonobuoy.
- Marine mammal detections by aircraft would be immediately reported to the assigned Aircraft Control Unit (if participating) for further dissemination to ships in the vicinity of the marine species. This action would occur when it is reasonable to conclude that the course of the ship will likely close the distance between the ship and the detected marine mammal.
- Safety zones would prevent exposure to sound levels greater than the lowest mean of the dose-function criteria (Section 4.4.6). When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 914 m (1,000 yd) of the sonar dome (the bow), the ship or submarine would limit active transmission levels to at least 6 decibels (dB) below normal operating levels.
- Ships and submarines would continue to limit maximum transmission levels by this 6 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 914 m (1,000 yd) beyond the location of the last detection.
- Should a marine mammal be detected within 457 m (500 yd) of the sonar dome, active sonar transmissions would be limited to at least 10 dB below the equipment's normal operating level. Ships and submarines would continue to limit maximum ping levels by this 10 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 914 m (1,000 yd) beyond the location of the last detection.

- Should the marine mammal be detected within 183 m (200 yd) of the sonar dome, active sonar transmissions would cease. Sonar would not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 914 m (1,000 yd) beyond the location of the last detection.
- If the need for power-down should arise, as detailed in "Safety Zones" above, Navy staff would follow the requirements as though they were operating at 235 dB - the normal operating level (i.e., the first power-down would be to 229 dB, regardless of the level above 235 db the sonar was being operated).
- Prior to start up or restart of active sonar, operators would check that the safety zone radius around the sound source is clear of marine mammals.
- Sonar levels (generally) – The Navy would operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.
- Helicopters would observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.
- Helicopters would not dip their sonar within 183 m (200 yd) of a marine mammal and would cease pinging if a marine mammal closes within 183 m (200 yd) after pinging has begun.
- Submarine sonar operators would review detection indicators of close-aboard marine mammals prior to the commencement of ASW operations involving active mid-frequency sonar.

5.1.2.4 Special Conditions Applicable for Bow-Riding Dolphins

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

5.1.2.5 Potential Mitigation Measures Under Development

The Navy is working to develop the capability to detect and localize vocalizing marine mammals using the installed sensors. Based on the current status of acoustic monitoring science, it is not yet possible to use installed systems as mitigation tools; however, as this science develops, it will be incorporated in the AFAST mitigation plan.

The Navy is also actively engaged in acoustic monitoring research involving a variety of methodologies (e.g., underwater gliders); to date, none of the methodologies have been developed to the point where they could be used as an actual mitigation tool. The Navy will continue to coordinate passive monitoring and detection research specific to the proposed use of active sonar. As technology and methodologies become available, their applicability and viability will be evaluated for incorporation into this mitigation plan.

5.1.3 Conservation Measures

5.1.3.1 Monitoring

The U.S. Navy is committed to demonstrating environmental stewardship while executing its National Defense mission and is responsible for compliance with a suite of Federal environmental and natural resources laws and regulations that apply to the marine environment. As part of those responsibilities, an assessment of the long-term and/or population-level effects of Navy training activities as well as the efficacy of mitigation measures is necessary. The Navy is developing an Integrated Comprehensive Monitoring Program (ICMP) for marine species in order to assess the effects of training activities on marine species and investigate population trends in marine species distribution and abundance in various range complexes and geographic locations where Navy training occurs. This program will emphasize active sonar training, with AFAST being a major component of the overall monitoring program.

The primary goals of the ICMP are:

- To monitor Navy training exercises, especially those involving mid-frequency sonar and underwater detonations, for compliance with the terms and conditions of Biological Opinions or Marine Mammal Protection Act (MMPA) authorizations.
- Estimate the number individuals (primarily marine mammals) exposed to sound levels above current regulatory thresholds
- Assess the effectiveness of the Navy's marine species mitigation
- To minimize exposure of protected species (primarily marine mammals) to sound levels from active sonar or sound pressure levels from underwater detonations currently considered to result in harassment.
- To document trends in species distribution and abundance in Navy training areas
- To add to the knowledge base on potential behavioral and physiological effects to marine species from mid-frequency active sonar and underwater detonations.
- To assess the practicality and usefulness of a number of mitigation tools and techniques.

The ICMP will serve as the basis for establishing Implementation Plans (IPs) for training activities as well as geographically based long-term monitoring sites. Training exercise IPs will be focused on short-term monitoring and mitigation for individual training activities. These exercise-specific Implementation Plans will be tailored to the specific logistical constraints for each exercise and include specifics concerning dates, location, spatial extent, appropriate monitoring methods, and reporting protocols. The IP will utilize information specific to the exercise to determine the most effective, logistically and financially feasible means to monitor each training event. Each IP will be developed to ensure compliance with all ESA Section 7 and MMPA authorization requirements.

By using a combination of monitoring techniques or tools appropriate for the species of concern, type of Navy activities conducted in the area, sea state conditions, and the size of the OPAREA, the detection, localization, and observation of marine species can be maximized. This ICMP will evaluate the range of potential monitoring techniques that can be tailored to any Navy range or exercise and the appropriate species of concern. The limitations and benefits to each type of monitoring technique and the type of environment or species of concern that would best be served by the technique will be addressed and a matrix of feasibility, temporal and spatial use, limitations, costs and availability of resources to accommodate the technique will be developed. The primary tools available for monitoring include the following:

- Visual Observations – Surface vessel, aerial and shore-based surveys, providing data on long term population trends (abundance and distribution) and response of marine species to Navy training activities. Both Navy personnel and independent visual observers will be considered.
- Acoustic Monitoring – Autonomous Acoustic Recorders (moored buoys), High Frequency Acoustic Recording Packages (HARPS), sonobuoys, passive acoustic towed arrays, shipboard passive sonar, and Navy Instrumented Acoustic Ranges can provide presence/absence and movement data which are particularly important for species that are difficult to detect visually or when conditions limit the effectiveness of visual monitoring.
- Photo identification and tagging – Contributes to understanding of movement patterns and stock structure which is important to determine how potential effects may relate to individual stocks or populations. Tagging with sophisticated D-tags may also allow direct monitoring of behaviors not readily apparent to surface observers.
- Oceanographic and environmental data collection – Data to be used for analyzing distribution patterns and developing predictive habitat and density models.

In addition, the ICMP will propose to continue or initiate studies of behavioral response, abundance, distribution, habitat utilization, etc. for species of concern using a variety of methods which may include visual surveys, passive and acoustic monitoring, radar and data logging tags (to record data on acoustics, diving and foraging behavior, and movements). This work will help to build the collective knowledgebase on the geographic and temporal extent of key habitats and provide baseline information to account for natural perturbations such as El Niño or La Niña events as well as establish baseline information to determine the spatial and temporal extent of reactions to Navy operations, or indirect effects from changes in prey availability and distribution.

In 2005, the Navy contracted with a consortium of researchers from Duke University, University of North Carolina at Wilmington, University of St. Andrews, and NMFS Northeast Fisheries Science Center to conduct a pilot study analysis and subsequently develop a survey and monitoring plan in support of the planned Atlantic Fleet Active Sonar Training (AFAST) activities. This survey and monitoring plan prescribes the recommended approach for data collection, including surveys (such as aerial/shipboard, frequency, and spatial extent) and data analysis (standard line-transect, spatial modeling) necessary to establish a fine-scale seasonal baseline of the distribution and abundance of protected species.

The baseline data collection portion of the program began in June 2007 and includes coordinated aerial, shipboard, and passive acoustic surveys, as well as deployment of high-frequency acoustic recording packages to supplement the traditional visual surveys. This intensive data collection effort is planned to continue in support of AFAST.

The Navy will coordinate with the local National Marine Fisheries Service (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 ASW training activities. The Navy will 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 (Chapter 5), exercise-specific implementation plans developed under the ICMP will ensure thorough monitoring and reporting of AFAST 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.

5.1.3.2 Research

The Navy provides a significant amount of funding and support to marine research. The agency provides nearly 10 million dollars annually to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to study marine mammals. The U.S. Navy sponsors seventy percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, sea turtles, fish, and birds, and
- Developing tools to model and estimate potential effects of sound.

This research is directly applicable to Atlantic Fleet training activities, particularly with respect to the investigations of the potential effects of underwater noise sources on marine mammals and other protected species. Proposed training activities employ sonar and underwater explosives, which introduce sound into the marine environment.

The Marine Life Sciences Division of the Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the effects of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are as follows:

1. Environmental Consequences of Underwater Sound,
2. Non-Auditory Biological Effects of Sound on Marine Mammals,

3. Effects of Sound on the Marine Environment,
4. Sensors and Models for Marine Environmental Monitoring,
5. Effects of Sound on Hearing of Marine Animals, and
6. Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

The Navy has also developed the technical reports referenced within this document, which include the Marine Resource Assessments and the Navy OPAREA Density Estimates (NODE) reports. Furthermore, research cruises by the National Marine Fisheries Service (NMFS) and by academic institutions have received funding from the U.S. Navy. For instance, the ONR contributed financially to the Sperm Whale Seismic Survey in the Gulf of Mexico, coordinated by Texas A&M. The goals of the SWSS are to examine effects of the oil and gas industry on sperm whales and what mitigations would be employed to minimize adverse effects to the species. All of this research helps in understanding the marine environment and the effects that may arise from the use of underwater noise in the Gulf of Mexico and western North Atlantic Ocean.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods on instrumented ranges. However, acoustic detection, identification, localization, and tracking of individual animals still requires a significant amount of research effort to be considered a reliable method for marine mammal monitoring. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential mitigation and monitoring tool.

Overall, the Navy will continue to fund ongoing marine mammal research, and is planning to coordinate long term monitoring/studies of marine mammals on various established ranges and operating areas. The Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include mitigation and monitoring programs; data sharing with NMFS and via the literature for research and development efforts; and future research as described previously.

5.1.4 Coordination and Reporting

The Navy would coordinate with NMFS Stranding Coordinators for any unusual marine mammal behavior. This includes any stranding, beached live/dead, or floating marine mammals that may occur coincident with Navy training activities.

These mitigation measures have been developed in full consideration of the recommendations of the joint National Oceanic and Atmospheric Administration (NOAA) / Navy report on the Bahamas marine mammal stranding event (Department of Commerce [DOC] and Department of the Navy [DON], 2001).

5.2 MITIGATION MEASURES RELATED TO EXPLOSIVE SOURCE SONOBUOYS (AN/SSQ-110A)

- Crews will conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 457 m (500 yd) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft operations, crews are allowed to 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 detonation. This 30-minute observation period may include pattern deployment time.
- For any part of the briefed pattern where a post (source/receiver sonobuoy pair) will be deployed within 914 m (1,000 yd) of observed marine mammal activity, deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 914 m (1,000 yd) of the intended post position, co-locate the explosive source sonobuoy (AN/SSQ-110A) (source) with the receiver.
- When able, crews will conduct continuous visual and aural monitoring of marine mammal activity. This is to include monitoring of own-aircraft sensors from first sensor placement to checking off station and out of RF range of these sensors.
- Aural Detection:
    - If the presence of marine mammals is detected aurally, then that should 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.
- Visual Detection:
    - If marine mammals are visually detected within 914 m (1,000 yd) of the explosive source sonobuoy (AN/SSQ-110A) intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 10 minutes, or are observed to have moved outside the 914 m (1,000 yd) safety buffer.
    - Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 914 m (1,000 yd) safety buffer.
- Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the “Payload 1 Release” command followed by the “Payload 2 Release” command. Aircrews shall refrain from using the “Scuttle” command when two payloads remain at a given post. Aircrews will ensure that a 914 m (1,000 yd) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.

- Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.
- Ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that can not be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.
- Mammal monitoring shall continue until out of own-aircraft sensor range.

5.3 MITIGATION MEASURES RELATED TO VESSEL TRANSIT AND NORTH ATLANTIC RIGHT WHALES

5.3.1 Mid-Atlantic, Offshore of the Eastern United States

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

NMFS has identifed ports located in the western Atlantic Ocean, offshore of the southeastern United States, where vessel transit during right whale migration is of highest concern for potential ship strike. The ports include the Hampton Roads entrance to the Chesapeake Bay, which includes the concentration of Atlantic Fleet vessels in Norfolk, Virginia. Navy vessels are required to use extreme caution and operate at a slow, safe speed consistent with mission and safety during the months indicated in Table 5-3 and within a 37 kilometer (km) (20 nautical mile [NM]) arc (except as noted) of the specified reference points.

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

Table 5-3. Locations and Time Periods When Navy Vessels Are Required to Reduce Speeds (Relevant to North Atlantic Right Whales)

Region	Months	Port Reference Points
South and East of Block Island	Sep–Oct and Mar–Apr	37 km (20 NM) seaward of line between 41-4.49N 071-51.15W and 41-18.58N 070-50.23W
New York / New Jersey	Sep–Oct and Feb-Apr	40-30.64N 073-57.76W
Delaware Bay (Philadelphia)	Oct–Dec and Feb–Mar	38-52.13N 075-1.93W
Chesapeake Bay (Hampton Roads and Baltimore)	Nov-Dec and Feb–Apr	37-1.11N 075-57.56W
North Carolina	Dec–Apr	34-41.54N 076-40.20W
South Carolina	Oct–Apr	33-11.84N 079-8.99W 32-43.39N 079-48.72W

5.3.2 Southeast Atlantic, Offshore of the Eastern United States

For purposes of these measures, the southeast encompasses sea space from Charleston, South Carolina, southward to Sebastian Inlet, Florida, and from the coast seaward to 148 km (80 NM) from shore. The mitigation measures described in this section were developed specifically to protect the North Atlantic right whale during its calving season (Typically from December 1 through March 31). During this period, North Atlantic right whales give birth and nurse their calves in and around a federally designated critical habitat off the coast of Georgia and Florida. This critical habitat is the area from 31-15N to 30-15N extending from the coast out to 28 km (15 NM), and the area from 28-00N to 30-15N from the coast out to 9 km (5 NM). All mitigation measures that apply to the critical habitat also apply to an associated area of concern which extends 9 km (5 NM) seaward of the designated critical boundaries.

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

Specific mitigation measures related to activities occurring within the critical habitat or associated area of concern include the following:

- When transiting within the critical habitat or associated area of concern, vessels will exercise extreme caution and proceed at a slow safe speed. The speed will be the slowest safe speed that is consistent with mission, training and operations.
- Speed reductions (adjustments) are required when a whale is sighted by a vessel or when the vessel is within 9 km (5 NM) of a reported new sighting less then 12 hours old.
- Additionally, circumstances could arise where, in order to avoid North Atlantic right whale(s), speed reductions could mean vessel must reduce speed to a minimum at which it can safely keep on course or vessels could come to an all stop.

- Vessels will avoid head-on approach to North Atlantic right whale(s) and will maneuver to maintain at least 457 m (500 yd) of separation from any observed whale if deemed safe to do so. These requirements do not apply if a vessel's safety is threatened, such as when change of course would create an imminent and serious threat to person, vessel, or aircraft, and to the extent vessels are restricted in the ability to maneuver.
- Ships shall not transit through the critical habitat or associated area of concern in a North-South direction.
- Ship, surfaced subs, and aircraft will report any whale sightings to Fleet Area Control and Surveillance Facility, Jacksonville, by most convenient and fast means. Sighting report will include the time, latitude/longitude, direction of movement and number and description of whale (i.e., adult/calf).

5.4 ALTERNATIVE MITIGATION MEASURES CONSIDERED BUT ELIMINATED

As described in Chapter 4, the vast majority of estimated sound exposures of marine mammals during proposed active sonar activities would not cause injury. Potential acoustic effects on marine mammals would be further reduced by the mitigation measures described above. Therefore, the Navy concludes the proposed action and mitigation measures would achieve the least practical adverse impact on species or stocks of marine mammals.

A determination of "least practicable adverse impacts" includes consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity in consultation with the Department of Defense (DoD). Therefore, the following additional mitigation measures were analyzed and eliminated from further consideration:

- Reduction of training. The requirements for training have been developed through many years of iteration to ensure sailors achieve levels of readiness to ensure they are prepared to properly respond to the many contingencies that may occur during an actual mission. These training requirements are designed provide the experience needed to ensure sailors are properly prepared for operational success. There is no extra training built in to the plan, as this would not be an efficient use of the resources needed to support the training (e.g. fuel, time). Therefore, any reduction of training would not allow sailors to achieve satisfactory levels of readiness needed to accomplish their mission.
- Use of ramp-up to attempt to clear the range prior to the conduct of exercises. Ramp-up procedures, (slowly increasing the sound in the water to necessary levels), are not a viable alternative for training exercises because the ramp-up would alert opponents to the participants' presence. This affects the realism of training in that the target submarine would be able to detect the searching unit prior to themselves being detected, enabling them to take evasive measures. This would insert a significant anomaly to the training, affecting its realism and effectiveness. Though ramp-up procedures have been used in testing, the procedure is not effective in training sailors to react to tactical situations, as it provides an unrealistic advantage by alerting the target. Using these procedures would not allow the Navy to conduct realistic training, or "train as they fight," thus adversely impacting the effectiveness of the military readiness activity.

- Visual monitoring using third-party observers from air or surface platforms, in addition to the existing Navy-trained lookouts.
  - The use of third-party observers would compromise security due to the requirement to provide advance notification of specific times/locations of Navy platforms.
  - Reliance on the availability of third-party personnel would also impact training flexibility, thus adversely affecting training effectiveness. The presence of other aircraft in the vicinity of naval exercises would raise safety concerns for both the commercial observers and naval aircraft.
  - Use of Navy observers is the most effective means to ensure quick and effective implementation of mitigation measures if marine species are spotted. A critical skill set of effective Navy training is communication. Navy lookouts are trained to act swiftly and decisively to ensure that appropriate actions are taken.
  - Use of third-party observers is not necessary because Navy personnel are extensively trained in spotting items on or near the water surface. Navy spotters receive more hours of training, and use their spotting skills more frequently, than many third-party trained personnel.
  - Crew members participating in training activities involving aerial assets have been specifically trained to detect objects in the water. The crew’s ability to sight from both surface and aerial platforms provides excellent survey capabilities using the Navy’s existing exercise assets.
  - Security clearance issues would have to be overcome to allow non-Navy observers onboard exercise participants.
  - Some training events will span one or more 24-hour periods, with operations underway continuously in that timeframe. It is not feasible to maintain non-Navy surveillance of these operations, given the number of non-Navy observers that would be required onboard.
  - Surface ships having active mid-frequency sonar have limited berthing capacity. As exercise planning includes careful consideration of this limited capacity in the placement of exercise controllers, data collection personnel, and Afloat Training Group personnel on ships involved in the exercise. Inclusion of non-Navy observers onboard these ships would require that in some cases there would be no additional berthing space for essential Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the exercise objectives.
  - The areas where training events will most likely occur in the AFAST Study Area cover approximately 412,115 square kilometers (km^2) (120,000 square nautical miles [NM^2]). Contiguous ASW events may cover many hundreds of square miles. The number of civilian ships and/or aircraft required to monitor the area of these events would be considerable. It is, thus, not feasible to survey or monitor the large exercise areas in the time required ensuring these areas are devoid of marine mammals. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an exercise took place. Given that

there are no adequate controls to account for these or other possibilities and there are no identified research objectives, there is no utility to performing either a before or an after the event survey of an exercise area.

  - Survey during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, most of the training events take place far from land, limiting both the time available for civilian aircraft to be in the exercise area and presenting a concern should aircraft mechanical problems arise.
  - Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness, since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the unceasing progress of the exercise and impact the effectiveness of the military readiness activity.
  - Multiple events may occur simultaneously in areas at opposite ends of the AFAST Study Area and continue for up to 96 hours. There are not enough qualified third-party personnel to accomplish the monitoring task.

- Reducing or securing power during the following conditions.
  - Low-visibility / night training: The Navy must train in the same manner as it will fight. ASW can require a significant amount of time to develop the "tactical picture," or an understanding of the battle space such as area searched or unsearched, identifying false contacts, understanding the water conditions, etc. Reducing or securing power in low-visibility conditions would affect a commander's ability to develop this tactical picture as well as not provide the needed training realism. By training differently than what would be needed in an actual combat scenario would decrease training effectiveness and reduce the crew's abilities.
  - Strong surface duct: The Navy must train in the same manner as it will fight. As described above, the complexity of ASW requires the most realistic training possible for the effectiveness and safety of the sailors. Reducing power in strong surface duct conditions would not provide this training realism because the unit would be operating differently than it would in a combat scenario, reducing training effectiveness and the crew's ability. Additionally, water conditions in the various proposed OPAREAs may change rapidly, resulting in continually changing mitigation requirements, resulting in a focus on mitigation versus training.
- Vessel speed: Establish and implement a set vessel speed.
  - As discussed in Section 5.3, Navy personnel are already required to use extreme caution and operate at a slow, safe speed consistent with mission and safety. Ships and submarines need to be able to react to changing tactical situations in training as they would in actual combat. Placing arbitrary speed restrictions would not allow them to properly react to these situations. By training differently than what would be

needed in an actual combat scenario would decrease training effectiveness and reduce the crew's abilities.

- Increasing power down and shut down zones.
    - The current power down zones of 457 and 914 m (500 and 1,000 yd), as well as the 183 m (200 yd) shut down zone were developed to minimize exposing marine mammals to sound levels that could cause temporary threshold shift (TTS) or permanent threshold shift (PTS), levels that are supported by the scientific community. Implementation of the safety zones discussed above will prevent exposure to sound levels greater than 195 dB re 1µPa for animals sighted. The safety range the Navy has developed is also within a range sailors can realistically maintain situational awareness and achieve visually during most conditions at sea.
    - Although the three action alternatives were developed using marine mammal density data and areas believed to provide habitat features conducive to marine mammals, not all such areas could be avoided. ASW requires large areas of ocean space to provide realistic and meaningful training to the sailors. These areas were considered to the maximum extent practicable while ensuring Navy's ability to properly train its forces in accordance with federal law. Avoiding any area that has the potential for marine mammal populations is impractical and would impact the effectiveness of the military readiness activity.
- Using active sonar with output levels as low as possible consistent with mission requirements and use of active sonar only when necessary.
    - Operators of sonar equipment are always cognizant of the environmental variables affecting sound propagation. In this regard, the sonar equipment power levels are always set consistent with mission requirements.
    - Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practicable when available and when required by the mission.
- Reporting marine mammal sightings to augment scientific data collection.
    - Ships, submarines, aircraft, and personnel engaged in training events are intensively employed throughout the duration of the exercise. Their primary duty is accomplishment of the exercise goals, and they should not be burdened with additional duties unrelated to that task. Any additional workload assigned that is unrelated to their primary duty would adversely impact the effectiveness of the military readiness activity they are undertaking.

6. CUMULATIVE IMPACTS

6.1 CUMULATIVE IMPACTS

The Navy's past experience in preparing cumulative impacts analyses and the National Environmental Policy Act of 1969 (NEPA) were utilized in determining the scope and format of the cumulative impacts analyses presented within this chapter of the Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS).

The approach taken in the analysis of cumulative effects follows the objectives of the National Environmental Policy Act (NEPA) of 1969, Council on Environmental Quality (CEQ) regulations and CEQ guidance. CEQ regulations (40 Code of Federal Regulations [CFR] §§ 1500-1508) provide the implementing procedures for NEPA. The regulations define cumulative effects as:

> "Cumulative impact" is the impact on the environment that results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7)."

> "To determine the scope of environmental impact statements, agencies shall consider ….[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement."

In addition, the CEQ has published guidance addressing implementation of cumulative impact analyses under NEPA. The CEQ guidance publication entitled *Considering Cumulative Impacts Under the National Environmental Policy Act, January 1997* states that the analyses should:

> "…determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative impacts of other past, present, and future actions... identify significant cumulative impacts…[and]…focus on truly meaningful impacts."

Based on the guidance provided within this CEQ publication, the Navy has determined the following types of potential cumulative impacts need to be analyzed:

- "additive" (the total loss of a resource from more than one incident),
- "countervailing" (adverse impacts that are compensated for by beneficial effects), and
- "synergistic" (when the total effect is greater than the sum of the effects taken independently).

However, the analysis of cumulative effects may go beyond the scope of project-specific direct and indirect effects to include expanded geographic and time boundaries and a focus on broad resource sustainability. The true geographic range of an action's effect may not be limited to an arbitrary political or administrative boundary. Similarly, the effects of an action may continue beyond the time the action ceases. This "big picture" approach is becoming increasingly important as growing evidence suggests that the most significant effects result not from the direct effects of a particular action, but from the combination of individual, often minor, effects of multiple actions over time. The underlying issue is whether or not a resource can adequately recover from the effect of an action before the environment is exposed to a subsequent action or actions.

The AFAST activities are expected to occur in existing Operating Areas (OPAREAs) located along the East Coast of the United States (U.S.) and in the Gulf of Mexico, collectively referred to as the Study Area. Military training, maintenance, and research, development, test, and evaluation (RDT&E) activities have previously occurred in these areas. Further, the mid- and high-frequency active sonar and improved extended echo ranging (IEER) system training, maintenance, and RDT&E activities are short-term, temporary, and do not involve land acquisition, new construction, or expansion of military presence. The activities involving mid- and high-frequency active sonar described in this EIS/OEIS are not new and do not involve significant changes in systems, tempo, or intensity from past activities, or any additional geographic locations.

For the purposes of determining cumulative effects in this chapter, the Navy reviewed all environmental documentation regarding known current and past federal and non-federal actions (Section 6.2) associated with the resources analyzed in Chapter 4. Additionally, projects in the planning phase were considered, including reasonably foreseeable (rather than speculative) actions that have the potential to interact with the proposed Navy action (see Section 6.3). Specific emphasis is placed on projects in and adjacent to each of the OPAREAs located along the East Coast and in the Gulf of Mexico that involve components capable of generating in-water sounds given the proportion of effects analysis devoted to this issue. The level of information available for the different projects varies. The best available science is used in this analysis. The cumulative analysis incorporates specific numbers and values for potential effects, where available; descriptive information is used in place of quantitative measures where they are unavailable. Additionally, the National Marine Fisheries Service (NMFS) will review all associated actions and should be capable of identifying whether or not any critical stock may be endangered from all the activities occurring in the AFAST Study Area.

6.1.1 Assumptions Used in the Analysis

The cumulative impacts analysis in this chapter differs from the analysis conducted for the AFAST Alternatives detailed in Chapter 4 because the cumulative impacts analysis considers an expanded geographic area and extended timeframe. Therefore, the cumulative impacts analysis includes additional effects on the physical, biological, and human environments associated with AFAST activities.

In addition, the cumulative impacts analysis takes into consideration combined effects of past, present, and reasonably foreseeable future activities. Therefore, the baseline utilized in the Alternatives analysis presented in Chapter 3 of this EIS/OEIS could not be used in the cumulative impacts analysis. The baseline associated with the cumulative impact analysis had to take into account the effects of both past and present activities. In accordance with the NEPA, the cumulative impacts analysis must take into consideration the incremental contribution of the proposed action to the existing baseline. However, as activities increase within the study area, the baseline will change. Thus, the baseline for the cumulative impacts analysis must include past, present, and reasonably foreseeable future activities.

The incremental contribution of the proposed action is relatively small and would most likely continue to reduce in size as non-military activities increase within the study area. Overall, it is more difficult to analyze cumulative impacts versus project-specific effects. The Navy recognizes the need to identify and quantify the factors causing the environmental change and the threshold triggers associated with the potential environmental response.

6.1.2 Summary and Significance of Past Cetacean Stranding Events Related to Military Use of Sonar

Cetaceans face threats from a multitude of man-made sources, including intentional hunting, fishing gear entanglement, ship strikes, ensonification, pollution, and toxic algal blooms. During the past 10 years, Navy sonar has been linked to only 5 stranding events, with a total of 51 stranded animals and 37 mortalities. The 37 mortalities equate to an average of less than 4 marine mammal mortalities per year over the past 10 years.

The majority of these five strandings are unique from other strandings because the stranding of whales occurred over a short period of time, stranded individuals were spatially co-located, traumas in stranded animals were consistent between events, and active sonar was known or suspected to be in use. Moreover, in several of these strandings, activities involved multiple ships operating in the same area over extended periods of time in close proximity. Furthermore, operations occurred across a relatively short horizontal distance, in areas surrounded by landmasses, and of at least 1,000 meters (m) (0.5 nautical miles [NM]) in depth near a shoreline with a rapid change in bathymetry. In these cases, unique conditions may have existed in the active sonar activity area that, in their aggregate, may have contributed to the marine mammal strandings. However, these conditions are not present in the majority of other documented marine mammal strandings, and current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause marine mammals to strand.

Overall, the number of deaths associated with mid-frequency sonar exposure is small in comparison to the number of marine mammals killed annually through fishing by-catch and whaling operations (high-frequency sonar dissipates so quickly in water that no measurable impacts to marine mammas are anticipated). For example, a 2003 report by scientists from Duke University and the University of St. Andrews estimated that more than 6,000 marine mammals die annually in U.S. waters as a result of by-catch (Read et al., 2003b). When extrapolated to consider global impacts, the number increases to 308,000 deaths annually. In addition to by-catch, some countries still engage in whaling operations, whether under the guise of research or for commercial purposes. Such operations led to the death of over 1,900 marine mammals in 2005 (International Whaling Commission [IWC], 2007). Thus, the overall contribution of cetaceans' stranding resulting in death associated with exposure to Navy mid-frequency sonar is relatively small when compared to all the other non-military activity related to marine mammal stranding and effects, as shown in Figure 6-1.

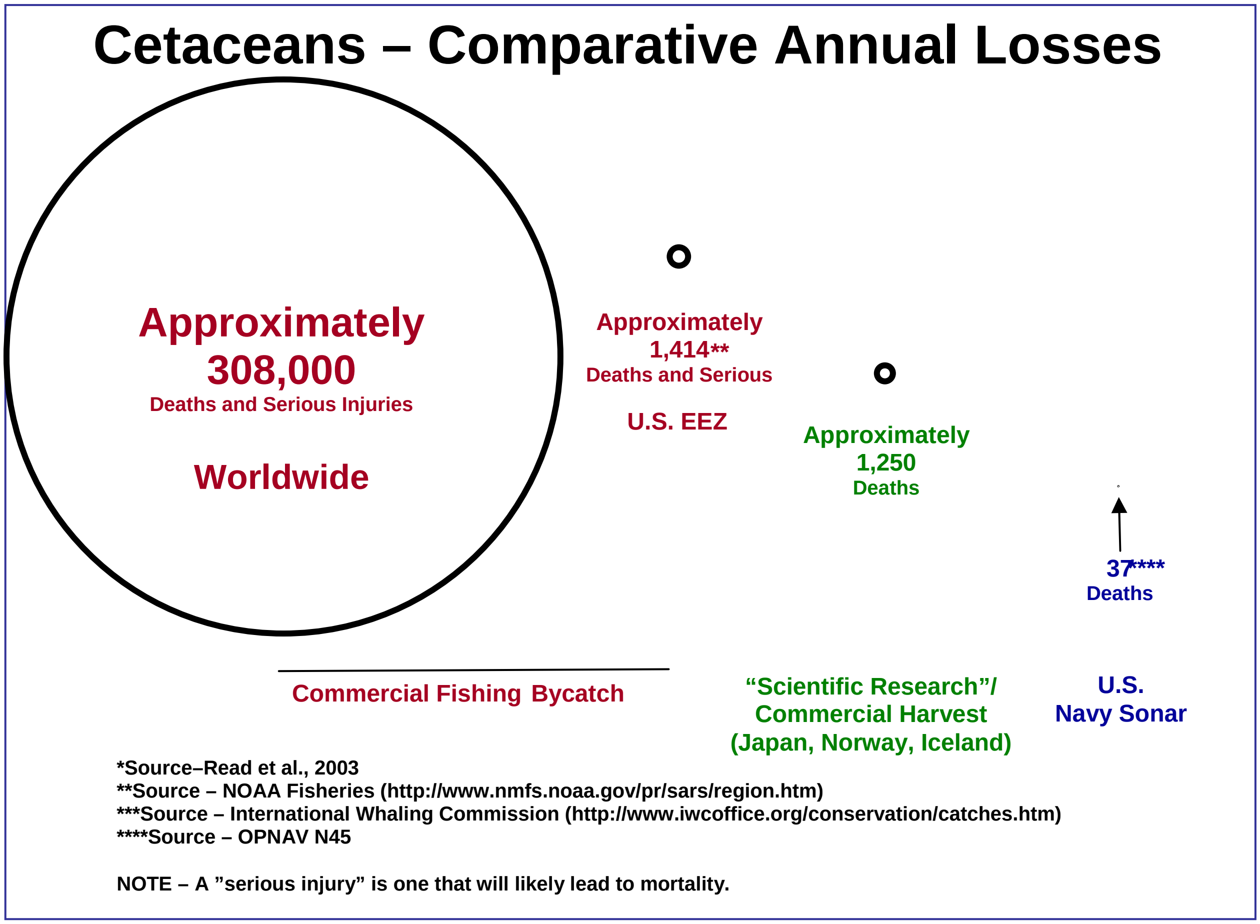

Figure 6-1. Annual Comparison of Cetacean Death by Activity

The Navy has made the protection of marine mammals a top priority. The Navy has led the way in marine mammal research, and in conjunction with the National Oceanic and Atmospheric Administration (NOAA), has developed 29 mandatory science-based mitigation measures that allow the Navy to conduct active sonar activities with the utmost care for the ocean environment.

For additional information on the marine mammal strandings, refer to Section 3.6.3, Cetacean Strandings; Section 4.4.14, Potential for Mortality: Cetacean Stranding Activities; and Appendix E, Cetacean Stranding Report.

6.2 PAST AND PRESENT ACTIONS

Various types of past and present actions not related to the Proposed Action have the potential to affect the resources identified in Chapter 3. The overview of these actions in this section emphasizes components of the activities that are relevant to the effects analysis in Chapter 4. Geographic distribution, intensity, duration, and the historical effects of similar activities are considered when determining whether a particular activity may contribute cumulatively and significantly to the effects identified in Chapter 4.

6.2.1 Commercial and Recreational Fishing

The fishing industry affects marine mammals and sea turtles. NOAA estimates that approximately 6,000 marine mammals die annually as a result of by-catch from U.S. fisheries (Read et. al., 2003a). Adverse effects to protected marine species are possible due to gillnet, longline, trawlgear, and pot fisheries. Additionally, commercial fisheries may accidentally entangle and drown or injure cetaceans by lost and expended fishing gear (e.g., Northridge and Hofman, 1999). For example, entanglement in fixed fishing gear, in particular in sink gillnets and a variety of pot and trap fisheries, is one of the most important factors depressing the growth rate of the North Atlantic right whale population (Kenney, 2002). Additionally, fisheries may indirectly compete with cetaceans by reducing the amount of primary food source accessible to cetaceans, thereby negatively affecting their numbers (Trites et al., 1997). Southeastern shrimp trawl and summer flounder/scup/black sea bass fisheries are considered to be most likely to adversely affect sea turtles; however, shrimp trawling has the greatest effect. The use of Turtle Excluder Devices (TEDs) in the shrimp fishery has reduced mortality by up to 50 percent. The implementation of new TED regulations is expected to further decrease mortality (Department of the Navy [DON], 2006h).

Fisheries are classified first, according to the total effect of all fisheries on each marine mammal stock and second, by addressing the effect of individual fisheries on each stock. This classification method includes consideration of the rate, in numbers of animals per year, of incidental mortalities and serious injuries of marine mammals due to commercial fishing operations relative to the potential biological removal (PBR) level for each stock (NMFS, 2007A). The PBR level is the maximum number of animals, not including natural mortalities, which may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (NMFS, 2007A). Category I fisheries are the most detrimental to marine mammals and are defined as having an annual mortality and serious injury of a stock in a given fishery of greater than or equal to 50 percent of the PBR level (NMFS, 2007A). Table 6-1 shows the Category I commercial fisheries in the Atlantic Ocean and Gulf of Mexico and the marine mammal species affected.

Table 6-1. Category I Commercial Fisheries in the Atlantic Ocean and Gulf of Mexico

Fishery Description	Estimated Number of Vessels/Persons	Marine Mammal Species Incidentally Killed/Injured		
Gillnet Fisheries	>1,011	Fin whale Humpback whale Long-finned pilot whale Minke whale Atlantic Ocean right whale Short-finned pilot whale	Bottlenose dolphin Common dolphin Harbor porpoise Risso's dolphin White-sided dolphin	Gray seal Harbor seal Harp seal Hooded seal
Longline Fisheries	94*	Cuvier's beaked whale Long-finned pilot whale Mesoplodon beaked whale Northern bottlenose whale Pygmy sperm whale Short-finned pilot whale	Atlantic spotted dolphin Bottlenose dolphin Common dolphin Pantropical spotted dolphin Risso's dolphin	----
Trap/Pot Fisheries	13,000	Fin whale Humpback whale Minke whale Atlantic Ocean right whale	----	Harbor seal

NMFS, 2007A
*Some Caribbean fisheries are included in this number

About 13 million Americans participate in saltwater recreational fishing along and just off the U.S. coasts. In the past ten years, the number of recreational fishing trips has risen 10 percent to 82 million trips in 2003 (NMFS, 2005a). Saltwater recreational fishing generates more than $30.5 billion and supports about 350,000 jobs (NMFS, 2005a).

6.2.1.1 Commercial and Recreational Fisheries –Atlantic Ocean, Offshore of the Southeastern United States

Fisheries off the southeastern U.S. Atlantic coast brought in over $344,000,000 and about 290,000 metric tons (319,670 short tons) of catch in 2005 (NMFS, 2007a and 2007b). Menhaden, flounder, mackerel, crab, sea scallops, and shrimp were the species caught that brought in the most money (NMFS, 2007c and 2007d). Recreational fishing brought in approximately 37,052 metric tons (40,842 short tons) of fish in 2006 (NMFS, 2007K).

6.2.1.2 Commercial and Recreational Fisheries –Atlantic Ocean, Offshore of the Northeastern United States

Fisheries off the northeastern U.S. Atlantic coast brought in about $1.2 billion and over 400,000 metric tons (440,924 short tons) of catch in 2005 (NMFS, 2007e and 2007f). The species that brought in the most money were Atlantic cod, flounder, goosefish, clams, American lobster, sea scallops, and crabs (NMFS, 2007g and 2007h). Recreational fishing brought in roughly 6,745 metric tons (7,435 short tons) of fish in 2006 (NMFS, 2007i).

6.2.1.3 Commercial and Recreational Fisheries – Eastern Gulf of Mexico

Fisheries in the eastern Gulf of Mexico brought in about $173,000,000 and over 42,000 metric tons (46,297 short tons) of catch in 2005 (NMFS, 2007j). Snapper, grouper, mullet, crab, oyster, shrimp, and lobster were the species caught that brought in the most money (NMFS, 2007j). In 2006, recreational fishing brought in about 13,766 metric tons (15,174 short tons) of fish (NMFS, 2007k).

6.2.1.4 Commercial and Recreational Fisheries – Western Gulf of Mexico

Fisheries in the western Gulf of Mexico brought in about $448,000,000 and over 448,000 metric tons (493,835 short tons) of catch in 2005 (NMFS, 2007i). The species that brought in the most money were snapper, menhaden, tuna, crab, oyster, and shrimp (NMFS, 2007j). Recreational fishing in 2006 brought in about 20,200 metric tons of fish (NMFS, 2007k).

6.2.2 Minerals Management Service Regulated Activities: Oil and Gas

The Minerals Management Service (MMS), within the Department of the Interior, manages the mineral resources of the federal offshore lands of the Outer Continental Shelf (OCS). The MMS leases OCS lands to commercial companies for the exploration, extraction, and production of mineral resources. The Atlantic OCS area is divided into four planning areas along the Atlantic seaboard: the Atlantic Ocean, Mid-Atlantic, South Atlantic, and the Straits of Florida. The Gulf of Mexico region is divided into the Eastern, Central, and Western Planning Areas (MMS, 2007a).

Many Section 7 consultations have been completed on MMS activities. Until 2002, Biological Opinions (BOs) resulting from Section 7 consultations concluded that one take of sea turtles may occur annually due to vessel strikes. Biological Opinions issued on July 11, 2002 (lease sale 184), November 29, 2002 (multi-lease sales 185, 187, 190, 192, 194, 196, 200, and 201), and August 20, 2003 (lease sales 189 and 197), have concluded that in addition to vessel strikes to sea turtles, adverse effects may occur from seismic surveys and expended materials. Explosive removal of offshore structures may adversely affect sea turtles and marine mammals (U.S. Air Force, 2005b).

In April 2006, MMS applied for a Letter of Authorization (LOA) from NMFS to “take” by harassment a small number of marine mammals, incidental to explosive removal of offshore structures in the Gulf of Mexico (NMFS, 2006h). In this application it was estimated that Level A harassment takes would be five dolphins over the course of five years, and Level B harassment takes would be 457 dolphins and whales combined per year (Federal Register, 2006e). However, it was stated that these numbers would be much lower in actuality due to the implementation of mitigation measures (NMFS, 2006h).

In April 2007, a final rule was printed in the Federal Register by the MMS requiring the lessees to provide information on how they will conduct their proposed activities in a manner consistent with the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA) (Minerals Management Service (MMS), 2007j). Each lessee would be required to employ monitoring systems and mitigation measures, submit biological environmental reports and environmental effects analyses, and obtain their own authorized incidental "take" permits from NMFS (MMS, 2007j).

6.2.2.1 MMS Regulated Activities – Atlantic Ocean, Offshore of the Southeastern United States

The Southeastern Atlantic Coast is divided by the MMS into three Planning Areas: Mid-Atlantic, South Atlantic, and Straits of Florida. These areas combined cover 715,970 km^2 (276,438 mi^2) from Delaware to the southern most tip of Florida. From 1959 until 2000, 307 blocks (8,531 km^2 or 3,294 mi^2) were leased (MMS, 2007b). There are currently no active leases and no activity in this area (MMS, 2007h). However, a special interest sale in the Mid-Atlantic region off the coast of Virginia has been proposed in late 2011 (MMS, 2007h). This proposed lease sale would only be held if the President of the United States chooses to modify the withdrawal in this area and Congress discontinues the annual statutory moratoria in the Mid-Atlantic (MMS, 2007h).

6.2.2.2 MMS Regulated Activities – Atlantic Ocean, Offshore of the Northeastern United States

The Atlantic Ocean Planning Area is composed of an area offshore that covers 373,930 km^2 (144,375 mi^2) from Maine to New Jersey (MMS, 2007a). In 1979, 63 blocks (1,452 km^2 or 560 mi^2) were leased (MMS, 2007b). However, there are currently no active leases and no activity in this area (MMS, 2007h).

6.2.2.3 MMS Regulated Activities – Eastern Gulf of Mexico

Two lease sales in the Eastern Gulf of Mexico Planning Area were held in 2003 and 2005 for Lease Sale 189 and Sale 197, respectively (MMS, 2003b). This lease sale area abuts the westernmost border of the Eastern Planning Area, and is comprised of 256 blocks covering more than 6,000 km^2 (2,317 mi^2) in water depths of 1,600 to 3,000 m (5,200 to 9,800 ft). The northeast corner of the proposed lease sale area is located in W-155A (approximately 150 km [90 mi] from the Alabama coast and 161 km [100 mi] from the Florida coast). The great majority (94 percent) of the area is located in Eglin Water Training Areas (EWTAs) 1 and 3. A small number of lease blocks have been drilled and/or are in gas production.

In addition, the Gulf of Mexico Energy Security Act of 2006, signed by President Bush on 20 December 2006, mandated portions of the Eastern Planning Area (Figure 6-2) be offered for oil and gas leasing (MMS, 2006c). Specifically, The Gulf of Mexico Energy Security Act of 2006 allows for oil and gas leasing in the "181 Area," comprising an area of approximately 2,347 km^2 (906 mi^2) in the Eastern Planning Area (this area is situated 201 km [125 mi] from the Florida panhandle) (MMS, 2006e).

6.2.2.4 MMS Regulated Activities – Western Gulf of Mexico

The MMS Central Planning Area extends into the western portion of W-155 (Pensacola OPAREA) (MMS, 2003b). A number of active lease blocks are present in the area, with a few additional blocks receiving lease bids in 2003. Additionally, The Gulf of Mexico Energy Security Act of 2006 will allow for oil and gas leasing in the "181 Area," comprising 2 million acres in the Central Planning Area. A second area of approximately 5.8 million acres is located in the Central Gulf of Mexico Planning Area south of the "181 Area" and is referred to as the "181 South Area." None of the acreage made available by the Gulf of Mexico Energy Security Act is located east of the Military Mission Line.

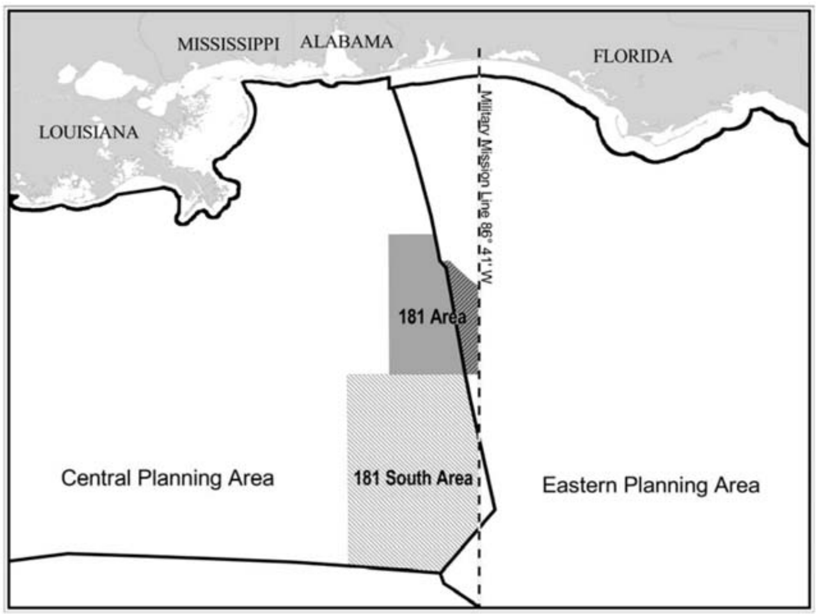

Figure 6-2. Eastern Gulf of Mexico Planning Area
Source: MMS, 2006f

The central Gulf of Mexico portion of the 181 Area was reviewed in a Draft Environmental Impact Statement (EIS) published in November 2006 and will be available for lease in Sale 205 scheduled for early fall 2007 (MMS, 2006b). MMS is immediately beginning the process of environmental review for the Eastern Gulf of Mexico portion of the "181 Area." As part of the environmental review process, MMS will hold public meetings in Florida and other involved states (MMS, 2006e). The second additional sale area, "181 South," will also receive an appropriate environmental review at a later date before any leasing occurs (MMS, 2006e).

Western Gulf Lease Sale 200 was held in August 2006. Mustang Island Area Blocks 793, 799, and 816 (off the southeastern coast of Texas) were included in this lease sale. These three blocks have been used by the Navy for equipment testing and MIW training exercises. However, the Navy did not object to these blocks being offered for lease under the condition of no surface occupancy. The following stipulations were added to operations in the naval MIW area:

(1) For below-seabed operations, the lessee agrees that no activity including, but not limited to, structures, drilling rigs, pipelines, and/or anchoring, will be located on the seabed or in the water column above within any portion of the lease. All exploration, development, and production activities or operations must take place from outside the lease by the use of directional drilling or other techniques.

(2) Prior to the submission of Exploration Plans and Development Operations Coordination Documents regarding any operations on or under the seabed of these blocks, the lessee will consult with the Commander, MIW Command, in order to determine the compatibility of the lessee's plans with scheduled military operations. The Explorations Plans and Development Operations Coordination Documents shall contain a statement certifying the consultation and indicating whether the Commander, MIW Command, has any objection to activities and schedule of the Explorations Plans and Development Operations Coordination Documents (MMS, 2006a).

Some activities associated with offshore exploration, development, and production could potentially contribute to the cumulative effects to the air, water, and biological resources analyzed in Chapter 4 (MMS, 2003b). However, the vast majority of such activities are located in the central and western Gulf of Mexico, from Mississippi to Texas. Because of the distance between these activities, it is expected that air and water movement will disperse any pollutants to the point of insignificance (MMS, 2003b). Underwater noise associated with these activities is concentrated in the central and western Gulf of Mexico as well (MMS, 2003b).

The potential exists for effects to protected marine mammals and sea turtles, particularly from underwater noise associated with seismic airgun exploration and explosive rig removal (MMS, 2003b). These species are quite mobile and may traverse large portions of the Gulf of Mexico during migrations or in search of prey. Therefore, they cannot be considered stationary resources that are immune to the effects of activities occurring outside the Study Area. For example, a dolphin could potentially be exposed to harassing or injurious levels of noise during oil exploration activities in the central Gulf of Mexico and subsequently be exposed to similar noise levels due to sonar or detonations in the Study Area a short time later (MMS, 2003b). NMFS has suggested that one of the criteria for behavioral effects is that the same individual animal be exposed to repeated stressors.

In 2002, consultation between the MMS and NMFS resulted in the implementation of mitigation measures intended to decrease effects to marine mammals (particularly sperm whales) resulting from seismic surveys. The MMS reports that since then, there have been virtually no incidents of injury or harassment. However, the MMS has obtained a permit from NMFS to "take" up to 200 bottlenose and spotted dolphins (combined) associated with oil and gas activities (NOAA, 2002A).

The oil and gas pipeline network offshore of Gulf Coast states is extensive. Figure 6-3 shows the extent of actual and proposed pipelines as of April 2003. A few pipelines encroach on the westernmost edge of W-155 (Pensacola OPAREA).

6.2.3 State Regulated Oil and Gas Activities

The Submerged Lands Act of 1953 gives individual states the rights to marine natural resources from the coastline to no more than 5.6 km (3 NM) into the Atlantic Ocean and Gulf of Mexico. In Texas and the west coast of Florida, state jurisdiction extends from the coastline to no more than 16.2 km (3 marine leagues) into the Gulf of Mexico (MMS, 2007c). Natural resources beyond the abovementioned areas would be regulated by the MMS. Therefore, any oil or gas activities occurring within 5.6 km (3 NM) of the coast would be state regulated.

6.2.3.1 State Regulated –Atlantic Ocean, Offshore of the Southeastern United States

There are currently no state-regulated oil or gas activities in the Southeastern Atlantic Coast region of the United States (MMS, 2007h).

6.2.3.2 State Regulated –Atlantic Ocean, Offshore of the Northeastern United States

There are currently no state-regulated oil and gas activities within the Northeastern Atlantic Coast region of the United States. (MMS, 2007h).

6.2.3.3 State Regulated – Eastern Gulf of Mexico

The State of Florida has experienced very limited drilling in coastal waters. A moratorium has stopped all drilling activities in Florida waters, and there are no plans for future lease sales (MMS, 2003b).

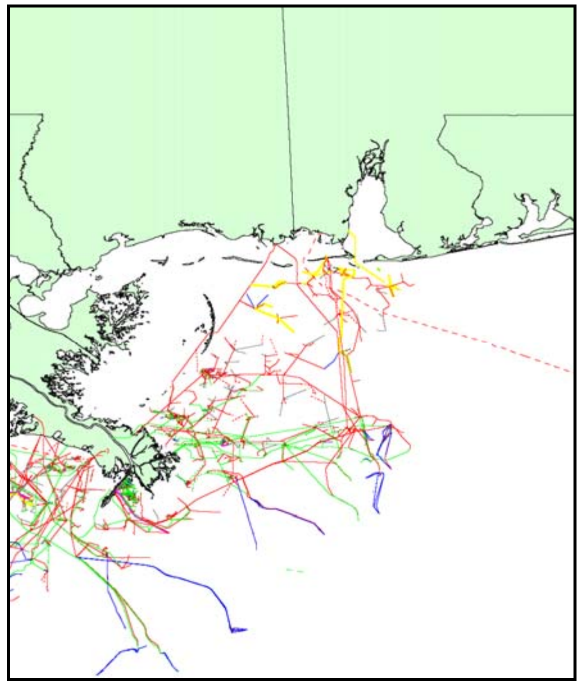

Figure 6-3. Actual and Proposed Pipelines Regulated by the MMS
Source: MMS, 2003c

Oil and gas activities conducted off the coast of states other than Florida are likely to have a similar suite of effects as those conducted in federal waters, but to a much lesser degree. State activities are not expected to contribute significantly to the overall effects of oil and gas activities in the Gulf of Mexico.

6.2.3.4 State Regulated – Western Gulf of Mexico

Texas and Louisiana offer some lease sales in state waters, independent of the Federal OCS Program. Production has been in decline in recent years, while the number of wells has risen (MMS, 2003b; U.S. Air Force, 2004A). This trend is expected to continue. The State of Mississippi began offering tax breaks to companies in 1994 based on the types of discovery and the methods used. As a result, many inactive wells have been brought back into production and new wells have been drilled (U.S. Air Force, 2004A). Alabama has leased a limited number of tracts in state waters. However, the last lease sale was held in 1997, and further lease sales are not expected in the near future (MMS, 2003b).

6.2.4 Dredging Operations

The construction and maintenance of federal navigation channels are ongoing activities on the U.S. Atlantic coast and in the Gulf of Mexico. NMFS has identified dredging operations as an activity that may cause sea turtle mortality. Hopper dredges move faster than sea turtles and can entrain (or trap) them. NMFS has issued BOs with the U.S. Army Corps of Engineers (USACE) for the U.S. Atlantic coast and the Gulf of Mexico and has concluded that the implementation of reasonable and prudent measures will result in no jeopardy to sea turtle species. Dredging activities also have the potential to affect the protected Gulf and shortnose sturgeons, particularly juveniles that may not be able to avoid entrainment. This potential effect has not been quantified. Dredging operations obviously affect the geology of an area, as the floor topography is altered and turbidity occurs.

One area that requires channel maintenance dredging is the Thames River, which is used by Naval Submarine Base (NSB) New London, near Groton, Connecticut. In 2004, the U.S. Navy requested a permit for maintenance and improvement dredging from the USACE of the Thames River (USACE, 2005). Permit Number NAE-2004-3047 was granted May 2005 to remove piers 4, 6, and 13; construct a new pier 6; and dredge and construct a cad cell. The USACE does not have turtle monitoring/takes information for this area, but between 1994 and 2003, the Atlantic Ocean region of the United States had the fewest number of turtle takes (Dickerson et al., 2004).

An area in the mid-eastern Atlantic coast of the United States that utilizes maintenance dredging on a regular basis is the Hampton Roads region of southeastern Virginia. A Notice of Intent (NOI) to prepare an EIS for dredging the Norfolk Harbor Channel was announced in 2006. That EIS is being prepared so that 7.7 km (4.8 mi) of the channel could be deepened in order to provide naval carriers with safe and unrestricted access (USEPA, 2006A). Hampton Roads, a natural tidal basin formed by the confluence of the James and Elizabeth Rivers, includes the waterways around Norfolk, Virginia Beach, Suffolk, Chesapeake, Portsmouth, Hampton, and Newport News, Virginia. A series of navigation channels (more than 10) lie in this area and require dredging to maintain their dimensions, which range from 107 to 305 m (350 to 1,000 ft) wide and 14 to 17 m (45 to 55 ft) deep (GlobalSecurity.org, 2005). The USACE Norfolk District has reported a total of 27 sea turtle takes between 2000 and 2006 due to dredging operations in the area of Hampton Roads (USACE, 2007c).

One southeastern Atlantic coast region in which maintenance dredging is necessary is within Cumberland Sound and NSB Kings Bay on the southeastern Georgia coast. Dredging in Kings Bay has occurred at least once a year since 1994. The USACE Jacksonville District has reported a total of 15 sea turtle takes between 2000 and 2007 due to dredging operations in the Kings Bay area (USACE, 2007d).

Another southeastern Atlantic coast area that requires maintenance dredging is Jacksonville Harbor and Naval Station (NS) Mayport in northeast Florida. In 2006 Jacksonville Port Authority (JAXPORT) deepened the final stretch of Jacksonville's main shipping channel from

11.5 to 12.2 m (38 to 40 ft). USACE is proposing to deepen the St. Johns River Main channel to 14 m (45 ft) (JAXPORT, 2007). To maintain adequate depths for naval ships, NS Mayport must dredge 458,732.92 cubic meters (m^3) (600,000 cubic yards [yd^3]) of sediment every 18 to 24 months from the entrance channel of the St. Johns River and the facility's turning basin (U.S. Environmental Protection Agency [EPA], 2000). Currently an EIS is being written by the Navy that proposes homeporting additional surface ships at NS Mayport. If that EIS is approved, it would require additional dredging to deepen the NS Mayport turning basin, the entrance channel, and the Jacksonville Harbor entrance channel and in addition would result in the removal and disposal of approximately 4,357,962.69 m^3 (5.7 million yd^3) of material (DON, 2006f). The USACE Jacksonville District has reported a total of six sea turtle takes between 2000 and 2007 due to dredging operations in the area of Jacksonville Harbor and NS Mayport (USACE, 2007d).

6.2.5 Maritime Traffic

6.2.5.1 Maritime Traffic – Commerce/Shipping Lanes

The waters off the U.S. Atlantic coast support a large volume of maritime traffic heading to and from foreign ports as well as traffic traveling north and south to various U.S. ports. Commercial shipping comprises a large portion of this traffic, and a number of commercial ports are located along the Atlantic and Gulf of Mexico U.S. coasts.

One of the primary shipping lanes in the northeastern Atlantic coast area is off northern New England with many arteries leading to ports in Massachusetts, New Hampshire, and Maine. Most of the eastern portion of the Boston OPAREA is free from commercial traffic, but commercial traffic can be expected in the western part of the OPAREA (DON, 2005). Several primary shipping lanes crisscross the Narragansett Bay OPAREA, leading to the major ports of New York City, New York and Newark, New Jersey, as well as Providence, Rhode Island. The Atlantic City OPAREA contains several primary shipping lanes leading from New York City and Newark to ports in Delaware Bay and the mid-Atlantic United States (DON, 2005). On July 1, 2007, in order to reduce the threat of vessel collisions with right and other whale species, NOAA and the USCG implemented a shift in the traffic separation scheme for Boston. Ships going in and out of Boston Harbor via shipping lanes will now travel a path that is rotated slightly to the northeast and narrowed. This lane shift adds about 6.9 km (3.75 NM) to the overall shipping lane distance (NOAA, 2007A).

A number of commercial ports are located in Chesapeake Bay and Delaware Bay in the mid-Atlantic U.S. coast area. There also are a number of inland ports that are accessed through these bay systems (DON, 2007a). The Virginia Capes (VACAPES) OPAREA is in the direct path of commercial shipping traffic traveling between the two major ports along the northeastern seaboard, New York and Boston, and Miami and other ports in the south (DON, 2007a).

The Cherry Point (CHPT) and Jacksonville/Charleston (JAX/CHASN) OPAREAs are also in the direct path of commercial shipping traffic traveling between New York, Boston, and Miami and other ports in the southeast. There are seven major shipping lanes in the JAX/CHASN and CHPT OPAREAs. Most of the lanes are parallel to the coastline but several branch off the main routes where they approach major shipping ports (DON, 2002b and 2002c).

A large volume of ship traffic navigates the Gulf of Mexico. Traffic includes ships traveling within the Gulf to ports in the United States and Mexico as well as in and out of the Gulf through the Florida Straits and Yucatan Channel. Commercial (domestic and international) shipping comprises the vast majority of this traffic. Nine primary shipping lanes radiate north from the Yucatan Straits into the Study Area while several major shipping lanes bisect the Florida Straits. Many large ports exist in the Gulf of Mexico area, the largest of which are Galveston, Texas; New Orleans, Louisiana; and Tampa, Florida (DON, 2007d).

Marine transportation is expected to grow. Surface vessel traffic is a major contributor to noise in all oceans, particularly at low frequencies. The effect on marine species is unknown, but it is possible that this persistent noise may affect marine mammals' use of sound for communication and hunting.

6.2.5.2 Maritime Traffic – Ship Strikes

NMFS identified commercial and recreational traffic and recreational pursuits as potentially having adverse effects on sea turtles and cetaceans through propeller and boat strike damage (U.S. Air Force, 2004A). Private vessels participating in high-speed marine activities are particular threats.

Ship strikes or ship collisions with whales are a recognized source of whale mortality worldwide. The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., the sperm whale). Laist et al. (2001) identified 11 species known to be hit by ships. Of these species, fin whales are struck most frequently; right whales, humpback whales, sperm whales, and gray whales are hit commonly. On the East Coast of North America, ship strikes remain a significant threat to some whale populations. For North Atlantic right whales, for example, ship strikes are believed to be a significant factor limiting the recovery of this species (Knowlton and Kraus, 2001).

A review of recent reports on ship strikes provides some insight regarding the types of whales, locations and vessels involved, but also reveals significant gaps in the data. The Large Whale Ship Strike Database report provides a summary of the 292 worldwide confirmed or possible whale/ship collisions from 1975 through 2002 (Jenson and Silber, 2003). The report also notes that these totals represent a minimum number of collisions, because the vast majority go undetected or unreported.

All types of ships can hit whales, and in most cases the animal is either seen too late, not observed until the collision occurs, or not detected. The ability of a ship to avoid a collision and to detect a collision depends on a variety of factors, including environmental conditions, ship design, size, and manning.

Note that smaller ships, such as Navy destroyers and Coast Guard cutters, have a number of advantages for avoiding ship strikes compared to most merchant vessels. For instance, naval and

Coast Guard ships have their bridges positioned forward, offering good visibility ahead of the bow.

Military crew sizes are also much larger than those of merchant ships, and they have dedicated lookouts posted during each watch. These vessels are generally twin screw and much more maneuverable than single screw commercial craft. Due to smaller ship size and higher deck manning, Navy and Coast Guard vessels are likely to detect any strike that does occur, and these agencies' standard operating procedures include reporting of ship strikes. Overall, the percentage of Navy traffic relative to other large shipping traffic is very small (on the order of 2 percent).

NOAA continues to review all shipping activities and their relationship to cumulative effects, in particular on large whale species. According to the NOAA report (Jenson and Silber, 2003), the factors that contribute to ship strikes of whales are not clear, nor is it understood why some species appear more vulnerable than others. Nonetheless, the number of known ship strikes indicates that deaths and injuries from ships and shipping activities remain a threat to endangered large whale species, and to Atlantic Ocean right whales in particular (Jenson and Silber, 2003).

Maritime traffic also increases underwater noise. The amount of noise produced by a ship depends on its type, size, and operational mode. Large commercial vessels emit low frequency noise in ranges similar to those used by some large whales (mysticetes) in communication to each other (NMFS, 2006a). This communication between whales could be masked by vessel noise. Masking not only interferes with communication, but also with the animal's ability to detect and avoid approaching ships (NMFS, 2006a). Masking can be due to one individual ship or the constant drone in the ocean from increases in boat traffic. Boat traffic has steadily increased over the years; however, the number of large ships is predicted to double over the next two to three decades (Southall, 2005).

6.2.6 Seismic Survey and Scientific Research

Seismic surveys occur throughout the Study Area. One of the most active organizations performing oceanographic seismic surveys is the Lamont-Doherty Earth Observatory (LDEO). Seismic surveys performed by LDEO utilize airguns, sonar, and sub-bottom profilers, all of which have the possibility of harassing marine mammals. The deepwater Gulf of Mexico is the premier source of gas production intended to offset declines from gas fields on the shelf. Modern three-dimensional seismic surveys are the main survey method used for these efforts and sometimes cover hundreds of blocks and involve several months of acquisition time (Petzet, 1999). The OCS Deep Water Royalty Relief Act (DWRRA) provides economic incentives for operators to develop fields in water depths greater than 200 m (656.17 ft). Between 18 and 47 percent of the lease blocks in the Gulf of Mexico are undergoing geological surveys in any given year. During Gulf Cetaceans (GulfCet) I and II surveys, seismic exploration signals were detected 10 to 21 percent of the time, respectively (Davis et al., 2000a).

The potential exists for effects to protected marine mammals and sea turtles from underwater noise associated with seismic airgun surveys. LDEO has had Incidental Harassment Authorizations (IHAs) for surveys off the northern Yucatan Peninsula, northern Gulf of Mexico, southeast Caribbean Sea, and in the mid- and northwest Atlantic Ocean (Federal Register, 2004A, 2003A, 2004B, 2003B, and 2003C). However, these IHAs are all now expired. NMFS has determined that minor adverse behavioral effects to sea turtles may result from seismic survey activities in deeper federal waters, but these effects would be short-term and minor. Effects to sea turtles have not yet been analyzed in states where nesting beaches and important foraging areas may be present (U.S. Air Force, 2005b).

In addition to seismic surveys, scientific research on protected species such as marine mammals and sea turtles and studies on the marine environment in general occur throughout the AFAST Study Area. For targeted research on particular species regulated by NMFS and the USFWS, a scientific research and enhancement permit is required for any proposed research activity that involves the "take" of a marine species (NMFS, 2007). Scientific Research and Enhancement Permits are required for research that results in the take of marine mammal species or involves any ESA-listed species that are not covered by the General Authorization. Permits cover a five-year period. The most recent permit was issued by NMFS in August 2007 and includes the observation of behavioral responses by beaked whales and other odontocetes to underwater sound. The permit, which covers activities being conducted by NMFS's Office of Science and Technology, authorizes research on marine mammals in waters to the east of Andros Island, Bahamas. Activities include the attachment of tags to and photography of cetaceans, and exposing them to sound, particularly from mid-frequency sonar. Additional permits authorized that are of particular interest in the AFAST Study Area include a wide variety of research activities on right whales. NMFS is currently analyzing the cumulative effects of these authorizations in the proposed Programmatic EIS on Northern Right Whale Research.

The 1994 amendments to the MMPA authorized, under a General Authorization, the conduct of activities that involve low-impact harassment levels of marine mammals in the wild. Activities encompassed by the General Authorization for Scientific Research do not require a scientific research and enhancement permit. The activities covered under the General Authorization are limited to bona fide research that only involves Level B harassment of non-ESA-listed marine mammals and generally include, but are not limited to, photo-identification studies, behavioral observations, vessel surveys, and aerial surveys over water or land, as well as over pinniped rookeries if flown at altitudes greater than 305 m (1,000 ft) (NOAA, 1994). In addition to the General Authorization, NMFS also issues commercial and education photography permits. These permits allow for photography of non-listed marine mammals that result at a maximum in Level B harassment. Additional activities authorized include those related to imports for public display of marine mammals, as well as import and export of marine mammal parts.

6.2.7 Expended Materials

Expended materials include any man-made object expended, disposed of, or abandoned that enters the coastal or marine environment. It may enter directly from a ship, or indirectly when washed out to sea via rivers, streams, and storm drains. Types of expended materials include plastics, abandoned vessels, glass, metal, and rubber. These materials can injure or kill marine life, interfere with navigation safety, create adverse economic effects to shipping and coastal industries, and pose a threat to human health (NOAA, 2007i).

During the 2005 International Coastal Cleanup Campaign event, U.S. volunteers discovered 88 animals entangled in expended materials. As shown in Table 6-2, expended fishing line was responsible for nearly half of all entanglements, followed closely by rope and fishing nets (Ocean Conservancy, 2005a).

Table 6-2. Summary of Animals Entangled in Expended Materials

Material	Birds	Fish	Invertebrates	Mammals	Reptiles
Balloon ribbon/string	4	0	0	0	0
Fishing line	21	10	6	3	1
Fishing nets	8	3	1	0	1
Miscellaneous	1	2	1	0	2
Plastic bags	1	6	0	0	1
Plastic sheeting	1	1	0	0	0
Rope	5	2	1	6	0

Source: Ocean Conservancy, 2005a

6.2.8 Environmental Contamination and Biotoxins

Insufficient information is available to determine how, at what levels, or in what combinations, environmental contaminants may affect cetaceans (Marine Mammal Commission [MMC], 2003). There is growing evidence that high contaminant burdens are associated with several physiological abnormalities, including skeletal deformations, developmental effects, reproductive and immunological disorders, and hormonal alterations (Reijnders and Aguilar, 2002). DeSwart et al. (1996) conducted a study where harbor seals were fed contaminated Baltic herring and their immune function was monitored over a two-and-a-half-year period. The results of this study showed that chronic exposure to environmental contaminants accumulated through the food chain had an adverse effect on the immune function of those harbor seals. This further suggests that environmental contaminants may have an adverse immunological effect on free-ranging seals in areas with similar contamination levels as that observed in this study (DeSwart et al., 1996). Since no similar studies have been conducted with other marine mammal species, it may be reasonably concluded that similar effects could occur in other marine mammals, such as cetaceans.

Several mortality activities (die-offs) have been reported for cetaceans. Biotoxins, viruses, bacteria, and El Niño activities have been implicated separately in recent mass mortality activities (Domingo et al., 2002). A mass mortality activity for humpback whales, apparently associated with biotoxins, occurred along the beaches of Massachusetts in 1987 through 1988. Geraci et al. (1989) concluded that the whales died from saxitoxin poisoning after consumption of Atlantic mackerel containing the toxin. During the summer of 2003, 17 humpback whales, 3 fin whales, 1 minke whale, 1 long finned pilot whale, and 3 whales of undetermined species were found dead in the vicinity of Georges Bank. Although a biotoxin (saxitoxin) was found in several samples collected, it was not present at lethal levels. Domoic acid was also detected and suspected as a probable cause, but because no brain samples were collected, the role of this biotoxin could not be confirmed (MMC, 2004; DON, 2005).

6.2.9 Marine Ecotourism (Whale-Watching and Dolphin-Watching)

Migrating baleen whales may be affected by whale-watching activities off the East Coast as well as in the Caribbean (Hoyt, 1995). Effects of whale-watching on cetaceans may be measured in a short time-scale (i.e., startle reaction) or as a long-term effect on reproduction or survivability (International Fund for Animal Welfare [IFAW], 1995). There is little evidence to show that short-term effects have any relation to possible long-term effects on cetacean individuals, groups, or populations (IFAW, 1995). Whale-watching could have an effect on whales by distracting them, displacing them from rich food patches, or by dispersing food patches with wake or propeller wash.

6.2.10 National Aeronautics and Space Administration (NASA) Activities

The National Aeronautics and Space Administration's (NASA's) main operational centers on the East Coast are located at Kennedy Space Center and Cape Canaveral Air Force Station in Florida and Wallops Flight Facility/Goddard Space Flight Center in Virginia. Activities at the Florida sites in 2007 and 2008 include five space shuttle launches, and four Delta II rocket launches (NASA, 2007c). No major launches are planned for Wallops Flight Facility/Goddard Space Flight Center. Operations at Wallops Flight Facility/Goddard Space Flight Center include many research-oriented activities such as the launching of sounding rockets and scientific balloons (NASA, 2007d).

6.2.11 Military Operations

6.2.11.1 Mine Exercise

Mine Exercises (MINEX) may occur as part of an Expeditionary Strike Group (ESG) Composite Training Unit Exercise (COMPTUEX) or a Combined Carrier Strike Group (CSG) COMPUTEX/ Joint Task Force Exercises (JTFEX), but they only involve underwater detonation (UNDET) activities when they are conducted as part of a Strike Group Training exercise on the East Coast. They do not involve mine laying or searching activities involving MIW sonar (these are done at the Unit Level and Intermediate Level Training in the Gulf of Mexico as part of a Gulf of Mexico Exercise [GOMEX] or squadron exercise [RONEX]). For an ESG COMPTUEX, UNDETs would occur in the CHPT box that is defined by the East Coast MINEX BO (up to 9 kg [20 lb] charges). For the Combined CSG COMPTUEX/JTFEX the UNDETs would occur in CHASN in the box defined by the East Coast MINEX BO (NMFS, 2002a).

The potential biological effects associated with the MINEX UNDETs are addressed in the MINEX BO issued by NMFS in 2002. The BO addresses potential impacts from MIW exercises and explosive ordnance disposal (EOD) unit-level training to loggerhead, Kemp's ridley, leatherback, hawksbill, and green sea turtles at several locations along the East Coast (Virginia Beach, Virginia; Onslow Bay, North Carolina; and Charleston, South Carolina). The BO analyzed a total of 40 MINEX events per year to be conducted between the three locations using C-4 or high explosives as well as the possible use of 4.5 or 9.1 kg (10 or 20 lb) charges, in rare instances.

NMFS states in the BO that proposed MINEX and explosive ordnance disposal training is not likely to jeopardize the continued existence of loggerhead, Kemp's ridley, leatherback, hawksbill, and green sea turtles. However, NMFS anticipates incidental take of these species and has issued an Incidental Take Statement (ITS) pursuant to Section 7 of the ESA. The ITS includes mitigation measures with implementing terms and conditions to help minimize harassment. In addition, the BO states that species of large whales, including species protected by the ESA, can be found in or near the area where this type of training would occur. However, the BO states that NMFS feels that the protective measure identified within the BO, if implemented, would allow the Navy the opportunity to reduce the chances of effects to these species to discountable levels. Mitigation measures have been designed and implemented for MINEXs in order to minimize any potential adverse effects to marine mammals and to avoid any significant or long-term adverse effects to marine mammals and the coastal, cultural, or marine environment (NMFS, 2002a).

6.2.11.2 Sinking Exercise of Surface Targets

A Sinking Exercise of Surface Targets (SINKEX) is defined as the use of a vessel as a target or test platform against which live ordnance is fired. The purpose of a SINKEX is to train personnel, test weapons, and study the survivability of ship structures. The result is the sinking of the vessel. SINKEX operations differ from ship shock trials in that the warheads used in a SINKEX are significantly smaller. The environmental considerations of a SINKEX are associated with the weapons used. The exact amount of ordnance and the type of weapon used in a SINKEX is situational and training-need dependent (DON, 2006e).

The U.S. Navy submitted a Biological Assessment (BA) to the National Oceanic and Atmospheric Administration (NOAA) pursuant to compliance with the ESA. NOAA concluded that SINKEXs in the western Atlantic Ocean are not likely to jeopardize the continued existence of ESA listed species in a Biological Opinion dated September 22, 2006 (DON, 2006e).

6.2.11.3 Naval Surface Fire Support Training

The Navy uses the Virtual At-Sea Training/Integrated Maritime Portable Acoustic Scoring and Simulator (VAST/IMPASS) system to qualify and recertify ships in naval surface fire support. The VAST/IMPASS system is a reusable, portable system that can be deployed anywhere in the open ocean. The system is comprised of five free-floating sonobuoys that are deployed in the shape of a pentagon/house array. The sonobuoys are capable of "scoring" the landing of 5-inch (in)/54 rounds aimed at a virtual target within the sonobuoy array. The buoys serve as collectors of acoustic information. When a 5-in/54 round impacts the water, accuracy is determined by the differential time that each individual buoy receives the sound (DON, 2005b).

The VAST/IMPASS system is used in open ocean areas along the eastern United States and in the Gulf of Mexico. Where live ordnance is used, the potential for marine mammal populations to be exposed to acoustic energy exists. Therefore, mitigation measures have been designed and implemented for the use of the VAST/IMPASS system to minimize any potential risks to marine mammals and to avoid any significant or long-term adverse effects to marine mammals and the coastal, cultural, and marine environment (DON, 2005b).

The Navy initiated formal consultation with NMFS in February 2004 by submitting a biological assessment (BA) for use of the IMPASS system in East Coast OPAREAs and the Eastern Gulf of Mexico Test and Training Area (EGMTTA). The Navy is currently awaiting NMFS's BO, but anticipates that the conclusion will be that the use of naval gunfire is not likely to jeopardize the existence of any listed species. The mitigation/mitigation measures have and will continue to be implemented for use of the IMPASS system in order to minimize any potential risks to threatened and endangered species.

6.2.11.4 Military Operations – Atlantic Ocean, Offshore of the Southeastern United States

Designated bomb boxes have been established in each OPAREA where inert bombs could be dropped during a major Atlantic Fleet training exercise. The process for selecting these sites within each OPAREA involved balancing operational suitability (close proximity to where the strike group is operating) and environmental suitability. Environmental suitability includes an area that possesses a low likelihood of encountering threatened and endangered species and that avoids the continental shelf, canyon areas, and the Gulf Stream, all of which are locations where threatened and endangered marine mammal and sea turtle species are most abundant. The use of the bomb box (Area J31) in the JAX/CHASN OPAREA is discussed in the 1997 NMFS BO, which concludes that Navy activities are not likely to jeopardize the continued existence of listed species (NMFS, 1997). Based on the combination of prudent site-selection and the mitigation measures to be implemented in all OPAREAs that were developed as part of the BO for protection of the North Atlantic right whale (NMFS, 1997), it is anticipated that dropping inert bombs in the established bomb boxes associated with major Atlantic Fleet exercises would not affect listed species.

6.2.11.4.1 VACAPES OPAREA

The VACAPES Complex includes land and offshore areas of Delaware, Maryland, Virginia, and North Carolina, incorporating air, land, and sea spaces that extend 287.06 km (155 NM) into the Atlantic Ocean. It is the principal training area for air, surface, and submarine units located in Hampton Roads, Virginia. The VACAPES Complex is also the primary homeport of the Atlantic Fleet. In addition to serving as the site for essential Navy training, the VACAPES Complex is host to activities for the RDT&E of emerging technologies. VACAPES Complex operations include aircraft training, surface training, subsurface training, and RDT&E.

Aircraft Training can include jet aircraft, helicopters, and unmanned aerial vehicle (UAV) flights, and can involve deployment of guns, missiles, and sonobuoys. Training can be against a mock enemy ship, submarine, or other aircraft. UAV activities are predominantly used for training in surveillance and intelligence gathering.

Surface Training utilizes vessels ranging in size from rubber-hull inflatable boats to aircraft carriers. Training can include activities geared toward improving navigation skills and object recognition through sonar use, underwater mine avoidance, and anti-terrorism measures. It can also involve gun or missile firings. Smaller ships generally train in shallow water areas to practice skills such as drug interception and the defense of larger ships.

Subsurface Training involves tracking ships or other submarines and can include simulated attacks on surface ships or submarines. These activities may also involve the use of passive sonar for tracking purposes. Active sonar, which allows the Navy to "see" underwater by emitting pulses of sound, may also be used at a more limited level. Submarines also practice training activities for mobility in complex environmental situations, underwater mine avoidance, and the deployment of special operations forces.

RDT&E includes the development of new vessels, aircraft, and weapons systems. RDT&E allows the Navy to increase their understanding of the actual battlefield environment, improve system design and performance, and maintain the technological edge necessary to meet future military requirements (DON, 2007e).

Patuxent River Naval Air Station (NAS) covers about 26 square kilometers (km^2) (10 mi^2) and 40 km (25 mi) of shoreline at the mouth of Patuxent River in southern Maryland. The NAS supports naval aviation operations through RDT&E of aircraft, aircraft components, and related products. The Navy's principal research, development, test, evaluation, engineering, and fleet support for naval aircraft, engines, avionics, aircraft support systems, and ship, shore, and air operations occurs at NAS Patuxent River. The installation also is home to the Navy Test Pilot School and supports unmanned aerial vehicle operations (GlobalSecurity.org, 2007a).

6.2.11.4.2 CHPT OPAREA

The CHPT OPAREA is located in the nearshore and offshore waters of North Carolina in the northwestern Atlantic Ocean. The CHPT OPAREA covers 63,285 km^2 (24,434 mi^2) of ocean area. Two military installations, Marine Corps Air Station (MCAS) Cherry Point and Marine Corps Base (MCB) Camp Lejeune, are located on land adjacent to the OPAREA. These installations often use the waters of the OPAREA for their training operations. The CHPT OPAREA is host to activities for research, development, testing, and evaluation of emerging maritime combat technologies.

MCAS Cherry Point, located about 145 km (90 mi) southwest of Cape Hatteras in North Carolina, is the world's largest MCAS, covering over 117 km^2 (45 mi^2). Military activities at MCAS Cherry Point revolve around training and support for air combat operations associated with the 2nd Marine Aircraft Wing (GlobalSecurity.org, 2007b).

NMFS issued a BO (NMFS, September 2002) in response to a BA sent by MCAS Cherry Point, North Carolina for the continued use of Bombing Target 9 (BT-9) and BT-11 in Pamlico Sound, North Carolina. The BO covers the use of BT-9 and BT-11 by various military aircraft and small watercraft training in ordnance delivery. In addition, non-explosive ordnance up to 2,000 lbs (907 kgs), strafing rounds, and explosive ordnance (not to exceed 100 lbs [45 kgs] trinitrotoluene [TNT] equivalent) are covered at BT-9. Only non-explosive ordnance is authorized at BT-11.

The BO states NMFS's belief that the use of explosive and non-explosive ordnance at BT-9 and non-explosive ordnance at BT-11 is not likely to jeopardize the continued existence of loggerhead, Kemp's ridley, green, or leatherback sea turtles. However, NMFS anticipates incidental takes of these species and has issued an ITS pursuant to Section 7 of the ESA. This ITS contains reasonable and prudent measures with implementing terms and conditions to help minimize takes.

The southern portion of Onslow County in North Carolina is the home of Camp Lejeune, the Marine Corps' largest amphibious training facility. Camp Lejeune is a 637 km^2 (246 mi^2) military training facility that includes 23 km (14 mi) of beach capable of supporting amphibious operations. It is home to the II Marine Expeditionary Force, 2nd Marine Division, 2nd Force Service Support Group and other combat units and support commands. There are 54 live-fire ranges, 89 maneuver areas, 33 gun positions, 25 tactical landing zones, and a Military Operations in Urban Terrain (MOUT) training facility. Military forces from around the world come to Camp Lejeune on a regular basis for bilateral and North Atlantic Treaty Organization (NATO)-sponsored exercises (GlobalSecurity.org, 2007c).

Training for amphibious landing is restricted at Camp Lejeune because of beach restrictions during turtle-nesting season, and a rare species of woodpecker makes inland training difficult. A loggerhead turtle nesting site is next to Camp Lejeune. North Carolina law protects the Atlantic sturgeon, American shad, green turtle, loggerhead sea turtle, and Kemp's ridley turtle. The loggerhead and green turtles are also federally listed threatened species, and the Kemp's ridley turtle is federally listed as an endangered species (GlobalSecurity.org, 2007c).

The United States Fish and Wildlife Service (USFWS) issued a BO (USFWS, May 2002) in response to a BA sent by MCB Camp Lejeune, North Carolina for the continued use and modification of designated military training areas on Onslow Beach, dune stabilization in the central and military training portions of the beach, and the continued recreational use of the beach. The BO addressed the effects of these actions on seabeach amaranth (*Amaranthus pumilus*), the loggerhead sea turtle and green sea turtle, and the Great Lakes, Atlantic Coast, and Northern Great Plains piping plover (*Charadrius melodus*) populations.

This BO states USFWS's belief that the continued use and modification of training areas, dune stabilization, recreational use of Onslow Beach, and the cumulative effects, are not likely to jeopardize the continued existence of seaside amaranth, loggerhead and green sea turtles, or the piping plover. However, USFWS anticipates incidental takes of sea turtles and piping plovers, and has issued an ITS pursuant to Section 7 of the ESA. This ITS contains reasonable and prudent measures with implementing terms and conditions to help minimize takes.

6.2.11.4.3 JAX/CHASN OPAREA

The JAX/CHASN Complex is comprised of land areas, airspace, and portions of the Atlantic Ocean off South Carolina, Georgia, and Florida, extending eastward to 77 degrees west (°W) longitude. The JAX/CHASN Complex is the principal training area for air, surface, and submarine units located in Charleston, South Carolina; Kings Bay, Georgia; and Jacksonville, Florida. In addition to serving as the site for essential Navy training, the JAX/CHASN Complex is host to activities for RDT&E of emerging maritime and combat technologies. Operations at JAX/CHASN are similar to those described for the VACAPES OPAREA above.

In 1997, NMFS issued a BO for naval activities that take place off the southeastern U.S. coast. The BO covered ship operations, naval gunfire, air operations, and moving surface target operations. The geographic scope included the sea area from Charleston, South Carolina, southward to approximately Sebastian Inlet, Florida (southern extent of the right whale critical habitat), and from the coast seaward to 148.16 km (80 NM) from shore (NMFS, 1997). As part of the BO, mitigation measures were implemented by naval vessels and aircraft during the North Atlantic right whale calving season (i.e., December 1 through March 31). To protect other listed species, some mitigation measures were implemented throughout the year (NMFS, 1997). The BO concluded that these actions may adversely affect but are not likely to jeopardize the continued existence of North Atlantic right whales and other ESA-listed species in the consultation area, and that Navy activities may adversely affect, but are not likely to jeopardize the continued existence of populations of endangered humpback and fin whales, or Kemp's ridley, leatherback, hawksbill, green, and loggerhead sea turtles.

NSB Kings Bay, Georgia, is located in coastal southeastern Georgia, along the western shore of Cumberland Sound approximately 3 km (2 mi) north of St. Mary's, Georgia and approximately 56 km (35 mi) north of Jacksonville, Florida. The site was designated as NSB Kings Bay in 1982, and encompasses approximately 65 km^2 (25 mi^2). Facilities at the base enable Kings Bay to serve as a homeport, refit site, and training facility for the Navy personnel who operate and maintain the Ohio-class strategic submarines (GlobalSecurity.org, 2007d).

The Navy Strategic Systems Programs proposed to construct and maintain security facilities to support continuous security service and incident response at NSB Kings Bay. Security improvements include a Waterfront Security Force Facility, an Auxiliary Reaction Force Facility, an Armored Fighting Vehicle Operational Storage Facility (AFVOSF); an Armory; road improvements to ensure efficient access to and from the proposed facilities; and construction of a new parking lot to replace lost parking spaces. No significant effects to environmental resources were expected.

NS Mayport is located near the Port of Jacksonville on the St. Johns River in northeast Florida. NS Mayport is home to 55 tenant commands and private organizations. Some two dozen ships are berthed in the Mayport basin, including Airborne Early Warning/Ground Environment Integration Segment (AEGIS) guided-missile cruisers, destroyers, guided-missile frigates, and aircraft carriers (GlobalSecurity.org, 2007e). NS Mayport covers 14 km^2 (5 mi^2) and is the third largest naval facility in the continental United States. NS Mayport is unique in that it is home to a busy seaport as well as an air facility that conducts more than 135,000 flight operations each year (GlobalSecurity.org, 2007e).

6.2.11.4.4 Mesa Verde Ship Shock Trial

The Navy published, on October 19, 2007, a Notice of Availability (NOA) for the Draft EIS/OEIS for the Ship Shock Trial of the Mesa Verde (LPD 19). A shock trial, in which explosives are detonated near a ship, is conducted on a Navy ship to determine whether it can withstand the unforgiving punishment wrought by sea combat. Through this announcement and document, the US Navy proposes to conduct a shock trial for a new class of ships: the SAN ANTONIO (LPD 17) Class at a site located offshore of Norfolk, Virginia; Mayport, Florida; or

Pensacola, Florida. This class includes 12 ships; however, the Navy will only conduct a ship shock test on the Mesa Verde (LPD 19). The trials will involve a series of four explosive charges weighing up to 4,536 kg (10,000 lb) in the spring and summer of 2008. The projected timeframe includes March 21, 2008 to September 20, 2008. The tests will take place in water depths of at least 183 m (600 ft) in non-territorial waters. Support operations, which include transits between the shore base and the offshore shock test area, would occur through United States (U.S.) territorial and non-territorial waters. These routine activities were not evaluated because they are part of the routine operations associated with the existing shore bases and there will be no increases in overall tempo.

The Navy analyzed three alternative sites offshore of Norfolk, Virginia; Mayport, Florida; and Pensacola, Florida. In addition to these locations, the Navy also analyzed a No Action Alternative, whereby the shock trial would not be conducted. The proposed shock trial would occur offshore by at least 65 km (35 NM) from Norfolk, 70 km (38 NM) from Mayport or 85 km (46 NM) from Pensacola. The Navy would time trials seasonally to minimize the potential risks to marine species. Proposed shock trial locations offshore of these three Navy facilities meet the operational requirements: suitable weather/sea state conditions; a manageable volume of commercial vessel traffic; and proximity to land-based support and infrastructure. The Navy excluded areas with particular environmental features: active petroleum lease blocks, oil and gas infrastructure, coral and artificial reefs, communications cables, critical habitats, danger zones, data buoys, explosive dumpsites, marine sanctuaries, navigation aids, ocean dredged material, acid waste, and sewage sludge disposal sites, shipping lanes, communication and navigation towers, unexploded ordnance sites, and shipwrecks.

The preferred alternative encompasses the location offshore Mayport taking place in spring/summer 2008. The Navy would implement protective measures here to minimize the risks to marine mammals and sea turtles although operations at any of the three locations would not pose a significant threat to marine species. Shock trials would not be conducted offshore Mayport, Florida until after May 1, 2008 due to the migratory patterns of northern right whales. Potential negative impacts include harassment, injury or death to marine animals within a danger zone around the test. The protective measures plan is modeled after the mitigation plan defined and approved by NMFS in the final rule for the USS Winston S. Churchill Final EIS (NOAA, 2001) and successfully implemented during this ship shock trial conducted in 2001 off Florida. The USS Winston S. Churchill shock trial consisted of three detonations and resulted in no deaths or injuries to marine mammals or sea turtles. All animals observed after the detonations appeared to behave normally (DON, 2001). If significant numbers of birds or fish are within 2 km (1 NM) of the detonation point, the Navy will not test in order to avoid large flocks and schools.

The trials will also put small amounts of scrap metal on the ocean floor, introduce explosive by-products into the ocean and atmosphere, and interrupt commercial and recreational fishing. None of these effects, including risk to animals from the blast, are expected to be significant because they will be brief and expend only small amounts of materials.

6.2.11.5 Military Operations –Atlantic Ocean, Offshore of the Northeastern United States

The Northeast OPAREAs are located in the western Atlantic Ocean off the Northeast Coast of the United States and the Southeast Coast of Canada and are made up of the Boston OPAREA, Narragansett OPAREA, and Atlantic City OPAREA. Lying adjacent to the Northeast OPAREAs are the states of Delaware, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine as well as the Canadian provinces of New Brunswick and Nova Scotia. Additional Navy special use areas within the Northeast OPAREAs include the COLE Special OPAREA, located in the Gulf of Maine, the Small Point Mining Range, just off the central Maine coast, and the CGULL OPAREA, located off the southern flank of Georges Bank. Submarine transit lanes are also located within the Boston and Narragansett Bay OPAREAs (DON, 2005b). Activities in these areas include surface-to-air gunnery, anti-submarine warfare (ASW) tactics, and surface/subsurface operations (GlobalSecurity.org, 2007f).

6.2.11.6 Military Operations – Eastern Gulf of Mexico

6.2.11.6.1 Mesa Verde Ship Shock Trial

As stated in Section 6.2.11.4.4, the Navy published a NOA for the Draft EIS/OEIS for the Ship Shock Trial of the Mesa Verde (LPD 19). One of the alternative locations is Pensacola, Florida. Refer to Section 6.2.11.4.4 for more information related to this project.

6.2.11.6.2 Navy Pre-Deployment Training at Eglin Air Force Base, Florida: Composite Training Unit Exercises and Joint Task Force Exercises

This Navy pre-deployment training consists of air-to-ground delivery of live weapons onto the Eglin Range complex, Eglin Air Force Base (AFB), Florida. Aircraft launch from carrier ships, either in the Gulf of Mexico or the Atlantic Ocean off Florida's east coast, fly to target, deliver ordnance, and return to the carrier (DON, 2004b). In these exercises, Opposing Forces aircraft launch from NAS Pensacola to provide simulated opposition to strike fighters. Other components of the exercise include using helicopters in simulated evacuation of military personnel, gunnery exercises, and low-level flight training from carriers in the Gulf of Mexico. Most of those activities take place in warning area 151 (W-151) (Panama City OPAREA). One training component, involving simulated ordnance delivery against targets in developed landscapes and flyover video of the attacks, occurs in the Tyndall Military Operations Area (MOA) at altitudes of 3,048 to 5,486 m (10,000 to 18,000 ft). The Navy will conduct up to two COMPTUEXs and three JTFEXs at Eglin AFB per year. The COMPTUEX and JTFEX would not necessarily be conducted concurrently. COMPTUEX training requires nine days of Eglin Range operations over a 10-calendar-day period, with the majority of operations occurring during the second week. JTFEX requires three days of Eglin Range operations over a three-calendar-day period. The airspace proposed for use includes W-151 (Panama City OPAREA) and W-155 (Pensacola OPAREA) (DON, 2004b).

Potential effects associated with COMPTUEX/JTFEX activities include air quality, noise, and airspace management (DON, 2004b). For each COMPTUEX, up to 696 sorties could be flown over the Gulf of Mexico within a 10-day period. This could occur twice per year. For each JTFEX, up to 30 sorties could be flown over the Gulf of Mexico within a three-day period. This could occur three times per year. The total potential number of annual sorties per year is therefore 1,482. Air pollutant emissions would result from these flights. Because the emissions generated by the training exercises are considered temporary, emission analysis was performed to estimate the amount of combustive emissions emitted from aircraft and from the expenditure of explosive ordnance. Emissions from the training exercises were compared to emissions in the three counties that encompass the Eglin Reservation. Emissions resulting from ordnance explosions were determined to be negligible (DON, 2004b). Table 6-3 shows the amount of air emissions associated with all Eglin activities, COMPTUEX/JTFEX aircraft activities, and the surrounding counties. Air emissions were determined to be non-significant (DON, 2004b).

Table 6-3. Air Emissions Associated With COMPTUEX/JTFEX Activities

Pollutant Emission Source	Pollutants (tons/year)				
	CO	**NO_x**	**PM_{10}**	**SO_x**	**VOCs**
Eglin AFB Stationary Emissions (CY 2001)	72	96	101	11	109
Eglin AFB Mobile Source Emissions (CY 2001)	16,935	80,823	6,143	12,672	5,752
Eglin AFB Totals	**17,007**	**80,919**	**6,244**	**12,683**	**5,861**
Santa Rosa County (CY 2001)*	68,684	14,157	12,537	6,434	16,390
Okaloosa County (CY 2001)*	71,952	8,296	7,363	698	11,135
Walton County Total Emissions (CY 2001)*	21,368	3,475	3,508	230	3,573
County Totals	**162,004**	**25,928**	**23,408**	**7,362**	**31,098**
COMPTUEX/JTFEX Explosive Ordnance Emissions	0.27	0.29	1.3	N/A	0.04
Percent of Eglin Total Emissions	0.0016	0.0004	0.02	N/A	0.0007
Percent of County Total Emissions	0.00017	0.0011	0.0055	N/A	0.00013

Source: DON, 2004c
CO = carbon monoxide; COMPTUEX = Composite Training Unit Exercise; CY = calendar year; JTFEX = Joint Task Force Exercises; N/A = not applicable; NO_x = nitrogen oxides; PM_{10} = particulate matter less than 10 microns in diameter; SO_x = sulfur oxides; VOC = volatile organic compound
* = Includes mobile sources

Noise from both fixed and rotary wing aircraft could enter the water, potentially disturbing marine species (DON, 2004b). In the large-scale COMPTUEX, approximately 1,100 rotary and fixed-wing aircraft sorties would be flown. While the number of daily sorties would be somewhat higher than what is usually flown, modeling has shown that the contribution to noise would not be significant. Another mitigating factor is the fact that the sorties occur over a small amount of time. Therefore, although the noise effects could be relatively intense and concentrated, primarily in W-151, the duration would be short (DON, 2004b).

The increased number of sorties flown during a COMPTUEX would require additional management of military and commercial airspace. However, these activities are expected to fall well within the management capabilities of airspace controllers (DON, 2004b).

6.2.11.6.3 Amphibious Ready Group/Marine Expeditionary Unit Readiness Training

The Navy and Marine Corps conducted one readiness training exercise at Eglin AFB. The training occurred in 2003 and Fleet Forces Command does not plan to conduct this training at Eglin AFB in the near future.

Transport of the Marine Expeditionary Unit (MEU) was conducted by naval ships from various locations throughout the United States to the Gulf of Mexico. Amphibious Ready Group (ARG) operations occurred within the Inner Transport Area, which covers an 8 by 32 km (5 by 20 mi) rectangular box approximately 1.9 to 11 km (1 to 7 mi) from the beach. During the 10-day exercise, ARG ships remained in the assigned box at slow speed (5 to 10 knots [5.8 to 11.5 miles per hour]) or at anchor (U.S. Marine Corps et al., 2003). Operations included launch/recovery of aircraft and launch/recovery of Landing Craft Air Cushion (LCAC), Landing Craft Utility (LCU), and Amphibious Assault Vehicles (AAVs). The ARG consisted of three amphibious ships that were augmented by two or three cruisers/destroyers. No ship-to-shore movements of ground forces occurred from cruisers and destroyers and no more than seven aircraft operated during a single activity (U.S. Marine Corps et al., 2003).

Potential effects from ARG/MEU operations included noise, socioeconomic effects, and effects to biological resources, particularly to sensitive species (U.S. Marine Corps et al., 2003). During the 10-day period of exercises, approximately 130 crossings of LCACs between Navy ships and shore, 78 crossings by AAVs, and 42 crossings by LCUs occurred. These crossings had the potential to transmit noise into the marine environment, potentially disturbing marine species such as sea turtles and marine mammals (U.S. Marine Corps et al., 2003). In addition, there was a potential for vessels to physically strike some animals.

The number of sea turtles potentially affected by surface vessels was evaluated in the BA for ARG/MEU activities and is summarized in Table 6-4.

Table 6-4. Sea Turtles Potentially Affected by ARG/MEU Activities

Species	Number of Sea Turtles at the Surface	Number of Surface and Submerged Sea Turtles	Number of Hatchlings
Loggerhead	3.9	26.0	2.0
Leatherback	0.5	2.2	0.1
Kemp’s ridley	0.2	0.7	0
Unidentified	0.4	2.2	N/A
Green	*	*	1.3
Total	**5**	**31**	**3.4**

Source: U.S. Marine Corps et al., 2003
ARG/MEU = Amphibious Ready Group/Marine Expeditionary Unit; N/A = not applicable
* Turtles listed as unidentified by GulfCet II are assumed to include green sea turtles

Table 6-4 indicates that the expected maximum number of sea turtles within the vessel transit area was less than 35. Realistically, effects from ARG/MEU operations that included, for example, vessel transit and troop movements were limited to turtles at the surface. Thus, less than nine turtles would occupy the surface of the transit area over the 10-day exercise. An additional potential effect to sea turtles was the possibility of surface vessels physically disturbing large *Sargassum* mats. These mats are considered likely habitat for juvenile turtles, as well as habitat for a number of fish species during various life stages. Large *Sargassum* mats, however, are distributed in a very patchy manner and are usually associated with ocean current convergence lines. Effects to *Sargassum* therefore were not considered likely (U.S. Marine Corps et al., 2003).

The USFWS issued a BO in 2003 in response to a BA submitted by the U.S. Navy and the U.S. Air Force. The USFWS anticipated incidental takes of the four species of sea turtles and the flatwoods salamander that occur on Eglin AFB and issued an ITS, pursuant to section 7 of the ESA. The ITS contains reasonable and prudent measures with implementing terms and conditions to help minimize takes.

NMFS issued a BO for the proposed MEU training on April 9, 2003. The BO states that the proposed air and land operations are not likely to adversely affect ESA-listed species under NOAA Fisheries purview, including sperm whales, Gulf sturgeon, and smalltooth sawfish. NOAA Fisheries further concluded that the proposed action’s effects on designated Gulf sturgeon critical habitat are insignificant. Finally, NMFS concluded that the proposed ARG/MEU training is not likely to adversely affect species or critical habitat protected by the ESA, including loggerhead, green, and leatherback sea turtles.

The vessels transiting between the Navy ships and shore would introduce noise into the water, which could disturb protected species such as sea turtles or marine mammals. The noise characteristics (frequency, energy level, etc.) were not quantified, but were considered inconsequential when compared to the baseline level of noise produced by surface vessels in the Gulf of Mexico (U.S. Marine Corps et al., 2003).

The magnitude and intensity of vessels, materials, and troops moving to and from shore necessitated the closing of the operation area to commercial and recreational fishing. However, considering the small size of the exercise areas and the short time duration required for each landing activity, MEU training and operations were not expected to interfere with commercial and recreational fishing activities, and the effect was considered minimal (U.S. Marine Corps et al., 2003).

6.2.11.6.4 Eglin Gulf Test and Training Range Operations

Eglin AFB supported nearly 39,000 sorties during the timeframe of fiscal years (FY) 1995 through 1999 (U.S. Air Force, 2002). Most of the sorties were flown over the Gulf of Mexico, in the Eglin Gulf Test and Training Range (EGTTR). Mission activities conducted within the EGTTR can be summarized as Air Operations and Ordnance Testing and Training. Air Operations include all manned and unmanned aircraft flights through the EGTTR. Ordnance testing and training involves the release of expendables, which are defined as items that are deployed, released, or consumed (or potentially consumed) while performing an activity. Examples of expendables include bombs, missiles, bullets, chaff, flares, and other miscellaneous items. Test and training missions are described below.

EGTTR activities may include effects to air quality, water quality, sensitive species and habitats, non-protected species, airspace management, and effects due to noise (U.S. Air Force, 2002). Mission-generated air emissions were analyzed to enable comparison to National Ambient Air Quality Standards (NAAQS). The results are summarized in Table 6-5.

Table 6-5. Air Emissions Associated With EGTTR Missions

Criteria Pollutant	Averaging Time	NAAQS	W-155A	W-155B	W-168 A/B/C	W-470A	W-470B	W-470C
CO	1-hour	40 mg/m^3	1.62E-06	1.08E-06	8.67E-08	2.41E-05	2.17E-05	3.94E-05
	8-hour	10 mg/m^3	1.13E-06	7.42E-07	6.07E-08	1.69E-05	1.52E-05	2.76E-05
NO_2	Annual	100 µg/m^3	4.30E-03	3.81E-03	6.72E-05	1.23E-01	1.10E-01	2.02E-01
SO_2	3-hour	1300 µg/m^3	2.95E-04	2.52E-04	8.09E-06	6.06E-03	5.30E-03	9.71E-03
	24-hour	365 µg/m^3	2.06E-04	1.76E-04	5.66E-06	4.23E-03	3.71E-03	6.79E-03
	Annual	80 µg/m^3	7.60E-05	6.51E-05	2.09E-06	1.56E-03	1.37E-03	2.50E-03
PM_{10}	24-hour	150 µg/m^3	2.92E-04	3.38E-04	1.65E-05	6.15E-03	5.63E-03	1.03E-02
	Annual	50 µg/m^3	1.08E-04	1.25E-04	6.10E-06	2.27E-03	2.08E-03	3.81E-03

Source: U.S. Air Force, 2002
EGTTR = Eglin Gulf Test and Training Range; CO = carbon monoxide; µg/m^3 = micrograms per cubic meter; mg/m^3 = milligrams per cubic meter; NAAQS = National Ambient Air Quality Standards; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns in diameter; SO_x = sulfur oxides
* Units of measurement for the criteria pollutants in each of the Warning Areas of the EGTTR are the same as those given for the NAAQS column

Water quality may be negatively affected from the introduction of chemical materials from jet fuel, munitions, chaff, and flares. Fuel may be introduced into the water by the occasional downing of a target drone and by emergency in-flight fuel release (U.S. Air Force, 2002). Table 6-6 and Table 6-7 show the maximum amount of fuel deposited by these actions between 1995 and 2000. In reality, the amount is far less because the extreme volatility of the substance results in a significant amount (approximately 99 percent) of evaporation during descent. The remainder would disburse through the action of waves and currents.

Table 6-6. Estimated Volume of Fuel Released by Drones During EGTTR Missions

Drone Type	Quantity	Average Fuel Amount (gallons/drone)	Total Fuel Released (gallons)
QF-4	21	1,030	21,630
QF-106/4	35	735	25,725
BQM-34	20	40	800
MQM-107	23	30	690
		TOTAL	**48,845**

Source: U.S. Air Force, 2002

Table 6-7. Estimated Fuel Release from In-Flight Emergencies (IFE) During EGTTR Missions

Aircraft Type	IFE Sorties that Released Fuel	Average Released Fuel (gallons/sortie)	Total Fuel Released (gallons)	Fuel (gallons) Reaching Surface
F-15/F-15E	220	735	161700	1,620
F-18	4	735	2940	30
F-111	2	735	1470	20
F-117	0.2	735	150	2
AC/MC/C-130	0.5	1,470	700	10
		TOTAL	**166,960**	**1,682**

Source: U.S. Air Force, 2002

Chaff is primarily used as a defense mechanism and is released from engaged aircraft. Discharge of chaff results in the release of millions of aluminum dipoles (short fibers similar in appearance to human hair) that create an electromagnetic cloud around the aircraft, shrouding the plane from enemy radar and defense systems. The main chemical component of concern in chaff is aluminum. Due to the wide dispersion over large areas of the eastern Gulf of Mexico, chaff dispersion would vary for each of the water ranges (U.S. Air Force, 2002). A small portion of the chaff may dissolve over time. An assessment suggests that approximately 0.06 percent of the initial aluminum weight would dissolve in seawater. Although no criteria exist for aluminum in oceanic waters, it is a naturally occurring trace element (river input) in seawater and found at variable concentrations. Effects are therefore considered negligible (U.S. Air Force, 2002).

Flares are high-temperature heat sources that are ejected from aircraft to confuse and divert enemy heat-seeking or heat-sensitive missiles. Flares are also used to illuminate surface areas during nighttime operations. The principle chemical element of concern is magnesium. The total amounts of magnesium added to the Gulf of Mexico surface waters would be less than 0.0002 percent (W-151) and 0.0005 (W-470) percent of the background concentration (1.35 grams per liter [g/L] [11,266 lbs/gallon [gal]) of magnesium in the Gulf of Mexico surface waters. Due to this extremely small amount, no adverse effects are anticipated (U.S. Air Force, 2002).

Test and training missions conducted by Eglin AFB result in numerous flight activities in the EGTTR involving a variety of aircraft and missiles flying at a wide range of altitudes and traveling at speeds ranging from slow subsonic to supersonic. Subsonic and supersonic aircraft noise is basically continuous over the EGTTR while missions are in progress. Supersonic noise from EGTTR missions was determined to be not likely to adversely affect dolphins or other biological resources, or socioeconomic (human) resources (U.S. Air Force, 2002).

Underwater noise resulting from gunnery missions has been calculated. Noise results from 25-millimeter (mm), 40-mm, and/or 105-mm rounds being fired at the water surface. Various noise levels were found to be pertinent to effects to protected species. The distance from an exploding shell that these noise levels would reach was determined, and then the number of animals potentially affected was calculated. Generally, for the purposes of the EGTTR Programmatic Environmental Assessment (EA), noise levels above 205 decibels (dB) referenced to 1 micropascal squared second (dB re 1 μPa^2 s) are considered injurious, levels above 182 dB re 1 μPa^2 s are considered non-injurious harassment, and levels above 176 dB re 1 μPa^2 s are considered behavioral harassment. This 176 dB re 1 μPa^2 value was employed by the U.S. Air Force for behavioral takes of marine mammal species and was based on the *EA for the Use of the AN/SSQ-110A Sonobuoys in Deep Ocean Waters.* The harassment level is now set at 177 dB for all Air Force activities. Table 6-8 and Table 6-9 show the number of protected species potentially affected. All gunnery missions used in these calculations occur in W-151.

Table 6-8. Yearly Estimated Number of Marine Mammals Affected by the Gunnery Mission Noise

Species	Adjusted Density (No./km^2)	Level A Harassment Injurious 205 dB* EFD for Ear Rupture	Level B Harassment Non-Injurious 182 dB* EFD for TTS	Level B Harassment Non-Injurious 176 dB* EFD for Behavior
Bryde's whale	0.007	<0.001	0.010	0.041
Sperm whale	0.011	<0.001	0.016	0.064
Dwarf/pygmy sperm whale	0.024	<0.001	0.035	0.139
Cuvier's beaked whale	0.10	<0.001	0.015	0.058
Mesoplodon spp.	0.019	<0.001	0.028	0.110
Pygmy killer whale	0.030	<0.001	0.044	0.174
False killer whale	0.026	<0.001	0.038	0.151
Short-finned pilot whale	0.027	<0.001	0.039	0.157
Rough-toothed dolphin	0.028	<0.001	0.041	0.163
Bottlenose dolphin	0.810	0.006	1.177	4.706
Risso's dolphin	0.113	0.001	0.164	0.657
Atlantic spotted dolphin	0.677	0.005	0.984	3.934
Pantropical spotted dolphin	1.077	0.008	1.565	6.258
Striped dolphin	0.237	0.002	0.344	1.377
Spinner dolphin	0.915	0.007	1.330	5.316
Clymene dolphin	0.253	0.002	0.368	1.470
Unidentified dolphin**	0.053	<0.001	0.077	0.308
Unidentified whale	0.008	<0.001	0.012	0.046
All marine mammals	4.325	0.032	6.29	25.13

Source: U.S. Air Force, 2002
EFD = Energy Flux Density; km^2 = square kilometers; No. = number; TTS = temporary threshold shift
* dB = dB re 1 µPa^2 s
** Bottlenose dolphin/Atlantic spotted dolphin

Table 6-9. Yearly Estimated Number of Sea Turtles Affected by the Gunnery Mission Noise

Species	160 dB	170 dB	180 dB	190 dB	200 dB
Sea Turtles (number)	215	20.2	2.1	0.2	0.02

Source: U.S. Air Force, 2002
dB = decibels

Underwater noise may also affect non-protected resources such as fish. Impulsive noise at sufficient intensity is known to cause injury to the swim bladder and other air spaces inside fish. However, the intermittent nature of both the EGTTR missions and the presence of large schools of fish make significant effects unlikely (U.S. Air Force, 2002).

Direct physical effects to sensitive species and habitat (sea turtles, marine mammals, and *Sargassum* mats) may occur when the surface of the water is physically struck by gunnery ordnance or other falling objects. However, only a small number of animals were calculated to be potentially affected (physically struck or startled) by falling objects (U.S. Air Force, 2002). The BO issued by NMFS estimates one sperm whale and four sea turtles. Eglin AFB has also requested a renewal for authorization to take up to 271 marine mammals by harassment incidental to conducting air-to-surface gunnery missions in the Gulf of Mexico (NMFS, 2007b.).

The large number of sorties flown over the EGTTR over the course of a year requires dedicated management of military and commercial airspace. However, these activities have been occurring for years, and control of the airspace is well established. Therefore, no additional effects are anticipated (U.S. Air Force, 2002).

6.2.11.6.5 Cape San Blas Activities

Eglin AFB maintains property on Cape San Blas (CSB), Florida. Air Force facilities on CSB indirectly support nearly all air operations within the EGTTR warning area W-151 (Panama City OPAREA), as well as some of the air operations in W-470. Additionally, CSB facilities directly support some air missions (5,415 during FY 1994 through FY 1997), including surface-to-air missile launches. Up to 26 surface-to-air missiles may be launched per year (4 Patriot, 16 Caesar Trumpet, and 6 Viper). Some smaller, portable missiles are also fired at QF-4 drones, with up to two drones potentially downed in the Gulf of Mexico per year. In addition, CSB may support limited surf zone testing and training activities in the nearshore shallow waters. Although no specific test or training missions are identified, typical activities include underwater navigation and reconnaissance missions, as well as small inert munitions activities as performed by the Navy Explosive Ordnance Disposal training school (U.S. Air Force, 1999).

CSB activities may include effects to air quality, water quality, sensitive species and habitats, airspace management, and effects due to noise. The CSB Programmatic EA identified issues associated with restricted access, noise, habitat alteration, expended materials, electromagnetic radiation, chemical materials, and direct physical effects (U.S. Air Force, 1999).

For the purpose of public safety and the security of test and training operations, use of land and water areas and airspace beyond Air Force property boundaries is occasionally and briefly restricted for some surface-to-air missile activities. It is expected that water access will be restricted for approximately 69 hours per year (U.S. Air Force, 1999).

Expended materials from CSB missions results primarily from the surface-to-air missile launch missions. Missile components and drones from missile tests typically consist of aluminum and steel housing assemblies, optical sensors, guidance and control electronics, radio transmitters and receivers, and a power supply that may include lithium or nickel-cadmium batteries. Although most typical missions do not plan for the intentional downing of drones, surface-to-air missiles and drone targets that potentially fall on land have relatively benign environmental effects. Expended materials falling into nearshore waters have the potential to physically strike a boat, person, marine animal, or other receptor at the surface. Calculations predict, however, that the likelihood is extremely remote (U.S. Air Force, 1999).

The introduction of chemical materials into the CSB environment occurs primarily from missile and rocket exhaust emissions as a result of the surface-to-air missile launch activities. The amount of chemical materials released into the air and water is summarized in Table 6-10.

Table 6-10. Chemical Materials Associated With Missile Launch Activities

Environmental Receptor	Chemical Material	Maximum Exposure (mg/m^3)
Air	Al_2O_3 (alumina)	0.021
	CO (carbon monoxide)	39.11
	HCl (hydrochloric acid)	0.012
	NO_x (nitrogen oxides)	0.009
Water	JP-8 Fuel (Jet Propulsion fuel, type 8)	0.023

Source: U.S. Air Force, 1999
mg/m^3 = milligrams per cubic meter

The number of aircraft and missile flights in the CSB vicinity requires management of military and commercial airspace. However, these activities are expected to fall well within the management capabilities of airspace controllers (U.S. Air Force, 1999).

6.2.11.6.6 Santa Rosa Island Activities

Eglin AFB controls 19,263,244 square meters (m^2) (19.3 km^2 or 7.4 mi^2) of Santa Rosa Island (SRI), which includes 15 Air Force test sites. In addition to the SRI land mass, the surf zone is also considered part of the zone of effect. The surf zone is a shallow area covering the continental shelf seaward of SRI to a depth of approximately 14.5 km (9 mi). The distance from the SRI shoreline that corresponds to this depth varies from approximately 0.8 km (0.5 mi) at the western side of the Air Force property to 2.4 km (1.5 mi) at the eastern side (U.S. Air Force, 2005a). Several activities conducted on SRI and in the surf zone have the potential to affect the resources analyzed in Chapter 4.

Electronic Countermeasures (ECM) and Electronic Systems Testing is conducted in the vicinity of SRI (U.S. Air Force, 2005a). Training is routinely done aircraft-against-aircraft or aircraft-against-ground/surface ship systems. Any part of the Eglin Range Complex can be used for this type of training, but it is mostly done over the water. Surface-to-air missile tests launch missiles from a variety of locations, including A-15 on SRI and surface vessels, at target aircraft in the EGTTR. A variety of surf zone testing/training activities may occur as needed and include mine clearance testing and explosive ordnance disposal training (U.S. Air Force, 2005a).

Although the number of missile and aircraft flights is not quantified, air pollutant emission is a potential effect issue, as is airspace management. Air sorties associated with SRI lack the intensity and frequency of those associated with other activities, and the effects are considered minimal (U.S. Air Force, 2005a).

If increased use of the surf zone occurs, the potential for effects to geology, water quality, cultural resources, marine life, and sensitive species and habitats exist (U.S. Air Force, 2005a). Mine clearance and ordnance disposal could result in underwater detonations on or close to the sediment. This could cause turbidity and damage to essential fish habitat (EFH) (such as natural or artificial reefs) and cultural resources. Turbidity would be very brief and localized, as wave and current action would disperse the sediments (U.S. Air Force, 2005a). Environmental regulations would require that such training not be undertaken in the vicinity of cultural resources, EFH, or other sensitive habitats. A small amount of chemical materials would be added to the water column, but would be diluted to the point of insignificance (U.S. Air Force, 2005a). Detonations could cause injury to sensitive species such as sea turtles and marine mammals, and to non-protected resources such as fish. However, surveys for the presence of protected species would be required before such activities. Therefore, effects are considered unlikely (U.S. Air Force, 2005a).

6.2.11.6.7 Precision Strike Weapons Test

The U.S. Air Force Air Armament Center (AAC) and the U.S. Navy, in cooperation with the 46th Test Wing Precision Strike Division (46 OG/OGMTP), proposes to conduct a series of Precision Strike Weapons (PSW) test missions during the next five years utilizing resources within the Eglin Military Complex, including two sites in the EGTTR (U.S. Air Force, 2005b). The weapons to be tested are the Joint Air-to-Surface Stand-off Missile (JASSM) AGM-158 A and B, and the small-diameter bomb (SDB) GBU-39/B. The JASSM is a precision cruise missile designed for launch from outside area defenses to kill hard, medium-hardened, soft, and area type targets. The SDB weapon is a 113-kg (250-lb) class, air-to-surface, precision-guided munition. As many as two live and four inert JASSM missiles per year would be launched from an aircraft above the Gulf of Mexico at a target located approximately 28 to 44 km (17.3 to 27.6 mi) offshore of Eglin AFB (U.S. Air Force, 2005b). Detonation of the JASSM would occur under one of three scenarios:

- Detonation upon impact with the target, about 1.5 m (5 ft) above the Gulf of Mexico surface.
- Detonation upon impact with a barge target at the surface of the Gulf of Mexico.
- Detonation at 120 milliseconds (msec) after contact with the surface of the Gulf of Mexico.

In addition to the JASSM explosive, as many as six live and 12 inert SDBs per year would also be dropped on the target. Targets would be located in less than 61 m (200 ft) of water and more than 22 km (12 NM) offshore (U.S. Air Force, 2005b). Detonation of the SDBs would occur under one of two scenarios:

- Detonation of one or two bombs upon impact with the target, about 1.5 m (5 ft) above the Gulf of Mexico surface.
- Height of burst test: Detonation of one or two bombs 3 to 8 m (about 10 to 26 ft) above the Gulf of Mexico surface.

Activities associated with PSW testing may potentially affect water quality, biological resources, and the anthropogenic (man-made) environment (U.S. Air Force, 2005b). Chemical products may be released into the aquatic environment during explosive detonations. The detonation of explosives usually results in the complete combustion of the original material and the emission of carbon dioxide, carbon, carbon monoxide, water, and nitrogen compounds. Residual chemical products are usually extremely dilute and are dispersed within hours by wave and current action. Although data is lacking, these compounds are not expected to persist in the marine environment, and there is expected to be no effects to sea turtles, marine mammals, or the marine environment in general (U.S. Air Force, 2005b). During the time of operations, a safety zone on the surrounding water surface would be closed to commercial and recreational fishing. However, the total closed area compared to other areas available in the Gulf of Mexico is insignificant. In addition, the closures would be infrequent (U.S. Air Force, 2005b).

Exploding JASSM and SDB bombs will result in both pressure waves and noise in the marine environment (U.S. Air Force, 2005b). Detonations would have the potential for effects to protected and non-protected marine species (sea turtles, marine mammals, and fish). As stated before, injury can result from the shock wave interacting with air spaces in an animal's body, such as swim bladders, the inner ear, and viscera. At further distances from the detonation, noise may cause hearing impairment or behavioral modification in individuals. The BO by NMFS (2005) related to PSW activities included calculations of sea turtles potentially affected before and after mitigation measures. After the implementation of the required measures, a total of 12 sea turtles may be affected (lethally and non-lethally) over a five-year period (NMFS, 2005c). The number of marine mammals potentially affected as estimated by Eglin AFB is summarized in Table 6-11 and Table 6-12. NMFS has approved an incidental take permit for Air Force/Navy activities to allow for 1 mortality, 2 injury, and 53 harassment takes of marine mammals) (Federal Register, 2006D).

Table 6-11. Marine Mammal Densities and Risk Estimates for Level A Harassment (205 dB EFD 1/3-Octave Band) Noise Exposure During PSW Missions

Species	Density	Number of Animals Exposed from 1-ft Depth Detonations	Number of Animals Exposed from >20-ft Depth Detonations
Summer			
Dwarf/pygmy sperm whale	0.013	0.0024	0.0247
Bottlenose dolphin	0.81	0.1491	1.5417
Atlantic spotted dolphin	0.677	0.1246	1.2886
T. truncatus/S. frontalis	0.053	0.0098	0.1009
TOTAL		**0.29**	**3.0**
Winter			
Dwarf/pygmy sperm whale	0.013	0.0024	0.0285
Bottlenose dolphin	0.81	0.1491	1.7737
Atlantic spotted dolphin	0.677	0.1246	1.4824
T. truncatus/S. frontalis	0.053	0.0098	0.1161
TOTAL		**0.29**	**3.4**

Source: U.S. Air Force, 2005b
dB = decibels; EFD = Energy Flux Density; ft = feet; PSW = Precision Strike Weapon

Table 6-12. Marine Mammal Densities and Risk Estimates for Level B Harassment (182 dB EFD 1/3-Octave Band) Noise Exposure During PSW Activities

Species	Density	Number of Animals Exposed from 1-ft Depth Detonations	Number of Animals Exposed from >20-ft Depth Detonations
Summer			
Dwarf/pygmy sperm whale	0.013	0.0226	0.5070
Bottlenose dolphin	0.81	1.4089	31.5886
Atlantic spotted dolphin	0.677	1.1776	26.3735
T. truncatus/S. frontalis	0.053	0.0922	2.0669
TOTAL		**2.7**	**60.5**
Winter			
Dwarf/pygmy sperm whale	0.013	0.0280	0.8633
Bottlenose dolphin	0.81	1.7448	53.7906
Atlantic spotted dolphin	0.677	1.4583	44.9300
T. truncatus/S. frontalis	0.053	0.1142	3.5196
TOTAL		**3.3**	**103.1**

Source: U.S. Air Force, 2005b
dB = decibels; EFD = Energy Flux Density; ft = feet; PSW = Precision Strike Weapons

6.2.11.6.8 Naval Surface Warfare Center Panama City Division

Naval Surface Warfare Center (NSWC) Panama City Division (PCD) is the U.S. Navy's premier research and development organization focused on littoral (coastal region) warfare and expeditionary (designed for military operations abroad) warfare. NSWC PCD provides RDT&E and support for expeditionary warfare, operations in extreme environments, MIW, maritime operations, and coastal operations. Littoral and expeditionary warfare operations are conducted in a natural operating environment with direct access to the Gulf of Mexico, St. Andrew Bay, and associated coastal regions. The Gulf of Mexico provides an environment that can substitute for many of the littoral areas in the world for current and future Navy operations. The NSWC PCD operations occur in W-151, W-155, W-470, and St. Andrew Bay.

RDT&E activities involve a variety of naval assets, including ships, aircraft, and underwater systems that support eight primary test capabilities: air, surface, and subsurface operations; sonar, electromagnetic, laser, and ordnance operations; and projectile firing occurring within or over the water environment up to the average high tide mark. The vast majority of the tests are conducted using inert/non-explosive mine substitutes, though occasionally testing requires actual mine detonation in real-world circumstances. A brief overview of the eight RDT&E operations is provided in the following paragraphs.

Air operations conducted by NSWC PCD to support the RDT&E activities mainly utilize helicopters (MH-53, MH-60, UH-1, and variants). Five types of RDT&E activities that are conducted from aircraft at NSWC PCD include (1) support activities for clearance and monitoring, (2) tows of an object that contains active or passive sensors towed in the water column (the water between the surface and the sea floor), (3) captive carriage to test the handling of aircraft during transport, separation, and release of objects, and (4) aerial separation of objects that would not be retrieved, to test inert objects, rockets, and/or mines and the aircraft's flight effects on deployment of such items. The fifth activity includes the only form of live aerial expendables, which includes gun firing at predetermined targets from a helicopter.

Surface operations for NSWC PCD RDT&E includes: support activities, tows (a type of test), deployment and recovery unmanned underwater vehicles (UUV), sonobuoys, targets, and other test systems, and the testing of new, alternative, or upgraded hydrodynamics and propulsion, navigational, and communication systems.

Subsurface operations activities include diving, salvage, robotic vehicles, UUVs, and mooring and burying of mines. NSWC PCD also develops, upgrades, and manages new underwater mine systems. Tests are required to collect data and information to analyze functionality of the various systems developed at NSWC PCD. Other MIW testing conducted at NSWC PCD requires the placement of temporary minefields at varying depths (surf zone to 183 m [600 ft]) at NSWC PCD. These temporary target fields consist of inert mines, mine-like objects (MLO), and versatile exercise mines (VEMs), which are used to simulate bottom and moored mine threats.

Sonar operations at NSWC PCD involve the testing of various sonar systems in the ocean and the laboratory to demonstrate the systems' capability to detect, locate, and characterize MLOs under various environmental conditions. These activities include sonars that range in frequency from 1 kilohertz (kHz) to 3 megahertz (MHz) and are typically mounted on a towed body or other underwater moving platform.

Electromagnetic operations at NSWC PCD consist of the development and testing of an array of magnetic sensors that generate electromagnetic fields used in mine countermeasures (MCM) operations.

Laser operations include underwater mine identification and air-to-water mine identification. Laser operations are typically conducted from aircraft, but ship-based tests are also conducted.

Ordnance operations and **projectile firing** make up the final two operations conducted at NSWC PCD. NSWC PCD leads the development of naval airborne, surface, organic, and shallow water MCM systems. Real-life test scenarios that involve live explosives are required to demonstrate the capability and effectiveness of the systems developed and tested at NSWC PCD. Live testing is only conducted after a system has successfully completed inert testing and an adequate amount of data has been collected to support the decision for live testing. These tests require that live mines be closely monitored and that the minimum number of live munitions necessary to meet the testing requirement be used. Live testing may occur from the surf zone out to the outer perimeter of NSWC PCD. Gunfire might be used during test missions, including 5-in, 20-mm, 25-mm, 30-mm, 40-mm, 76-mm, and various small arms ammunition. Projectiles associated with these rounds are mainly armor-piercing projectiles. The 5-inch round is a high-explosive projectile containing approximately 3.63 kg (8 lbs) of explosive material.

6.2.11.7 Military Operations – Western Gulf of Mexico

6.2.11.7.1 NAS Corpus Christi

NAS Corpus Christi is located just south of Corpus Christi, Texas, on the eastern side of the state. The main function of the NAS is to provide services and materials to support naval air training activities. The installation supports some 400,000 naval flight operations per year (GlobalSecurity.org, 2007g). NAS Corpus Christi is also home to the Mine Warfare Command (COMINEWARCOM), which uses the MH-53E Sea Dragon. The Sea Dragon helicopter tows advanced minesweeping packages to search the seas for mines (GlobalSecurity.org, 2007g).

Just north of NAS Corpus Christi is Aransas National Wildlife Refuge, which is home to sandhill cranes, pelicans, and the endangered whooping crane. Due to the high volume of flight operations from NAS Corpus Christi and the surrounding communities, the Aransas National Wildlife Refuge is one of the highest bird strike potential areas in the nation (GlobalSecurity.org, 2007g).

6.3 REASONABLY FORESEEABLE FUTURE ACTIONS RELEVANT TO THE PROPOSED ACTION

6.3.1 Military Operations

6.3.1.1 Navy Training That Doesn't Utilize Active Sonar Use in Range Complexes

The Navy has historically conducted Atlantic Fleet training operations other than those utilizing active sonar in the same range complexes along the east coast and the Gulf of Mexico as those described in this EIS/OEIS. U.S. Atlantic Fleet is currently preparing environmental planning documents that will assess the potential for environmental effects associated with current and future non-active sonar training activities and actions, and RDT&E events, which are conducted within seven range complexes. The range complexes consist of inland ranges and targets, airspace, and at-sea surface and subsurface space. These environmental documents are:

- An EIS/OEIS for the VACAPES Range Complex. This complex is located along the eastern coasts of Virginia and North Carolina. The NOI to prepare the EIS/OEIS, along with an announcement of scoping meetings, was published in the Federal Register on December 8, 2006. Four public scoping meetings were held in January 2007, and comments were received from December 8, 2006 to January 23, 2007. A revised NOI was published in the Federal Register on September 5, 2007, and public comments were received from September 5, 2007 to September 30, 2007. A draft EIS/OEIS is scheduled for release to the pubic in the summer of 2008.

- An EIS/OEIS for the JAX/CHASN Range Complex. This complex is located along the eastern coasts of South Carolina, Georgia, and Florida. The NOI to prepare the EIS/OEIS, along with an announcement for scoping meetings, was published in the Federal Register on January 26, 2007. Four scoping meetings were conducted in February 2007 and comments received from January 26, 2007 to March 13, 2007. A draft EIS/OEIS is scheduled for release to the pubic in the summer of 2008.

- An EIS/OEIS for the CHPT Range Complex. This complex is located along the eastern coasts of North Carolina and South Carolina. The NOI to prepare the EIS/OEIS, along with an announcement for scoping meetings, was published in the Federal Register on

April 30, 2007. Two scoping meetings were conducted in May 2007 and public comments received from April 30, 2007 to June 12, 2007. A draft EIS/OEIS is expected for release to the public in the winter of 2008.

- An EIS/OEIS for the GOMEX Range Complex. This complex is located in the Gulf of Mexico along the western coast of Florida, along the southern coasts of Alabama and Louisiana, and along the southern and western coast of Texas. The NOI to prepare the EIS/OEIS, along with an announcement for scoping meetings, was published in the Federal Register on August 31, 2007. Four scoping meetings were conducted in September 2007, and public comments were received from August 31, 2007 to November 5, 2007. A draft EIS/OEIS is schedule for release to the public in the winter of 2008.

- An Environmental Assessment/Oversees Environmental Assessment (EA/OEA) for the Key West Range Complex off of the southern coast of Florida. Completion of the EA/OEA is expected in the spring of 2008.

- An EA/OEA for the Atlantic City Range Complex, the Narragansett Range Complex, and the Boston Area Range Complex, collectively known as the North East Range Complexes. These complexes are located from Maine to New Jersey. Completion of the EA/OEA is expected in the spring of 2008.

The types of training and RDT&E events that make up the Proposed Action and will be assessed in these environmental documents include both current and future training and RDT&E, and proposed improvements to the range complexes. The majority of the training to be assessed represents on-going activities that have historically been conducted by the Navy on the East Coast and in the Gulf of Mexico. The types of training and RDT&E events that will be assessed include: air-to-surface bombing events on land ranges and at sea using explosive and non-explosive ordnance; gunnery events using explosive and non-explosive ordnance; mine hunting, identification, classification, and countermeasures events using various types of equipment; underwater detonations using explosive ordnance; missile firing events using explosive and non-explosive ordnance; maritime interdiction operations involving various types of craft; combat search and rescue events; aircraft flight and maneuver training using helicopters, fixed-wing aircraft, and unmanned aerial vehicles; amphibious landings; electronic combat training; and other various types of training using lasers, flares and evasive devices. Environmental resources that will be addressed in these documents include: the physical environment; sea turtles and marine mammals; fish and EFH; seabirds and migratory birds; endangered and threatened species; land use; airspace; noise; air quality; geology; soils; water quality; geology; water resources and water quality; hazardous materials; cultural resources; socioeconomics; and safety.

The Navy anticipates there will be takes of marine mammals and effects to endangered species as a result of training events involving the use of explosive ordnance in at-sea areas. For these effects, the Navy will seek a Letter of Authorization (LOA) under the Marine Mammal Protection Act (MMPA) and will consult under Section 7 of the Endangered Species Act as required. The National Marine Fisheries Service (NMFS) is the regulatory authority for these authorizations/consultations, and is therefore a cooperating agency in the Virginia Capes, Cherry

Point, Jacksonville/Charleston, and Gulf of Mexico EIS/OEISs. Effects to other resources are undetermined at this time.

6.3.1.2 Atlantic Coast

6.3.1.2.1 Arrival of New Submarines at NSB Kings Bay, Georgia

Beginning with the arrival of the USS Tennessee in 1989, NSB Kings Bay housed 10 Trident submarines by 1997. However, a 1992 nuclear policy review recommended that the Ohio-class fleet ballistic missile submarines be reduced from 18 to 14 by the year 2005 (Wiss, 2006). As a result of the realignment process, five submarines departed NSB Kings Bay, Georgia, for Bangor NSB, Washington, between 2002 and 2005. The losses of these five submarines are expected to be offset by incoming submarines, which include the USS Florida, USS Georgia, and USS Alaska. Each submarine is expected to provide an annual economic impact of $9.5 million to the area. The population in Camden County is expected to increase by 1,000 residents because it is anticipated that each guided nuclear missile submarine (i.e., submersible ship, guided nuclear ballistic [SSGN]) will bring two crews of 160 sailors and their families (Wiss, 2006).

The USS Georgia will be homeported at NSB Kings Bay in 2007, after a $1 billion renovation at Norfolk Navy Shipyards. The submarine will be converted from a ballistic nuclear submarine (SSBN) to an SSGN (Wiss, 2006). An SSBN carries 24 Trident missiles, whereas an SSGN is fitted to carry up to 154 conventional cruise missiles.
The Navy commissioned the USS Alaska on January 25, 1986. It was the seventh Trident Nuclear Powered Fleet Ballistic Missile Submarine to be constructed and one of eight Trident submarines assigned to Bangor, Washington. This submarine is scheduled to undergo a two and a half year overhaul in Norfolk, Virginia, and then be homeported at NSB Kings Bay, Georgia. The relocation is due in part to the recent Base Realignment and Closure (BRAC) process and also the Navy's desire to split the ballistic missile submarine fleet between the Pacific Coast and the East Coast. The arrival of the ship at NSB Kings Bay will follow closely behind the relocation of the USS Florida and USS Georgia to the region.

6.3.1.2.2 Homeporting of Additional Surface Ships at Naval Station Mayport, Florida

The Navy is currently developing an EIS proposing to homeport additional Atlantic Fleet surface ships at Naval Station Mayport, Florida. Homeporting additional ships at Naval Station Mayport would ensure effective support of Fleet operational requirements through efficient use of waterfront and shore side facilities at the NS (DON, 2006f). The Proposed Action could relocate existing ships to Naval Station Mayport or assign new fleet ships to the naval station. The Proposed Action could include: wharf improvements, maintenance facilities improvements, utilities upgrades, personnel support improvements construction of carrier vessel, nuclear (CVN) nuclear propulsion plant maintenance facilities, and dredging (DON, 2006f).

6.3.1.2.3 Undersea Warfare Training Range

The Navy is proposing to construct and operate an underwater instrumented range off the Southeastern U.S. coast. The proposed instrumented range would be a 1,713-km^2 (500-square-nautical-mile [NM^2]) area of the ocean with undersea cables and sensor nodes, creating an undersea warfare training range (USWTR), and to use the area for ASW training (DON, 2005a). The purpose of the proposed action is to enable the Navy to train effectively in an ocean environment encompassing required water depths (e.g. 36.6 to 274 meters [120 to 900 feet] depth) at a suitable location for Navy Atlantic Fleet units. Such training would typically involve up to three vessels and two aircraft using the range for any one training event. Range instrumentation is required to provide real-time feedback to Navy participants. The instrumented area would be connected to the shore via a single trunk cable, which allows data gathered during exercises to be transferred for participant feedback. The proposed action would require logistical support for ASW training, including the handling (i.e., launch and recovery) of exercise torpedoes (non-explosive) and submarine target simulators (DON, 2005a).

A Draft EIS/OEIS was released on October 28, 2005, to evaluate the potential environmental consequences associated with constructing and operating a USWTR. In response to comments received from federal agencies, state agencies, and members of the public, Navy determined that the DEIS should be revised and a new DEIS issued, incorporating suggestions received during the public review and comment period. The changes contemplated involve the addition of an alternative and a modification of the methodology used to analyze impacts on marine mammals.

The Navy anticipates analyzing four alternative sites. The candidate sites are located in the Atlantic Ocean approximately 30 to 50 nautical miles offshore, within existing Navy Operating Areas (OPAREAs). The three candidate previously identified as alternatives would continue to be considered: Offshore of northeastern Virginia, offshore of southeastern North Carolina, and offshore of northeastern Florida. A site offshore of central South Carolina will be added as a fourth alternative.

Due to these changes, the Navy reopened the scoping period on September 21, 2007, and invited the public to submit comments by October 22, 2007, relevant to the scope of issues to be addressed in the revised EIS/OEIS.

The EIS/OEIS will evaluate the potential environmental effects associated with: Physical environment; water resources; sound in the water; biological resources, including marine mammals, fish, and threatened and endangered species; coastal uses and resources; socioeconomic resources; and cultural resources. The analysis will include an evaluation of direct and indirect impacts, and will account for cumulative impacts from other actions. No decision will be made to implement any alternative until the EIS/OEIS process is completed and a Record of Decision is signed by the Assistant Secretary of the Navy (Installations and Environment).

Potential negative impacts would be from the cable installation and sound (due to sonar). The cable installation would temporarily displace some bottom sediments and benthic organisms and increase local sedimentation rates as the material returned to the sea floor, however, impacts are not expected to be significant given that installation activities would be temporary (DON, 2005a). Sound impacts from use of mid-frequency active sonar from the undersea warfare training has the potential for "takes" due to harassment from noise to marine mammals (DON, 2005a).

6.3.1.3 Gulf of Mexico

6.3.1.3.1 Naval Explosive Ordnance Disposal School Training

The mission of the Naval Explosive Ordnance Disposal School (NEODS) is to detect, recover, identify, evaluate, render safe, and dispose of unexploded ordnance that constitutes a threat to people, material, installations, ships, aircraft, and operations. The NEODS facilities are located at Eglin AFB, Florida. The proposed training at Eglin involves recognizing ordnance, reconnaissance, measurement, basic understanding of demolition charges, and neutralization of conventional and chemical ordnance. MCM detonation is one important function of NEODS, which involves mine-hunting and mine-clearance operations (U.S. Air Force, 2004B).

The NEODS proposes to use the Gulf of Mexico waters off of SRI for a portion of the class. The NEODS would utilize areas approximately 2 to 6 km (1 to 3.45 mi) offshore of Test Site A-15, A-10, or A-3 for MCM training. The students would be taught techniques for neutralizing mines by diving and hand-placing charges adjacent to the mines. The detonation of small, live explosive charges adjacent to the mine disables the mine function. Inert mines are utilized for training purposes. This training would occur offshore of SRI six times annually, at varying times within the year (U.S. Air Force, 2004B).

During training, five charges packed with C-4 explosive material will be set up adjacent to the mines. A charge contains a total net explosive weight of nearly 3 kg (6 lbs), with C-4 comprising 2 kg (5 lbs) of the total. No more than five charges will be utilized over the two-day period. The five 2-kg (5-lb) C-4 charges will be detonated individually with a maximum separation time of 20 minutes between each detonation. The time of detonation will be limited to an hour after sunrise and an hour before sunset. MLOs/inert mines, VEMs, and other expended materials will be recovered and removed from the Gulf of Mexico waters when training is completed (U.S. Air Force, 2004B).

NEODS activities could potentially cause effects to geology, water quality, noise, biological and cultural resources, and artificial reefs. Detonations will likely disturb sediments and produce turbidity, but the effects are temporary and not considered significant. Activities conducted on or in the vicinity of sensitive habitats, such as natural or artificial reefs, could negatively affect the function of such structures as fish habitat. Cultural resources could also be damaged by the detonations or associated activities. However, environmental regulations require surveys for such resources, which should result in no effects.

C-4 is a common variety of military plastic explosive, and the explosive material RDX (also known as cyclonite or hexogen) makes up around 90 percent of C-4 by weight. According to the BO by NMFS concerning NEODS activities, bioaccumulation of RDX does not appear to be of concern in aquatic organisms, and there are no data to indicate biomagnification of RDX in fish and other animal tissues. RDX and any other chemical resulting from detonations would occur in extremely low concentrations and would be dispersed by wave and current action. The BO concludes that, although data is lacking, there appears to be no effects on sea turtles, marine mammals, or the marine environment in general.

Detonations would result in both pressure waves and noise in the marine environment. Effects to sea turtles and marine mammals could result from exposure to these metrics (U.S. Air Force, 2004B and 2004C). The BO by NMFS included calculations of sea turtles potentially affected before and after mitigation measures. After the implementation of the required measures, a total of six sea turtles are expected to be affected (lethally and non-lethally) over a five-year period. The number of marine mammals potentially affected as estimated by Eglin AFB is summarized in Table 6-13. NMFS has approved an incidental take permit for NEODS activities allowing for 14 dolphin takes by harassment (NMFS, 2006g).

Table 6-13. Number of Marine Mammal Exposed to Noise Due to NEODS Activities

Species	Density (per km^2)	Number of Animals Exposed to Level A Harassment from 30 Detonations per Year	Number of Animals Exposed to Level B Harassment from 30 Detonations per Year
Summer			
Bottlenose dolphin	0.81	0.21	3.96
Atlantic spotted dolphin	0.677	0.18	3.30
T. truncatus/S. frontalis	0.053	0.01	0.27
TOTAL		**0.40**	**7.53**
Winter			
Bottlenose dolphin	0.81	0.21	4.02
Atlantic spotted dolphin	0.677	0.18	3.36
T. truncatus/S. frontalis	0.053	0.01	0.27
TOTAL		**0.40**	**7.65**

U.S. Air Force, 2004B
km^2 = square kilometers; NEODS = Naval Explosive Ordnance Disposal School

6.3.1.3.2 Mine Warfare Command (COMINEWARCOM) Training off Panama City and Pensacola, Florida

The U.S. Navy has proposed to conduct MIW training activities offshore Panama City and Pensacola, Florida (DON, 2004c). The training sites in the Panama City/Pensacola OPAREAs consist of seven established sites located in the eastern Gulf of Mexico just off the Florida panhandle. The sites are located various distances from the coast, from 7.8 to 31 km (4.8 to 19.3 mi) offshore in waters ranging from 20 m to 40 m (65.6 ft to 131 ft) deep (Figure 6-4).

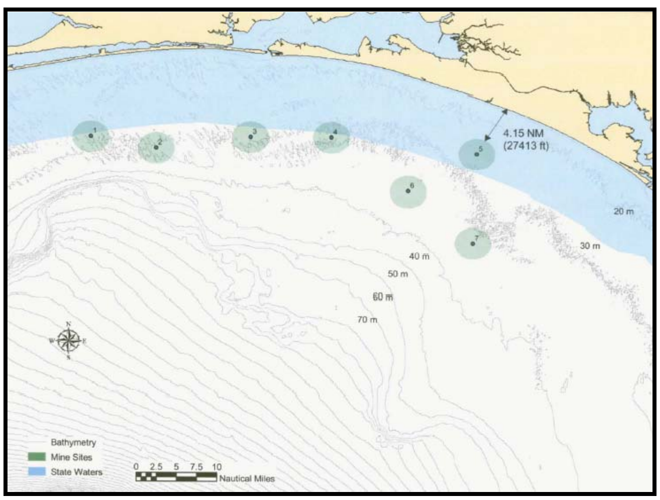

Figure 6-4. Proposed COMINEWARCOM Areas
Source: Geo-Marine Incorporated, 2004

Training activities are anticipated to include the deployment of 27 kg (60 lb) charges of C-4 explosive by MIW ships at a frequency of 28 times per year, throughout the seven proposed sites. The Navy also plans to conduct additional training, including the detonation of 2, 5, and 9 kg (5, 10, and 20 lb) charges on practice MLOs/inert mines and VEMs and mine firing mechanisms by MIW divers at a maximum frequency of 14 to 20 times per year throughout the test sites. Of these 14 to 20 detonations, about 90 percent would consist of 2 to 5 kg (5 to 10 lb) charges, with the remaining 10 percent consisting of 9 kg (20 lb) charges (DON, 2004c).

Activities within the scope of this project may potentially affect geology, water quality, cultural resources, biological resources, and the anthropogenic (man-made) environment. Detonations of the C-4 explosives would disturb sediments and produce turbidity, but the effects would be temporary and not considered significant (DON, 2004c). Activities conducted on or in the vicinity of sensitive habitats, such as natural or artificial reefs, could negatively affect the function of such structures as fish habitat (DON, 2004c). Cultural resources could also be damaged by the detonation or associated activities. However, environmental regulations require surveys for such resources, which should result in no effects.

C-4 explosives are not expected to negatively affect marine species or the marine environment. During the time of operations, a safety zone on the water surface would be closed to commercial and recreational fishing. However, the total closed area compared to other areas available in the Gulf of Mexico is insignificant. In addition, the closures would be infrequent (DON, 2004c).

Detonations would have the potential for effects to occur to protected and non-protected marine species (e.g., sea turtles, marine mammals, and fish) (DON, 2004c and 2004d). Injury can result from the shock wave interacting with air spaces in an animal’s body, such as swim bladders, the inner ear, and viscera. In addition, noise of sufficient intensity could cause auditory damage to protected species, particularly marine mammals. Mitigation measures would be required for these activities (DON, 2004c and 2004d).

6.3.1.3.3 Conversion of Two F-15 Fighter Squadrons to F-22 Fighter Squadrons at Tyndall AFB, Florida

The U.S. Air Force has identified the need to replace the F-15 aircraft with the new F-22 “Raptor” (U.S. Air Force, 2000). Advantages of the F-22 include the use of stealth technology, sophisticated radar and electronic systems, and the ability to fly at supersonic speeds without using afterburners. The Air Force proposes to convert two of the three F-15 Fighter Squadrons at Tyndall AFB, Florida, to F-22 Fighter Squadrons. The conversion would occur over a five-year period with a continual reduction of F-15s lasting three or more years. This plan relies on a gradual transition of aircraft with the total number of aircraft stationed at Tyndall AFB slowly increasing to a maximum of 104 during FY 2008 and ending with a total number of 87 in FY 2011. At the end of the conversion, a single F-15 Fighter Squadron would remain at Tyndall. A total of 60 F-22s would ultimately be assigned to Tyndall (U.S. Air Force, 2000).

The introduction of a new aircraft would obviously require increased training sorties. The total number of sorties would increase by approximately 26 percent during the peak year (FY 2008). Starting at the end of the conversion (FY 2011), a 7 percent annual increase over current operations is anticipated. Around Tyndall AFB, the increase in airspace use is approximately three operations per hour, and in the special use areas (military airspace), the increase averages approximately two sorties per day (U.S. Air Force, 2000). Table 6-14 shows the estimated annual number of sorties throughout the conversion period.

Table 6-14. Estimated Annual Number of Sorties Associated with F-22 Conversion at Tyndall AFB

Aircraft	Current	Peak Year FY 2008	Changes in Sorties Current to Peak	End-State FY 2011	Changes in Sorties Current to End-State
F-15	16,688	8,783	-7,905	5,270	-11,418
F-22	0	12,222	+12,222	12,600	+12,600
Cumulative Total	**16,688**	**21,005**	**+4,317**	**17,870**	**+1,182**

Source: U.S. Air Force, 2000

Two major airspace actions are proposed: (1) expanded utilization of currently used special airspace, and (2) expanded use of other available special use airspace in the region. The over-water airspace proposed for use includes W-470, W-151, and W-168 (U.S. Air Force, 2000). The estimated annual number of sorties is summarized in Table 6-15.

Table 6-15. Estimated Annual Number of Sorties by Airspace Associated with F-22 Conversion at Tyndall AFB

Airspace	Baseline (FY 1998)	Peak (FY 2008)		End-State (FY 2011)	
	F-15	F-15	F-22	F-15	F-22
W-470 A	4,391	2,249	1,791	1,350	1,846
W-470 B	3,180	1,628	1,297	977	1,337
W-470 C	1,205	617	491	370	507
W-151 A,B	856	510	670	306	690
W-151 C,D	857	451	1,403	271	1,446
W-168	0	65	2,326	39	2,398
Total by Aircraft	**10,489**	**5,520**	**7,978**	**3,313**	**8,224**
Total by Year	**10,489**	**13,498**		**11,537**	

Source: U.S. Air Force, 2000

F-22 training would result in an increase in the quantities of chaff and flares expended, the majority of which are expended over water ranges (U.S. Air Force, 2000). As part of the program, the Air Force proposes to train pilots in the use of the internal aircraft gun. This would consist of shooting 20-mm inert training rounds at targets towed by an F-15 aircraft. The aerial gunnery training would occur only in W-470 and W-151. Tyndall currently does not utilize 20-mm training as part of F-15 training (U.S. Air Force, 2000). The estimated quantities of chaff bundles, flares, and 20-mm rounds are shown in Table 6-16.

Table 6-16. Estimated Annual Number of Chaff and Flare Expenditures Associated with F-22 Conversion at Tyndall AFB

Airspace	Baseline (FY 1998)		Peak Year (FY 2008)			End-State (FY 2011)		
	Chaff	Flares	Chaff	Flares	20 mm	Chaff	Flares	20 mm
W-470 A	128,042	64,021	91,882	45,941	45,967	72,682	36,341	45,967
W-470 B	92,717	46,359	66,533	33,266	45,967	52,630	26,315	45,967
W-470 C	35,146	17,573	25,221	12,610	4,086	19,950	9,975	4,086
W-151 A,B	24,970	12,485	26,819	13,410	3,065	22,655	11,327	3,065
W-151 C,D	24,984	12,492	42,164	21,082	3,065	39,048	19,524	3,065
W-168	0	0	54,382	27,191	0	55,423	27,711	0
Over-water Total	**305,859**	**152,930**	**307,001**	**153,500**	**102,150**	**262,388**	**131,193**	**102,150**

Source: U.S. Air Force, 2000

Increased noise produced in the Warning Areas is expected to be inconsequential (U.S. Air Force, 2000).

The resulting effects on air quality were estimated for Tyndall AFB and for Bay County for both the peak year and the end-state. The results are summarized in Table 6-17.

Table 6-17. Estimated Effects on Air Quality Associated with F-22 Conversion at Tyndall AFB

Category	Pollutant (% Change)					
	CO	NO_2	PM_{10}	SO_2	Pb	VOCs
Tyndall Peak Year (FY 2008) Change	-7.10%	46.42%	10.59%	17.84%	20.00%	-24.90%
Bay County Peak Year Change	-0.07%	1.34%	0.20%	0.01%	-	-0.52%
Tyndall End-State (FY 2011) Change	-23.93%	30.69%	0.14%	1.90%	20.00%	-42.15%
Bay County End-State Change	-0.25%	0.89%	0.00%	0.00%	-	-0.88%

Source: U.S. Air Force, 2000

CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particulate matter less than 10 microns in diameter; SO_x = sulfur oxides; Pb = lead; VOC = volatile organic compound

Training activities would result in extremely small (maximum of 0.04 percent of background in W-470) quantities of chemical elements such as aluminum and magnesium being added to the marine waters of the Gulf of Mexico. These additions are too small to affect Gulf of Mexico waters or any of the biological resources found there. The levels would be further reduced through the physical movements of tides, currents, waves, and wind, which serve to disperse chemical materials (U.S. Air Force, 2000). In addition, there is a potential for increased noise levels within the W-470 area. However, based on the location of Tyndall AFB and its close proximity to the Gulf of Mexico, the majority of flights including takeoffs and landing would not occur over populated areas.

6.3.1.3.4 B61 Joint Test Assembly Weapons Systems Evaluation Program

Air Combat Command (ACC) has requested the use of Eglin AFB as an alternative to the Department of Energy's (DOE) Tonopah Test Range for conducting B61 Joint Test Assembly (JTA) Weapons Systems Evaluation Program (WSEP) flight tests (U.S. Air Force, 2004D). The military has nuclear weapons in active inventory, which are full-up weapons ready for use, called war reserve (WR) nuclear weapons. Every year a certain number of these WR nuclear weapons are randomly selected to be shipped to a DOE production facility where selected parts from those WR weapons are used to build a JTA. The JTAs are then flight tested to assess the performance of the WR parts. Each JTA retains as many of the WR components as possible including portions of the explosive package, but no JTA configuration is capable of providing a nuclear detonation (U.S. Air Force, 2004D).

The goal for the testing is high-speed, low- and high-altitude release on Test Area (TA) B-70 (U.S. Air Force, 2004D). The desired target will be an 8,361 m^2 (91 m x 91 m [300 x 300 ft]) concrete pad constructed on TA B-70. Additional testing would include a shallow-water drop in the Gulf of Mexico (W-151 in less than or equal to 15 m [50 ft] depth). Aircraft drop JTAs during flight following a predetermined altitude (152 to 1,829 m [500 to 6,000 ft]) as directed by Flight Safety. The JTAs would be immediately removed after each test. Therefore, other on-site assets may include chase boats used in the retrieval of the JTA from the Gulf of Mexico target drop areas (U.S. Air Force, 2004D). The preferred testing scenario involves one JTA drop every two years for each profile on both TA B-70 and W-151 (Table 6-18).

Table 6-18. JTA WSEP Flight Test Proposed Action (per Two-Year Period)

Profile	B-70	EGTTR W-151 Shallow-Water Drop
Freefall Air (FFA) – parachute	1	1
Retarded Ground (REG) – parachute	1	1

Source: U.S. Air Force, 2004D
EGTTR = Eglin Gulf Test and Training Range; JTA = Joint Test Assembly; WSEP = Weapons Systems Evaluation Program

The chemical materials of interest for the B61 JTA testing are depleted uranium, thermal batteries, neutron generators, and other hazardous materials and explosives. All other explosives and hazardous materials contained in the B61 JTA are classified Secret and cannot be identified or discussed in detail (U.S. Air Force, 2004D).

These activities may potentially affect water quality and biological resources (protected species) (U.S. Air Force, 2004D). Although the B61 JTA spin rocket and motor would produce explosion products that may enter Gulf of Mexico waters, these amounts are minimal and are not expected to produce any environmental effects. The B61 JTA would be immediately retrieved upon entry into the Gulf of Mexico, and the neutron generator should remain intact. Calculations regarding the possible direct physical strike of a protected marine animal suggest that only 0.000045 dolphins and 0.00000895 sea turtles would be affected per test. These numbers are so low as to be discountable (U.S. Air Force, 2004D).

6.3.1.3.5 Fiber Optic Cable Installation

There is a proposal for Eglin AFB to partner with Gulf Fiber Corp. and the U.S. Navy to bring an armored fiber optic cable from the Gulf of Mexico to either Panama City, Florida, or Eglin property on SRI (U.S. Air Force, 2004A). If the cable goes to Eglin property, it would be run to Test Site A-3, and from there would be connected to the AT&T backbone near U.S. Highway 98.

Gulf Fiber Corp. is developing a fiber network between production oil platforms off Texas, Louisiana, Mississippi, and Alabama, and would provide the military with fiber conductivity into the Gulf of Mexico. This capability would support joint Gulf Test and Training Range operations (U.S. Air Force, 2004A). Figure 6-5, Figure 6-6, and Figure 6-7 show the current fiber optic ring, a proposed pathway from an oil platform to A-3, and possible future routes.

Resources potentially affected by the cable installation include geology, biological resources, and cultural resources (U.S. Air Force, 2004A). Installation of the cable would necessitate the disturbance of the sea floor for relatively long distances. The proposed pathways could intersect with EFH, artificial reefs, and submerged cultural resources (U.S. Air Force, 2004A).

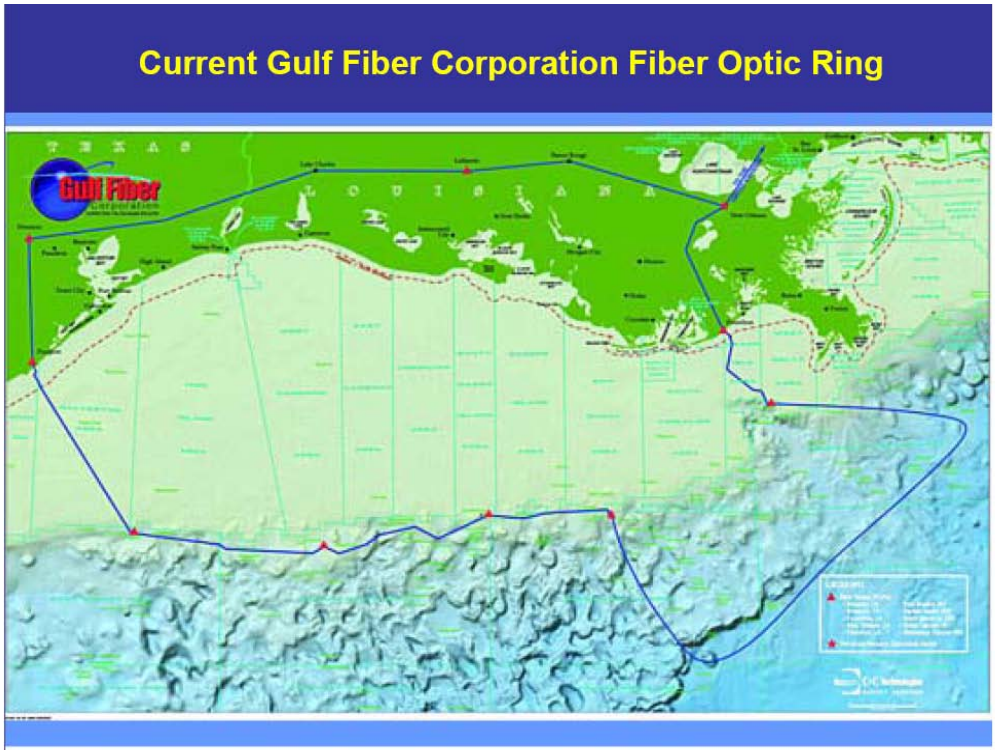

Figure 6-5. Existing Fiber Optic Ring in the Gulf of Mexico
Source: U.S. Air Force, 2004A

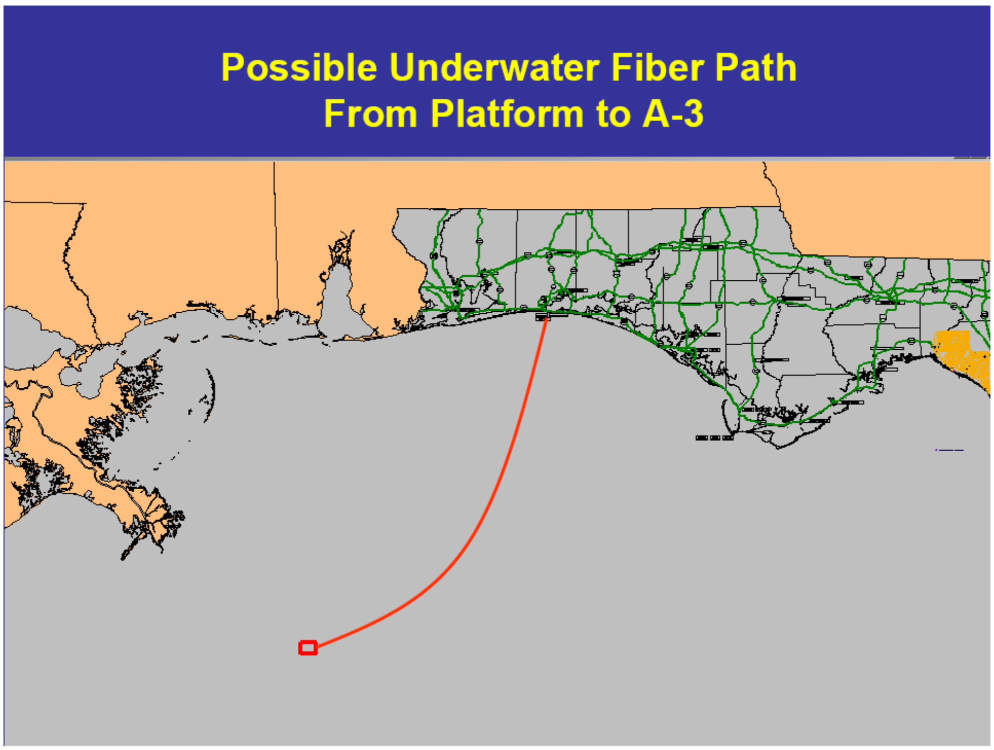

Figure 6-6. Proposed Fiber Optic Cable Pathway from Oil Platform to A-3
Source: U.S. Air Force, 2004A

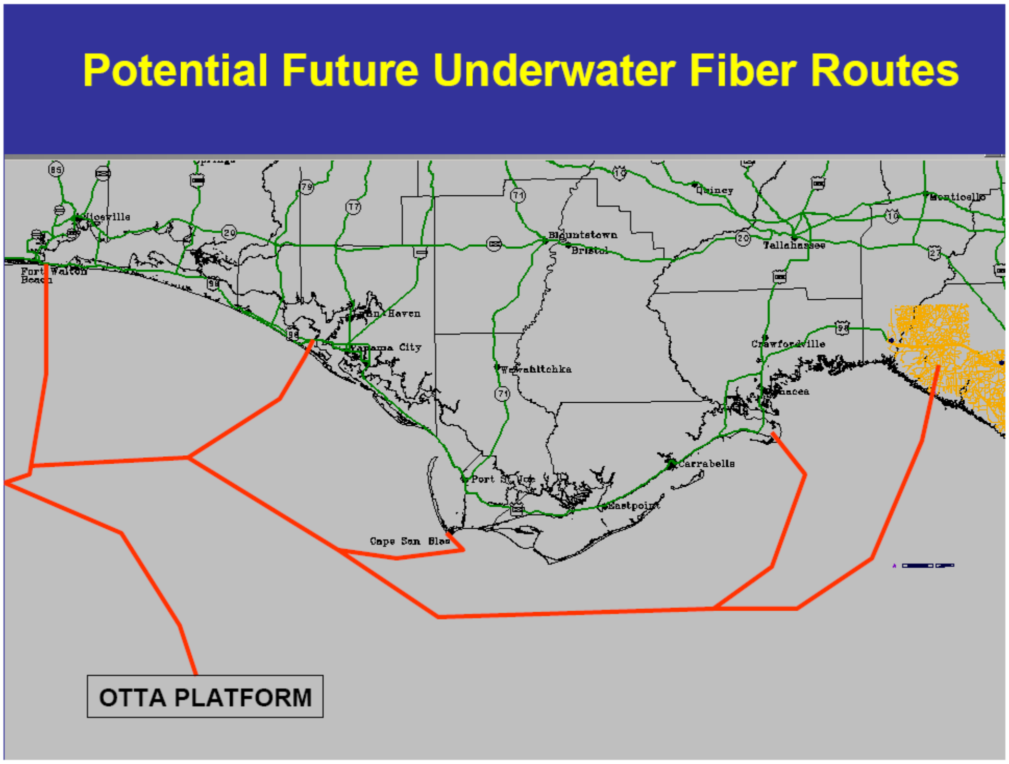

Figure 6-7. Potential Future Fiber Optic Cable Pathways
Source: U.S. Air Force, 2004A

6.3.2 Onshore and Offshore Liquefied Natural Gas Facilities

Liquefied natural gas (LNG) is natural gas that has been cooled about -260 degrees Fahrenheit (°F) until the gas is in its liquid form. When natural gas is liquefied, it decreases to 1/600 its original volume, which makes it ideal for shipping (Federal Energy Regulatory Commission [FERC], 2005). LNG is transported to LNG terminals by tankers equipped with insulated walls and systems to keep the LNG in liquid form. Once LNG is unloaded from ships at LNG terminals, it is stored as a liquid until it is warmed to convert it back to natural gas. The natural gas is then sent through pipelines for distribution (FERC, 2005).

LNG is odorless, colorless, non-toxic, and will not burn as a liquid. LNG vapors will not explode in a confined environment and are only flammable at concentrations of 5 to 15 percent with air (FERC, 2005). This makes LNG relatively harmless unless vapors are at flammable concentrations around an ignition source.

FERC, the USCG and the Maritime Administration (MARAD) regulate LNG facilities. LNG facilities that lie within state waters are regulated by FERC per the Energy Policy Act of 2005. The USCG and MARAD have jurisdiction over the LNG facilities within federal waters under the Federal Deepwater Ports Act of 1974 (FERC, 2006a).

6.3.2.1 Atlantic Ocean, Offshore of the Southeastern United States

There are currently no existing or proposed FERC or MARAD/USCG regulated LNG terminals offshore of the southeastern United States (FERC, 2007).

6.3.2.2 Atlantic Ocean, Offshore of the Northeastern United States

There are currently no existing FERC or MARAD/USCG regulated LNG terminals offshore of the northeastern United States; however, two LNG terminals are located within water bodies adjacent to the Atlantic Ocean. Additionally, two terminals have been proposed and approved by MARAD/USCG offshore of Boston, Massachusetts (FERC, 2007).

Existing LNG Facilities, Nearshore Northeastern United States

Everett Marine LNG Terminal - Everett, MA

The Everett Marine Terminal began service in 1971 as the first LNG import facility in the country. It is located along the Mystic River, across from Boston, Massachusetts, so in order for tankers to reach the terminal they must pass through the Boston harbor (CRS, 2003). Tractebel LNG North America Limited Liability Company (LLC), a subsidiary of SUEZ LNG NA, owns the facility, who since its inception has received over 600 shipments of LNG from a variety of international sources. “Currently, the Everett Marine Terminal meets approximately 20 percent of New England's annual gas demand” (SUEZ, 2007). Richard L. Grant, President and Chief Executive Officer of Tractebel LNG North America LLC, testified in front of the U.S. Senate Committee on Energy and Natural Resources (CENR) that, “over the last 40 years there have been approximately 33,000 LNG carrier voyages, covering more than 97 million km (60 million mi) without a single major accident or safety problem either in port or on the high seas” (CENR, 2005).

Dominion Cove Point LNG, LP – Cove Point, MD

The Cove Point terminal began service in 1978 but was forced to close in 1980. In 1995, it was reopened to liquefy, store, and distribute domestic natural gas, and in July 2003 received its first LNG imports. The terminal is owned by Dominion Corporation and is located on the Chesapeake Bay, approximately 97 km (60 mi) southeast of Washington, DC (CRS, 2003). The demand for natural gas in the United States is expected to grow by at least 20 percent over the next decade (Dominion, 2007a). As a response to this increased demand, the FERC authorized the expansion of Cove Point LNG’s existing import terminal and pipeline, as well as the construction of new downstream pipeline and storage facilities as part of the Cove Point Expansion Project (FERC, 2006b). According to the Cove Point Expansion Project website, construction of the LNG facilities began in August of 2006. Pipeline facility construction began in 2007 and will continue through 2008. In the fall of 2008, it is expected to be ready for service (Dominion, 2007b).

Approved LNG Facilities, Northeastern United States

Fall River, Massachusetts LNG Terminal Project

Weaver's Cove Energy has proposed the development of a 30-hectare (73-acre) LNG terminal in Fall River, MA, which will consist of an LNG ship unloading jetty, a storage tank and vaporization system, and truck loading facilities. This project will require the Taunton River to be dredged in order to accommodate a turning basin. The terminal is planned for the eastern shore of the Taunton River. On July 28, 2006, the Commonwealth of Massachusetts approved the Environmental Impact Report for the project after determining that it complies with the Massachusetts Environmental Policy Act. The FERC approved the project on July 19, 2006, after declining requests for a rehearing on the project made by several agencies. Construction on the terminal, which is the only LNG plant approved by FERC in New England, will begin in early 2008. The plant should enter service in 2010-2011 (Weaver's Cove Energy, 2005).

Gloucester, Massachusetts Offshore LNG Project

Two LNG pipelines have been proposed in the ocean off Gloucester, Massachusetts, approximately 30 miles north of Boston. Both projects are offshore buoy systems connected to pipelines, allowing ships to offload LNG while at sea. The Northeast Gateway project, owned by Excelerate Energy LLC, will be 21 km (13 mi) offshore, and the Neptune project, owned by SUEZ Energy North America, will be 11 km (7 mi) offshore. The project was approved by FERC and the MARAD in May, 2007. Approval was dependent on the installation of a whale acoustic detection system as a mitigation measure, designed to avoid ship strikes. Construction on the projects will be complete in 2010 (SUEZ 2006/Northeast Gateway 2007).

Proposed LNG Facilities, Northeastern United States

Passamaquoddy Bay, Maine LNG Projects

The Quoddy Bay LNG project is a partnership between the Passamaquoddy Tribe and the Quoddy Bay energy development company to construct a LNG import and regasification complex on the Pleasant Point Reservation in Washington County, Maine. The facility has not been approved by FERC; however, construction will begin in 2008, and it is anticipated that the plant will be fully operational in early 2011 (Quoddy Bay, 2007).

The Downeast LNG project is planned for an area in the Passamaquoddy Bay near Robbinston, Maine. The project consists of LNG terminals and storage. The project has not been approved by FERC (Downeast LNG, 2007).

A third LNG terminal in the area is planned in the Red Beach section of the Passamaquoddy Bay in northern Maine. The Saint Croix Development Group is planning the facility, which will include a receiving terminal and LNG storage. The project has not been approved by FERC (Gulf of Maine Times, 2005).

Sparrows Point LNG Proposal – Sparrows Point, MD

In January of 2007, AES Sparrows Point LNG, LLC submitted an application to FERC for the construction and operation of a LNG or LNG import and re-gasification facility located at the Sparrows Point Industrial Complex near Baltimore, Maryland. The project will include a marine receiving terminal, three full containment 160,000 m^3 (209,272 yd^3) storage tanks, and facilities to support ship berthing and cargo offloading. Construction is expected to begin in 2008 and be completed in 2010. A Final EIS is currently being prepared and expected to be released later this year (AES Sparrowpoint, 2007).

Long Island Sound LNG

Broadwater Energy, LLC proposed the construction and operation of a floating storage and regasification unit for LNG in Long Island Sound approximately 14 km (9 mi) off the shore of Long Island in New York waters and approximately 18 km (11 mi) off the Connecticut shoreline. The project is a joint venture between TCPL USA LNG, Inc. (a subsidiary of TransCanada Corporation) and Shell Broadwater Holdings LLC (a subsidiary of Shell Oil Company). In November 2006, Broadwater Energy LLC submitted a Draft EIS to FERC. After some modifications to mitigate certain environmental, safety, and security concerns, the FERC found that there would be limited adverse impact to the Long Island Sound. Broadwater plans to begin operation in 2010 (Broadwater Energy, 2007).

Safe Harbor Energy

The Atlantic Sea Island Group LLC is proposing to construct, own, and operate a LNG receiving, storage, and regasification facility called Safe Harbor Energy. Upon completion, it will be capable of delivering up to 0.07 billion yd^3 (2 billion ft^3) of natural gas per day to the New York metropolitan region. The facility will be located on an island to be constructed in federal waters on the Outer Continental Shelf, approximately 22 km (13.5 mi) south of the city of Long Beach, New York, on Long Island and 23 mi (37 km) southeast of the New York Harbor entrance. Atlantic Sea Island Group, LLC has taken the first steps in the NEPA process by completing the application and starting to prepare an EIS. Safe Harbor Energy anticipates the first shipment of LNG to the facility in 2014 (Safe Harbor Energy, 2007).

6.3.2.3 Eastern Gulf of Mexico

There are currently no existing or proposed and approved FERC or MARAD/USCG regulated LNG terminals in the eastern Gulf of Mexico. However, two terminals, one off the western coast of Florida and the other in the eastern Gulf of Mexico have been proposed to MARAD/USCG and are awaiting a decision (FERC, 2007).

6.3.2.4 Western Gulf of Mexico

The western Gulf of Mexico is the only region in which a MARAD/USCG-regulated LNG terminal (Gulf Gateway Energy Bridge - Excelerate Energy) has been constructed (FERC, 2007).

Two proposed LNG terminals, one offshore of Louisiana and the other at Port Pelican have been approved for construction by MARAD/USCG (FERC, 2007).

6.3.3 MMS Regulated Activities: Alternative Energy Development (Offshore Wind, Wave, and Ocean Current Energy Capture)

United States Department of the Interior, Minerals Management Service (MMS), released a final programmatic EIS in support of the establishment of a program for authorizing alternative energy and alternate use (AEAU) activities on the Outer Continental Shelf (OCS), as authorized by Section 388 of the Energy Policy Act of 2005 (EPAct), and codified in subsection 8(p) of the Outer Continental Shelf Lands Act (OCSLA). The final programmatic EIS examines the potential environmental effects of the program on the OCS and identifies policies and best management practices that may be adopted for the program.

Offshore wind farms are being used in a number of countries to harness the energy of the moving air over the oceans and converting it to electricity. At present, the only wind farms worldwide are located off the coasts of Europe in waters 30 m (98 ft) deep or less. These wind farms currently harness just over 600 megawatts (MW) of offshore wind energy. However, offshore wind projects proposed worldwide through 2010 would produce more than 11,000 MW. Of these proposed projects, wind farm energy production in the United States would amount to roughly 500 MW (MMS, 2007e). With the passage of the Energy Policy Act of 2005, the MMS was given jurisdiction over offshore alternative energy projects, including wind farms (MMS, 2007d).

Construction and everyday operation of offshore wind farms has the potential to affect several environmental resources, especially biological resources. Potential effects might include bird collisions with rotors or towers, increases in underwater noise due to construction and operational vibrations, the creation of underwater electromagnetic fields, and sea floor alterations due to installation (MMS, 2007e).

6.3.3.1 MMS – Atlantic Ocean, Offshore of the Southeastern United States

There are currently no proposed wind farm activities in this area.

6.3.3.2 MMS – Atlantic Ocean, Offshore of the Northeastern United States

6.3.3.2.1 Patriot Renewables, LLC-Proposed Buzzards Bay Wind Farm

Patriot Renewables, LLC is studying the feasibility of siting the South Coast Offshore Wind project in Buzzards Bay, located in Massachusetts (Patriot Renewables, 2006). This proposed wind farm would lie approximately 1.6 to 4.8 km (1 to 3 mi) offshore and be comprised of 90 to 120 turbines spaced 804 to 402 m (0.5 to 0.25 mi) apart (Patriot Renewables, 2006). Due to its proposed location within state-regulated waters, this wind farm would be regulated by the State of Massachusetts, not the MMS.

6.3.3.2.2 Cape Wind Offshore Wind Farm on Nantucket Sound

Cape Wind Associates, LLC has proposed the establishment of a wind farm project in federal waters of Nantucket sound off Massachusetts. The wind farm would be located 8.05 km (5 mi) or more from shore and consist of 130 turbines over an area of 62.16 km^2 (24 mi^2) (MMS, 2007d). The Cape Wind offshore wind farm would produce roughly over 1.4 million MW-hours per year, and save the area an estimated $800 million in energy costs over the next 20 years (Cape Wind, 2007). An EIS for this project is currently being prepared (MMS, 2007d).

6.3.3.2.3 Long Island Power Authority Offshore Wind Farm on Southside of Long Island Sound, New York

Long Island Power Authority (LIPA) and Florida Power and Light Energy propose the development of the Long Island Offshore Wind Park project in federal waters about 5.8 km (3.6 mi) south of Jones Beach Island, Long Island, New York. This proposed wind farm would consist of 40 turbines covering 20.72 km^2 (8 mi^2) (MMS, 2007f). The Long Island Offshore Wind Park would produce about 435,000 MW-hours per year, and would decrease the amount of fossil fuels required for energy production by an estimated $810 million over the course of 20 years (LIPA, 2007A and 2007B).

6.3.3.3 MMS – Eastern Gulf of Mexico

There are currently no proposed wind farm activities in this area.

6.3.3.4 MMS – Western Gulf of Mexico

6.3.3.4.1 Galveston-Offshore Wind, LLC Wind Farm, Galveston, Texas

Galveston-Offshore Wind, LLC has proposed building a 150-MW wind farm about 11.27 km (7 mi) off the coast of Galveston Island, Texas (DOE, 2005). This wind farm would consist of 50 turbines, with a height of about 79.25 m (260 feet) and a turbine blade length of approximately 50.29 m (55 yards). Over the course of the 30-year land lease (of 4,595.21 hectares[11,355 acres]) signed by Galveston-Offshore Wind, LLC, the amount of electricity produced by the wind farm would be equivalent to the amount of electricity produced by burning 20.7 million barrels of oil (Texas General Land Office [TGLO], 2005). Due to the proposed wind farm location within state-regulated waters, it would be regulated by the State of Texas, not the MMS.

6.3.3.4.2 Superior Renewables Wind Farm, Padre Island, Texas

Superior Renewable Energy LLC has proposed the construction of a wind farm 4.8 to 12.87 km (3 to 8 mi) off the coast of Padre Island, south of Baffin Bay. Superior Renewable Energy LLC has been granted a 30-year land lease from the State of Texas for 16,146.96 offshore hectares (39,900 offshore acres) (TGLO, 2006). Because the wind farm would be located in State waters, the State of Texas would regulate all activities, not the MMS. It is estimated that over 100 turbines will be installed to produce 500 MW of electricity (Washington Post, 2006). The amount of energy produced over the course of the 30-year lease by this wind farm would be equivalent to the amount of energy produced by burning 69 million barrels of oil. Due to the proposed wind farm location within state-regulated waters, it would be regulated by the State of Texas, not the MMS.

Environmental concerns that have been raised in regard to the development of this wind farm have dealt with the possibility of bird strikes and effects on bird migration patterns (TGLO, 2006).

6.3.4 Maritime Traffic, Commerce, and Shipping Lanes

The Coast Guard is conducting a Port Access Route Study (PARS) on the area east and south of Cape Cod, Massachusetts, to include the northern right whale critical habitat, mandatory ship reporting system area, and the Great South Channel including Georges Bank out to the exclusive economic zone (EEZ) boundary (Coast Guard, 2007). The purpose of the PARS is to analyze potential vessel routing measures that might help reduce ship strikes with the highly endangered North Atlantic right whale while minimizing any adverse effects on vessel operations. The recommendations of the study will inform the Coast Guard and may lead to appropriate international actions.

6.4 DISCUSSION OF CUMULATIVE IMPACTS RELATIVE TO THE PROPOSED ACTION

6.4.1 Assessing Proposed Action Impacts

Where feasible, the cumulative impacts were assessed using quantifiable data. However, in that quantifiable data was not always available; this analysis utilized qualitative information where necessary. For example, commercial shipping, commercial and recreational fishing, boating, and other activities occurring are not required to comply with the NEPA or analyze potential effects; therefore, there is little to no analysis data available for these activities. Since a quantitative analysis of potential effects for these areas is not possible; qualitative information, such as known marine species injuries or deaths was used as appropriate. In addition, since an analysis of potential environmental effects for future actions (identified in Section 6.3) has not been completed, assumptions based on past actions were used.

All past, present, and reasonably foreseeable future military activities described in this chapter are grouped together under Military Operations. It should be noted that the individual military actions tend to affect different resources, and when grouped together should not be interpreted to mean that each military activity would affect all resources.

6.4.1.1 Sediment Contamination (Sediment Quality)

According to impact analysis in Chapter 4, no significant impacts to sediments from expended materials are expected under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.1.1 AFAST EIS/OEIS Conclusions

An update to the 1996 EA for the Canadian Forces Maritime Experimental and Test Ranges (CFMETR) near Nanoose, British Columbia, was completed in 2005 by Environmental Sciences Group, Royal Military College of Canada (ESG). This document analyzed chemical effects associated with expendable components from activities involving sonobuoys, torpedoes, EMATTs, and ADCs (ESG, 2005). Specifically, the analysis focused on lead, copper, lithium, and Otto fuel. The document stated that metal contaminants were most likely to concentrate in fine-grained particulate matter, especially when smaller than 63 μm. The findings of the EA demonstrated that CFMETR operations did not cause a measurable effect on sediment quality (ESG, 2005). Therefore, based on the conclusions of this EA and because AFAST activities involve activities similar in nature to those analyzed in the EA, it is anticipated that metal contaminants from expended materials during AFAST operations have the potential for a minor, but recoverable impact to sediments from expended materials. No significant impacts from AFAST activities are anticipated.

6.4.1.1.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Any expending of materials at sea, over a long period of time, can cause potential incremental effects to sediment quality. However, the study area where the Proposed Action and actions previously described in this chapter are occurring is vast and chemical releases would rapidly dilute in the water; thus, accumulation of chemicals in sediments is not likely to occur. Therefore, it is expected that although there would be a potential for minor incremental, but recoverable, adverse cumulative effects, these effects would not be considered significant as they would be localized and temporary. No significant cumulative impacts to sediments from expended materials are anticipated from the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.2 Marine Debris (Marine Habitat)

According to impact analysis in Chapter 4, no significant impacts to the marine habitat from expended components are expected under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.2.1 AFAST EIS/OEIS Conclusions

Expended materials will settle to the ocean bottom and will be covered by sediments over time. Due to the small size and low density of materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor. However, active sonar activities will not likely occur in the exact same location each time and, due to ocean current, the materials will not likely settle in the same vicinity.

6.4.1.2.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Any expending of materials at sea, over a long period of time, can cause potential incremental effects to the marine habitat. However, the study area where the Proposed Action and actions previously described in this chapter are occurring is vast and the expended components are not expected to float at the water surface or remain suspended within the water column. Therefore, it is expected that although there would be a potential for minor incremental, but recoverable, adverse cumulative effects, these effects would not be considered significant. No significant cumulative impacts to the marine habitat from expended materials are anticipated from the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.3 Water Quality

6.4.1.3.1 AFAST EIS/OEIS Conclusions

Chapter 4 analyzed the potential effects to water quality from sonobuoy, ADC, EMATT batteries, explosive sonobuoys (AN/SSQ-110A), and OF II combustion byproducts associated with torpedoes. XBTs were not analyzed since they do not use batteries. Moreover, the scuttling of sonobuoys were not analyzed since, once scuttled, their electrodes are largely exhausted during operations and residual constituent dissolution occurs more slowly than the releases from activated seawater batteries. As such, only the potential effects of batteries and explosions on marine water quality in and surrounding the sonobuoy operation area was completed. It was determined that there would be no significant impact to water quality from seawater batteries, lithium batteries, and thermal batteries associated with scuttled sonobuoys under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

ADCs and EMATTs use lithium sulfur dioxide batteries. The constituents in the battery react to form soluble hydrogen gas and lithium dithionite. The hydrogen gas eventually enters the atmosphere and the lithium hydroxide dissociates, forming lithium ions and hydroxide ions. The hydroxide is neutralized by the hydronium formed from hydrolysis of the acidic sulfur dioxide, ultimately forming water. Sulfur dioxide, a gas that is highly soluble in water, is the major reactive component in the battery. The sulfur dioxide ionizes in the water, forming bisulfite (HSO_3) that is easily oxidized to sulfate in the slightly alkaline environment of the ocean. Sulfur is present as sulfate in large quantities (i.e., 885 mg/L) in the ocean. Thus, it was determined that there would be no significant impact to water quality from lithium sulfur batteries associated with scuttled ADCs and EMATTs under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In addition, it was determined that explosion residuals associated with the explosive source sonobuoy (AN/SSQ-110A) would not significantly impact the water quality under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. This determination is based on the fact that only a very small percentage of the available hydrogen fluoride explosive product is expected to become solubilized prior to reaching the surface and rapid dilution would occur upon mixing with the ambient water.

OF II is combusted in the torpedo engine and the combustion byproducts are exhausted into the torpedo wake, which is extremely turbulent and causes rapid mixing and diffusion. Combustion byproducts include carbon dioxide, carbon monoxide, water, hydrogen gas, nitrogen gas, ammonia, hydrogen cyanide (HCN), and nitrogen oxides. All of the byproducts, with the exception of hydrogen cyanide, are below the EPA standards for marine water quality criteria. Hydrogen cyanide is highly soluble in seawater and dilutes below the EPA marine water quality criterion within 6.3 m (20.7 ft) of the torpedo. Therefore, it was determined there would be no significant impact to water quality as a result of OF II under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.3.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Effects to water quality from past, present, and reasonably foreseeable future activities would most likely occur from the degradation of expended materials and increased turbidity due to localized disturbances of ocean bottom sediments caused by construction, dredging, and oil and gas industry activities. However, these effects would most likely be minor and temporary and would not have a significant impact on marine water quality. Moreover, water quality conditions would most likely return to normal after project completion. Therefore, when combined with construction, dredging, and oil and gas industry actions, AFAST activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 are not expected to significantly impact marine water quality. Cumulative impacts would be minor, but recoverable and would not be significant.

6.4.1.4 Sound In The Environment

6.4.1.4.1 AFAST EIS/OEIS Conclusions

The potential cumulative impacts associated with active sonar activities focus on the addition of underwater sound to existing oceanic ambient noise levels, which in turn could have potential effects on marine animals. Anthropogenic sources of ambient noise that are most likely to contribute to increases in ambient noise levels are commercial shipping, offshore oil and gas exploration and drilling, and use of sonar (DON, 2007f). The U.S. Navy does not anticipate the use of low-frequency sonar within the AFAST Study Area for the next five years; therefore, only the potential impact that mid- and high-frequency sonars may have on the overall oceanic ambient noise level is reviewed in the following contexts:

- Recent changes to ambient sound levels in the Atlantic Ocean and Gulf of Mexico;
- Operational parameters of the sonar operating during AFAST activities, including proposed mitigation;
- The contribution of active sonar activities to oceanic noise levels relative to other human-generated sources of oceanic noise; and
- Cumulative impacts and synergistic effects.

Section 3.5 of this EIS/OEIS presents sources of oceanic ambient noise, which include physical, biological, and anthropogenic noise. Very few studies have been conducted to determine ambient sound levels in the ocean. However, ambient sound levels for the EGTTR, located in the Gulf of Mexico, generally range from approximately 40 dB to about 110 dB (U.S. Air Force, 2002). In a study conducted by Andrew et al. (2002), oceanic ambient sound from the 1960s was compared to oceanic ambient sound from the 1990s using a receiver off the coast of California (DON, 2007f). The data showed an increase in ambient noise of approximately 10 dB in the frequency range of 20 to 80 Hz and at 200 and 300 Hz, and about 3 dB at 100 Hz over a 33-year period (DON, 2007f).

Anthropogenic sound can be introduced into the ocean by a number of sources, including vessel traffic, industrial operations onshore, seismic profiling for oil exploration, oil drilling, and sonar operations. In open oceans, the primary persistent anthropogenic sound source tends to be commercial shipping, since over 90 percent of global trade depends on transport across the seas (Scowcroft et al., 2006). Container shipping movements represent the largest volume of seaborne trade. Moreover, there are approximately 20,000 large commercial vessels at sea worldwide at any given time. The large commercial vessels produce relatively loud and predominately low-frequency sounds. Most of these sounds are produced as a result of propeller cavitation (when air spaces created by the motion of propellers collapse) (Southall, 2005). In 2004, NOAA hosted a symposium entitled, “Shipping Noise and Marine Mammals.” During Session I, Trends in the Shipping Industry and Shipping Noise statistics were presented that indicate foreign waterborne trade into the United States has increased 2.45 percent each year over a 20-year period (1981-2001) (Southall, 2005). International shipping volumes and densities are expected to increase in the foreseeable future (Southall, 2005). Although it is unknown how international shipping volumes and densities will continue to grow, current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and vessel design are as, or more, significant than the total number of vessels. Densities along existing coastal routes are expected to increase both domestically and internationally. New routes are also expected to develop as new ports are opened and existing ports are expanded. Vessel propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall, 2005). The increase in shipping volumes and densities will most likely increase overall ambient sound levels in the ocean. However, it is not known whether these increases would have an effect on marine mammals (Southall, 2005).

According to the NRC (2003), the oil and gas industry has five categories of activities which create sound: seismic surveys, drilling, offshore structure emplacement, offshore structure removal, and production and related activities. Seismic surveys are conducted using air guns, sparker sources, sleeve guns, innovative new impulsive sources and sometimes explosives, and are routinely conducted in offshore exploration and production operations in order to define subsurface geological structures. The resultant seismic data are necessary for determining drilling location and currently, seismic surveys are the only method to accurately find hydrocarbon reserves. Since the reserves are deep in the earth, the low frequency band (5 to 20

Hz) is of greatest value for seismic surveys, because lower frequency signals are able to travel farther into the seafloor with less attenuation (DON, 2007f).

Air gun firing rate is dependent on the distance from the array to the substrate. The typical intershot time is 9 to 14 seconds, but for very deep water surveys, inter-shot times are as high as 42 sec. Air gun acoustic signals are broadband and typically measured in peak-to-peak pressures. Peak levels from the air guns are generally higher than continuous sound levels from any other ship or industrial noise. Broadband SLs of 248 to 255 dB from zero-to-peak are typical for a full-scale array. The most powerful arrays have source levels as high as 260 dB, zero-to-peak with air gun volumes of 130 L (7,900 in^3). Smaller arrays have SLs of 235 to 246 dB, zero-to-peak.

For deeper-water surveys, most emitted energy is around 10 to 120 Hz. However, some pulses contain energy up to 1,000 Hz (Richardson et al., 1995), and higher. Drill ship activities are one of the noisiest at-sea operations because the hull of the ship is a good transmitter of all the ship's internal noises. Also, the ships use thrusters to stay in the same location rather than anchoring. Auxiliary noise is produced during drilling activities from sources such as helicopters and supply boats. Offshore drilling structure emplacement creates some localized noise for brief periods of time, and emplacement activities can last for a few weeks and occur worldwide. Additional noise is created during other oil production activities, such as borehole logging, cementing, pumping, and pile-driving. Although sound pressure levels for the other activities have not yet been calculated, sound pressure levels for pile-driving have. More activities are occurring in deep water in the Gulf of Mexico and offshore West Africa areas. These oil and gas industry activities occur year-round (not individual surveys, but collectively) and are usually operational 24 hours per day and 7 days per week, as compared to the limited and intermittent sonar transmissions.

Active sonar was probably the first wide-scale, intentional use of anthropogenic noise within the oceans. The outbreak of World War (WW) I in 1914 initiated the development of a number of military sonar applications (Urick, 1983). By 1935, several adequate sonar systems had been developed, and by 1938 with the imminence of WWII, production of sonar sets started in the U.S. (Urick, 1983).

There are both military and commercial sonars. Military sonars are used for target detection, localization, and classification while commercial sonars are used for depth sounding, bottom profiling, fish finding, and detecting obstacles in the water. Commercial sonars are typically higher in frequency and lower in power as compared with military sonars. Commercial sonar use is expected to continue to increase, although it is not believed that the acoustic characteristics will change (DON, 2007f).

The U.S. Navy will consult with NMFS to address potential effects to marine mammals and sea turtles from sound associated with AFAST activities under the ESA and the MMPA. Mitigation measures will be employed during AFAST activities to minimize potential effects to the greatest extent practicable. As such, the potential exists for moderate, but recoverable effects to occur to sea turtles and marine mammals from the introduction of sound into the environment. However, with the implementation of proper mitigations, no significant impacts are anticipated.

6.4.1.4.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The potential for cumulative impacts and synergistic effects from all acoustic sources, including sonar, is analyzed in relation to overall oceanic ambient noise levels, including the potential for sound introduced by AFAST training to add to overall ambient levels of anthropogenic noise. Increases in ambient noise levels have the potential to cause masking, and decrease in distances that underwater sound can be detected by marine animals. These effects have the potential to cause a long-term decrease in a marine mammal's efficiency at foraging, navigating, or communicating (DON, 2007f). In addition, it is possible marine mammals will experience acoustically-induced stress (NRC, 2003). However, sounds resulting from one-time exposure are less likely to have population-level effects than sounds that mammals are exposed to repeatedly over extended periods of time (NRC, 2003).

Merchant ships and sound of seismic surveys cover a wide frequency band and are long in duration. The majority of proposed AFAST activities is away from harbors or heavily traveled shipping lanes. The loudest underwater sounds in the Proposed Action area are those produced by hull-mounted mid-frequency active tactical sonar. High-frequency sonar, specifically above 200 kHz, would dissipate rather quickly and is unlikely to impact marine mammals. Mid-frequency active sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal and frequency domains. In particular, the pulse lengths are short, the duty cycle low, and active sonars transmit within a narrow band of frequencies (typically less than one-third octave). Low-frequency sonar will not be used in AFAST activities.

NRC (2003) stated that although techniques are being developed to identify indicators of stress in natural populations, determining the contribution of noise exposure to those stress indicators will be very difficult, but important, to pursue in the future when the techniques are fully refined. There are scientific data gaps regarding the potential for active sonar to cause stress in marine animals. Even though an animal's exposure to active sonar may be more than one time, the intermittent nature of the sonar signal, its low duty cycle, and the fact that both the vessel and animal are moving provide a very small chance that exposure to active sonar for individual animals and stocks would be repeated over extended periods of time, such as those caused by shipping noise. Since active sonar transmissions will not significantly increase anthropogenic oceanic noise, cumulative impacts and synergistic effects from stress are not reasonably foreseeable. Therefore, it is expected there would be a potential for minor incremental, but recoverable, cumulative impacts to ambient ocean sound from implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 when combined with the cumulative actions listed in the previous sections of this chapter.

6.4.1.5 Marine Mammals

6.4.1.5.1 AFAST EIS/OEIS Conclusions

In addition to underwater sound, activities that affect marine mammals include by-catch, ship strikes, and authorized takes. Changes in the environment from climate change induced by humans also threaten marine mammals. As discussed in Section 6.1, the greatest threat to cetacean mortality and injury occurs in the commercial fishing industry. More whales die every year through entanglement in fishing gear than from any other cause. Gillnets, set nets, trammel nets, seines, trawling nets and longlines pose the biggest threat. Gillnets contribute a very high proportion of global cetacean bycatch because of their low cost and widespread use. In the Northeast of the U.S., traps and pots are left in the water for extended periods of time. Whales may become entangled in the lines and have been observed swimming with portions of the gear wrapped around fins, flukes, the neck, and mouth. Animals may travel long distances over time before they free themselves of the gear or die from the entanglement (Angliss and Demaster, 1998). Scientists and the regulatory community have found that:

- Entanglements that caused serious injury most frequently involved humpback whales, followed by right whales, then minke and fin whales.
- Fatal entanglements most frequently involved minke whales, followed by humpback whales, right whales, and fin whales.
- Fatal entanglements were most frequently reported off the coast of Massachusetts. Additional fatal entanglements were reported off the coasts of North Carolina, Virginia, South Carolina, and Maine.

Programs targeted specifically to address the effects on large whales from commercial fisheries include a gear research and development program to reduce the amount of potentially hazardous gear in the water and the disentanglement network whose personnel work to locate, assess, and remove gear from entangled whales, Recommendations under the recovery plan specific for right whales to reduce commercial fishery interactions with whales include gear restrictions and modifications, research, and regulatory and enforcement actions (NMFS, 2007L).

Entanglements may also occur with recreational fishing gear. Little data exists for recreational fishing interactions with marine mammals. Large whale entanglements may also result from interactions with recreational fishing. Finfish recreational fisheries typically involve rod and reel and hand lines while traps/pots are common for the lobster and crab industry. The risk of entanglement in recreational gear is relatively small for marine mammals (NMFS, 2007L).

Marine mammals may be injured or killed from ship strikes throughout the world, including the AFAST Study Area. Since 1885, 292 ship strikes have been reported involving 11 different species. Of these documented cases, 198 were fatal, 48 included injury, 39 were unknown, and 7 showed no signs of injury (Jensen and Silber, 2003). In many injury cases, however, the fate of the whale is unknown (NMFS, 2007L).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., the sperm whale). Laist et al. (2001) identified 11 species known to be hit by ships. Of these species, fin whales are struck most frequently; right whales, humpback whales, sperm whales, and gray whales are hit commonly. The review, which involved 58 known vessel collisions revealed that while all sizes and types of vessels can hit and injure whales, the most severe injuries result from collisions involving ships that are greater than 80 meters in length or traveling at speeds exceeding 13 knots (Laist et al., 2001).

Given the depleted nature of many of these stocks, this effect represents a potentially significant source of risk. For example, the total estimated ship strike mortality and serious injury for the endangered right whale between 1999 and 2003 was estimated at 1.0 whale per year (USA waters 0.8; Canadian waters, 0.2) (Waring et al., 2006). The behavior of right whales makes them particularly vulnerable to collisions. Right whales swim close to shore and in or adjacent to major shipping lanes. In addition, they spend much of their time at the surface, skim feeding, resting, mating, and nursing. These behaviors can occur for periods of an hour or more (NMFS, 2007L). Calves, which spend most of their time at the surface due to their undeveloped diving capabilities, are particularly vulnerable. It is likely that these numbers underestimate the true mortality from ship strikes because experts generally believe that many ship strikes go unreported or undetected (NMFS, 2007L).

The risk of such strikes is high near the Northeast seaboard's busiest ports and shipping lanes, some of which are located near preferred habitat of whales. For example, the main shipping lane to Boston traverses the Stellwagen Bank National Marine Sanctuary, a major feeding and nursery area for several species of baleen whales. Similarly, Cape Cod Canal, another major channel for shipping along the New England coast, provides passage from Buzzards Bay to Cape Cod Bay, an area known for large whale activity (Hoyt, 2001). In southeastern waters, shipping channels associated with Jacksonville and Fernandina, Florida and Brunswick, Georgia bisect the area that contains the highest concentration of whale sightings within right whale critical habitat. These channels and their approaches serve several commercial shipping ports and military bases (NMFS, 2007L).

A number of initiatives have been implemented to reduce potential interactions between marine mammals and ships (NMFS, 2007L). Perhaps the most comprehensive effort focuses on right whales. A mandatory ship reporting system provides information to mariners entering right whale habitat through periodic notices and aerial surveys notify mariners of right whale sighting locations. Other support includes shipping industry liaisons, recovery team recommendations, and ESA section 7 consultation work (NMFS, 2007L). Canada has taken similar measures including designation of conservation areas, implementation of a Vessel Traffic System in the Bay of Fundy similar to NOAA’s EWS, and the movement of shipping lanes away from high densities of right whales (NMFS, 2007L).

Research is also continuing in areas related to whale and ship interactions. Efforts are focused on understanding marine mammal biology and ecology and its implications for conservation and management in this area. Particular projects have focused on understanding behavior around vessels and developing new technologies to improve management of vessel-whale interactions (NMFS, 2007L).

Climate change caused by increasing greenhouse gas concentrations from human activities has the potential to introduce additional pressures on marine mammals. Key changes in the climate may include increased precipitation and ocean temperature, decreased sea ice coverage, and increases and decreases in salinity (NMFS, 2007L). These effects in turn may influence habitats, food webs, and species interactions. Evaluations of the direct effects of climate change on whales are generally confined to cetaceans in the Arctic and Antarctic regions, where the impacts of climate change are expected to be the strongest. The possibility exists that the indirect effects of climate change on prey availability and cetacean habitat will be more widespread, and could affect marine mammals in the AFAST Study Area. For example, climate change could exacerbate existing stresses on fish stocks that are already overfished and indirectly affect prey availability (NMFS, 2007L). Additional effects include increased algal blooms and biotoxins and increased pollutant runoff and chemical contaminants from precipitation (NMFS, 2007L). Habitat shifts are another possible implication of climate change. Walther et al. (2002) examined recent shifts of marine communities in response to rising water temperatures, concluding that most cetaceans will experience roughly poleward shifts in prey distributions (Walther et al., 2002). For some marine mammal species, these small changes may have little material effect, but for species already vulnerable because of severe existing problems, like the North Atlantic right whale, these changes could be significant obstacles to species survival (NMFS, 2007L).

Authorized takes of marine mammal species also include scientific research and subsistence use. Discussion of takes associated with scientific research is included in the Section on Seismic Surveys and Scientific Research. The subsistence hunting of marine mammals by Native Americans in U.S. waters generally occurs in the Pacific Ocean. Potential impacts resulting from the proposed activity will be limited to individuals of marine mammal species located off the East Coast and in the Gulf of Mexico, and will not affect Arctic marine mammals. Since the AFAST activities will not take place in Arctic waters, additional discussion on subsistence use is not warranted.

Acoustic analysis was performed in order to estimate the effects associated with active sonar use. Chapter 4 discusses the methodology used to measure these effects in detail. The results of acoustic analysis indicates that 24,849 ESA-listed marine mammals may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 19,144 under Alternative 1, 19,188 under Alternative 2, and 21,108 under Alternative 3. It also indicates that one ESA-listed marine mammals may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, one under Alternative 1, two under Alternative 2, and one under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. The Navy finds that ESA-listed species may experience a cumulative impact from AFAST activities; however, they are not expected to adversely affect the populations of ESA-listed species. As part of the environmental documentation for this EIS/OEIS, the Navy has entered into early consultation with NMFS in accordance with Section 7 of the ESA. See Section 4.4.11 for additional information.

Acoustic analysis indicates that 4,335,480 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 2,480,526 under Alternative 1, 2,418,552 under Alternative 2, and 4,355,238 under Alternative 3. Acoustic analysis also indicates that 133 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, 87 under Alternative 1, 92 under Alternative 2, and 116 under

Alternative 3. No mortalities are predicted due to AFAST active sonar activities. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. The Navy has determined that AFAST activities will have a negligible impact on marine mammal species or stock. The Navy has initiated consultation with NMFS in accordance with the MMPA for concurrence. See Section 4.4.11 for additional information.

Marine mammals are also subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Most documented cases of entanglements occur when whales encounter the vertical lines of fixed fishing gear. Possible expended materials from AFAST activities include sonobuoys, torpedoes, and ADCs, and EMATTs. It was determined in Chapter 4 that the overall possibility of marine mammals ingesting parachute fabric or becoming entangled in cable assemblies is very remote. Furthermore, it is unlikely that a marine mammal would come into direct contact with a torpedo, torpedo flex hose, ADC, or EMATT.

6.4.1.5.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The exposure numbers mentioned above are considered conservative, and the Navy anticipates that any potential adverse effects to marine mammals will be further minimized by the implementation of the mitigation measures identified in Chapter 5. In addition, the Navy is requesting a LOA pursuant to the MMPA, which also requires NMFS to develop the regulations that govern the issuance of an LOA. By issuing the LOA, NMFS would authorize the Navy to proceed with the Proposed Action.

The Navy is also consulting with NMFS in accordance with Section 7 of the ESA to ensure that AFAST activities would not jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of a critical habitat. This consultation will be complete when NMFS prepares a final BO and issues an incidental take statement.

Therefore, while there is the potential for moderate, recoverable cumulative effects to marine mammals under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3, no significant cumulative impacts are anticipated.

6.4.1.6 Sea Turtles

6.4.1.6.1 AFAST EIS/OEIS Conclusions

Sea turtles experience a number of natural and anthropogenic threats throughout their diverse life history. Natural threats include hurricanes, cold stunning, and biotoxin exposure. Sand accretion and rainfall associated with hurricanes and waves generated from storm surges can damage sea turtle nesting habitat extensively. For example, in 1992, all of the eggs over a 145 km (90 mile) length of coastal Florida were destroyed by storm surges on beaches that were closest to the eye of Hurricane Andrew (Milton et al., 1994). Man-made threats on land include beach erosion, armoring, nourishment, and cleaning; artificial lighting; increased human presence; recreational beach equipment and driving; coastal construction; planting exotic dune and beach vegetation; and poaching. Anthropogenic threats at sea include entanglement in gear of commercial fisheries, ingestion of marine debris, and strikes by vessels.

A large portion of the sea turtle mortalities related to humans comes from commercial fishing. Sea turtles entangled in fishing gear generally experience a reduced ability to feed, dive, surface/breathe, or perform any other behavior essential to survival. They may be more susceptible to boat strikes if forced to remain at the surface, and entangling lines can constrict blood flow. In the AFAST Study Area, commercial fisheries affect in particular loggerhead, leatherback, green, and Kemp's ridley sea turtles. The following paragraphs describe the effects from fisheries to each of these species and efforts NMFS has taken to reduce their mortality in the industry operations (NMFS, 2007L).

Thousands of loggerhead sea turtles interact with commercial fisheries each year. Basin-wide average bycatch rates, extrapolated to account for total longline effort in the Atlantic and Mediterranean, yielded a minimum estimate of over 200,000 loggerheads caught in these waters in 2000. Although not all of these interactions would have been lethal, thousands of potential turtle mortalities may have occurred based on the estimate by NMFS that 17 to 42 percent immediate and delayed post-hooking mortality rates for loggerheads (NMFS, 2001d). Aguilar et al. (1995) estimated that the Spanish swordfish longline fleet, which is only one of the many fleets operating in AFAST Study Area, captures more than 20,000 juvenile loggerheads annually (killing as many as 10,700). Observer records indicate that an estimated 6,900 loggerheads were captured by U.S. fishermen between 1992 and 1998. An estimated 43 of these turtles were dead (NMFS, 2007L).

Loggerheads are also caught in coastal waters of the AFAST Study Area, for example, in pound net gear and trawls in the Mid-Atlantic and Chesapeake Bay; in gillnet fisheries in the Mid-Atlantic, and in Northeast sink gill net fisheries. Annual peaks in loggerhead strandings in the Mid-Atlantic regularly occur in early summer and late fall, coinciding with increased gillnet activity. Observers have documented lethal takes of loggerheads and Kemp's ridleys in these fisheries (TEWG, 2000). Shrimp trawlers, however, represent the most significant source of incidental takes from commercial fisheries, and are believed to be the largest single source of mortality in southeastern U.S. waters. Magnuson et al. (1990) estimated 5,000 to 50,000 loggerheads killed each year by the offshore commercial shrimp fleet in the southeastern Atlantic and Gulf of Mexico.

Of the Atlantic turtle species, leatherbacks may be the most vulnerable to entanglement in fishing gear because of their body type (large size, long pectoral flippers, and lack of a hard shell), their attraction to organisms that collect on buoys and buoy lines at or near the surface, and perhaps their attraction to the lightsticks used to attract target species in longline fisheries. They are also susceptible to entanglement in gillnets (used in various fisheries) and to capture in trawl gear (e.g., shrimp trawls). According to observer records, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992 and 1999, of which 88 were released dead. Since the U.S. fleet accounts for only five to eight percent of the longline vessels in the Atlantic Ocean, the impact from the takes of the other 23 countries actively fishing in the area would likely result in annual take estimates of thousands of leatherbacks over different life stages. Other fisheries that endanger leatherback sea turtles include the trap/pot, blue crab, lobster, stone crab, gillnet, sink net, and pound net fisheries (NMFS, 2007L).

In addition to the natural threats of other sea turtles, green turtles appear susceptible to fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body. Juveniles are most commonly affected. The occurrence of these tumors may impair foraging, breathing, or swimming and lead to death. Sea sampling coverage in the pelagic driftnet, pelagic longline, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles. Strandings of green turtles in Virginia indicate that they may also be susceptible to interactions with the state pound net fishery (NMFS, 2007L).

Takes of Kemp's ridley turtles have been recorded by sea sampling coverage in the Northeast otter trawl fishery, pelagic longline fishery, and southeast shrimp and summer flounder bottom trawl fisheries. Among U.S. commercial fisheries, the southeast shrimp trawl fishery is known to take the highest number of leatherback sea turtles with an estimated 640 leatherback captures annually. Approximately 25 percent (160) of the captured animals die from drowning (Henwood and Stuntz, 1987). Although not the largest known source of anthropogenic mortality, gillnet and crab pot fishing gear has taken Kemp's ridley sea turtles. Of the juveniles caught by fishing, four fishermen caught an estimated four percent in gill nets and 0.2 percent by crab pots. Tag returns for adult turtles indicate that seven percent were caught in gill nets (Marquez et al., 1989).

To address the threats to sea turtles, NMFS has identified ways to reduce mortality in commercial fisheries. For example, the agency has worked with the industry to develop and use turtle excluder devices (TEDs) in trawls to reduce turtle takes. These devices are particularly beneficial to the smaller sea turtle species (NMFS, 2007L). To protect the larger leatherback species, NMFS has established a Leatherback Conservation Zone, which restricts, when necessary, shrimp trawl activities from off the coast of Cape Canaveral, Florida to the Virginia/North Carolina border. NMFS can quickly and temporarily close the area or portions it when high concentrations of leatherbacks are present, to shrimp fishermen who do not use TEDs with an escape opening large enough to exclude leatherbacks. Additional measures include fishery closures during particular seasons and in specified geographic locations, seasonal restrictions on fishing gear, and reporting and monitoring requirements for fisheries such as pound netting. The agency conducts stock assessments and convenes groups to develop and implement take reduction plans. NMFS also conducts outreach efforts to the recreational fishing community (NMFS, 2007L).

All of the turtles species found in the AFAST Study Area are ESA-listed species. As such, the Navy's has initiated early consultation with NMFS in accordance with Section 7 of the ESA. Acoustic analysis for mid- and high-frequency active sonar activities was not performed for sea turtles due to the fact that sea turtles appear to be most sensitive only to low frequencies. Acoustic effects on sea turtles from explosive source sonobuoys (AN/SSQ-110A) were analyzed in Chapter 4. Acoustic analysis indicates that a total of three sea turtles may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, nine under Alternative 1, seven under Alternative 2, and two under Alternative 3. Acoustic analysis also indicates that a total of one sea turtle may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, two under Alternative 1, two under Alternative 2, and one under Alternative 3. Included in the Level A exposure numbers, acoustic analysis indicates that no sea turtles may be exposed to levels of sound likely to result in mortality under all of the Alternatives. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. See Section 4.5.2 for additional information.

Similar to marine mammals, sea turtles are subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Possible expended materials from AFAST activities include sonobuoys, torpedoes, and ADCs, and EMATTs. However, it was determined in Chapter 4 that the overall possibility of a sea turtle ingesting parachute fabric or becoming entangled in cable assemblies is very remote. Furthermore, it is unlikely that a sea turtle would come into direct contact with a torpedo, torpedo flex hose, ADC, or EMATT. As such, it was determined there would be no significant impact to sea turtles as a result of expended materials during active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.6.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The Navy has determined that sea turtles may experience a cumulative effect from AFAST activities; however they will not likely adversely affect sea turtle populations. As mentioned above, the Navy has entered early consultation with NMFS in accordance with Section 7 of the ESA. In addition, sea turtles are more likely to be impacted from interaction with equipment used during fishery practices than from activities conducted during a naval active sonar activity. While the estimates for the incidental catch of sea turtles in longline fisheries vary from year to year, approximately 800 to 3,500 sea turtles in the Atlantic interact with longline fisheries (Dietrick et al., 2007). The highest sea turtle interaction rates are in the Gulf of Mexico through the mid-Atlantic and Grand Banks (Dietrich et al., 2007). It is expected that the mitigation measures identified in Chapter 5 would be implemented to minimize any potential adverse effects to sea turtles. Moreover, the Navy is consulting with NMFS in accordance with Section 7 of the ESA for any potential effects active sonar activities may have on sea turtles. As such, there is the potential for moderate, but recoverable cumulative impacts to sea turtles under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. No significant cumulative impacts are anticipated.

6.4.1.7 Marine Fish

6.4.1.7.1 AFAST EIS/OEIS Conclusions

Studies have indicated that acoustic communication and orientation of fish may be restricted by sound regimes in their environment. However, most marine fish species are not expected to be able to detect sounds in the mid- and high- frequency range of the operational sonars used in the

Proposed Action, and therefore, the sound sources do not have the potential to mask key environmental sounds. The few fish species that have been shown to be able to detect mid-frequencies do not have their best sensitivities in the range of the operational sonars. Additionally, vocal marine fish largely communicate below the range of mid- and high-frequency levels used in the Proposed Action.

Moreover, there is no information available that suggests exposure to non-impulsive acoustic sources results in significant fish mortality on a population level. Mortality has been shown to occur in one species, a hearing specialist, however, the level of mortality was considered insignificant in light of natural daily mortality rates. Experiments have shown that exposure to loud sound can result in significant threshold shifts in certain fish that are classified as hearing specialists (but not those classified as hearing generalists). Threshold shifts are temporary, and it is not evident that they lead to any long-term behavioral disruptions. Considering the best available data, none exists that demonstrate any long-term negative effects on marine fish from underwater sound associated with sonar activities. Further, while fish may respond behaviorally to mid and high-frequency sources, this behavioral modification is only expected to be brief and not biologically significant.

In regards to the explosive source sonobuoy (AN/SSQ-110A), Chapter 4 discussed that the huge variations in the fish population, including numbers, species, sizes, and orientation and range from the detonation point, make it very difficult to accurately predict mortalities at any specific site of detonation. Most fish species experience a large number of natural mortalities especially during early life-stages, and therefore any small level of mortality caused by the AFAST activities involving the explosive source sonobuoy (AN/SSQ-110A) will most likely be insignificant to the population as a whole.

Therefore, it was determined that there would be no significant impact to fish populations as a result of active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.7.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The overall effect on fish stocks would be negligible compared to the impact of commercial and recreational fishing in the Study Area. After completion of an active sonar activity, repopulation of an area by fish should take place within a matter of hours. No long-term changes to species abundance or diversity, loss or degradation of sensitive habitats, or effects to threatened and endangered species is expected. Moreover, implementation of mitigation measures designed to avoid significant or long-term impacts would further protect marine life and the environment. As such, there is the potential for minor, but recoverable cumulative impacts to marine fish under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3. Impacts would be temporary and localized and would not be considered significant.

6.4.1.8 Essential Fish Habitat (EFH)

6.4.1.8.1 AFAST EIS/OEIS Conclusions

EFH types include hardbottom, softbottom, estuaries, reefs, wrecks, inshore areas, oyster reefs, and vegetated bottom. Impacts to EFH as pertinent to the area covered by this EIS/OEIS may arise from:

- Fishing gear
- Dredging
- Boat groundings
- Coastal construction
- Oil and hazardous materials
- Exotic species
- Toxic algal blooms
- Storm surges and wind generated waves

Mobile fishing gear such as trawls and fixed fearing gear including gillnets and traps/pots can affect EFH. Trawling changes the benthic habitat through direct contact, alters the food web by taking target and non-target species, and changes the chemistry of the water column (NMFS, 2007L). Mobile gear fisheries that affect EFH include bottom trawling related to foreign fisheries, in state waters, and domestic groundfish fisheries. Fixed gear also impacts the benthic community and EFH through these effects. The fixed fisheries with potential to affect EFH includes trap/pot fisheries for lobster, crab, and shrimp; fixed gear fisheries for American lobster, red crab, Jonah crab, hagfish, and black sea bass; and anchored gillnet fisheries that target monkfish and dogfish (NMFS, 2007L).

Dredging also changes EFH and affects prey on and in marine sediments. Large amounts of sediment may be re-suspended, which can change the chemistry and physical composition of the water column. These actions can cause overall changes to the benthic community if they occur over long periods and widespread areas (NMFS, 2007L).

Like dredging, vessel groundings can directly alter the physical structure of the benthic habitats and cause direct mortality to organisms living on and in the sediments. These effects occur to a site-specific, localized area (NMFS, 2007L). There are no documented effects to EFH from vessel groundings and ecosystem wide effects are not expected from such events.

Development of ports and other infrastructure has occurred throughout the coastal zone along the U.S. Atlantic coast and Gulf of Mexico. These projects also have the potential to affect EFH through the alteration of physical structure, direct mortality to organisms, re-suspension of sediments, chemical and physical modification of the water column, and local changes in community structure (NMFS, 2007L). Similar to vessel groundings, the effects are site-specific and restricted to the local area. Ecosystem wide effects not expected from the construction of ports (NMFS, 2007L).

The use of oil and hazardous materials in the marine environment creates opportunities for spills and pollution to occur. Within the AFAST Study Area, spills range from the release of small amounts of fuel to thousands of gallons of oil. Large spills cause direct mortality to birds, fish, sea turtles, and marine mammals; alter the chemical composition of the water column; and change the structure of the benthic community (NMFS, 2007L). Habitats that may be affected include coastal, inshore, and offshore areas from accidental release by vessel accidents, ruptured pipelines, and oil platform spills. Oil spills may also affect pelagic communities through the formation of surface slicks. Other hazardous pollutants, such as metal contaminants, pesticides and herbicides, and chlorine, can also be found in the water column and persist in the sediments of coastal, inshore, and offshore habitats (NMFS, 2007L).

Exotic species are introduced into the marine environment accidentally and intentionally. These introductions alter the physical and biological characteristics of the ecosystem habitats. Non-native species that have been introduced include finfish, shellfish, plants, and parasites. The issues related to exotics include increased competition, niche overlap, predation on native organisms, decreased genetic integrity, and transmission of disease. There are documented cases where exotic species have pushed native species towards extinction. The scientific and regulatory communities are working to develop ways to combat exotics; methods include producing sterile organisms and securing facilities and infrastructure that has the potential to introduce non-native species (NMFS, 2007L).

Toxic algal blooms have occurred throughout the AFAST Study Area in conjunction with the loading of nutrients into the water column and benthic habitats. These blooms change the physical and chemical composition of the water column and can cause mortality to marine organisms. Toxic algal blooms include events related to toxic microscopic algae and non-toxic seaweeds, which can grow uncontrollably and displace native species, alter habitat suitability, and deplete oxygen levels. Communities generally rebound and are adapted to the intermittent occurrence. If they do not, then the marine food web is affected by adverse effects on eggs, corals, sponges, sea turtles, seabirds, and marine mammals (NMFS, 2007L).

Storm surges and wind generated waves also have the potential to affect EFH. The potential exists for surges and waves to alter the bottom and change the characteristics of the water column (NMFS, 2007L). The effects, however, are not generally extensive and do not extend to the entire ecosystem.

No effects to EFH are anticipated from active sonar since acoustic transmissions are brief in nature. In addition, the explosive source sonobuoy (AN/SSQ-110A) will be detonated within the water column. As such, the explosive force resulting from the detonation would be of sufficient distance from the bottom and will not have the potential to disturb the sea floor. Therefore, there will be no significant effect to EFH from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.8.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Since the majority of AFAST activities are short-term and occur underwater, interaction with EFH during active sonar activities is not expected to be significant. Any impacts would be temporary and localized and as such, there is the potential for minor, but recoverable cumulative effects to EFH. No significant cumulative impacts are anticipated.

6.4.1.9 Sea Birds

6.4.1.9.1 AFAST EIS/OEIS Conclusions

The primary threats to sea birds include commercial fishing and exploitation from hunting sea birds and collecting eggs. Additional considerations include exotic species, marine debris and pollution including underwater sound. The longline fishing industry experiences high incidental catch rates of sea birds because the operations use baited hooks on a main line that remain in the air or near the surface of the water (NMFS, 2001d). The bait attracts birds, which may accidentally get hooked and then drown or entangle as they are dragged underwater. Additionally, personnel on vessels discard fish, scraps, and bait. The availability of these food sources attracts sea birds and in turn, the individuals get hooked or entangled in the main lines (NMFS, 2001d). The majority of research in this area has been conducted in the Pacific because of the concentration of longline operations in Hawaii and Alaska. The Final U.S. National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries addresses Atlantic operations including Atlantic tuna, swordfish, sharks, and billfish (NMFS, 2001d). Historically, NMFS observer programs have focused on sea turtles and marine mammals and have only limited data on sea bird by-catch (NMFS, 2001d). Quantitative information is not currently available on the incidental catch of seabirds in fisheries of the U.S. Atlantic coast and Gulf of Mexico.

A number of mitigation measures are under development and have been implemented voluntarily. Such measures include the use of bird-scaring devices and weighted lines, the practice of night setting, and the avoidance of offal (e.g., discarded bait and fish scraps) dumping. Other practices include education and outreach to fishermen and the public and continued research to assess sea bird interactions and appropriate mitigations (NMFS, 2001d).

There is no scientific evidence to suggest birds can hear sounds underwater. Moreover, studies researching the potential effects of underwater sound to diving birds during pile-driving and seismic surveys, determined that airguns did not cause harm. Explosives did result in injury, but only when the seabirds were near the detonation (Turnpenny and Nedwell, 1994). Furthermore, seabirds spend a short period of time underwater, and it is extremely unlikely that the timing of active sonar use would coincide with the dive of a seabird. Therefore, it was determined that there will be no significant impacts to seabirds from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In addition, entanglement and the actual drowning of a seabird in a parachute assembly is unlikely, since the parachute would have to land directly on the animal, or a diving seabird would have to be diving exactly underneath the location of the sinking parachute. The potential for a seabird to encounter an expended parachute is extremely low, given the generally low probability of a seabird being in the immediate location of deployment. Therefore, it was determined that there will be no adverse effects to seabirds from entanglement associated with active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.9.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Other activities previously described in this chapter have the potential to impact sea birds and migratory birds. Since the majority of AFAST activities are short-term and occur underwater it is expected that only rare, if any, occurrences of an interaction between active sonar activity and diving seabirds could be expected. As such, there is the potential for minor, but recoverable cumulative impacts to seabirds under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3 when combined with other actions. Impacts would be temporary and localized and would not be considered significant.

6.4.1.10 Marine Invertebrates

6.4.1.10.1 AFAST EIS/OEIS Conclusions

According to the NRC (2003), there is very little information available regarding the hearing capability of marine invertebrates. However, since acoustic transmissions are brief in nature, effects to marine invertebrates from active sonar are not anticipated. In addition, there is a huge variation in marine invertebrates, including numbers, species, sizes, and orientation and range from the detonation point, which makes it very difficult to accurately predict effects at any specific site of detonation from the explosive source sonobuoy (AN/SSQ-110A). Most invertebrates experience large number of natural mortalities especially since they are important foods for fish, reptiles, birds, and mammals. Any level of mortality caused by AFAST activities involving the explosive source sonobuoy (AN/SSQ-110A) would most likely be insignificant to the population as a whole. In addition the explosions associated with the explosive source sonobuoy (AN/SSQ-110A) will be occurring within the water column. Based on the small net explosive weight (NEW) of the explosive, it is not likely that the pressure wave associated with the detonation will reach the bottom of the ocean, where the majority of invertebrates live. Therefore, it was determined that there will be no adverse effects to marine invertebrates from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.10.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Other activities described earlier in chapter 6 which would most likely have the greatest effect on marine invertebrates are dredging, commercial fishing, environmental contamination and biotoxins. AFAST activities would be relatively isolated due to the large expanses of area between activity locations. As such, there is a potential for minor, but recoverable, cumulative impacts to marine invertebrates under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3. Impacts would be temporary and localized and would not be considered significant.

6.4.1.11 Marine Plants and Algae

6.4.1.11.1 AFAST EIS/OEIS Conclusions

No effects to marine plants and algae are anticipated from active sonar since plants and algae are acoustically transparent. In addition, the detonation of the explosive source sonobuoy (AN/SSQ-110A) will occur within the water column. *Sargassum* mats are easily identified and will be avoided wherever possible. Therefore, it was determined that there will be no adverse effects to marine plants and algae from active sonar and no adverse effects to marine plants and algae from the explosive source sonobuoy (AN/SSQ-110A) under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.11.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Other activities described earlier in Chapter 6 which would most likely have the greatest affect on marine invertebrates are dredging, commercial fishing, environmental contamination and biotoxins. AFAST activities would be relatively isolated due to the large expanses of area in between activity locations. As such, minor, but recoverable cumulative impacts to marine plants and algae could occur under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.12 National Marine Sanctuaries

6.4.1.12.1 AFAST EIS/OEIS Conclusions

Under Alternative 1, Alternative 2, and Alternative 3, the U.S. Navy will not conduct active sonar activities in the Stellwagen Bank, USS Monitor, Gray’s Reef, Flower Garden, and Florida Keys National Marine Sanctuaries. Therefore, there would be no effect to the Stellwagen Bank, USS Monitor, Gray’s Reef, Flower Garden, and Florida Keys National Marine Sanctuaries under Alternative 1, Alternative 2, or Alternative 3.

Under the No Action Alternative, the Navy could conduct active sonar activities; however, at the present time, the Navy does not conduct active sonar activities in the Stellwagen Bank, USS Monitor, Gray’s Reef, Flower Garden, and Florida Keys National Marine Sanctuaries. If it is determined that an active sonar activity may occur in the Gray’s Reef, Flower Garden, or Florida Keys National Marine Sanctuaries, naval activities will be carried out in a manner that avoids to the maximum extent practicable any adverse impacts on sanctuary resources and qualities. If necessary, the Navy would consult with the Director, Office of Ocean and Coastal Resource Management in accordance with 15 CFR 922. In addition, Stellwagen Bank and USS Monitor National Marine Sanctuary regulations specifically preclude the Navy from conducting operations in this area without first entering consultation. If it is determined that an active sonar activity or vessel transit may occur in the Stellwagen Bank or USS Monitor National Marine Sanctuaries the Navy would consult with the Director, Office of Ocean and Coastal Resource Management in accordance with 15 CFR 922. Therefore, there would be no effect to the Stellwagen Bank, USS Monitor, Gray's Reef, Flower Garden, and Florida Keys National Marine Sanctuaries under the No Action Alternative.

6.4.1.12.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The Navy concludes that AFAST activities would not significantly impact any NMS in the operating areas and are not likely to destroy or cause the loss of resources related to the marine sanctuary. However, because AFAST activities do occur within the vicinity of the NMS, it is determined that there is a potential for minor, but recoverable, cumulative effects to the NMS under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3. The impacts would be temporary and localized and would not be significant.

6.4.1.13 Airspace Management

6.4.1.13.1 AFAST EIS/OEIS Conclusions

Under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3, there will be no change to existing airspace configuration and scheduling of airspace and Notices to Airmen (NOTAMs) will be completed prior to the activity to ensure aircraft and pilot safety. Therefore, it was determined that there will be no effect to airspace management under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.13.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

AFAST activities will occur in special use Warning Areas, which are plotted on aeronautical charts so all pilots are aware of their location and the potential for military flight training in the respective airspace.

The airspace between and adjacent to the Warning Areas is designated as an Air Traffic Control Assigned Airspace (ATCAA). The Federal Aviation Administration (FAA) ARTCC's are responsible for air traffic flow control or management within this airspace transition. There are currently 22 ARTCCs in the United States (FAA, 2007). Within the AFAST Study Area, ARTCCs are located in New Hampshire, Virginia, and Florida (FAA, 2007). As stated previously, there will be no changes to existing airspace configuration or the scheduling of airspace as a result of AFAST activities. The Fleet Air Control Surveillance Facility (FACSFAC) is responsible for scheduling, monitoring, and controlling air traffic for the airspace within the Warning Areas. FACSFAC Pensacola is responsible for coordinating naval airspace and requests by the 46th Test Wing at Eglin AFB, Florida.

A NOTAM will be completed prior to AFAST training that involves aircraft maneuvers associated with active sonar activities and sonobuoy drops, as well as flights of helicopters dipping the AN/AQS-22 (ALFS) sonar. The release of NOTAMs ensures aircraft and pilot safety. Furthermore, the proper coordination and scheduling with the FAA and respective FACSFAC on all matters affecting airspace significantly reduces or eliminates the possibility of indirect or cumulative impacts on civilian and other military aviation and airspace use. No cumulative impacts to airspace management are anticipated.

6.4.1.14 Energy (Water, Wind, Oil and Gas)

6.4.1.14.1 AFAST EIS/OEIS Conclusions

There are currently no wind farms or active gas or oil exploration sites along the East Coast. There are identified water energy projects along the East Coast, but all locations are outside the AFAST Study Area. In addition, there are no existing or proposed water energy developments or wind farms in the Gulf of Mexico. Therefore, there will be no effect to water energy development, wind farms, or gas and oil exploration from active sonar activities off the southeastern or northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no effect to water energy development or wind farms from active sonar activities in the Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

Oil and gas drilling is occurring in non-territorial portions of the eastern Gulf of Mexico, and within the territorial and non-territorial portions of the western Gulf of Mexico. The proposed AFAST activities do not include any increases in tempo over past activities or any changes in locations and there were no documented significant effects to oil and gas drilling platforms during past active sonar activities. Moreover, there will be no significant effect to oil and gas drilling from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.14.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The only potential for incremental cumulative impacts is to gas and oil exploration in the Gulf of Mexico. However, the Navy would not approach energy facilities or energy vessels. Therefore, cumulative impacts due to the implementation of Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative and the activities mentioned previously in Chapter 6 would be minor and recoverable. Therefore, the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3 will not result in any significant incremental cumulative impacts with regard to oil and gas exploration in the Gulf of Mexico and only minor, but recoverable, cumulative impacts are anticipated.

6.4.1.15 Recreational Boating

6.4.1.15.1 AFAST EIS/OEIS Conclusions

Potential effects to recreational boating would most likely come from interactions with military vessels. However, most military actions would occur during weekdays, whereas most recreational boating occurs during the weekend. In addition, the Navy would not conduct active sonar activities in the vicinity of recreational boats. Therefore, there is a very low probability of an interaction. As such, as presented in the Chapter 4 analysis, there would be no effects to recreational boating from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.15.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that the activities would be very short in duration and interaction with recreational boaters is unlikely, cumulative impacts due to the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 with other activities described in this chapter would be minor and short term. No significant cumulative impacts to recreational boating would occur.

6.4.1.16 Commercial and Recreational Fishing

6.4.1.16.1 AFAST EIS/OEIS Conclusions

Potential effects to commercial and recreational fishing would most likely come from interactions with military vessels. However, the majority of commercial fish landings by weight and by value in the southeastern and northeastern Atlantic coast occur in state waters, which is also the primary location for recreational fishing activities. In the Gulf of Mexico, the majority of fishing takes place in federal waters on artificial reefs and hotspots such as canyons and humps. The Navy would not conduct active sonar activities within the vicinity of fishing vessels. Therefore, there is a very low probability of an interaction. As presented in the Chapter 4 analysis, there would be no significant impacts to commercial and recreational fishing from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.16.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that active sonar activities would be very short in duration and interaction with commercial and recreational fishing vessels is unlikely, cumulative impacts due to the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 with other activities described in this chapter would most likely be minor, temporary, and localized. Therefore, the proposed action will not result in any significant incremental cumulative impacts with regard to commercial and recreational fishing.

6.4.1.17 Commercial Shipping

6.4.1.17.1 AFAST EIS/OEIS Conclusions

Potential effects to commercial shipping vessels would most likely come from interactions or delays associated with military vessels along the shipping routes. Shipping routes exist throughout the nearshore and offshore waters of the study area. However, the ocean area for active sonar activities by the Navy is significantly larger than the area encompassed by shipping routes. Moreover, there have been no documented significant effects to commercial shipping from previous active sonar activities, and the Navy will avoid shipping vessels that transit through the active sonar area. Therefore, there is a very low probability of an interaction. As presented in the Chapter 4 analysis, there would be no significant impacts to commercial shipping from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.17.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that active sonar activities would be very short in duration and interaction with commercial shipping vessels is unlikely, cumulative impacts due to the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 with other activities described in this chapter would most likely minor, temporary and localized. Therefore, the proposed action will not result in any significant incremental cumulative impacts with regard to commercial shipping.

6.4.1.18 Scuba Diving

6.4.1.18.1 AFAST EIS/OEIS Conclusions

Recreational diving activities typically occur at known diving sites. The Professional Association of Diving Instructors (PADI) recommends that certified scuba divers limit their dive depths to 12 m (40 ft), and certified open-water divers limit their dives to 18 m (60 ft). While more experienced divers are generally limited to 30 m (100 ft), in general, no recreational diver should exceed 40 m (130 ft) (PADI, 2006). Therefore, the likelihood of affecting divers will decrease inversely in proportion to water depth. With the exception of MIW Independent ULT, Object Detection/Navigational Sonar ULT, and RDT&E activities, all other active sonar activities occur in water depths greater than 30 m (100 ft). These activities would be in very short duration, generally lasting from 1 to 6 hours. As such, as presented in the Chapter 4 analysis, there would be no significant effects to scuba diving from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.18.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that the activities would be very short in duration, cumulative impacts associated with the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 and military activities described in this chapter would be minor, temporary, and localized. Therefore, the proposed action will not result in any significant incremental cumulative impacts with regard to recreational diving

6.4.1.19 Marine Mammal Watching

6.4.1.19.1 AFAST EIS/OEIS Conclusions

Potential effects to marine mammal watching would come from the closure of areas for military operations. However, marine mammal watching occurs within a few miles of shore and rarely in federal waters. Tours in the southeast typically last from one to two hours in such hotspots for dolphin watching as the Virginia Beach, Virginia; Nags Head, North Carolina; and Hilton Head Island, South Carolina. Tours in the northeast typically range from three to six hours in length, with an average duration of three and one-half to four hours (Whale and Dolphin Conservation Society [WDCS], 2007). Within the Gulf of Mexico, tours generally last from one and a quarter to three and one-half hours, with average trip durations of two hours. Given the short duration of marine mammal excursions and the fact that most trips occur close to shore, the potential for effects to the industry will be low. As such, it was determined in the Chapter 4 analyses that there would be no significant effect to marine mammal watching from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.19.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that the activities would be very short in duration, cumulative impacts associated with the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 and military activities described in this chapter would be minor and temporary. Therefore, the proposed action will not result in any significant incremental cumulative impacts with regard to marine mammal watching.

6.4.1.20 Cultural Resources at Sea

6.4.1.20.1 AFAST EIS/OEIS Conclusions

As stated in Chapter 4, known shipwrecks are located within and adjacent to the OPAREAs in the AFAST Study Area. Potential effects to cultural resources at sea would come from physical disturbance, but as stated previously, the small size and low density of expended materials will not cause effects to the sediment stability on the ocean bottom. Many details, including latitudes and longitudes of submerged wrecks and obstruction in coastal waters of the United States are cataloged in the Automated Wreck and Obstruction Information System. The Navy will avoid all known cultural resources and would consult with the applicable agencies, including the State Historic Preservation Officer if effects to cultural resources are anticipated, as required by law. Therefore, it was determined that there will be no significant effects to cultural resources from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.20.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Most past, present, and reasonably foreseeable future ocean activities such as commercial ship traffic, fishing, energy exploration, or scientific research, would not substantially affect underwater cultural resources. This is most likely due to lack of physical contact with shipwrecks since their locations are cataloged. Moreover, any activities with the potential for significant impacts on cultural resources will require Section 106 consultation, and would be mitigated as required by law. Where avoidance was practiced, no cumulative impact would result since there would be no contact with the cultural resource. Where cultural resources could not be avoided, Section 106 consultation would mitigate any potential adverse affects to the cultural resources. Therefore, there is the potential for minor, but recoverable cumulative impacts to cultural resources under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.21 Environmental Justice

6.4.1.21.1 AFAST EIS/OEIS Conclusions

As discussed previously, the active sonar activities that are described in this EIS/OEIS are not new and do not involve significant changes in systems, tempo, or intensity from past events. Moreover, there will be no significant effects to geology, water quality, marine habitat, airspace management, cultural resources, or socioeconomics within the AFAST Study Area under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. As such, implementation of the proposed action will not pose disproportionate high or adverse effects to minority or low-income populations, or environmental health and safety risks to children.

6.4.1.21.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Since the proposed action will not pose disproportionate high or adverse effects to minority or low-income populations, or environmental health and safety risks to children, the proposed action will not result in any cumulative impacts.

6.5 ASSESSING INDIVIDUAL PAST, PRESENT, AND FUTURE IMPACTS

In this chapter, past and present actions, as well as reasonably foreseeable future actions, have been identified. A value of "NE" through "***" was assigned to each action based on its potential to cause an adverse effect to a specific resource area. An example of each value is as follows:

- A "NE" value would be given to an action that has no adverse effects to a particular resource.
- A "*" would be given to an action that has the potential for minor, but recoverable, adverse effects to a particular resource. Examples include a negligible or less than significant effect to a resource.

- A "**" would be given to an action that has the potential for moderate, but recoverable, adverse effects to a particular resource. Examples include a measurable effect to a resource, but an effect that would be recoverable.
- A "***" would be given to an action that has the potential for major, non-recoverable, adverse effects to a particular resource. Examples include a significant effect to a resource, including effects that are not recoverable.

Once a value was assigned to each resource for an individual action, an assessment was conducted to determine whether there would be cumulative impacts to the resource area in relation to the Proposed Action. Cumulative impacts were considered likely to occur for the following actions:

- Actions occurring at the same or overlapping areas at the same or similar time.
- Actions occurring in the vicinity at the same or similar time.
- Actions occurring at the same or overlapping areas at some other time.

The same valuation process was used to determine the overall cumulative impact to a resource. It is important to note that even if a resource was given a value of "**" or "***" for an individual action, it does not automatically generate a cumulative impact of "**" or "***." This is due to difference in space and time from other actions or the resource that is potentially affected. For instance, as discussed in Chapter 1, regulatory permits can be granted for certain actions that involve the likely "taking" of protected species, such as marine mammals, sea turtles, or migratory birds. Even though these individual effects would be considered moderate to severe (depending on the action and species affected), regulations are in place to ensure the continued survival of the respective species. Moreover, the implementation of mitigation and mitigation measures for individual actions has the potential to further reduce the cumulative impact.

Table 6-19 summarizes the results of the environmental analysis for each resource area identified previously in this EIS/OEIS that could potentially be affected by the Proposed Action; other past, present, and reasonably expected future actions potentially affecting the same resources; and the magnitude of each individual action.

Table 6-19. Summary of Cumulative Impacts in the Study Area

		Sediment Quality	Marine Debris (Marine Habitat)	Water Quality	Sound in the Environment	Marine Mammals	Sea Turtles	Marine Fish	Essential Fish Habitat	Sea Birds	Marine Invertebrates	Marine Plants and Algae	National Marine Sanctuaries	Airspace Management	Energy Exploration and Offshore Drilling	Recreational Boating	Commercial and Recreational Fishing	Commercial Shipping	SCUBA Diving	Marine Mammal Watching	Cultural Resources	Environmental Justice
Past and Present Actions	Military Operations	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	NE
	MMS: Oil and Gas	**	*	**	*	**	**	*	*	**	*	*	*	NE	---	NE	NE	NE	NE	NE	*	NE
	State Oil and Gas	**	*	**	*	**	**	*	*	**	*	*	*	NE	---	NE	NE	NE	NE	NE	*	NE
	Dredging	**	**	**	*	NE	**	**	**	NE	**	**	**	NE	NE	NE	NE	NE	NE	NE	*	NE
	Commercial and Recreational Fishing	*	**	NE	*	**	**	**	**	**	**	NE	**	NE	NE	NE	---	NE	NE	NE	*	NE
	Maritime Traffic	*	*	*	*	**	*	NE	NE	NE	NE	NE	*	NE	NE	---	NE	---	NE	NE	*	NE
	Scientific Research	NE	*	NE	NE	*	*	*	*	*	*	*	*	NE	**	NE	**	NE	NE	NE	NE	NE
	Debris	---	--	*	NE	**	**	**	**	**	**	NE	*	NE	NE	*	*	*	*	NE	*	NE
	Environmental Contamination and Biotoxins	---	--	**	NE	**	**	**	**	**	**	**	**	NE	NE	NE	**	NE	NE	NE	NE	NE
	Marine Ecotourism	NE	*	*	*	*	*	NE	NE	NE	NE	NE	*	NE	NE	---	NE	NE	---	---	NE	NE
Future Actions	Military Operations	*	*	*	*	*	*	*	*	*	*	*	*	*	NE	*	*	*	*	*	*	NE
	NASA	NE	*	NE	*	NE	NE	NE	NE	*	NE	NE	NE	*	NE	NE	NE	NE	NE	NE	NE	NE
	Offshore LNG	*	**	*	*	*	*	*	*	*	*	*	*	NE	NE	NE	NE	NE	NE	NE	*	NE
	Offshore Windfarms	*	*	**	*	*	*	*	*	**	*	*	*	NE	NE	NE	NE	NE	NE	NE	*	NE
AFAST Proposed Action		*	*	*	*	**	**	*	*	NE	NE	NE	NE	NE	*	NE	*	*	NE	*	*	NE
Cumulative Impacts		*	*	*	*	**	**	*	*	*	*	*	*	NE	*	*	*	*	*	*	*	NE

NE = No adverse effects; * = Potential for minor, but recoverable, adverse effects; ** = Potential for moderate, but recoverable, adverse effects; *** = Potential for major, non-recoverable, adverse effects

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