Final Environmental Impact Statement

Shock Trial of the WINSTON S. CHURCHILL (DDG 81)

Department of the Navy
February 2001

RESPONSIBLE AGENCIES:

Department of the Navy (lead agency)
National Marine Fisheries Service (cooperating agency)

PROPOSED ACTION AND GEOGRAPHIC LOCATION:

Shock Trial of the WINSTON S. CHURCHILL (DDG 81)
Offshore of Mayport, Florida; Norfolk, Virginia; or Pascagoula, Mississippi

CONTACT FOR FURTHER INFORMATION:

Navy Point-of-Contact: Ms. Lyn Carroll
Email Address: ddg81eis@tst.tracor.com
Voice Message: (703) 413-4099

TYPE OF REPORT:

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ABSTRACT:

WINSTON S. CHURCHILL (DDG 81) is the third ship in a new flight of guided missile destroyers being acquired by the Navy. These are referred to as the Flight IIA ships and they represent the largest single upgrade to the ARLEIGH BURKE class destroyer. The FEIS evaluates the environmental consequences of conducting a shock trial of WINSTON S. CHURCHILL at an offshore location. The ship would be subjected to a series of up to four 4,536 kg (10,000 lb) explosive charge detonations sometime between 1 May and 30 September 2001. The FEIS evaluates a "no action" alternative and analyzes in detail the alternative of conducting a shock trial at sea at one of three test areas. The test areas are offshore of Naval Station Mayport, Florida; Naval Station Norfolk, Virginia; and Naval Station Pascagoula, Mississippi. Alternatives are compared with respect to project purpose and need, operational criteria, and environmental impacts. The "no action" alternative would not meet the purpose and need because it would prevent the Navy from adequately assessing the survivability of Flight IIA ships. The entire manned ship must be shock tested at sea because, unlike computer modeling and component testing, it would provide the means to assess the shock response of the entire ship and the interaction of the ship's systems and components. The alternative of conducting a shock trial at sea is evaluated in detail. From an operational perspective, Norfolk and Mayport rank higher and are about equal, with Pascagoula ranking lower and well behind the other two. Most environmental impacts of the shock trial would be similar at the three test areas. These include minor and/or temporary impacts to the physical and biological environments and existing human uses of the area. The main environmental issue is the risk of impacts to marine mammals and sea turtles, which differs among test areas. Based on the best available scientific data, the risk of mortality and injury to marine mammals and turtles is higher at Norfolk and lower at, and about equal between, Mayport and Pascagoula. Therefore, the preferred alternative is to conduct a shock trial at Mayport. This alternative would meet the project purpose and need, satisfy operational requirements, and minimize environmental impacts.

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Acronyms and Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
BRAC	Base Closure and Realignment
CEQ	Council on Environmental Quality
CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
CL	Ceiling concentration
CTS	Compound threshold shift
DEIS	Draft Environmental Impact Statement
DOI	Department of the Interior
DRC	Damage risk criteria
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
GPS	Global Positioning System
GulfCet	Distribution and Abundance of Cetaceans in the North-Central and Western Gulf of Mexico (MMS study)
HBX	High Blast eXplosive
LFT&E	Live Fire Test & Evaluation
MAMES	Mississippi-Alabama Marine Ecosystems Study
MART	Marine Animal Recovery Team
MBTA	Migratory Bird Treaty Act
MMATS	Marine Mammal Acoustic Tracking System
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MSC	Military Sealift Command
NAS	Naval Air Station
NEPA	National Environmental Policy Act
NIOSH	National Institute for Occupational Safety and Health
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSSN	New Attack Submarine
OPNAVINST	Chief of Naval Operations Instruction
OSHA	Occupational Safety and Health Administration
OTC	Officer in Tactical Command
PERSTEMPO	Personnel Tempo (Navy regulations)
PTS	Permanent threshold shift
ROD	Record of Decision
SEAMAP	Southeast Environmental Assessment and Mapping Program
SETS	Southeast Turtle Surveys
STEL	Short-term exposure limit
TM	Tympanic membrane
TTS	Temporary threshold shift
USC	U.S. Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service

EXECUTIVE SUMMARY

This is a Final Environmental Impact Statement (FEIS) for the shock trial of WINSTON S. CHURCHILL (DDG 81). The FEIS was prepared by the Department of the Navy with the cooperation of the National Marine Fisheries Service (NMFS).

WINSTON S. CHURCHILL is the third ship in a new "flight" of 23 guided missile destroyers known as the Flight IIA ships of the ARLEIGH BURKE (DDG 51) class destroyers. A flight is a subset of a class of ships to which significant changes have been made. Flight IIA ships represent the largest single upgrade to the original ARLEIGH BURKE class destroyers. Features include the SPY-ID phased array, wide-area, anti-jam radar; vertical launch missile system; extensive command, communications, and data link systems; and sophisticated SQS-53C sonar system. By the year 2010, ARLEIGH BURKE class destroyers will represent the major force in the surface Navy.

Each new class of ships (or major upgrade) constructed for the Navy must undergo a shock trial. A shock trial is a series of underwater detonations that send a shock wave through the ship's hull to simulate near misses during combat. A shock trial allows the Navy to assess the survivability of the hull, the ship's systems, and the capability of the ship to protect the crew. WINSTON S. CHURCHILL was selected as the Flight IIA shock trial ship because it has additional design changes that will not be included in the first two Flight IIA ships, and therefore it is more representative of the flight.

PROPOSED ACTION

The proposed action is to conduct a shock trial of WINSTON S. CHURCHILL at an offshore location between 1 May and 30 September 2001. The test was scheduled for this period based on the likelihood of favorable weather and the availability of the ship. The FEIS analyzes in detail alternative areas offshore of Naval Station Mayport, Florida; Naval Station Norfolk, Virginia; and Naval Station Pascagoula, Mississippi (**Figure ES.1**).

In the shock trial, WINSTON S. CHURCHILL would be exposed to a series of underwater detonations of a 4,536 kg (10,000 lb) charge. The ship and the explosive charge would be brought closer together with each successive detonation to increase the severity of the shock. The gradation in severity would allow the Navy to fully assess the survivability of the ship and its systems. The plan is to subject WINSTON S. CHURCHILL to three detonations, which is the number of detonations needed to collect adequate data on survivability. A fourth detonation would be conducted only if one of the planned three detonations fails to provide technically acceptable data (e.g., due to equipment failure or some other technical problem). The shock trial would be conducted at a rate of one detonation per week to allow time to perform detailed inspections of the ship's systems prior to the next detonation.

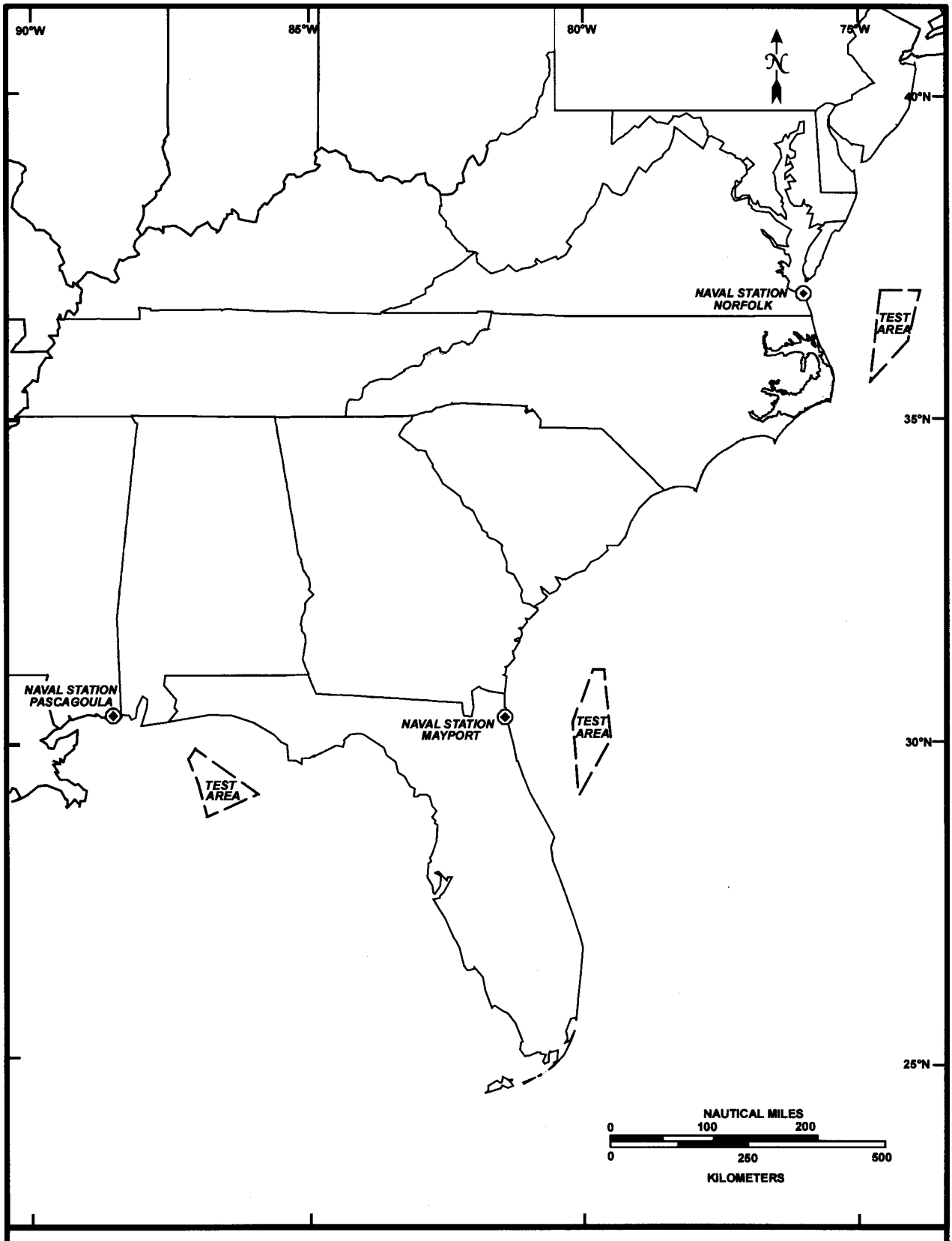

Figure ES.1. Potential test areas for the DDG 81 shock trial.

PROJECT PURPOSE AND NEED

The purpose of the project is to generate data that can be used to assess the survivability of Flight IIA ships. An entire manned ship must be shock tested at sea to obtain information to assess the survivability of the ship that is not obtainable through computer modeling and component testing on machines or in surrogates. Shock trials have proven their value as recently as the Persian Gulf War when ships were able to survive battle damage and continue their mission because of ship design, crew training, and survivability lessons learned during previous shock trials.

Section 2366, Title 10, United States Code (10 USC 2366) requires realistic survivability testing of a covered weapon system to ensure the vulnerability of that system under combat conditions is known. This statute requires that the Navy determine both what constitutes realistic survivability testing and whether a system is covered. In this case, the Navy has determined that the Flight IIA destroyer is a covered system. Realistic survivability testing means testing for the vulnerability of the ship in combat by firing munitions likely to be encountered in combat with the ship configured for combat. This testing is commonly referred to as "Live Fire Test & Evaluation" (LFT&E). Realistic testing by firing live ammunition at the ship or detonating a real mine against the ship's hull, however, could result in the loss of a multi-million dollar Navy asset. Therefore, the Navy has established an approved LFT&E program to complete the vulnerability assessment of Flight IIA ships as required by 10 USC 2366. The LFT&E program includes three major areas that together provide for a complete and comprehensive evaluation of the survivability of Flight IIA ships in a near miss, underwater explosion environment. These areas are computer modeling and analysis, component testing, and an at-sea ship shock trial. As discussed in Section 1.0 of the FEIS, computer modeling and component tests provide valuable information regarding the survivability of the ship. However, only the at-sea shock trial would provide the real-time data necessary to fully assess ship survivability.

USS JOHN PAUL JONES (DDG 53) was shock tested off the coast of California in June 1994 to assess the survivability of the original DDG 51 class destroyer. However, Flight IIA ships are significantly different from the original DDG 51 class destroyers in their design. Due to the number of major structural and equipment changes between Flight IIA ships and DDG 51 class destroyers, a new shock trial is necessary to assess the shock response of Flight IIA ships and the interaction of ship systems and components.

ALTERNATIVES

The FEIS evaluates two alternatives: (1) no action and (2) conducting a shock trial at an offshore location. Three alternative test areas for the shock trial are identified that meet all operational requirements. The three test areas are compared from operational and environmental perspectives.

No Action Alternative

Under this alternative, no new activities affecting the physical environment would be conducted to assess the response of Flight IIA ships to underwater detonations. This alternative would avoid all environmental impacts of the shock trial.

The "no action" alternative would prevent the Navy from being able to assess the survivability of Flight IIA ships. A shock trial at sea provides the only means to assess the shock response of the entire ship and the interaction of the ship's systems and components. The LFT&E program for Flight IIA ships already includes the maximum reasonable amount of computer modeling and component testing.

The "no action" alternative involves no activity affecting the physical environment. However, the "no action" alternative is implicit in the environmental analysis throughout the document. The Existing Environment section provides a "no action" benchmark against which the proposed action can be evaluated. The Environmental Consequences section compares impacts of an action (conducting a shock trial) with the alternative of "no action."

Shock Trial at an Offshore Location (Preferred Alternative)

Conducting a shock trial at an offshore location is the proposed action and the Navy's preferred alternative. Within this alternative, a multi-step process was used to identify, eliminate, and finalize alternative offshore locations for assessment in the EIS. Alternative areas for the shock trial were identified based on operational requirements. Portions of the candidate test areas were excluded to avoid environmental impacts. Mitigation measures were developed that would minimize potential impacts at each test area. Environmental impacts of conducting a shock trial at each of the alternative test areas were analyzed.

Operational Requirements. Alternative areas for the proposed shock trial were evaluated by the Navy according to operational criteria. A location along the East Coast or Gulf of Mexico would best meet operational needs because WINSTON S. CHURCHILL will be homeported on the East Coast. Only three Naval Stations along the East Coast and Gulf of Mexico have sufficient homeported ships to support the shock trial: Naval Station Mayport, Naval Station Norfolk, and Naval Station Pascagoula. Test areas offshore of these three Naval Stations can meet all other operational requirements including water depth of at least 183 m (600 ft), suitable weather/sea state conditions, a manageable volume of commercial ship traffic, and proximity to aircraft, a ship repair facility, and an ordnance loading facility. A detailed analysis concluded that all three test areas could support the shock trial. From an operational perspective, Norfolk and Mayport rank higher and are about equal, with Pascagoula ranking lower and well behind the other two.

Operational Characteristics: Mayport

Advantages:	Disadvantages:
• The area has favorable weather and sea state conditions. • The area has the lowest amount of commercial shipping traffic of the three areas. • Helicopters are homebased at Naval Station Mayport.	• A Military Sealift Command (MSC) tug would have to be deployed out of Naval Amphibious Base Little Creek (VA) for the duration of the shock trial. • Repair facilities are limited (one floating drydock in Mayport and one contract shipyard in Savannah). • There is no explosives storage (dayload only). • Aircraft would have to be deployed to Naval Air Station (NAS) Jacksonville to support the trial. • It is not the homeport of WINSTON S. CHURCHILL.

Operational Characteristics: Norfolk

Advantages:	Disadvantages:
• Naval Station Norfolk is the homeport of WINSTON S. CHURCHILL. • Largest number of homeported ships to support shock trial. • Home-based F-14 or F/A-18 aircraft are available at nearby NAS Oceana. • An MSC tug is available at nearby Naval Amphibious Base Little Creek. • The nearby Naval Weapons Station Yorktown is available to store and load the explosives.	• Weather conditions overall are less favorable than at either Mayport or Pascagoula, though adequate to conduct the shock trial. • Helicopters would need to be transferred from Mayport to NAS Norfolk for the duration of the trial. • Ship repair facilities, though more extensive than at Mayport, do not include a DDG 51 class shipbuilder.

Operational Characteristics: Pascagoula

Advantages:	Disadvantages:
• The area has the most favorable weather and sea state conditions. • A DDG 51 class shipbuilder is present at Pascagoula.	• There is heavier ship traffic than at the other test areas. • An MSC tug would have to be deployed out of Naval Amphibious Base Little Creek (VA) for the duration of the trial. • Helicopters would need to be transferred from Mayport to NAS Pensacola for the duration of the trial. • Aircraft would have to be deployed to NAS Pensacola or Tyndall Air Force Base to support the trial. • There is no explosives storage (dayload only). • The number of homeported ships to support the trial is minimal. • Fleet support activities at this Naval Station are minimal. • It is farthest from the homeport of WINSTON S. CHURCHILL.

Exclusionary Mapping. Some environmental features such as explosives dumpsites and shipping lanes were deliberately avoided in defining the test areas. After the test areas were defined, exclusionary mapping was conducted to determine whether portions of the test areas should be excluded. Environmental features that were included in the exclusionary mapping were as follows:

- Active petroleum lease blocks;
- Artificial reef sites and areas;
- Communications cables;
- Critical habitats;
- Data buoys;
- Explosives dumpsites;
- Hard bottom and coral areas;
- Marine sanctuaries;
- Navigation aids;
- Ocean dredged material, acid waste, and sewage sludge disposal sites;
- Pipelines (oil and gas);
- Platforms (oil and gas);
- Shipping lanes;
- Towers (communications or navigation);
- Unexploded ordnance; and
- Wrecks and obstructions.

Buffer zones were added to appropriate environmental features with the goal of protecting resources or avoiding conflicts at the time of the shock trial. Various buffer distances were used, depending on the type of environmental feature. The exclusionary mapping indicates that each test area has a large area remaining in which the shock trial could be conducted.

Comparison of Alternatives

Table ES.1 summarizes the analysis of alternatives with respect to project purpose and need, operational criteria, and environmental impacts.

Purpose and Need. The "no action" alternative (including computer modeling and component testing) is not a reasonable alternative because it would not provide the information and data necessary to assess the survivability of the ship as required by 10 USC 2366. The alternative of conducting a shock trial at an offshore location would meet the project purpose and need.

Operational Analysis. As explained previously, a detailed analysis concluded that all three potential test areas (Mayport, Norfolk, and Pascagoula) could support the shock trial. From an operational perspective, the Norfolk and Mayport test areas rank higher and are about equal, whereas the Pascagoula test area is significantly less suitable for supporting the shock trial.

Environmental Analysis. Potential environmental impacts of conducting a shock trial at the Mayport, Norfolk, and Pascagoula test areas are analyzed in the Environmental Consequences section of the FEIS and summarized in **Table ES.2**. Most environmental impacts of the shock trial would be similar at Mayport, Norfolk, or Pascagoula. These include minor and/or temporary impacts to the physical and biological environments and existing human uses of the test site. However, there are significant differences with respect to potential impacts on marine mammals and sea turtles, as discussed below.

Table ES.1. Summary of alternatives analysis.

Basis for Comparison	Alternative			
	No Action (Includes Maximum Reasonable Amount of Computer Modeling and Component Testing)	**Shock Testing at an Offshore Location**		
		Mayport Area	Norfolk Area	Pascagoula Area
Meets project purpose and need	No	Yes	Yes	Yes
Meets operational requirements	No further analysis (alternative does not meet project purpose and need)	Yes (Ranked higher, similar to Norfolk)	Yes (Ranked higher, similar to Mayport)	Yes (Ranked lower)
Environmental impacts				
- Marine mammals	No further analysis (alternative does not meet project purpose and need)	Lower risk of impacts (similar to Pascagoula)	Higher risk of impacts than Mayport or Pascagoula	Lower risk of impacts (similar to Mayport)
- Sea turtles	No further analysis (alternative does not meet project purpose and need)	Lower risk of impacts (similar to Pascagoula)	Higher risk of impacts than Mayport or Pascagoula	Lower risk of impacts (similar to Mayport)
- Other	No further analysis (alternative does not meet project purpose and need)	Most other environmental impacts similar at the three areas (**see Table ES.2**)		

Table ES.2. Comparison of potential environmental impacts of a shock trial at the Mayport, Norfolk, and Pascagoula test areas.

Environmental Component	Section of FEIS Analyzing Impacts	Description of Potential Impact	Comparison of Alternative Areas
		IMPACTS EVALUATED UNDER EXECUTIVE ORDER 12114 (impacts outside U.S. territorial seas)	
Biological Environment			
Marine mammals	4.1.1	Mitigation will minimize risk, but marine mammals could be killed or injured if not detected within Safety Range. At greater distances, animals may experience disruption of hearing-based behaviors.	Risk of a marine mammal being killed, injured, or experiencing hearing disruption would be higher at Norfolk and lower and about equal at Mayport or Pascagoula.
Sea turtles	4.1.2	Mitigation will minimize risk, but turtles could be killed or injured if not detected within Safety Range. At greater distances, turtles may experience disruption of hearing-based behaviors.	Risk of a sea turtle being killed, injured, or experiencing hearing disruption would be higher at Norfolk and lower and about equal at Mayport or Pascagoula.
Seabirds	4.1.3(a)	Seabirds above the detonation point could be killed or stunned by the plume of water ejected into the air. Other seabirds resting or feeding at the surface could be killed or injured by the shock wave. It is unlikely that more than a few birds would be affected.	Mayport, Norfolk, and Pascagoula similar.
Fish	4.1.3(b)	Pelagic (water column) fish near the detonation point may be killed or injured. Many of the same species occur at all three areas. Demersal (bottom) fish will not be affected.	Mayport, Norfolk, and Pascagoula similar.
Ichthyoplankton and *Sargassum* communities	4.1.3(c)	Floating organisms near the detonation point would be killed, but populations would be rapidly replenished through reproduction and mixing with adjacent waters.	Mayport, Norfolk, and Pascagoula similar.

Table ES.2. (Continued).

Environmental Component	Section of FEIS Analyzing Impacts	Description of Potential Impact	Comparison of Alternative Areas
		IMPACTS EVALUATED UNDER EXECUTIVE ORDER 12114 (continued) (impacts outside U.S. territorial seas)	
Benthic communities	4.1.3(d)	No direct effect on benthic organisms is expected. No habitat disturbance is expected. Metal fragments deposited on the seafloor will be colonized by invertebrates and attract fish.	Mayport, Norfolk, and Pascagoula similar.
Socioeconomic Environment			
Commercial and recreational fisheries	4.1.4(a)	Individuals of commercial or recreational fishery species may be killed or injured, but no significant impact on fishery stocks is expected. Commercial and recreational fishing activities within 18.5 km (10 nmi) of the detonation point will be temporarily interrupted.	Mayport, Norfolk, and Pascagoula similar.
Ship traffic	4.1.4(b)	Ship traffic passing within 18.5 km (10 nmi) of the detonation point would need to alter course or be escorted from the area.	Mayport, Norfolk, and Pascagoula similar.
Physical Environment			
Geology and sediments	4.1.5(a)	Metal fragments will be deposited on the seafloor. No cratering or sediment disturbance expected.	Mayport, Norfolk, and Pascagoula similar.
Air quality	4.1.5(b)	Temporary, localized increase in concentrations of explosion products in the atmosphere. No hazard to marine or human life.	Mayport, Norfolk, and Pascagoula similar.
Water quality	4.1.5(c)	Temporary, localized increase in concentrations of explosion products in the ocean. No hazard to marine life.	Mayport, Norfolk, and Pascagoula similar.

Table ES.2. (Continued).

Environmental Component	Section of FEIS Analyzing Impacts	Description of Potential Impact	Comparison of Alternative Areas
		IMPACTS EVALUATED UNDER NEPA [a] (impacts onshore and within U.S. territorial seas)	
Biological Environment	4.2.1	No significant direct or indirect impacts on marine biota, including plankton, pelagic fish, marine mammals, sea turtles, benthic organisms, and seabirds.	Mayport, Norfolk, and Pascagoula similar.
Socioeconomic Environment	4.2.2	No significant direct or indirect impacts on the local economy, including ship traffic and the fishing and tourism industries.	Mayport, Norfolk, and Pascagoula similar.
Physical Environment	4.2.3	No significant direct or indirect impacts on geology and sediments, air quality and noise, or water quality.	Mayport, Norfolk, and Pascagoula similar.

[a] Shore support operations and movement of vessels and aircraft within territorial seas are not unusual or extraordinary and are part of the routine operations associated with the existing shore bases.

Marine Mammal Impacts. Potential impacts on marine mammals are analyzed in detail in Section 4.1.1 of the FEIS and summarized in **Table ES.2**. Potentially significant direct impacts include mortality, injury, and temporary disruption of hearing-based behaviors. At either Mayport, Norfolk, or Pascagoula, mitigation methods described in Section 5.0 would result in selection of a test site with low densities of marine mammals. In addition, most marine mammals would be detectable during pre-detonation aerial surveys, surface observations, and passive acoustic monitoring, minimizing the risk of death or injury. The Norfolk test area has a higher density of marine mammals, including several endangered species (particularly sperm whales and fin whales). Due to these higher densities, the likelihood of finding a suitable test site is lower at Norfolk than at either Mayport or Pascagoula. The number of marine mammals potentially killed, injured, or experiencing disruption of hearing-based behaviors during the shock trial would be higher at Norfolk than at either Mayport or Pascagoula. The risk would be lower and about equal at Mayport and Pascagoula.

Sea Turtle Impacts. Potential impacts on sea turtles are analyzed in detail in Section 4.1.2 of the FEIS and summarized in **Table ES.2**. Potentially significant direct impacts include mortality, injury, and disruption of hearing-based behaviors. At either Mayport, Norfolk, or Pascagoula, mitigation methods described in Section 5.0 would result in selection of a test site with low densities of sea turtles. Because the Norfolk test area has a higher density of sea turtles, the likelihood of finding a test site with no detectable turtles is lower there than at either Mayport or Pascagoula. The number of sea turtles potentially killed or injured during the shock trial is higher at Norfolk than at either Mayport or Pascagoula. The risk would be lower and about equal at Mayport and Pascagoula.

Preferred Alternative

The preferred alternative is to conduct a shock trial at Mayport between 1 May and 30 September 2001 with mitigation to minimize risk to marine mammals and turtles. Although all three test areas meet minimum operational requirements, the Norfolk and Mayport test areas rank higher operationally, whereas the Pascagoula test area is significantly less suitable for supporting the shock trial. Environmentally, the risk of impacts to marine mammals and turtles is higher in the Norfolk test area, and is lower at, and about equal between, Mayport and Pascagoula. Therefore, considering all other aspects of the three candidate test areas to be about the same, conducting the shock trial at Mayport would meet the project purpose and need, satisfy operational requirements, and minimize environmental impacts.

ENVIRONMENTAL CONSEQUENCES

Impact discussions in the Environmental Consequences chapter are divided into separate subsections to distinguish between those aspects of the proposed action evaluated under the National Environmental Policy Act (NEPA) and those evaluated under Executive Order 12114. NEPA applies to activities and impacts within U.S. territory, whereas Executive Order 12114 applies to activities and impacts outside territorial seas. The proposed action includes operations that would occur both within and outside U.S. territory. The shock trial and

associated mitigation operations would occur at least 79 km (43 nmi) offshore at the Mayport area, 60 km (32 nmi) offshore at the Norfolk area, or 50 km (27 nmi) offshore at the Pascagoula area, outside U.S. territorial seas. No impacts from the actual shock trial (detonation of explosives) would occur in U.S. territory. The only operations that would occur within territorial limits are shore support activities and vessel and aircraft movements in territorial waters (i.e., transits between the shore base and the offshore shock trial site). These shore support activities and vessel and aircraft movements are not unusual or extraordinary and are part of the routine operations associated with the existing shore bases.

The proposed action involves underwater detonations that would produce a shock wave and noise, release chemical products into the ocean and atmosphere, and deposit metal fragments on the seafloor. During each test, there would be increased vessel traffic, including ships and aircraft monitoring for marine mammals and turtles. Routine ship traffic (including commercial and recreational fishing vessels) would be temporarily excluded from the test area.

Marine Mammals. Potentially significant impacts on marine mammals include mortality, injury, and temporary disruption of hearing-based behaviors. Numbers of marine mammals that may be killed by the detonations was estimated by using a model to predict the range for onset of extensive lung hemorrhage. Numbers of marine mammals potentially injured was similarly calculated using a model to predict the range for onset of slight lung hemorrhage. Disruption of hearing-based behaviors was estimated using a model to predict the range for onset of temporary threshold shift (TTS). TTS is a change in the threshold of hearing (the quietest sound that the animal can hear), which could temporarily affect an animal's ability to hear calls, echolocation sounds, and other ambient sounds.

Marine mammals could be killed or injured if they are present near the detonation point and not detected during pre-detonation monitoring. Marine mammals at greater distances may experience disruption of hearing-based behaviors. At any of the three test areas, site selection surveys would be conducted to choose a specific test site with low densities of marine mammals and turtles (see Mitigation). Potential deaths and injuries of marine mammals would be minimized by using marine mammal and turtle observers aboard aircraft and the shock trial ship, as well as passive acoustic monitoring. However, because of differences in marine mammal populations among test areas, the numbers potentially killed or injured would be higher at Norfolk than at Mayport or Pascagoula. Potential impacts from four detonations are estimated as follows:

Potential Marine Mammal Impacts

	Mayport	Norfolk	Pascagoula
Mortalities	4	7	3
Injuries	6	12	4
Disruption of hearing-based behaviors	2,885	14,640	3,132
Species most likely to be affected	• Bottlenose dolphin • Risso's dolphin	• Pilot whale • Atlantic spotted dolphin • Bottlenose dolphin	• Dwarf/pygmy sperm whale • Bottlenose dolphin

The higher numbers for disruption of hearing-based behaviors at Norfolk reflect the test area's water depth (onset TTS ranges are greater in deep water) as well as the marine mammal density differences.

At Mayport or Pascagoula, it is unlikely that any endangered marine mammals would be killed or injured. Sperm whales could be present, but in low densities, and these animals are very likely to be detected by visual and/or passive acoustic monitoring (see Section 5.0 and Appendix B). The probability of a sperm whale being present undetected in the Safety Range at either Mayport or Pascagoula is less than 1%. No other endangered whales are expected to occur at Mayport or Pascagoula during the test period.

Sperm whales and fin whales are the most abundant endangered cetaceans likely to be present at Norfolk. There is a small, but non-negligible (>1%) chance that an individual sperm whale, fin whale, or sei whale would be killed or injured if the shock trial were conducted at Norfolk. The probability of a humpback whale being killed or injured is less than 1%. No other endangered whales are expected to occur at Norfolk during the test period.

Sea Turtles. Potentially significant impacts on sea turtles could include mortality and injury. In the FEIS, the same criteria developed for marine mammals were used to estimate potential impacts on sea turtles. At any of the test areas, site selection surveys would result in selection of a test site with low densities of sea turtles. Because of the difference in turtle densities between areas, the risk of a turtle being killed or injured would be higher at Norfolk than at Mayport or Pascagoula. Potential impacts from four detonations are estimated as follows:

Potential Turtle Impacts

	Mayport	Norfolk	Pascagoula
Mortalities	1	2	1
Injuries	2	3	1
Disruption of hearing-based behaviors	232	855	199

Leatherback turtles (an endangered species) make up most of the population at the Mayport and Pascagoula test areas, whereas loggerhead turtles (a threatened species) are more abundant at Norfolk. Juvenile and hatchling sea turtles are unlikely to be affected because detonation would be postponed if large *Sargassum* rafts or debris lines (the preferred habitat of these turtles) were present within the Safety Range.

Seabirds. A few seabirds (if present on the water surface or in the air immediately above the detonation point) could be killed or stunned by the plume of water ejected into the air. As part of the mitigation plan, the Navy would postpone detonation if flocks of seabirds were sighted within 1.85 km (1 nmi) of the detonation point. This would avoid any large mortality of seabirds.

Fish and Other Small Marine Life. Fish and other small marine life near the detonation point would be killed or injured by the shock wave. A large fish kill would not be expected because detonation would be postponed if large schools of fish were observed within 1.85 km (1 nmi) of the detonation point (see Mitigation). Small fish with swimbladders (e.g., dwarf herring, round scad, Atlantic menhaden, and chub mackerel) are the ones most likely to be affected if present within about 1,645 m (5,400 ft) of the detonation point. Larger pelagic fish such as billfish, dolphinfish, tunas, and wahoo may be affected within a radius of about 915 m (3,000 ft). Fish without a swimbladder (e.g., sharks) are unlikely to be affected unless they are within about 22 m (73 ft) of the detonation point. Although individual fish would be killed and injured, no impact on fish populations is expected because the species found at the Mayport, Norfolk, and Pascagoula test areas are abundant and widely distributed. Other small marine life such as plankton would also be affected but would be rapidly replenished through population growth and mixing of test site waters with adjacent waters. Due to the water depth of at least 183 m (600 ft), bottom dwelling fish and invertebrates are unlikely to be affected at any of the test areas.

Fishing and Shipping Activities. Fishing vessels and other ships and aircraft would be excluded from an area of 9.3 km (5 nmi) radius before, during, and after each detonation, for a period of up to 12 hours. This exclusion zone is an electronic emissions control zone that virtually eliminates the possibility of an inadvertent detonation caused by radio/radar induced electrical current in the explosive firing circuit. The exclusion zone also provides an area of safe maneuvering for the charge-handling vessel and the towed charge. Ships within a 18.5 km (10 nmi) radius would be warned to alter course or would be escorted from the area. The most common fishing activities at both areas are surface and bottom longlining and trolling. Due to the short duration of the tests and advance warning through *Notices to Airmen and Mariners*, the interruption is not expected to significantly affect commercial or recreational fisheries or other ship traffic at Mayport, Norfolk, or Pascagoula.

Water and Air Quality. Underwater explosions would release chemical products into the ocean and atmosphere and deposit metal fragments on the seafloor. Due to the low initial concentrations and rapid dispersion of the chemical products, they would pose no hazard to marine or human life. Predicted atmospheric concentrations are well below human safety standards within 305 m (1,000 ft) downwind. Predicted concentrations in the surface pool above the detonation point are below water quality criteria. The small metal fragments would gradually corrode but are not expected to produce significant adverse impacts on the seafloor; they would provide a substrate for growth of epibiota and attract fish.

MITIGATION AND MONITORING

Mitigation, as defined by the Council on Environmental Quality, includes measures to minimize impacts by limiting the degree or magnitude of a proposed action and its implementation. The proposed action includes mitigation designed to minimize risk to marine mammals and turtles. A detailed marine mammal and sea turtle mitigation plan has been developed that includes test area selection and pre- and post-detonation monitoring. The plan is summarized below and described in detail in Section 5.0 of the FEIS. Other mitigation measures described in the FEIS

include environmental buffer zones to avoid impacts to certain environmental features; an exclusion zone to avoid impacts to routine vessel and air traffic; and measures to deal with unexploded ordnance in the unlikely event of a misfire.

Marine Mammal and Sea Turtle Mitigation Plan

A detailed Marine Mammal and Sea Turtle Protection/Mitigation Plan is presented in Section 5.0. The plan includes the same type of mitigation and monitoring efforts that were used successfully during the shock trial of the USS JOHN PAUL JONES in 1994. Those shock trial operations included two 4,536 kg (10,000 lb) detonations and no deaths or injuries of marine mammals were detected.

The mitigation plan represents the final step in a sequence of actions to avoid or reduce environmental impacts. The Mayport, Norfolk, and Pascagoula test areas were initially selected based on the Navy's operational requirements. Then, portions of each test area were excluded based on environmental considerations. Finally, the results of impact analysis in the Environmental Consequences section were used to compare the risk of impacts to marine mammals and turtles among test areas.

The mitigation plan would build upon these efforts to avoid and further reduce potential environmental impacts. Within a test area, one primary and two secondary test sites would be selected where marine mammal and turtle populations are the lowest, based on the results of aerial surveys to be conducted one to two days prior to the first detonation. This would ensure that the final test site selected for the shock trial poses the least possible risk to the marine environment. Pre-detonation monitoring would be conducted on the day of the shock trial to evaluate the test site and verify that the Safety Range and Buffer Zone are free of visually and acoustically detectable marine mammals; sea turtles; large *Sargassum* rafts, debris lines, and/or concentrations of jellyfish (all are possible indicators of turtle presence); large schools of fish; and flocks of seabirds. Finally, post-detonation monitoring would be conducted to determine the effectiveness of the mitigation efforts. A ship-based Marine Animal Recovery Team (MART) and aerial observers would monitor the test site and surrounding waters for injured or dead animals after each detonation. Communications with stranding network personnel would be maintained throughout the shock trial period.

The concept of a Safety Range is an integral part of the mitigation plan. The area within the Safety Range would be monitored by all components of the mitigation team and detonation would not occur until it is clear of detectable marine mammals and sea turtles, as well as indicators of sea turtle presence such as large *Sargassum* rafts, debris lines, and jellyfish aggregations. The purpose of the Safety Range is to prevent deaths and injuries to marine mammals and sea turtles. The Safety Range radius of 3.7 km (2 nmi) around the detonation point exceeds the estimated ranges for mortality and injury to a marine mammal or sea turtle associated with detonation of a 4,536 kg (10,000 lb) explosive. Based on the analysis presented in Appendix D, the maximum range for mortality (onset of extensive lung injury) is 1.35 km (0.73 nmi) and the maximum range for injury (onset of slight lung injury) is 2.25 km (1.22 nmi). These are conservative ranges, and take into account the worst-case depth effects.

The Safety Range extends well beyond these ranges to encompass the maximum area that can be effectively monitored both visually and acoustically. Its radius is approximately 2.7 times the onset mortality range and 1.6 times the range for onset of slight lung injury.

The mitigation plan includes three components: (1) aerial surveys/monitoring; (2) shipboard monitoring from WINSTON S. CHURCHILL; and (3) passive acoustic monitoring. Aerial and shipboard monitoring teams would identify and locate animals on the surface, whereas the acoustic monitoring team would detect and locate calls from submerged marine mammals. This combination of monitoring components would be used to detect marine mammals and turtles within the Safety Range and to minimize the risk of impacts to these animals.

COORDINATION AND CONSULTATION WITH THE NMFS

The NMFS has two regulatory roles in the project. First, it is responsible for administering the Endangered Species Act of 1973 as it applies to sea turtles and most marine mammals. The DEIS served as a Biological Assessment that the Navy submitted to the NMFS, requesting formal consultation under Section 7 of the Endangered Species Act. The NMFS subsequently issued a Biological Opinion which is included in Appendix G of the FEIS.

The NMFS also has a regulatory role under the Marine Mammal Protection Act of 1972. In January 2000, following the release of the DEIS, the Navy submitted a separate application to the NMFS for an "incidental take authorization" under section 101(a)(5)(A) of the Marine Mammal Protection Act. In December 2000, the NMFS published a Proposed Rule in the Federal Register (65 FR 77546). The Proposed Rule specifies mitigation, monitoring, and reporting requirements for the shock trial. A Final Rule must be issued before the shock trial can proceed.

The NMFS is also a cooperating agency with the Navy in preparing the EIS. Because of its regulatory responsibilities under the Endangered Species Act and the Marine Mammal Protection Act, the NMFS limited its role in preparation of the EIS mainly to providing review and comment. The only formal comments received from the agency concern essential fish habitat, and they are addressed in Appendix I of the FEIS.

1.0 INTRODUCTION

This document is a Final Environmental Impact Statement (FEIS) for the shock trial of the WINSTON S. CHURCHILL. The Department of the Navy is the lead agency and the National Marine Fisheries Service (NMFS) is a cooperating agency for the FEIS.

1.1 BACKGROUND

WINSTON S. CHURCHILL (DDG 81) is the third ship in a new flight[1] of 23 ARLEIGH BURKE (DDG 51) class guided missile destroyers being acquired by the Navy. These are referred to as the Flight IIA ships and they represent the largest single upgrade to the original DDG 51 class destroyer. ARLEIGH BURKE class destroyers are the world's most capable multi-mission surface warships. Features include the SPY-ID phased array, wide-area, anti-jam radar; vertical launch missile system; extensive command, communications, and data link systems; and sophisticated SQS-53C sonar system. By the year 2010, ARLEIGH BURKE class destroyers will represent the major force in the surface Navy.

Each new class of ships or major upgrade (Flight IIA ships in this case) must be shock tested to assess the survivability of the hull, the ship's systems, and the capability of the ship to protect the crew after a near miss from an underwater explosion. A shock trial is a series of underwater detonations that propagate a shock wave through the ship's hull under deliberate and controlled conditions. A shock trial assesses a ship's survivability and vulnerability in combat situations by simulating near misses from underwater explosions. The Navy can then measure the effect of the shock wave on the hull, equipment, and personnel safety features. This information is used to improve the shock resistance of the ship and follow-on ships of the class, thereby reducing the risk of crew injury.

1.2 PROJECT PURPOSE AND NEED

The purpose of the project is to generate data that can be used to assess the survivability of Flight IIA ships. An entire manned ship must be shock tested at sea to obtain information to assess the survivability of the ship that is not obtainable through computer modeling and component testing on machines or in surrogates. Shock trials have proven their value as recently as the Persian Gulf War when ships were able to survive battle damage and continue their mission because of ship design, crew training, and survivability lessons learned during previous shock trials.

Section 2366, Title 10, United States Code (10 USC 2366) requires realistic survivability testing of a covered weapon system to ensure the vulnerability of that system under combat conditions is known. This statute requires that the Navy determine both what constitutes realistic survivability testing and whether a system is covered. In this case, the Navy has determined that the Flight IIA destroyer is a covered system. Realistic survivability testing means testing for the vulnerability of the ship in combat by firing munitions likely to be encountered in combat with the ship configured

[1] A flight is a subset of a class of ships to which significant modifications/upgrades have been made.

for combat. This testing is commonly referred to as "Live Fire Test & Evaluation" (LFT&E). Realistic testing by firing live ammunition at the ship or detonating a real mine against the ship's hull, however, could result in the loss of a multi-million dollar Navy asset. Therefore, the Navy has established an approved LFT&E program to complete the vulnerability assessment of Flight IIA ships as required by 10 USC 2366. As documented in the Navy's Live Fire Test and Evaluation Management Plan for DDG 51 class ships (Revision 2), dated May 1998, the LFT&E program includes three major areas that together provide for a complete and comprehensive evaluation of the survivability of Flight IIA ships in a near miss, underwater explosion environment. These areas are computer modeling and analysis, component testing, and an at-sea ship shock trial. As described below, computer modeling and component tests provide valuable information regarding the survivability of the ship. However, only the at-sea shock trial would provide the real-time data necessary to fully assess ship survivability.

Computer Modeling. Computer modeling of surface ship responses to underwater explosions is an extremely difficult analytical problem. In order to have confidence in the results of any analysis, it is necessary to validate response calculations with actual test data. The Navy is aggressively developing the analytical capability to solve this type of problem. However, no analytical approach to date has demonstrated the capability to correlate well with test data collected during previous shock trials and component testing.

Computer modeling can be used to approximate the general shock response motions of a surface ship to underwater explosions. The computer analysis calculates accelerations, velocities, and displacement values that correspond to shock inputs to the ship's systems and equipment. These calculated inputs can be compared with equipment component shock test results or previously recorded shock trial data to identify potential high risk areas. Computer modeling predictions can also be used to estimate the structural integrity of foundations, cabinets, or housings that support and enclose equipment. For example, computer modeling can predict whether or not a steel foundation would bend or deform, or whether attachment welds or hold down bolts would fail. However, computer modeling cannot predict the operability of equipment and systems or the broad range of responses and interactions of complex mechanical systems which is demonstrated during equipment component testing and a ship shock trial. More importantly, computer modeling cannot predict the manner in which equipment or systems fail. Such information is crucial to redesigning equipment and systems so that they will continue to operate after an underwater explosion. Combat experience has demonstrated that unknown or unexpected failures cannot be adequately predicted with computer models.

Component Testing. Component testing also provides essential information regarding the survivability of the ship. The Navy tests components on specially designed test machines and fixtures in the laboratory. These machines provide a rapid acceleration to the equipment installed on the fixture. The damage, or lack of damage, resulting from the test assists in the assessment of the components' performance under a shock load. These laboratory test machines are limited by the weight of the item to be tested. Therefore, the shock effects on the overall system and the system's interaction with other ship systems and structure cannot be fully evaluated.

Shock Trial. Shock testing the entire ship provides much of the information missing from computer modeling and component shock testing. A ship shock trial is a series of underwater detonations that propagate a shock wave through the ship's hull under deliberate and controlled conditions. Shock trials simulate near misses from underwater explosions similar to those encountered in combat. The ship is fully manned during a shock trial with the appropriate systems operating. A shock trial provides the only means to assess the shock response of the entire ship and the interaction of the ship's systems and components.

Need for A New Shock Trial. USS JOHN PAUL JONES (DDG 53) was shock tested off the coast of California in June 1994 to assess the survivability of the original DDG 51 class destroyer. However, as illustrated in **Figure 1.1**, Flight IIA ships are significantly different from the original DDG 51 class destroyers in their design. Major structural changes include the addition of two helicopter hangars on the aft end of the ship, Vertical Launch System foundation changes, and raising of the aft AN/SPY-1D Radar Arrays. The helicopter hangers enable Flight IIA ships to carry two SH-60B Seahawk helicopters, which greatly improves their anti-submarine and anti-surface warfare capabilities. The hangar design is new and unique to Flight IIA destroyers. The addition of the hangars also resulted in changes to the ship's ordnance magazines to store additional weapons for the helicopters.

Major equipment changes in Flight IIA ships include a ship-wide Fiber Optic Data Multiplexing System (FODMS), a 60 Hz zonal power distribution system, and the widespread use of commercial equipment in various mission critical systems to reduce the cost of the ships. None of these systems have ever undergone an at-sea shock test. The FODMS is a data transfer system used to transfer command and monitoring signals to and from mission critical systems throughout the ship. This system uses a fiber optic data bus, whereas the DMS tested during the USS JOHN PAUL JONES shock trial used a coaxial, copper data bus. The 60 Hz zonal power distribution system divides the ship into six electrical zones to substantially improve the continued operation of vital equipment under combat conditions. This is accomplished by locating the ship's power distribution components (i.e., switchboards and load centers) at various locations throughout the ship. On USS JOHN PAUL JONES, the switchboards were located in three areas on the ship and there were a total of two load centers. On Flight IIA ships, there are 12 switchboards and 16 load centers located throughout the ship.

In conclusion, due to the number of major structural and equipment changes between Flight IIA ships and DDG 51 class destroyers, a new shock trial is necessary to assess the shock response of Flight IIA ships and the interaction of ship systems and components.

Typically the lead ship of a new class or major upgrade is shock tested. WINSTON S. CHURCHILL was selected as the shock trial ship because it has additional design changes that will not be included in the first two Flight IIA ships, and therefore it is more representative of the flight. The most significant change is a new 5-inch/62 caliber gun, which also has never undergone an at-sea shock trial.

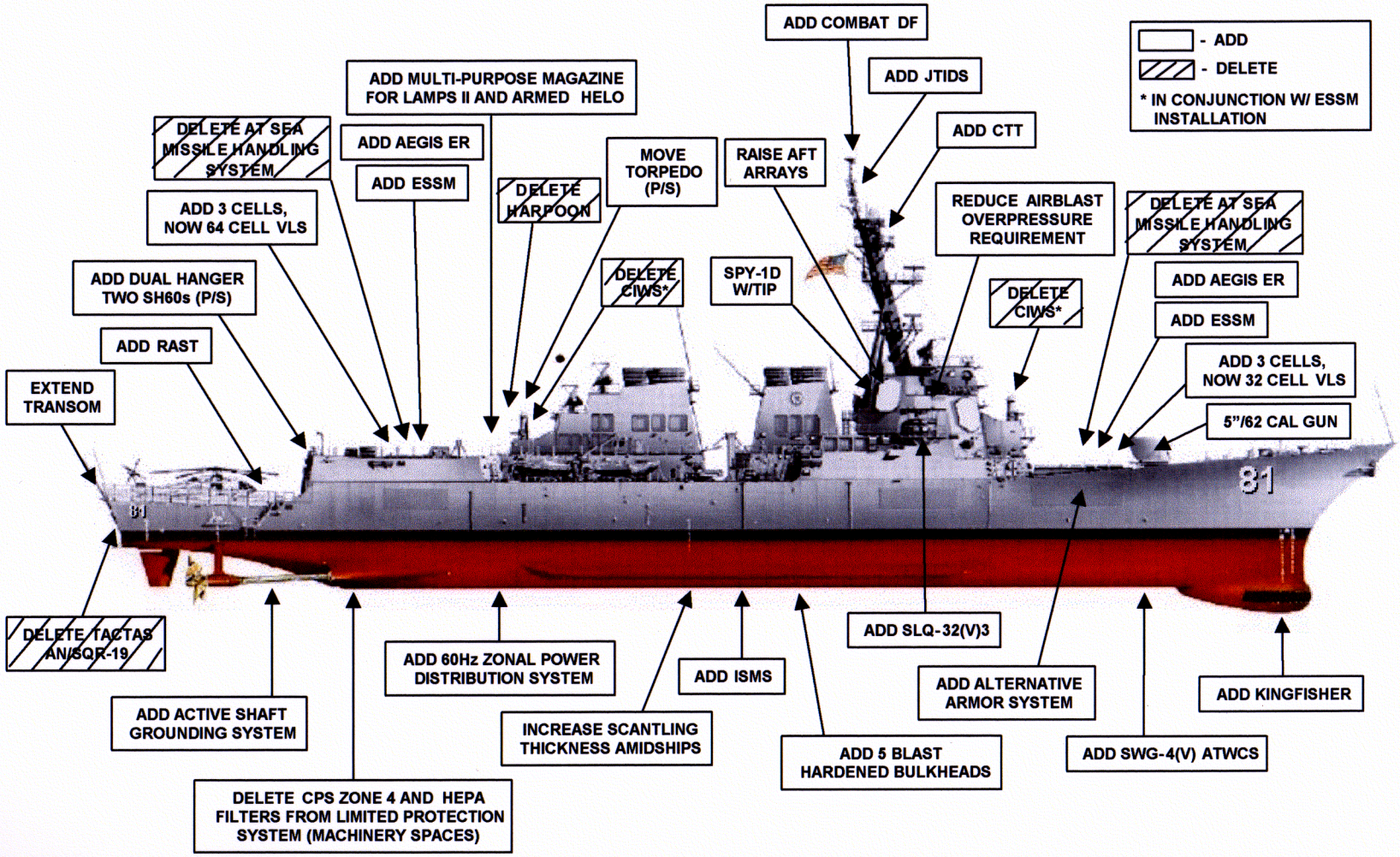

Figure 1.1. Design changes in the Flight IIA ships as compared with the original DDG 51 class destroyers.

1.3 PROPOSED ACTION

The proposed action is to conduct a shock trial of WINSTON S. CHURCHILL at an offshore location between 1 May and 30 September 2001. The FEIS analyzes in detail alternative areas offshore of Naval Station Mayport, Florida; Naval Station Norfolk, Virginia; and Naval Station Pascagoula, Mississippi (**Figure 1.2**). Details of the proposed action are presented in Section 2.2. The proposed action includes mitigation to minimize risk to marine mammals and turtles, as described in Section 5.0.

The shock trial would expose WINSTON S. CHURCHILL to a series of underwater detonations designed to assess the survivability and vulnerability of the ship. The ship and the explosive charge would be brought closer together with each successive detonation to increase the severity of the shock. This gradation in severity would ensure that the survivability of the ship and its systems is fully assessed and the point at which failure modes begin is accurately determined. A charge weight of 4,536 kg (10,000 lb) would be used to ensure that the entire ship is subjected to the desired maximum level of shock intensity. The shock trial would be conducted at a rate of one detonation per week to allow time to perform detailed inspections of the ship's systems prior to the next detonation.

The plan is to subject WINSTON S. CHURCHILL to three detonations, which is the number of detonations needed to collect adequate data on survivability. Previous surface ship shock trials have consisted of, or planned for, four detonations, with one used mainly to prepare the crew, the ship, and all test equipment. However, for this shock trial, the preliminary detonation would be omitted and the ship would be subjected to the three higher severity detonations. The first detonation would be conducted to ensure the ship's systems are prepared for the subsequent higher severity detonations. The second detonation would be conducted to ensure the safety of ship's systems during the third detonation, and to assess the performance of design changes implemented as a result of the first detonation. The third and most severe detonation would be conducted to assess design changes from the previous detonations, and to collect data for design changes implemented after the shock trial. A fourth detonation would be conducted only if one of the planned three detonations fails to provide technically acceptable data (e.g., due to equipment failure or some other technical problem). Because of the potential need for a fourth detonation, the proposed action will be described in the remainder of this document as consisting of up to four detonations.

USS JOHN PAUL JONES (DDG 53), the most recent surface ship to be tested, was subjected to a shock trial in 1994. That shock trial was originally planned to consist of four detonations. Unfortunately, weather conditions in the test area caused significant delays to trial operations and negatively affected the deployment preparations of JOHN PAUL JONES. As a result, the shock trial had to be reduced to two detonations. However, a minimum of three detonations is planned for the WINSTON S. CHURCHILL shock trial to reduce the chance of significant damage at the highest severity detonation and to collect an adequate set of data for design changes implemented after the shock trial.

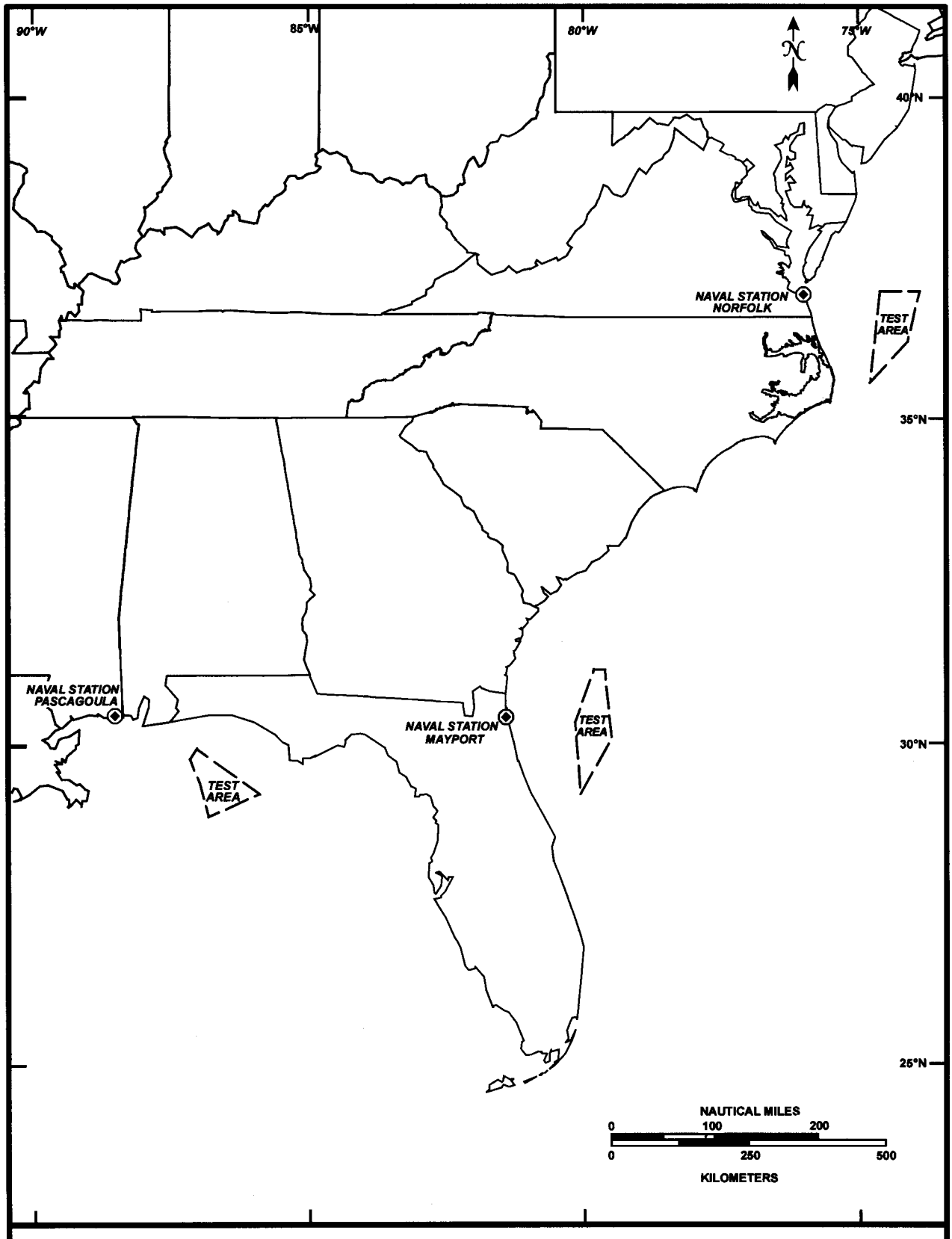

Figure 1.2. Potential test areas for the DDG 81 shock trial.

WINSTON S. CHURCHILL was christened in April 1999 and delivered to the Navy in the fall of 2000. A series of post-delivery operational tests and trials will be conducted before the ship will be available for the shock trial, which is scheduled to occur between 1 May and 30 September 2001. The test is scheduled for this period because of the likelihood of favorable weather as well as the availability of the ship. As explained in Section 2.2.2(e), weather and sea state conditions are critical for conducting the shock trial and for preventing impacts to marine mammals and turtles. Because the ship's availability must be scheduled far in advance and because the preferred test area was not known prior to the EIS, it was necessary to select a time period when the shock trial could be conducted with a high probability of success at any of the three test areas. For potential test areas along the Atlantic coast and Gulf of Mexico, favorable weather and sea state conditions are most likely to occur during the months of May through September.

1.4 BASIS FOR PREPARING THE ENVIRONMENTAL IMPACT STATEMENT

The FEIS was prepared in accordance with Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions"; the National Environmental Policy Act (NEPA) of 1969; the regulations implementing NEPA issued by the Council on Environmental Quality (CEQ), 40 Code of Federal Regulations (CFR) Parts 1500-1508; and Navy regulations implementing NEPA procedures (32 CFR 775). NEPA sets out procedures Federal agencies must follow in analyzing environmental impacts of major Federal actions within U.S. territory. Executive Order 12114 sets out procedures Federal agencies must follow in analyzing environmental impacts of major Federal actions occurring outside U.S. territory in the global commons or within the territory of another nation. Executive Order 12114 is based upon the independent authority of the President, not the statutory authority of NEPA. It furthers the purposes of NEPA but is not governed by CEQ regulations.

While NEPA and Executive Order 12114 represent two distinct, independent processes, the Navy has conducted the analysis under these two processes concurrently for the proposed shock trial because the proposed action includes operations that would occur both within and outside U.S. territorial seas. The shock trial and associated mitigation operations would occur in offshore waters outside of territorial seas. The only operations that would occur within territorial seas are shore support activities and vessel and aircraft movements in territorial waters (i.e., transits between the shore base and the offshore shock trial location). Shore support activities and vessel and aircraft movements are part of the routine operations associated with the existing shore bases and would not involve any unusual or extraordinary activities. Impact discussions in this FEIS (Section 4.0, Environmental Consequences) are divided into separate subsections to distinguish between those operations that are evaluated under NEPA and those that are evaluated under Executive Order 12114.

1.5 PUBLIC INVOLVEMENT

The preparation of an Environmental Impact Statement provides three main opportunities for public involvement. First, there is "scoping," the early and open process for identifying issues to be addressed in the EIS. To begin the scoping process for this EIS, a Notice of Intent was published in the *Federal Register* and local newspapers (*Virginian Pilot*, *Florida Times Union*, *Mayport Beaches Leader*, *Mobile Register*, *Mississippi Press*) during January 1999. It was also sent to Federal, state, and

local elected officials and agency representatives, and other interested parties. The Notice of Intent explained how to submit oral and written comments.

Three public scoping meetings were held during January 1999 to explain the project and allow the public to voice their concerns. Meeting dates, locations, number of attendees, and number of oral comments received are listed below:

- 19 January 1999 – Granby High School auditorium, Norfolk, Virginia. Three members of the public attended. No one provided oral comments.
- 20 January 1999 – Fair Hall, Jackson County Fairgrounds, Pascagoula, Mississippi. Seven members of the public attended. Two people provided oral comments.
- 21 January 1999 – Mayport Middle School cafeteria, Atlantic Beach, Florida. Ten members of the public attended, and three provided oral comments.

In addition to the comments received during the public meetings, three letters were received by the end of the comment period on 20 February 1999. The public meeting and written comments were reviewed to make sure that all issues would be addressed in the Draft EIS. **Table 1.1** summarizes the issues raised by the public in oral and written comments.

The second major opportunity for public participation came when the Navy distributed the Draft EIS to interested persons for review and comment (see Appendix A for the distribution list). The notice of availability for the DEIS was published in the Federal Register on December 10, 1999 (64 FR 69267). The public review period originally ended on January 24, 2000, but was subsequently reopened and extended to March 31, 2000.

The Navy hosted three public hearings in Norfolk, Virginia; Pensacola, Florida; and Neptune Beach, Florida to receive oral and written comments on the Draft EIS. Hearing dates, locations, number of attendees, and number of comments received are as follows:

- 13 March 2000 – Granby High School Auditorium, Norfolk, Virginia. Eight people attended (excluding Navy and contractor personnel), and one person provided oral comments.
- 14 March 2000 – Hagler Auditorium, Pensacola Junior College, Pensacola, Florida. No members of the public attended, no comments received.
- 15 March 2000 – Fletcher High School Auditorium, Neptune Beach, Florida. Nine people attended, and three spoke.

In addition to the public hearing comments, 14 sets of written comments were received from Federal, state, and local agencies, non-governmental organizations, and individuals. All oral and written comments are addressed in Appendix I of the FEIS. **Table 1.2** summarizes changes to the EIS resulting from public comments.

A third opportunity for public input is the 30-day public review period following publication of the notice of availability for the FEIS. The Navy will distribute the FEIS to interested persons (including all commenters on the Draft EIS) for review. After closure of the public review period, the Navy will issue its Record of Decision (ROD) for publication in the *Federal Register*.

Table 1.1. Summary of issues identified by the public during the scoping process.

Issue/Concern	Relevant EIS Section(s)
PURPOSE AND NEED, ALTERNATIVES	
• Oppose the shock trial/do not test	2.1 No Action Alternative
• Oppose a shock trial off Mayport	2.3 Comparison of Alternatives
• Evaluate the possibility of testing using computer simulations instead of explosives	1.2 Project Purpose and Need
• Test on scale models in tanks rather than in the environment	1.2 Project Purpose and Need
• Clarify the requirements that the shock trial be conducted near a Navy facility	2.2.2 Potential Test Areas
IMPACTS	
• Impacts on dolphins and migrating whales	4.1.1 Marine Mammals
• Impacts on sea turtles during nesting season	4.1.2 Sea Turtles
• Possibility of fish kills washing up on beaches	4.1.4(c) Other Socioeconomic Issues
• Impacts on shrimping industry (Mayport)	4.1.4(a) Commercial and Recreational Fisheries
• Impacts on kingfish tournament during June/July (Mayport)	4.1.4(a) Commercial and Recreational Fisheries
• Impacts to other marine organisms	4.1.3 Other Components of Biological Environment
• Impacts on public fishing, boating, and swimming	4.1.4(a) Commercial and Recreational Fisheries 4.1.4(b) Ship Traffic 4.1.4(c) Other Socioeconomic Issues
• Impacts of detonations on local and regional geology including seismic events and sediment slumping (Pascagoula)	4.1.5(a) Geology and Sediments
• Impacts on seepage of oil from sediments (Pascagoula)	4.1.5(a) Geology and Sediments
• Impacts on air quality	4.1.5(b) Air Quality and Noise
• Impacts on water quality	4.1.5(c) Water Quality
• Noise impacts	4.1.5(b) Air Quality and Noise

Table 1.2. Technical changes in the Final Environmental Impact Statement.

Change	Relevant Public Comments (numbers refer to Appendix I)
1.0 INTRODUCTION (includes Purpose and Need)	
• Clarified legal requirement for shock trial	C8, N1
• Provided additional explanation for why a new shock trial is needed	K1, K2, P1
2.0 ALTERNATIVES	
• Refined the analysis of operational factors affecting shock trial	(none)
• Explained why a ship exclusion zone of 5 nmi is needed	C6, C14
• Identified conducting a shock trial at Mayport as the Preferred Alternative (Draft EIS said Mayport or Pascagoula would be used)	A1, B2, B3, G1, G3, I3, I6, M7, N3, O1, P1
3.0 EXISTING ENVIRONMENT	
• Section 3.2.1, added information on humpback whales near Norfolk	C11
• Section 3.3.1, added information on deepwater groupers potentially occurring at Mayport	H2
• Section 3.3.5, added information on planned petroleum industry activities near Pascagoula test area	C9, E2
4.0 ENVIRONMENTAL CONSEQUENCES	
• Section 4.1.1, added rationale for injury criteria	C7, C17, C34
• Section 4.1.1, reviewed and refined discussion of marine mammal harassment for clarity and consistency	C2, C4, C13, C15, C20, C21, C31, C36, C37
• Section 4.1.1, rounded incidental take numbers to 2 decimal places	C10, C14, C16, C18, C31
• Section 4.1.3(d), added information on deepwater groupers potentially occurring at Mayport	H2
• Section 4.1.4, added information on planned petroleum industry activities near Pascagoula test area	C9, E2
5.0 MITIGATION AND MONITORING	
• Section 5.4 changed to state that all components of monitoring program must be in place or detonation would be postponed	K7
• Section 5.5.3, added details on passive acoustic monitoring system	C23
• Sections 5.6.1 and 5.6.2, added "debris lines" to turtle indicators that would be avoided during site selection and whose presence during pre-detonation monitoring would result in postponement	G1, G3
• Section 5.6.1, added warm core rings to features to be avoided during site selection at Norfolk	C25
• Sections 5.7.1, 5.7.2, added details on tagging mammals & turtles	C28
6.0 CUMULATIVE IMPACTS	
• Section 6.1.4(d), added information on planned petroleum industry activities near Pascagoula test area and reworded discussion of an ongoing programmatic environmental assessment being conducted by the Minerals Management Service	E3, E4
7.0-13.0 VARIOUS SECTIONS	
• No important changes	--
APPENDICES	
• Appendix G, added NMFS Biological Opinion	--
• New Appendix I (Public Comments and Responses) added	--

1.6 COORDINATION AND CONSULTATION WITH THE NMFS

The NMFS has two regulatory roles in the project. First, the NMFS is responsible for administering the Endangered Species Act of 1973 (16 USC 1531 *et seq.*) as it applies to sea turtles and most marine mammals. The DEIS served as a Biological Assessment that the Navy submitted to the NMFS, requesting formal consultation under Section 7 of the Endangered Species Act. The NMFS subsequently issued a Biological Opinion, which is included in Appendix G of the FEIS.

The NMFS also has a regulatory role under the Marine Mammal Protection Act of 1972 (16 USC 1361 *et seq.*). In January 2000, following the publication of the DEIS, the Navy submitted a separate application to the NMFS for an "incidental take authorization" under section 101(a)(5)(A) of the Marine Mammal Protection Act. In December 2000, the NMFS published a Proposed Rule in the Federal Register (65 FR 77546). The Proposed Rule specifies mitigation, monitoring, and reporting requirements for the shock trial. A Final Rule must be issued before the shock trial can proceed.

As noted above, the NMFS is also a cooperating agency with the Navy in preparing the EIS. Because of its regulatory responsibilities under the Endangered Species Act and the Marine Mammal Protection Act, the NMFS limited its role in preparation of the EIS mainly to providing review and comment. The only formal comments from the agency concern essential fish habitat, and they are addressed in Appendix I of the FEIS.

1.7 EIS FORMAT

The FEIS follows the format specified by Navy regulations (32 CFR 775). The document is issue-oriented, providing greater analytical detail on more significant concerns and less information on other topics. The FEIS contains the following major sections:

- Executive Summary – gives an overview of the document and its findings;
- Introduction – explains the project purpose and need, the public participation process, and the format of the FEIS;
- Alternatives – discusses alternatives including "no action," the proposed action, and alternative areas for the proposed action; compares alternatives; and selects a preferred alternative;
- Existing Environment – describes the physical, biological, and socioeconomic characteristics of the environment that might be affected by the shock trial;
- Environmental Consequences – analyzes potential impacts of the shock trial on the physical, biological, and socioeconomic environment;
- Mitigation and Monitoring – describes measures to avoid, minimize, or reduce environmental impacts; and
- Other sections and appendices – as listed in the Table of Contents.

2.0 ALTERNATIVES

Alternatives for meeting the project purpose and need are described and evaluated in this section. The alternatives are (1) no action and (2) conducting a shock trial at an offshore location. Alternative offshore areas for the shock trial are compared from operational and environmental perspectives. A preferred alternative has been identified based on these comparisons.

As discussed in Section 1.2, the Live Fire Test & Evaluation program for Flight IIA ships already includes the maximum reasonable amount of computer modeling and component testing. Therefore, computer modeling and component testing are not reasonable stand-alone alternatives to the shock trial. Instead, they are considered part of the "no action" alternative.

2.1 NO ACTION

Under this alternative, no new activities affecting the physical environment would be conducted to predict the response of Flight IIA ships to underwater detonations. This alternative would avoid all environmental impacts of the shock trial.

The "no action" alternative would prevent the Navy from being able to assess the survivability of Flight IIA ships as required by law (10 USC 2366). The intent of 10 USC 2366 is to ensure that the combat survivability of the ship is assessed before it is exposed to hostile fire. The information obtained during a shock trial is used to improve the shock resistance of the ship and therefore reduce the risk of injury to the crew. As discussed in Section 1.2, the Navy has established a Live Fire Test & Evaluation program to assess the survivability of Flight IIA ships. The program consists of three major areas that together provide the data necessary to assess the ships' survivability: computer modeling and analysis, component testing, and an at-sea ship shock trial. The program already includes the maximum reasonable amount of computer modeling and component testing. A shock trial at sea provides the only means to assess the shock response of the entire ship and the interaction of the ship's systems and components.

The "no action" alternative involves no activity affecting the physical environment. However, the "no action" alternative is implicit in the environmental analysis throughout the document. The Existing Environment section provides a "no action" benchmark against which the proposed action can be evaluated. The Environmental Consequences section compares impacts of an action (conducting a shock trial) with the alternative of "no action."

2.2 SHOCK TRIAL AT AN OFFSHORE LOCATION

The alternative discussed in this section is the proposed action, which is to conduct a shock trial at an offshore location. The analysis focuses on selection of alternative offshore locations for the shock trial. A multi-step process was used to identify, eliminate, and finalize alternative offshore locations for further assessment in this EIS, as explained below. First, the logistics of the shock trial are described. Then, alternative areas for the shock trial are identified based on operational requirements. Portions of the test areas that were excluded for environmental reasons are identified. Finally, mitigation measures included in the proposed action are described.

2.2.1 Description of Shock Trial

The plan is to subject WINSTON S. CHURCHILL to three 4,536 kg (10,000 lb) explosive charge detonations, which is the minimum number of detonations needed to collect adequate data on survivability. A fourth detonation would be conducted only if one of the planned three detonations fails to provide technically acceptable data (e.g., due to equipment failure or some other technical problem). The series of detonations would be conducted at a rate of one per week to allow time to perform detailed inspections of the ship's systems prior to the next detonation. The shock trial would occur sometime between 1 May and 30 September 2001. This time period is based on the Navy's operational and scheduling requirements.

Prior to the shock trial, the ship would be examined, configured, and prepared to accommodate the shock testing equipment. The status of each ship compartment would be documented. Shore support and facilities would be readied, and the crew would be trained for the trial.

The specific site would be selected from within one of the test areas meeting the operational requirements described later in this section. The final site for the shock trial would be selected 1 to 2 days before the first detonation, based on satellite imagery and aerial surveys for marine mammals and turtles (see Section 5.0). An exclusion zone of 9.3 km (5 nmi) radius would be established around the detonation point to exclude all non-test ship, submarine, and aircraft traffic for up to 12 hours per detonation. This exclusion zone is an electronic emissions control zone that virtually eliminates the possibility of an inadvertent detonation caused by radio/radar induced electrical current in the explosive firing circuit. It also provides an area of safe maneuvering for the charge-handling vessel and the explosive it is towing. *Notices to Airmen and Mariners* would be published in advance of each detonation. Any traffic entering an 18.5 km (10 nmi) radius around the detonation point would be warned to alter course or would be escorted from the site. Since the WINSTON S. CHURCHILL and the operations vessel would be moving during the shock trial (see below), these zones around the detonation point would also be moving.

An operations vessel would tow the explosive charge in parallel with the WINSTON S. CHURCHILL using the parallel tow method, as shown in **Figure 2.1**. The charge would be approximately 610 m (2,000 ft) behind the operations vessel and suspended from a pontoon at a depth of 61 m (200 ft) below the water surface. For each detonation, WINSTON S. CHURCHILL would cruise in the same direction as the operations vessel at a speed of up to 7 kts with the charge directly abeam of it. After an initial inspection for damage, WINSTON S. CHURCHILL would travel back to the shore facility for detailed post-detonation inspections and preparations for the next detonation. For each subsequent detonation, the WINSTON S. CHURCHILL would move closer to the charge so the ship experiences a more severe shock level.

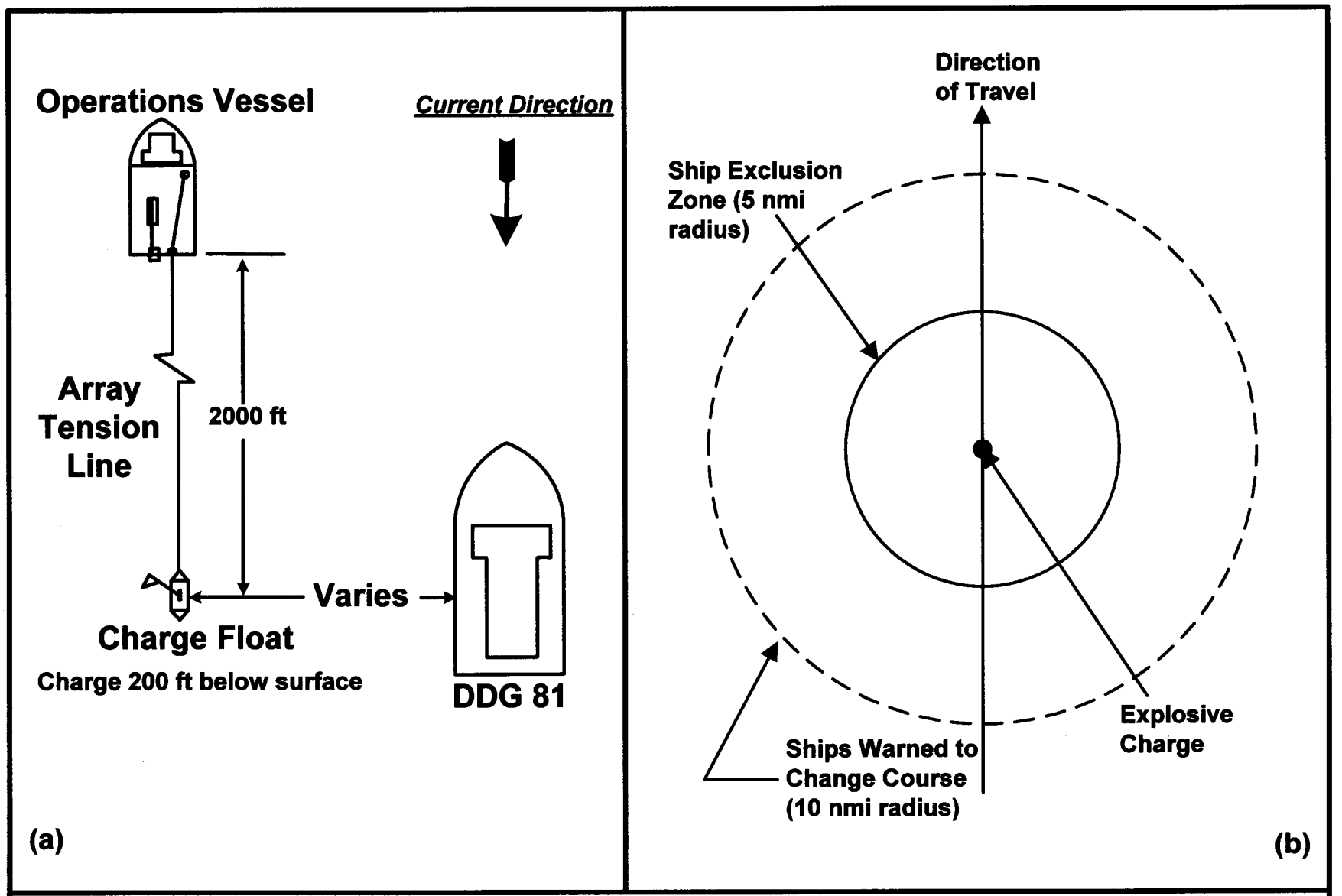

Figure 2.1. (a) Test array and vessels and (b) operational and exclusion zones for the proposed shock trial.

A conventional Navy explosive (High Blast eXplosive, HBX-1) would be used for each detonation. HBX-1 consists of the following components (by weight): cyclotrimethylene trinitramine – 39.32%; trinitrotoluene – 37.76%; aluminum powder – 17.10%; wax – 4.57%; and miscellaneous fillers – 1.25%. The charge would be held in a cylindrical steel container measuring 1.5 m (5 ft) in diameter by 1.7 m (5.6 ft) long with a total weight of 1,297 kg (2,860 lb) in air. The largest possible unrecoverable fragment from the explosion that would settle to the seafloor after each detonation would be the top plate and crossbar (charge container components), which together weigh 204 kg (450 lb). After each detonation, the test array would be recovered and floats and rigging debris would be removed.

2.2.2 Potential Test Areas

Figure 2.2 illustrates the process of selecting and evaluating potential test areas for the shock trial, based on operational requirements. The following steps are discussed below:

(a) Specify operational requirements.
(b) Conduct preliminary screening to identify Naval Stations that could support the trial.
(c) Identify nearby Navy facilities and assets required for the shock trial.
(d) Draw operational arcs and define test areas.
(e) Evaluate conditions affecting operations in the test areas.
(f) Rank the test areas according to operational criteria.

(a) Operational Requirements

The factors considered by the Navy in identifying potential test areas for the shock trial are summarized in **Table 2.1** and discussed below.

Table 2.1. Operational requirements for a shock trial test area.

Type of Requirement	Criterion
PERSTEMPO (Navy personnel tempo regulations requiring a ship to spend a day in homeport for every day away from homeport for crew quality of life and efficiency)	It is most efficient to conduct the shock trial near the homeport of the ship being tested and other ships supporting the shock trial
Water depth	Minimum of 183 m (600 ft) to minimize effects of bottom bounce on test interpretation
Proximity to Naval Station with homeported ships	370 km (200 nmi) (18 hour transit at 10 to 12 kts)
Proximity to Naval Air Station or other military airbase for aircraft and helicopters	185 km (100 nmi) maximum operational range
Proximity to Naval Station support facility	240 km (130 nmi) (13 hour tow at 10 kts) from harbor entrance buoy
Proximity to ship repair facility	240 km (130 nmi) (13 hour tow at 10 kts) from harbor entrance buoy
Proximity to ordnance loading station	370 km (200 nmi) (18 hour transit at 10 to 12 kts)
Ship traffic	A test area with little or no ship traffic is preferred; Established shipping lanes should be avoided
Weather and sea state	Ideal conditions: seas < 0.6 m (2 ft), light wind, visibility ≥ 18.5 km (10 nmi) Marginal conditions: seas < 1.8 m (6 ft), winds < 21 kts, visibility ≥ 9.3 km (5 nmi)

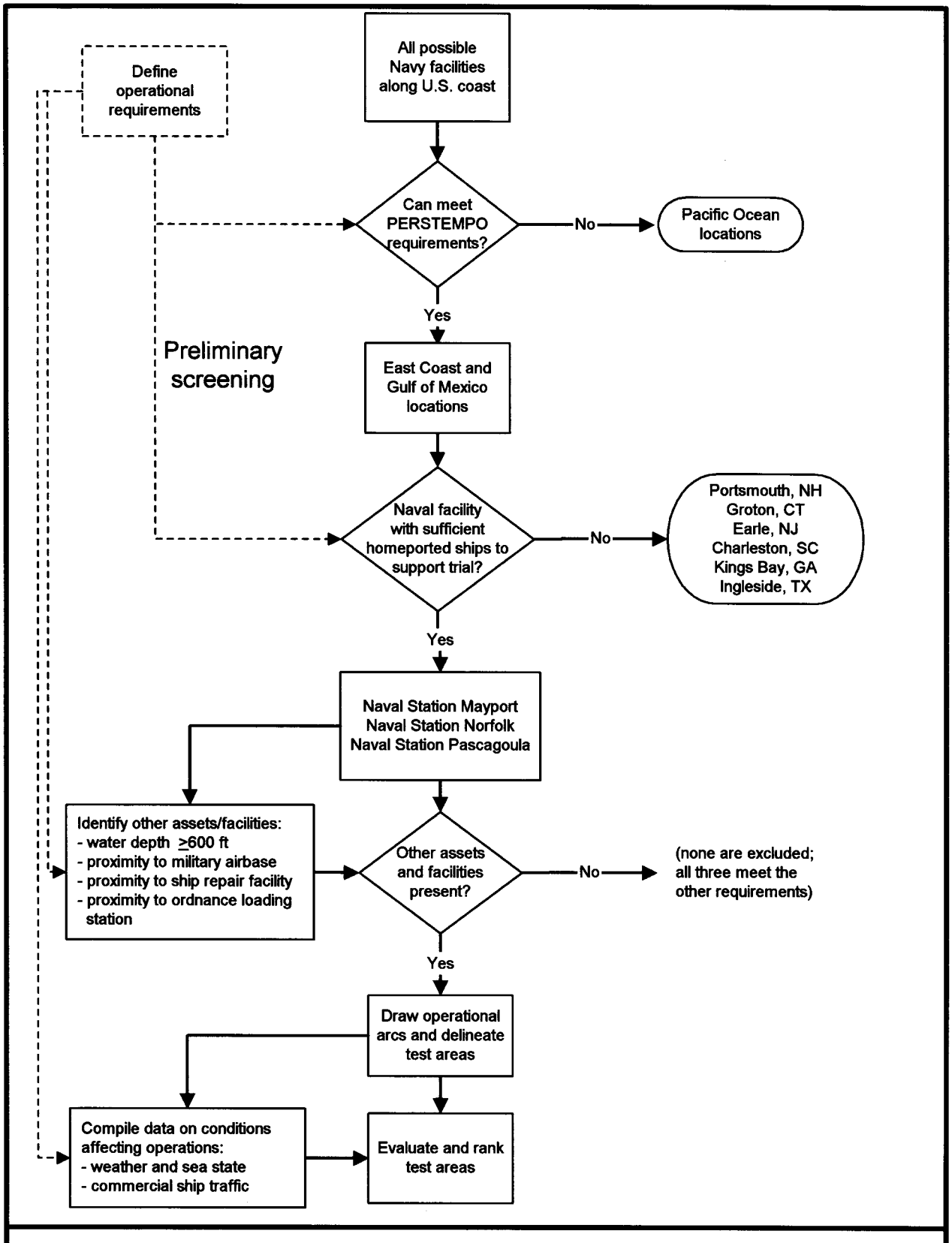

Figure 2.2. Flow chart for selection of potential test areas based on operational requirements.

PERSTEMPO. Navy Personnel Tempo (PERSTEMPO) regulations require a ship to spend a day in homeport for every day it is away from homeport for purposes of crew quality of life and efficiency (OPNAVINST 3000.13A, 21 December 1990). The PERSTEMPO Program, directed by the Chief of Naval Operations and supported by the Secretary of Defense, is designed to balance operational needs with quality of life for Navy sailors and their families. For the shock trial, approximately 700 Navy personnel (3 ships, 2 aircraft, 1 helicopter) would be required to participate in the test operations with an additional 350 personnel (1 ship, 2 aircraft, 1 helicopter) on call. Deployment time for each of these personnel will be greater if operations are conducted away from their homeport. WINSTON S. CHURCHILL will be homeported at Naval Station Norfolk, Virginia. If the trial were conducted away from Norfolk, deployment time for the crew could be from 2.5 to 4 months, which includes time spent installing special equipment on the ship at the shore support facility, completing system engineering baseline test runs and crew training, and conducting the shock trial. For the support assets, ships and aircraft, deployment time is approximately 2 months. Therefore, to maximize availability of fleet resources to meet operational requirements while minimizing deployment time to meet PERSTEMPO regulations, it is most efficient to schedule the shock trial near the homeport(s) of the required assets or a majority of the assets.

Water Depth. An underwater explosion creates a shock wave that propagates in all directions. When the shock wave comes into contact with the ocean floor, some of its energy may be reflected back toward the ship, depending on actual bottom conditions. The reflected wave (or bottom bounce) typically does not damage the ship, but it can complicate interpretation of shock trial results due to variability in the arrival time and amplitude of the reflection. Therefore, avoiding the bottom bounce provides a "cleaner" test without complicating variables. Based on previous experience and modeling, a water depth of at least 183 m (600 ft) is required to minimize the effects of bottom bounce on test interpretation.

Proximity to Naval Station with Homeported Ships. A variety of Navy ships are needed for shock trial support. In recent years, obtaining these Navy assets has become increasingly difficult as both the budget and the size of the Navy have decreased. Supporting a shock trial reduces assets available to meet the other mission goals of the Atlantic Fleet and the above-mentioned PERSTEMPO requirements. Therefore, to minimize transit times, meet PERSTEMPO requirements, and make the most effective use of Navy assets, it is imperative that the shock trial be conducted at a location that is close to a large Navy installation with available ships to support the trial.

Navy ships would be needed at the test site to monitor, divert, and escort non-test ships away from the exclusion zone, provide communications, air traffic control, provide search and rescue if needed, and perform other tasks as assigned. Two ships having surface and air search radars, active and passive sonar, and a platform to refuel LAMPS III helicopters are needed (one ship for trial support and one as backup support). For a sufficient number of these ships (i.e., frigates, cruisers, and destroyers) to be available, a Naval Station must be within 370 km (200 nmi) of the test site. This is based on a transit speed of 10 to 15 kts and a daylight port entry and exit. This distance will minimize the ships' deployment time to three days – one day to deploy to the test area, one day to support the operations on test day, and one day to return to port.

In addition to the ship requirements stated above, a Military Sealift Command (MSC) ocean-going tug that has been modified to accept explosive handling equipment is needed to transport and deploy explosives and conduct related operations.

Proximity to Naval Air Station or Other Military Airbase. Military aircraft and helicopters are needed to operate and test combat and communication systems before, during, and after the test; to serve as observation and photographic platforms; and to provide emergency response and rescue if required. Specifically, four F-14 Tomcats or four F/A-18 Hornets (2 trial/2 backup) and two SH-60B Seahawk (LAMPS III) helicopters (1 trial/1 backup) are required. A distance of 185 km (100 nmi) is the maximum that would allow tactical combat aircraft to transit to the trial site, remain on station to support combat system exercises (about 1 hour), and return to base with a safe fuel reserve. Helicopters are also limited by the 185 km (100 nmi) distance in the event that landing on a ship at sea becomes unsafe due to deteriorating weather, sea conditions, visibility, or equipment casualty.

Proximity to Naval Station Support Facility. A Naval Station that can provide limited maintenance and depot level support for ships (e.g., tradespeople, spare parts, cranes) must be located less than an 18 hour transit from the test site to repair/replace damaged equipment and systems. The transit time was determined based on a worst-case scenario in which WINSTON S. CHURCHILL is disabled from the explosion, causing it to require a tow to a Naval Station. Damage assessment, repair attempts, and rigging for tow would take approximately 6 hours. Based on a typical noon-time detonation, towing operations would begin at approximately 6 p.m. (1 to 2 hours before dusk). The towed ship would be required to enter port during daylight hours to reduce the possibility of a collision. Since the distance from the 183 m (600 ft) contour to shore would be too great to allow the ship to come into port on the same day, the next day was chosen as the maximum travel time. Setting a maximum transit time limits the risks associated with ship towing, especially night towing, and the possibility of less than favorable sea conditions during the tow. Prior to entering port, the ship would be towed to calm water (safe harbor or bay area) and transferred to harbor tugs for the remaining transit. Assuming the towed ship entered the harbor/bay area 13 hours later (7 a.m.), 1 hour would be needed to transfer the ship to harbor tugs, 2 hours to transit from the harbor/bay area to port, and 1 hour to berth and secure the ship pierside. An additional hour was added for potential delays due to weather, tow difficulties, and ship traffic. Therefore, a total of 18 hours is the maximum transit time from test site to the supporting Naval Station. This transit time equates to a maximum distance of 240 km (130 nmi) from the test site to the harbor/bay area based on a tow speed of 10 kts over a 13 hour period.

Proximity to Ship Repair Facility. A ship repair facility must be located less than an 18 hour transit from the test site to provide drydocking, special trades, equipment, and materials to perform post-test inspections and prepare for the next detonation. The 18 hour transit time is determined using the same rationale given above and also equates to a maximum distance of 240 km (130 nmi) from the test site to the harbor/bay area. The ideal repair facility would be either of the DDG 51 class shipbuilders: Ingalls Shipbuilding Division (Pascagoula, Mississippi) or Bath Iron Works (Bath, Maine). However, other Navy or contract shipyards would be acceptable provided they have a drydock capable of supporting a minimum of 9,200 tons.

Proximity to Ordnance Loading Facility. Prior to each test, an explosive charge would be loaded onto the operations vessel at an ordnance loading facility. The facility must have qualified personnel and equipment to handle the explosives and must be located within an 18 hour transit (about 370 km or 200 nmi) of the test site. A greater transit time and distance would reduce the time available to prepare for the next test and could preclude using windows of opportunity to test on weather-favorable days. The transit time was based on the following scenario. The operations vessel would arrive at the ordnance pier at the beginning of the facility working hours (8 a.m.) and start onloading the explosive one hour later (9 a.m.). Once the explosive is secured, the vessel would leave by 11 a.m. for the test area. The operations vessel must arrive at the test site by 5 a.m. the next morning (18 hours later) to begin assessing sea conditions, weather, and ocean currents prior to shock trial operations. The cruising speed for this type of vessel (T-ATF or similar) is 10 to 12 kts. Therefore, the maximum transit distance is about 200 nmi (11 kts x 18 hours).

Ideally, the explosive would be stored and loaded at the same location. This would be the case if a Naval Weapons Station were used. Alternatively, the explosive could be stored at another location and transported to the ordnance loading facility on the test day, providing the facility has a certified loading area (pier/wharf) rated at least 4,536 kg (10,000 lb) for 1.1 hazard class explosives.

Ship Traffic. Because ships passing near the shock trial site could delay operations, an area with little or no ship traffic is preferred. Established shipping and submarine transit lanes should be avoided. An exclusion zone of 9.3 km (5 nmi) radius would be established around the test site to exclude all non-test ship, submarine, and aircraft traffic. *Notices to Airmen and Mariners* would be published in advance of each test. Any traffic entering an 18.5 km (10 nmi) radius around the detonation point would be warned to alter course or would be escorted from the site. If there is heavy ship traffic, testing could be delayed while support vessels divert and escort the traffic away from the test site.

Weather and Sea State. Safe deployment, maintenance, and recovery of the test array (explosive, rigging, charge float, tow line, and instrumentation and firing cables) require good weather and sea conditions. Personnel on the operations vessel need a stable work platform while handling equipment and materials. Ideal test conditions are seas of 0.6 m (2 ft) or less, a light wind, and unlimited visibility ($\geq$18.5 km or 10 nmi). Conditions become marginal when seas approach 1.8 m (6 ft), winds approach 34 kph (21 mph), and visibility is less than 9.3 km (5 nmi).

(b) Preliminary Screening

To maximize availability of fleet resources to meet operational requirements while minimizing deployment time to meet PERSTEMPO regulations, it is most efficient to schedule the shock trial near the homeport(s) of the required assets or a majority of the assets. Since WINSTON S. CHURCHILL is an East Coast homeported ship, Pacific Ocean sites (Southern California, Hawaii, and Washington) were eliminated from consideration due to the extended time necessary for transit to and from these sites through the Panama Canal. Only potential test areas on the East Coast or in the Gulf of Mexico were considered further.

The U.S. Navy currently has active ships homeported at the following facilities along the East Coast and Gulf of Mexico:

- Portsmouth Naval Shipyard, NH
- Naval Submarine Base New London (Groton, CT)
- Naval Submarine Base Kings Bay, GA
- Naval Weapons Station Earle, NJ
- Naval Station Norfolk, VA
- Naval Amphibious Base Little Creek (Norfolk, VA)
- Naval Weapons Station Charleston, SC
- Naval Station Mayport, FL
- Naval Station Pascagoula, MS
- Naval Station Ingleside, TX

However, only three of these facilities have an adequate number and type of ships (e.g., LAMPS III capable frigates, cruisers, and/or destroyers) available to support the shock trial:

- Naval Station Mayport
- Naval Station Norfolk
- Naval Station Pascagoula

Naval Station Norfolk and nearby Naval Amphibious Base Little Creek together have all of the necessary homeported ships to support the trial. The other two locations have active homeported ships to support the trial, but it would be necessary to deploy an MSC tug (used for explosives handling) out of Little Creek to the supporting station prior to and during shock trial operations.

In addition to having sufficient homeported ships, these three Naval Stations would meet the requirement for a Naval Station support facility that can provide limited maintenance and depot level support for ships (e.g., tradespeople, spare parts, cranes). Preliminary examination of nautical charts indicated large areas meeting the minimum depth requirement (183 m or 600 ft) are located within 240 km (130 nmi) of the harbor entrances of the three Naval Stations. Therefore, further analysis focused on defining potential test areas near Mayport, Norfolk, and Pascagoula.

(c) Nearby Navy Assets and Facilities

The preliminary screening identified Naval Station Mayport, Naval Station Norfolk, and Naval Station Pascagoula as the three locations that (1) have sufficient homeported ships to support the shock trial and (2) could serve as a support facility. The next step is to identify nearby Navy assets and facilities necessary to meet the previously defined operational requirements.

<u>Navy Assets: Aircraft and Helicopter Support</u>. NAS Oceana, Virginia Beach, Virginia is homebase for F-14 and F/A-18 aircraft. However, since F-14s and F/A-18s can fly to and operate out of supporting air bases, other military air stations/bases near Mayport, Norfolk, and Pascagoula are also acceptable. The air stations/bases that could meet this requirement are as follows:

Mayport area:
- NAS Jacksonville, FL
- Marine Corps Air Station (MCAS), Beaufort SC (homebase to 84 Marine Corps F/A-18 aircraft)

Norfolk area:
- NAS Oceana, Virginia Beach, VA
- NAS Norfolk, VA

Pascagoula area:
- NAS Pensacola, FL
- Tyndall Air Force Base, Panama City, FL

Naval Air Stations/Naval Stations that homebase SH-60B Seahawk helicopter squadrons are also limited. The only one identified near the three potential test areas is Naval Station Mayport, Florida (Squadrons HSL-42, HSL-44, HSL-46, and HSL-48). To operate out of other Naval Stations, helicopters and their crews would need to be moved to the supporting base prior to trial operations and remain there during the trial period. The list of facilities that could support trial operations near the three potential test areas are:

Mayport area:
- Naval Station Mayport, FL

Norfolk area:
- NAS Norfolk, VA

Pascagoula area:
- NAS Pensacola, FL
- Naval Station Pascagoula, MS

Ship Repair Facilities. Acceptable repair facilities were identified based on the size of the available certified drydocks. For a Flight IIA ship, a drydock capable of supporting a minimum of 9,200 tons is needed. The preferred repair facility would be either of the DDG 51 class shipbuilders: Ingalls Shipbuilding Division (Pascagoula, Mississippi) or Bath Iron Works (Bath, Maine). The latter is too far from any of the test areas to be considered. Acceptable repair facilities near the three potential test areas are:

Mayport area:
- Intermarine USA, Savannah, GA
- Naval Station Mayport, FL

Norfolk area:
- Colonna's Shipyard, Inc., Norfolk, VA
- Metro Machine Corporation, Portsmouth, VA
- Norfolk Shipbuilding and Drydock Corp., Norfolk, VA
- Norfolk Naval Shipyard, Portsmouth, VA
- Newport News Shipbuilding & Drydock Co., Newport News, VA

Pascagoula area:
- Ingalls Shipbuilding Div., Pascagoula, MS
- Atlantic Marine, Inc., Mobile, AL
- Bender Shipbuilding and Repair Co., Inc., Mobile, AL
- Avondale Shipyards Div., New Orleans, LA

Ordnance Storage/Loading Facilities. Naval Station Norfolk has a nearby Naval Weapons Station (Yorktown, Virginia) capable of both storing and loading the shock trial charges. If Naval Station Mayport is selected as the support facility, the charges could be stored and loaded at Naval Weapons Station Charleston, South Carolina, but the 370 km (200 nmi) maximum range from Charleston would limit the extent of a potential test area off Mayport. Alternatively, the charges could be stored at Charleston and transported to Naval Station Mayport the same day for loading (referred to as "dayloading"). At Pascagoula, arrangements could be made to transport the explosive from the Louisiana Army Ammunition Plant (Shreveport, Louisiana) and load it onto the operations vessel the same day. For the three potential test areas, the following facilities can either store and load or dayload the explosives:

Mayport area:
- Naval Weapons Station Charleston, SC (store and load)
- Naval Station Mayport, FL (dayload only, with storage at Naval Weapons Station Charleston, SC)

Norfolk area:
- Naval Weapons Station Yorktown, VA (store and load)

Pascagoula area:
- Naval Station Pascagoula, MS (dayload only, with storage at Louisiana Army Ammunition Plant, Shreveport, LA)

(d) Operational Arcs and Delineation of Test Areas

Based on the operational criteria and analysis, three potential test areas (Mayport, Norfolk, and Pascagoula) were defined. Two criteria essentially determined the location, size, and shape of the test areas:

- Water depth of 183 m (600 ft) or more.
- Maximum distance of 185 km (100 nmi) from a military air base near the Naval Station serving as the shock trial support facility.

The test areas meeting these two criteria also meet all of the other distance requirements (i.e., within 240 km [130 nmi] of a Naval Station support facility; within 370 km [200 nmi] of a Naval Station with homeported ships, within 240 km [130 nmi] of ship repair facilities, and within 370 km [200 nmi] of an ordnance loading station). Portions of each test area were excluded for reasons discussed below, and each test area was redefined to best fit a simple geometric pattern of five points or fewer.

Mayport. The Mayport test area is shown in **Figure 2.3**. Naval Station Mayport would be the support facility and would provide LAMPS III capable frigates, cruisers, or destroyers. Helicopters would operate from Naval Station Mayport, while F-14 and F/A-18 aircraft deployed from either NAS Oceana or MCAS Beaufort would conduct day operations out of NAS Jacksonville. An MSC tug would be deployed out of the Naval Amphibious Base Little Creek (Virginia) to Mayport for the duration of the trial. Explosives would be stored at Naval Weapons Station Charleston and then transported to Mayport for immediate loadout prior to each test day. Ship repair facilities consist of one floating drydock in Mayport (to be completed by 2000) and one contract shipyard in Savannah.

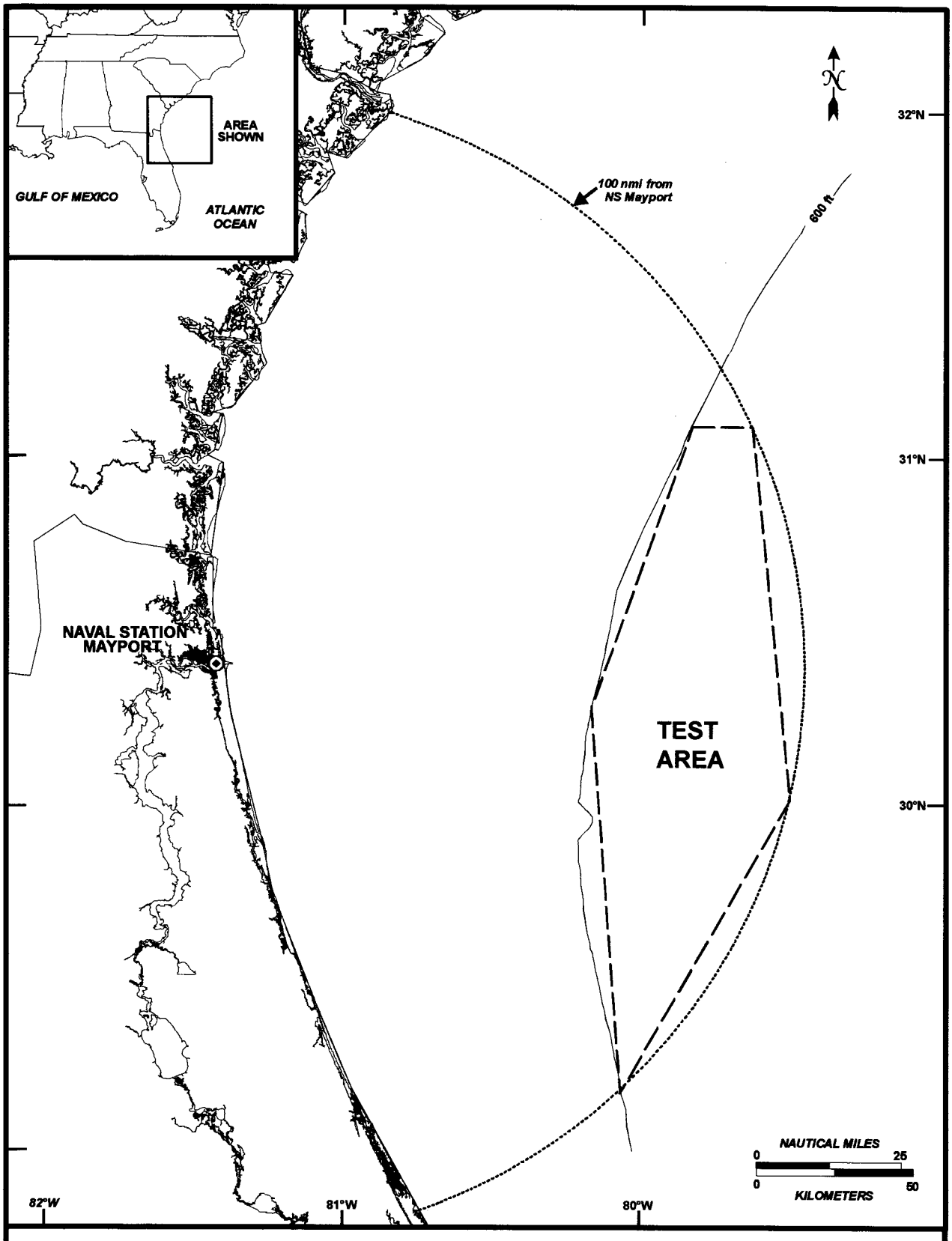

Figure 2.3. Mayport test area.

Due to the proximity of the two air bases (Naval Station Mayport for helicopters, NAS Jacksonville for F-14 and F/A-18 aircraft), the 185 km (100 nmi) arc was drawn from Naval Station Mayport. This arc and the 183 m (600 ft) depth contour were used to initially bound the test area. The northern tip of the available area was excluded to avoid an explosives dumping area.

31°05'N 79°50.5'W
31°05'N 79°38.5'W
30°0.5'N 79°31'W
29°9.7'N 80°05'W
30°16.3'N 80°10.8'W

Norfolk. The Norfolk test area is shown in **Figure 2.4**. Naval Station Norfolk would be the support facility and would deploy Navy ships for range support. Helicopters would be transferred from Mayport to NAS Norfolk for the duration of the trial period. F-14 or F/A-18 aircraft would operate out of NAS Oceana (Virginia Beach). An MSC tug from Naval Amphibious Base Little Creek would transport and deploy the explosives from Yorktown Naval Weapons Station. One government and four contractor shipyards are in the Norfolk vicinity.

The 183 m (600 ft) depth contour and a single 185 km (100 nmi) arc from NAS Oceana were used to initially bound the test area. The northern portion of the available area was removed to avoid the formerly proposed Norfolk Canyon National Marine Sanctuary (National Oceanic and Atmospheric Administration [NOAA], 1991) and an abandoned explosives dumpsite (exclusions are discussed further in Section 2.2.3). The remaining area was defined by the following coordinates:

36°57'N 74°38'W
36°57'N 73°54.5'W
36°10.3'N 74°07.3'W
35°32.2'N 74°48'W

Pascagoula. The Pascagoula test area is shown in **Figure 2.5**. Naval Station Pascagoula would be the support facility and would supply Navy ships for range support. Helicopters transferred from Mayport would operate out of NAS Pensacola. F-14 or F/A-18 aircraft would be deployed from either NAS Oceana, Virginia or MCAS Beaufort, South Carolina to operate out of either NAS Pensacola or Tyndall Air Force Base. An MSC tug would be deployed out of Naval Amphibious Base Little Creek, Virginia to Pascagoula for the duration of the trial period. Explosives would be stored at the Louisiana Army Ammunition Plant, Shreveport, Louisiana and transported to Naval Station Pascagoula for immediate loading prior to each test day.

The area is defined by the 183 m (600 ft) isobath and the overlapping 185 km (100 nmi) arcs from NAS Pensacola and Tyndall Air Force Base. A western portion of the available area was excluded due to an explosives dumpsite, a lightering area, and vicinity to two safety fairways (ship traffic lanes). The remaining area was defined by the following coordinates:

29°42'N 87°10.5'W
29°51.7'N 87°3.5'W
29°10'N 85°55'W
28°48.5'N 86°50'W
29°20'N 87°00'W

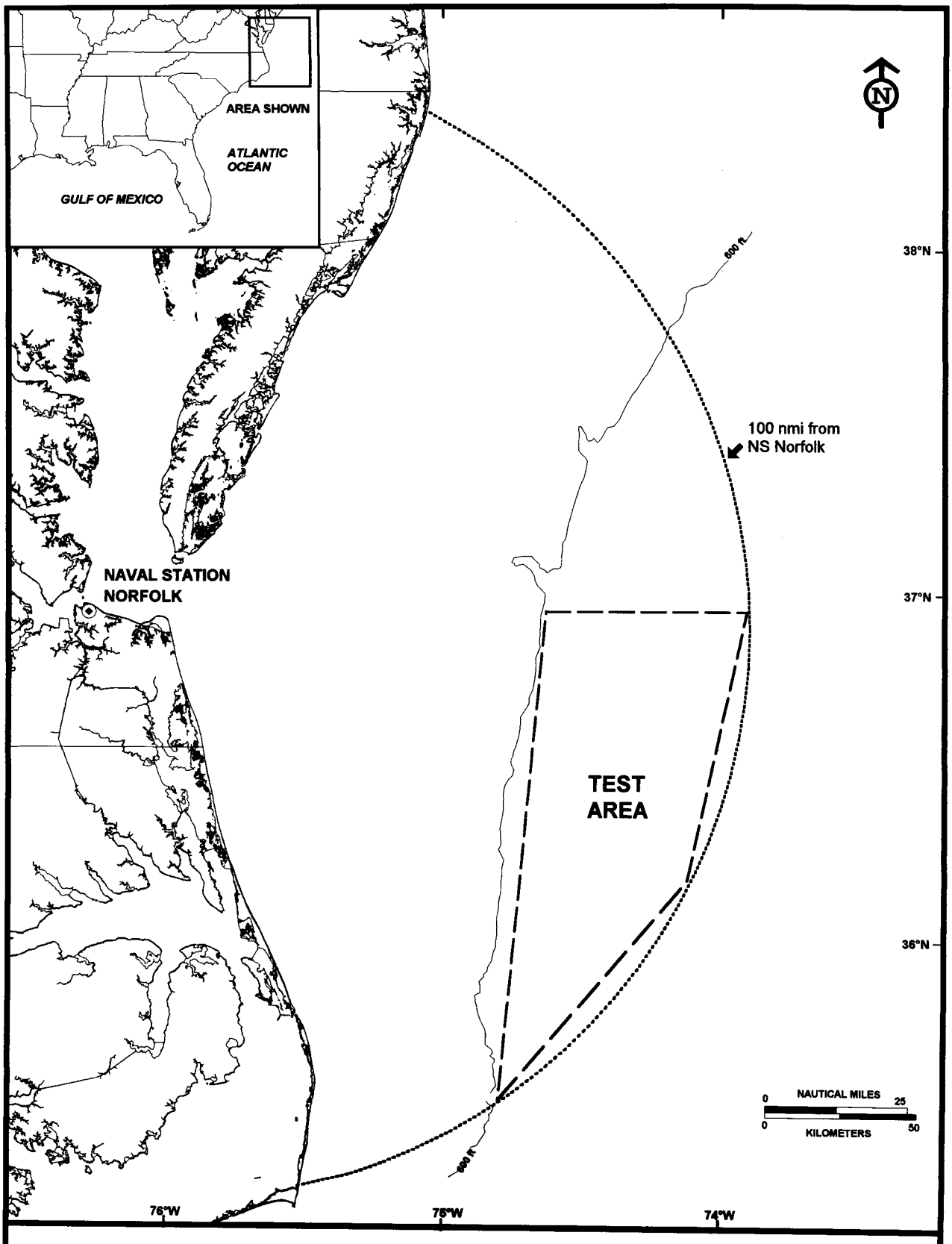

Figure 2.4. Norfolk test area.

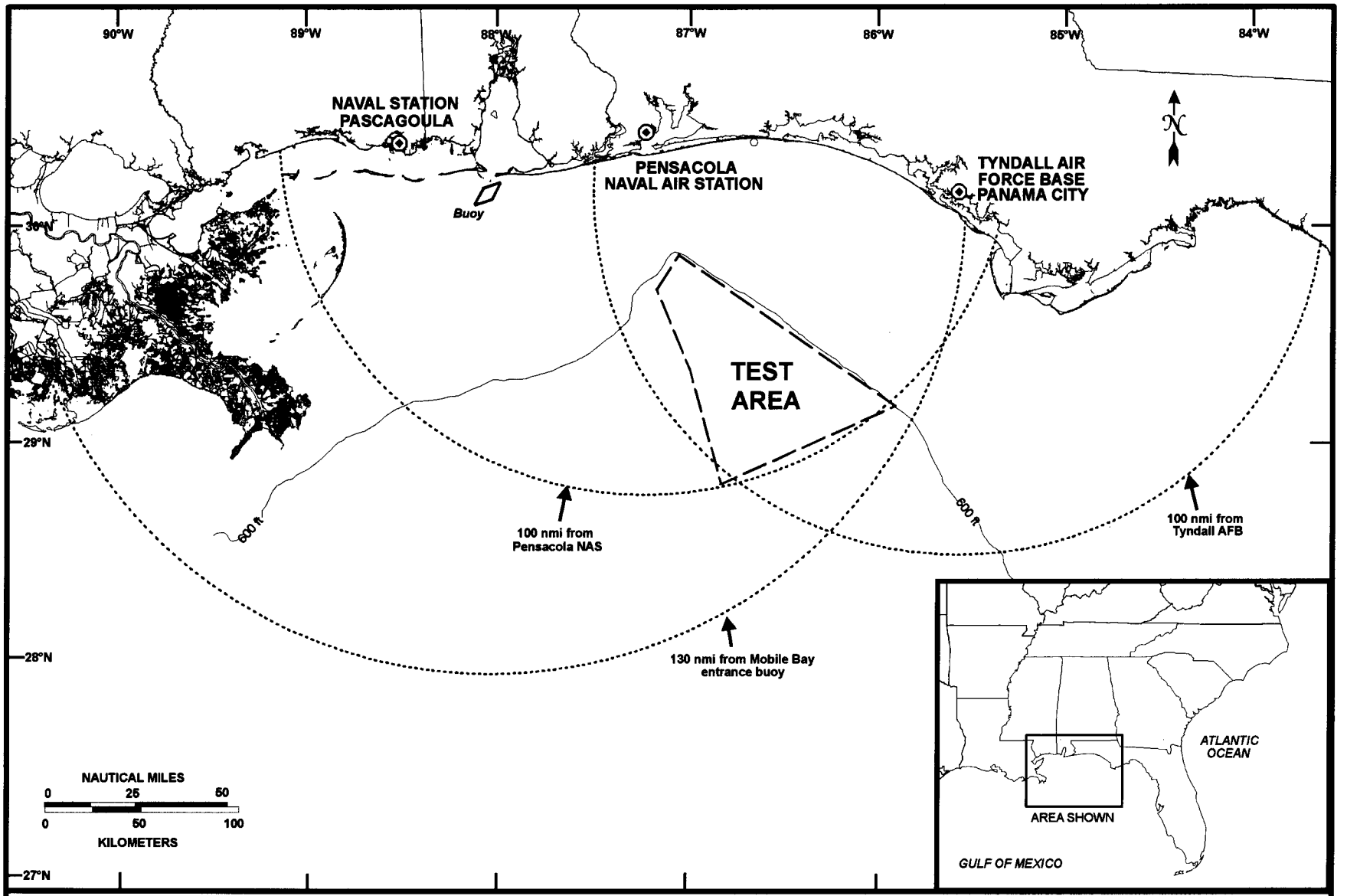

Figure 2.5. Pascagoula test area.

(e) Conditions Affecting Operations

Weather and Sea State. Weather and sea state affect the ability to conduct the shock trial and associated mitigation efforts. Ideal test conditions are seas of 0.6 m (2 ft) or less, a light wind, and unlimited visibility ($\geq$10 nmi). Conditions become limiting or marginal when seas approach 2 m (6 ft), winds approach 21 mph, and visibility is less than 9.3 km (5 nmi). Mitigation will require visibility of at least 5.6 km (3 nmi) (see Chapter 5), which is less stringent than the marginal visibility criterion listed above. Mitigation also involves other specific sea state requirements (see Section 5.0), the frequency of which cannot be estimated directly; however, the marginal conditions are considered to be an index of conditions that would not be suitable for mitigation.

Table 2.2 lists frequency of occurrence for weather/sea state conditions during each month of the year for the Mayport, Norfolk, and Pascagoula test areas. These data are derived from atlases prepared by the Department of the Navy (1986a,b, 1989) that summarize reports from ships of opportunity within 1° latitude/longitude blocks. Based on these data, the May through September time period offers the best opportunity for favorable weather and sea state conditions. All three test areas have a high percentage of ideal or at least marginal conditions during this time period. Pascagoula generally has the highest, and Norfolk the lowest, incidence of favorable wave heights and visibility during this time period. During the remaining months and especially during winter, all three test areas tend to have a higher incidence of less favorable conditions, particularly wave heights and winds, due to extratropical cyclones.

Wave Height: On a monthly average basis, the Mayport test area has ideal wave heights from 23.9% to 49.9% of the time and at least marginal conditions 73.3% to 98.2% of the time. The averages during the May through September period are 43.2% for ideal conditions and 92.9% for at least marginal conditions. The Norfolk test area has ideal wave heights from 18.1% to 44.8% of the time and at least marginal conditions 64.7% to 91.9% of the time. The averages during the May through September period are 38.8% for ideal conditions and 86.4% for at least marginal conditions. The Pascagoula test area has ideal wave heights from 29.1% to 71.8% of the time and at least marginal conditions 69.2% to 97.4% of the time. The averages during the May through September period are 61.3% for ideal conditions and 94.4% for at least marginal conditions.

Wind: On a monthly average basis, the Mayport test area has at least marginal wind speeds approximately 80% to 99% of the time. Although the May through September period includes the Atlantic hurricane season, on the average winds tend to be calmer and the percentage of at least marginal wind speeds is about 94%. The Norfolk test area has at least marginal wind speeds approximately 70% to 95% of the time. During the May through September period, the percentage of at least marginal wind speeds is about 93%. The Pascagoula test area has at least marginal wind speeds approximately 85% to 100% of the time. During the May through September period, the percentage of at least marginal wind speeds is about 97%.

Table 2.2. Monthly average weather and sea state conditions for the potential test areas based on data from ships of opportunity (From: Department of the Navy, 1986a,b, 1989). The proposed test period is May through September.

Condition	Percent Occurrence of Specified Condition											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MAYPORT					<---------- TEST PERIOD ---------->							
Ideal Conditions												
Seas ≤ 2 ft	24.9	24.6	27.5	34.1	37.9	43.6	48.0	49.9	36.6	23.9	26.9	26.1
Visibility ≥ 10 nmi	59.6	63.9	61.3	61.5	64.8	63.1	67.1	65.4	68.3	69.6	59.9	64.2
Limiting Conditions												
Seas ≤ 6 ft	76.9	74.5	80.5	86.5	91.4	93.4	98.2	93.4	88.0	73.3	74.9	77.4
Wind ≤ 21 kts*	80	80	85	90	90	97	99	90	95	80	85	85
Visibility ≥ 5 nmi	96.5	95.0	96.0	97.1	98.5	97.2	96.6	97.9	98.6	98.1	97.6	97.6
NORFOLK												
Ideal Conditions												
Seas ≤ 2 ft	18.1	19.9	21.3	28.7	36.1	41.0	44.8	39.0	33.1	28.1	24.8	19.4
Visibility ≥ 10 nmi	61.5	60.9	59.0	53.6	51.3	51.7	57.7	55.7	61.2	62.6	69.7	69.7
Limiting Conditions												
Seas ≤ 6 ft	64.7	64.8	67.0	76.9	85.3	88.4	91.9	87.5	79.0	72.3	70.8	65.1
Wind ≤ 21 kts*	72	70	75	75	95	92	95	91	92	85	75	72
Visibility ≥ 5 nmi	93.3	92.2	90.5	89.6	89.5	90.3	93.2	94.3	94.1	94.2	96.1	95.8
PASCAGOULA												
Ideal Conditions												
Seas ≤ 2 ft	42.8	36.5	40.0	47.1	51.2	67.3	71.8	71.8	44.2	37.0	29.1	35.9
Visibility ≥ 10 nmi	68.6	65.0	68.7	63.0	70.7	73.0	72.4	68.3	68.0	74.0	69.3	75.8
Limiting Conditions												
Seas ≤ 6 ft	85.1	69.2	77.8	95.1	92.4	96.2	97.4	97.2	88.8	87.2	76.9	90.0
Wind ≤ 21 kts*	90	90	92	95	95	99	100	100	89	90	87	85
Visibility ≥ 5 nmi	93.2	94.6	93.7	93.7	96.2	98.0	97.9	96.6	96.5	98.4	97.7	97.9

*Wind data were only available for speeds less than or equal to 21 knots (24.2 mph) and not the desired 21 mph (18.2 kts).

Visibility: On a monthly average basis, the Mayport test area has ideal visibility most of the time and at least marginal visibility nearly all the time, with little variation throughout the year. The averages during the May through September period are 65.7% for ideal visibility and 97.8% for at least marginal visibility. The Norfolk test area has ideal visibility most of the time and at least marginal visibility nearly all the time, with little variation throughout the year. The averages during the May through September period are 55.5% for ideal visibility and 92.3% for at least marginal visibility. The Pascagoula test area has ideal visibility most of the time and at least marginal visibility nearly all the time, with little variation throughout the year. The averages during the May through September period are 70.5% for ideal visibility and 97.0% for at least marginal visibility.

Ship Traffic. Although shipping lanes have been avoided in the delineation of potential test areas, commercial and military ship traffic is present to varying degrees. As an index of ship traffic, data were obtained from the Office of Naval Intelligence, Sea Watch Locational/Event Database. The database includes information on military, merchant, and fishing vessels, but very little on coastal trade and private and pleasure crafts. Military traffic is excluded from consideration here because it can be controlled as necessary during the shock trial period. Results for the non-military traffic during May through September (average of 1996 and 1997) are summarized in **Table 2.3**.

Pascagoula has the highest level of ship traffic, reflecting the maritime activity associated with the petroleum industry and nearby ports (Mobile and New Orleans). The area off Mayport has the lowest level of commercial ship traffic and Norfolk is intermediate.

Table 2.3. Summary of commercial ship traffic in the test areas during May through September 1996 and 1997 (Data from: Office of Naval Intelligence, Sea Watch Locational/Event Database).

Month	Commercial Ships per Month		
	Mayport	Norfolk	Pascagoula
May	71	114.5	246
June	72.5	116.5	218
July	78	111.5	229.5
August	68.5	115	226
September	83.5	130	236.5
Average	74.7	117.5	231.2

(f) Further Operational Considerations

Numbers of Homeported Ships. One of the factors used by the Navy to identify the potential test areas for the shock trial was the proximity to Naval Stations with sufficient homeported ships which meet the operational requirements of the shock trial. Obtaining these assets has become increasingly difficult as both the budget and size of the Navy have decreased. Supporting a shock trial reduces the assets available to meet the other mission goals of the Atlantic Fleet and PERSTEMPO requirements. Therefore, the number of homeported ships at each Naval Station was considered to determine the likelihood of acquiring two dedicated ships for the shock trial. The number of ships currently available at each Naval Station that could be used to support the shock trial are summarized below:

- Naval Station Norfolk: 41
- Naval Station Mayport: 21
- Naval Station Pascagoula: 4

A greater number of ships at the support base increases the likelihood of a dedicated vessel being available when needed.

Fleet Support Activities. Various Fleet support activities are co-located on all Naval Stations to provide technical, logistics, training, maintenance, and industrial support to the fleet. Fleet support activities would be used to support the shock trial in order to minimize the number of support personnel required to be temporarily relocated to the test site for the shock trial. The Fleet support activities that were considered are discussed below:

- Combatant Home Engineering Team (CHET): Provide coordination of engineering, training, and logistic support field representatives in each home port area, coordination of maintenance and modernization efforts, and waterfront engineering and waterfront logistic assistance.

- Fleet Technical Support Center (FTSC): Provide direct support to the fleet in matters of waterfront technical assistance, maintenance training, and logistics services associated with the installation, operation, maintenance, and readiness of shipboard equipment and systems.

- Ship Intermediate Maintenance Activity (SIMA): Provide maintenance, repair, conversion, and training to the fleet.

- Fleet and Industrial Support Center (FISC): Provide supply and support services to fleet units and shore commands.

The available resources at each Fleet support activity are directly related to the number of homeported ships at each Naval Station, which has been listed in the preceding subsection. Therefore, with respect to fleet support activities, Norfolk is rated excellent, Mayport good, and Pascagoula minimal.

(g) Operational Ranking of Test Areas

Table 2.4 compares the three test areas according to operational criteria. Norfolk and Mayport rank higher and about equal operationally, with Pascagoula ranking lower and well behind the other two. Each area has its operational advantages and disadvantages as summarized below.

This analysis is a refined version of the rankings presented in the DEIS. Operational characteristics of the test areas have not changed. However, the revised analysis explicitly considers the number of homeported ships and the availability of fleet support activities discussed under (f) Further Operational Considerations. The revised ranking also places less weight on "ideal" weather conditions (five weather-related variables have been reduced to three). The revised rankings more accurately reflect the operational advantages and disadvantages of the three test areas.

Mayport

Advantages:	Disadvantages:
• The area has favorable weather and sea state conditions. • The area has the lowest amount of commercial shipping traffic of the three areas. • Helicopters are homebased at Naval Station Mayport.	• An MSC tug would have to be deployed out of Naval Amphibious Base Little Creek (VA) for duration of shock trial. • Repair facilities are limited (one floating drydock in Mayport and one contract shipyard in Savannah). • There is no explosives storage (dayload only). • Aircraft would have to be deployed to NAS Jacksonville to support the trial. • It is not the homeport of WINSTON S. CHURCHILL.

Norfolk

Advantages:	Disadvantages:
• Naval Station Norfolk is the homeport of WINSTON S. CHURCHILL. • Largest number of homeported ships to support shock trial. • Home-based F-14 or F/A-18 aircraft are available at nearby NAS Oceana. • An MSC tug is available at nearby Naval Amphibious Base Little Creek. • The nearby Naval Weapons Station Yorktown is available to store and load the explosives.	• Weather conditions overall are less favorable than at either Mayport or Pascagoula, though adequate to conduct the shock trial. • Helicopters would need to be transferred from Mayport to NAS Norfolk for the duration of the trial. • Ship repair facilities, though more extensive than at Mayport, do not include a DDG 51 class shipbuilder.

Pascagoula

Advantages:	Disadvantages:
• The area has the most favorable weather and sea state conditions. • A DDG 51 class shipbuilder is present at Pascagoula.	• There is heavy ship traffic. • An MSC tug would have to be deployed out of Naval Amphibious Base Little Creek (VA) for the duration of the trial. • Helicopters would need to be transferred from Mayport to NAS Pensacola for the duration of the trial. • Aircraft would have to be deployed to NAS Pensacola or Tyndall Air Force Base to support the trial. • There is no explosives storage (dayload only). • Number of homeported ships to support the trial is minimal. • Fleet support activities at this Naval Station are minimal. • It is farthest from the homeport of WINSTON S. CHURCHILL.

Table 2.4. Operational evaluation of Mayport, Norfolk, and Pascagoula test areas.

Criterion	Basis for Scoring	Scoring of Alternative Areas			Comments
		Mayport	Norfolk	Pascagoula	
Facilities and Assets					
Naval Station within 240 km (130 nmi)	0 = no* 1 = yes	1	1	1	By definition, all areas are within 370 km (200 nmi) of a Naval Station
Ship repair facility within 240 km (130 nmi)	0 = no* 1 = contract/Navy yards 2 = shipbuilder	1	1	2	Ingalls Shipbuilding (DDG 51 class shipbuilder) is located in Pascagoula
Ordnance loading facility within 370 km (200 nmi)	0 = no* 1 = dayload available 2 = ordnance facility	1	2	1	Mayport requires storage at Naval Weapons Station Charleston, SC; Pascagoula requires storage at Louisiana Army Ammunition Plant, Shreveport, LA
Naval assets (ships) available at homeport	0 = none* 1 = <5 ships 2 = 5-10 ships 3 = 11-20 ships 4 = >20 ships	4	4	1	By definition, all areas are within 370 km (200 nmi) of a Naval Station with ships, but numbers available differ
Naval assets (MSC tug) within 370 km (200 nmi)	0 = no 1 = yes	0	1	0	MSC tug (for explosives handling) would be deployed to Mayport or Pascagoula
Naval assets (aircraft) within 185 km (200 nmi)	0 = no* 1 = nearby air station 2 = homebased aircraft	1	2	1	Aircraft support for Mayport would use NAS Jacksonville; support for Pascagoula would use NAS Pensacola or Tyndall AFB
Naval assets (helicopters) within 185 km (200 nmi)	0 = no* 1 = nearby air station 2 = homebased helos	2	1	1	Helicopter support for Norfolk would use NAS Norfolk; support for Pascagoula would use NAS Pensacola
Fleet support activities available	0 = none* 1 = minimal 2 = good 3 = excellent	2	3	1	Pascagoula has minimal capability to support shock trial
Proximity to DDG 81 homeport	0 = Pacific Ocean* 1 = Gulf coast 2 = Southeast coast 3 = homeport (Norfolk)	2	3	1	PERSTEMPO requirement favors use of homeport
Conditions Affecting Operations					
Water depth of at least 183 m (600 ft) available	0 = no* 1 = yes	1	1	1	By definition, all areas meet this requirement.
Ship traffic (commercial ships/month)	0 = Over 300 1 = 201-300 2 = 101-200 3 = 1-100 4 = none	3	2	1	Military traffic excluded from consideration because it can be controlled
Obstructions	0 = significant 1 = avoidable or none	1	1	1	All have unexploded ordnance that can be avoided
Marginal sea state (occurrence of seas < 6 ft during May-Sept)	0 = <50% 1 = 50%-69% 2 = 70%-84% 3 = 85%-94% 4 = 95%-100%	3	3	3	
Marginal wind speed (occurrence of winds < 21 kts during May-Sept	0 = <50% 1 = 50%-69% 2 = 70%-84% 3 = 85%-94% 4 = 95%-100%	3	3	4	
Marginal visibility (occurrence of visibility ≥ 5 nmi during May-Sept)	0 = <50% 1 = 50%-69% 2 = 70%-84% 3 = 85%-94% 4 = 95%-100%	4	3	4	
TOTAL SCORE (higher is better)		**29**	**31**	**23**	

* Critical requirement. A zero (0) in this category is not acceptable for a potential test area.

(h) Conclusions

Three potential test areas for the shock trial have been identified based on operational requirements. The test areas are located offshore of the following facilities:

- Naval Station Mayport
- Naval Station Norfolk
- Naval Station Pascagoula

A detailed analysis concluded that all three test areas could support the shock trial. From an operational perspective, the Norfolk and Mayport test areas rank higher and are about equal, whereas the Pascagoula test area ranks lower and is significantly less suitable for supporting the shock trial.

If this alternative (shock testing at an offshore location) is selected, the final test site would be selected within either the Mayport, Norfolk, or Pascagoula test area. The three test areas are the focus of detailed environmental analysis in this FEIS.

2.2.3 Environmental Exclusionary Mapping

Some environmental features such as explosives dumpsites and shipping lanes have previously been noted and were deliberately avoided in defining the test areas. More detailed exclusionary mapping was conducted to determine whether portions of the test areas needed to be excluded from testing (Department of the Navy, 1999a). Environmental features that were included in the exclusionary mapping were as follows:

- Active petroleum lease blocks;
- Artificial reef sites and areas;
- Communications cables;
- Critical habitats;
- Data buoys;
- Explosives dumpsites;
- Hard bottom and coral areas;
- Marine sanctuaries;
- Navigation aids;
- Ocean dredged material, acid waste, and sewage sludge disposal sites;
- Pipelines (oil and gas);
- Platforms (oil and gas);
- Shipping lanes;
- Towers (communications or navigation);
- Unexploded ordnance; and
- Wrecks and obstructions.

Buffer zones were added to appropriate environmental features with the goal of protecting resources or avoiding conflicts at the time of the shock trial. Various buffer distances were used, depending on the type of environmental feature (**Table 2.5**). The exclusionary mapping (**Table 2.6**) indicates that each test area has a large area remaining in which the shock trial could be conducted (Department of the Navy, 1999a).

Table 2.5. Buffer zones and rationale for environmental exclusionary mapping (From: Department of the Navy, 1999a).

Buffer Size	Feature	Rationale
1 nmi (1.85 km)	Artificial reef site or area	Protect fish aggregations
	Hard bottom or coral area	Protect fish aggregations
	Wreck or obstruction	Protect fish aggregations
	Explosives dumpsite (no longer used), acid waste or sewage sludge disposal site (no longer used) or unexploded ordnance	Avoid disturbing site contents and protect fish aggregations
	Pipeline (oil and gas)	Avoid pipeline damage and protect fish aggregations
2.5 nmi (4.6 km)	Marine sanctuary	Based on NMFS (1995) buffer request for formerly proposed Norfolk Canyon National Marine Sanctuary (SEAWOLF FEIS; Department of the Navy, 1998a)
3 nmi (5.6 km)	Critical habitat for endangered or threatened species	Based on buffered Safety Range for SEAWOLF FEIS (Department of the Navy, 1998a)
5 nmi (9.3 km)	Data buoy or tower	Avoid radio interference
10 nmi (18.5 km)	Ocean dredged material disposal site (active)	Avoid disrupting routine ship traffic due to vessel warning zone (active disposal sites could have routine vessel traffic)
	Platform (oil and gas)	Avoid disrupting routine ship traffic due to vessel warning zone (manned platforms typically have daily supply vessel and helicopter traffic)
	Shipping lane	Avoid disrupting routine ship traffic due to vessel warning zone
No exclusion or buffer	Active petroleum lease block	Mapped but not excluded. Active leases do not necessarily have any structures or activities, and lease stipulations mandate coordination with the military. Navy would coordinate with Minerals Management Service prior to shock trial to determine status
	Communications cable (inactive)	Mapped but not excluded. No exclusion needed for inactive cable
	Navigation aid	Mapped but not excluded

Table 2.6. Summary of environmental features within and outside the test areas (From: Department of the Navy, 1999). Only the features that resulted in an exclusion (indicated by an asterisk *) are shown on the test area maps.

	Test Area		
	Mayport	Norfolk	Pascagoula
Areal Information			
Total Test Area in km^2 (nmi^2)	8,296 (2,422)	7,050 (2,059)	6,344 (1,852)
Excluded Area in km^2 (nmi^2)	440 (128)	657 (192)	864 (252)
Remaining Area in km^2 (nmi^2)	7,856 (2,294)	6,393 (1,867)	5,480 (1,600)
Excluded Area in %	5.3	9.3	13.6
Remaining Area in %	94.7	90.7	86.4
Features Present Within One or More Test Areas			
Active petroleum lease blocks	Absent	At least portions of 9 blocks plus 4 blocks on periphery	At least portions of 9 blocks
Communications cables	1 no longer used	Absent	Absent
Explosives dumpsites	1 no longer used (*)	1 no longer used (*)	1 no longer used (*)
Hard bottom/coral areas	2 inside, 3 on edge of test area (*)	Absent	Absent
Marine sanctuaries	None near test area	Buffer of formerly proposed Norfolk Canyon National Marine Sanctuary overlaps with test area (*)	None near test area
Shipping lanes	Absent	Absent	Buffers overlap with test area (*)
Unexploded ordnance	2 inside, 1 on edge of test area (*)	1 inside test area (*)	Absent
Wrecks and obstructions	1 inside, 2 on edge of test area (*)	1 inside, 2 on edge of test area (*)	Absent

Table 2.6. (Continued).

	Test Area		
	Mayport	Norfolk	Pascagoula
Features Present Outside Test Areas			
Artificial reefs	Numerous inshore of 183 m (600 ft) depth contour	Numerous inshore of 183 m (600 ft) depth contour	Numerous inshore of 183 m (600 ft) depth contour
Critical habitats	Right whale critical habitat is at least 87 km (47 nmi) inshore of test area	None near test area	None near test area
Data buoys	1 inshore of test area	2 inshore of 183 m (600 ft) depth contour	3 at least 35 km (19 nmi) outside of test area
Navigation aids	Tens inshore of 183 m (600 ft) depth contour	Tens inshore of 183 m (600 ft) depth contour	Hundreds inshore of 183 m (600 ft) depth contour
Ocean dredged material and other disposal sites	4 inshore of 183 m (600 ft) depth contour	4 inshore of 183 m (600 ft) depth contour	9 inshore of 183 m (600 ft) depth contour
Pipelines (oil and gas)	Absent	Absent	Thousands of segments outside and far west of test area
Platforms (oil and gas)	Absent	Absent	Hundreds outside and far west of test area
Towers (communications or navigation)	8 inshore of 183 m (600 ft) depth contour	4 inshore of 183 m (600 ft) depth contour	Absent

(a) Mayport

As defined by the Navy coordinates, the Mayport test area is 8,296 km^2 (2,422 nmi^2) in size. Environmental features within the test area include a submarine communications cable (no longer used and not excluded), an explosives dumpsite, two unexploded ordnance sites, two hard bottom areas, and a single wreck (**Figure 2.6**). Environmental features on the periphery of the Mayport test area include three hard bottom areas, one unexploded ordnance site, and two wrecks. All other environmental features occur outside of the test area. Exclusions within the Mayport test area equal 440 km^2 (128 nmi^2) or 5.3% of the total area, leaving 7,856 km^2 (2,294 nmi^2) or 94.7 % for operations.

(b) Norfolk

As defined by the Navy coordinates, the Norfolk test area is 7,050 km^2 (2,059 nmi^2) in size. Environmental features within the test area include at least portions of nine active petroleum lease blocks (not excluded), one explosives dumpsite, part of the buffer zone for the formerly proposed Norfolk Canyon National Marine Sanctuary, one unexploded ordnance site, and one wreck (**Figure 2.7**). On the periphery of the Norfolk test area are four other active petroleum lease blocks (not excluded) and three wrecks. All other environmental features occur outside the test area. Exclusions within the Norfolk test area equal 657 km^2 (192 nmi^2) or 9.3% of the total area, leaving 6,393 km^2 (1,867 nmi^2) or 90.7% for operations.

Active petroleum lease blocks within and on the periphery of the Norfolk test area were not excluded because there are no oil and gas pipelines or platforms at present. However, if the Norfolk test area is selected, the Navy would coordinate with the MMS and appropriate military commander(s) before the shock trial to determine whether any platforms or rigs are present or activities are planned in the active blocks.

(c) Pascagoula

As defined by the Navy coordinates, the Pascagoula test area is 6,344 km^2 (1,852 nmi^2) in size. Environmental features within the test area include at least portions of nine active petroleum lease blocks (not excluded), part of an explosives dumpsite, and buffer zones for shipping lanes (**Figure 2.8**). All other environmental features occur outside the test area. Exclusions within the Pascagoula test area equal 864 km^2 (252 nmi^2) or 13.6% of the total area, leaving 5,480 km^2 (1,600 nmi^2) or 86.4% for operations.

Active petroleum lease blocks within and on the periphery of the Pascagoula test area were not excluded because there are no oil and gas pipelines or platforms at present. However, Chevron U.S.A. and partners are planning a gas development project in the Destin Dome 56 Unit, a group of lease blocks located northeast of the Pascagoula test area. It is possible that activities such as drilling and platform and pipeline installation could be occurring there by the time of the shock trial. Therefore, if the Pascagoula test area is selected, the Navy would coordinate with the MMS and appropriate military commander(s) before the shock trial to determine whether any platforms or rigs are present or activities are planned in the active blocks.

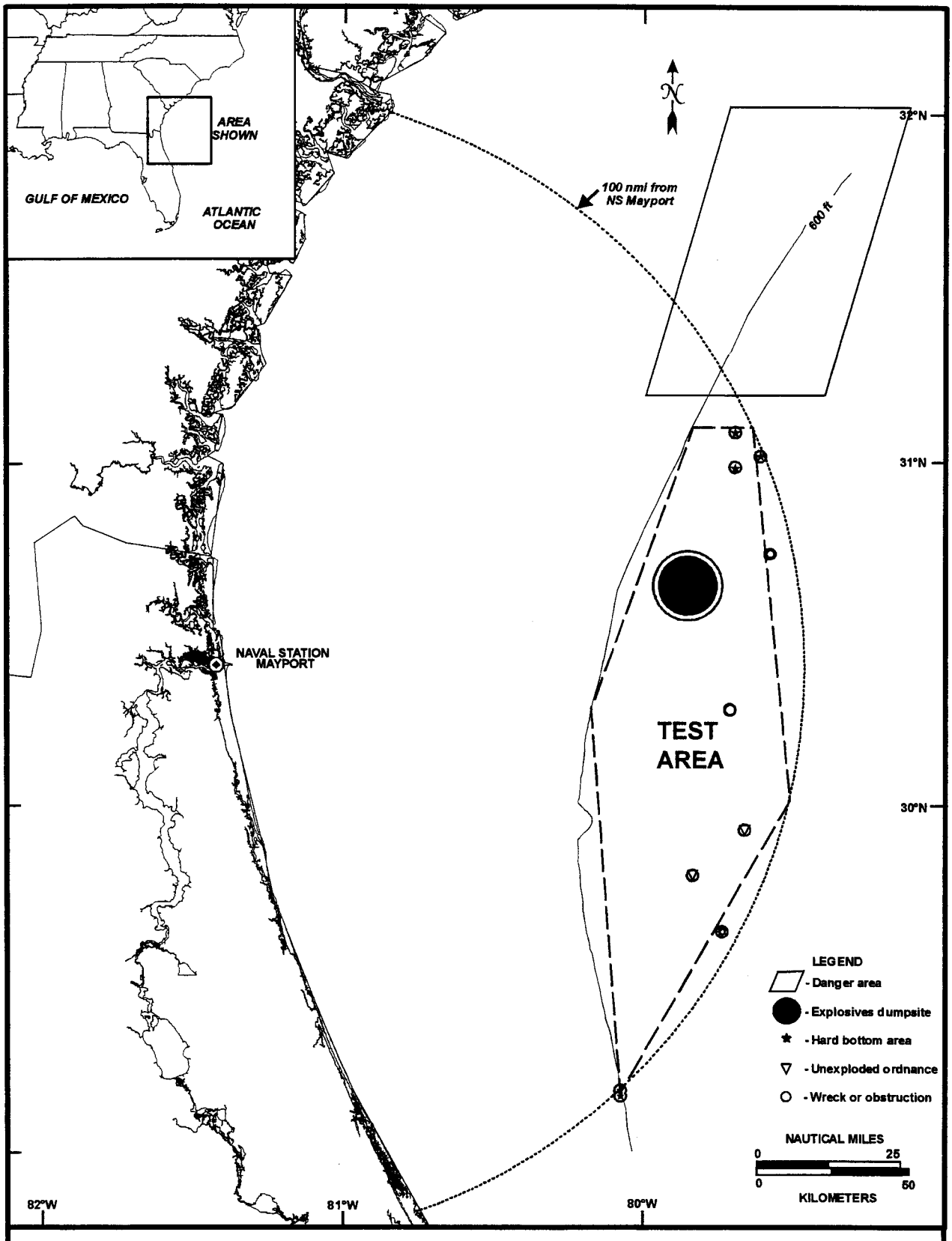

Figure 2.6. Exclusionary map of the Mayport test area.

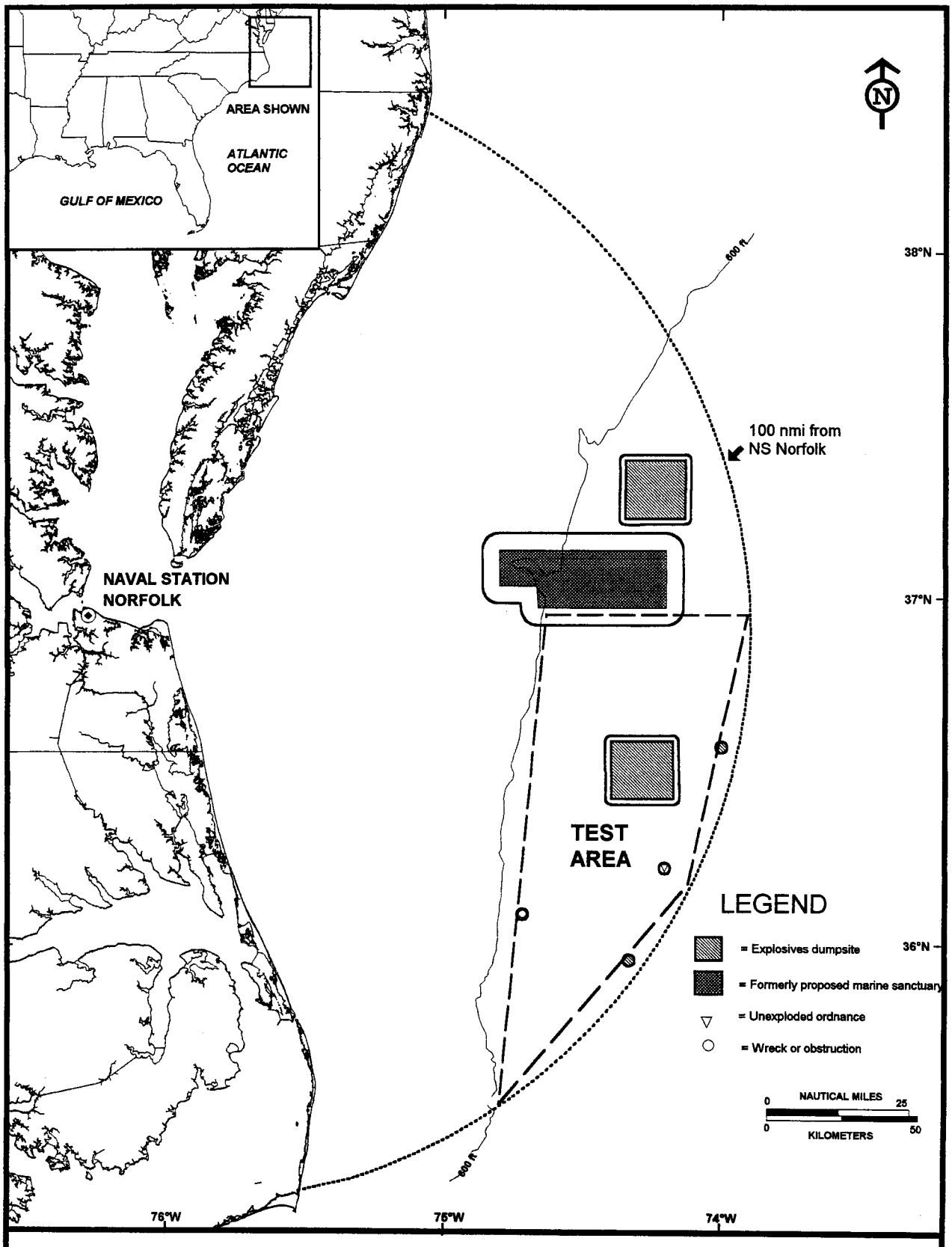

Figure 2.7. Exclusionary map of the Norfolk test area.

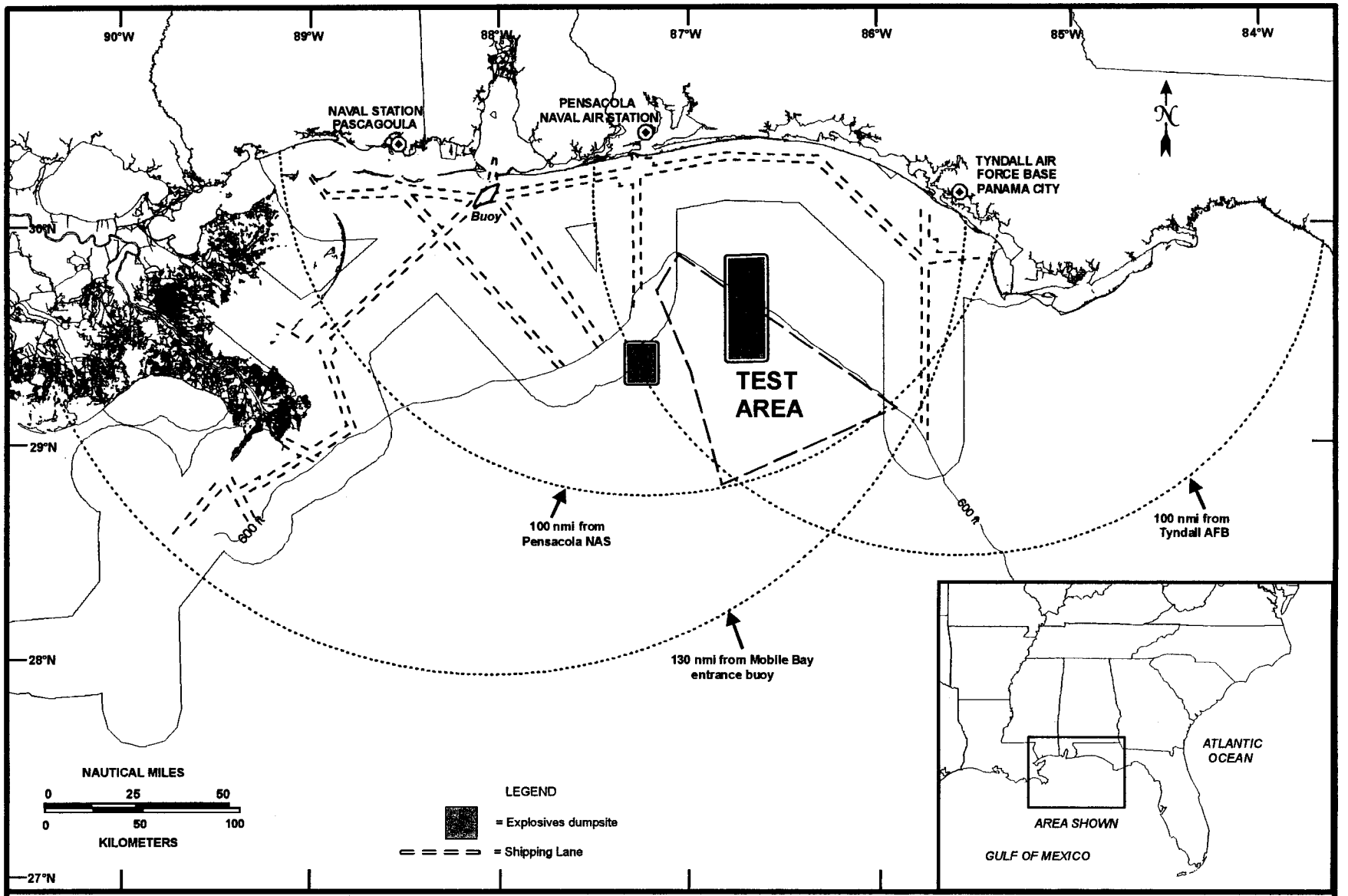

Figure 2.8. Exclusionary map of the Pascagoula test area.

2.2.4 Mitigation Measures included in Proposed Action

Mitigation, as defined by the Council on Environmental Quality, includes measures to minimize impacts by limiting the degree or magnitude of a proposed action and its implementation. The proposed action includes mitigation measures designed to minimize risk to marine mammals and turtles. Mitigation measures include a detailed marine mammal and sea turtle mitigation plan that includes site selection and pre- and post-detonation monitoring. The marine mammal and sea turtle mitigation plan is summarized below and described in more detail in Section 5.0. Other mitigation measures include an exclusion zone to avoid impacts to routine ship and air traffic, and measures to deal with unexploded ordnance in the unlikely event of a misfire.

(a) Marine Mammal and Sea Turtle Mitigation Plan

A detailed Marine Mammal and Sea Turtle Protection/Mitigation Plan is presented in Section 5.0. The plan includes the same type of mitigation and monitoring efforts that were used successfully during the shock trial of USS JOHN PAUL JONES in 1994 off the coast of southern California where marine mammal population densities are significantly greater than at the Mayport, Norfolk, or Pascagoula test areas. Those shock trial operations included two 4,536 kg (10,000 lb) detonations and no deaths or injuries of marine mammals were detected (Naval Air Warfare Center, 1994). The mitigation plan for the shock trial would similarly avoid impacts and minimize risk to marine mammals and sea turtles in three main ways:

- Site selection. Initial, general site selection would be based on operational requirements and surveys. Within the test area selected for the shock trial (e.g., Mayport, Norfolk, or Pascagoula), aerial surveys would be conducted and satellite imagery would be analyzed to select a small test site having low densities of marine mammals and turtles.

- Pre-detonation monitoring. Prior to each detonation, aerial and shipboard observers would search for marine mammals and turtles at the test site. Passive acoustic surveys would also be used to detect marine mammal calls. If any marine mammal or sea turtle were detected within the Safety Range of 3.7 km (2 nmi) radius around the detonation point, testing would be postponed. Testing would also be postponed if large *Sargassum* rafts, debris lines, or jellyfish concentrations (all are indicators that turtles may be present) were detected in the Safety Range, or if flocks of seabirds or large fish schools were detected within 1.85 km (1 nmi) of the detonation point. Postponement would also occur in certain circumstances when a marine mammal or turtle is detected in a Buffer Zone extending from 3.7 to 5.6 km (2 to 3 nmi) from the detonation point. Detonation would not occur until monitoring indicated that the Safety Range is clear of detectable marine mammals, sea turtles, large *Sargassum* rafts and debris lines, and large concentrations of jellyfish.

- Post-detonation monitoring. After the explosion, aerial and shipboard observers would survey the test site. A Marine Animal Recovery Team led by a marine mammal veterinarian would document and attempt to recover any dead animals and monitor any animals that appear to be injured. If the survey showed that marine mammals or turtles were killed or injured or if any marine mammals or turtles are detected in the Safety Range immediately following a detonation, testing would be halted until procedures for subsequent detonations could be reviewed and changed as necessary. Communications with stranding network personnel would be maintained throughout the shock trial period.

(b) Vessel Exclusion Zone

An exclusion zone of 9.3 km (5 nmi) radius would be established around the detonation point to exclude all non-test ship, submarine, and aircraft traffic. Enforcement of the exclusion zone would commence 5 to 6 hours prior to each detonation and could last for up to 12 hours per detonation. Any traffic within an 18.5 km (10 nmi) radius would be warned to alter course or would be escorted from the site. *Notices to Airmen and Mariners* would be published in advance of each test. An immediate "hold" on the test would be ordered if any unauthorized craft entered the exclusion zone and could not be contacted. The "hold" would continue until the exclusion zone was clear of unauthorized vessels. The size of the exclusion zone is necessary for operational security and to allow large ships sufficient time to change course. The exclusion zone is an electronic emissions control zone that virtually eliminates the possibility of an inadvertent detonation caused by radio/radar induced electrical current in the explosive firing circuit. It also provides an area of safe maneuvering for the charge-handling vessel and the explosive it is towing. It is also intended to minimize broad-band noise from ship engines, which could interfere with passive acoustic monitoring for marine mammals.

(c) Unexploded Ordnance

The probability of a charge not detonating during a test is remote. Should a charge fail to explode, the Navy would attempt to identify the problem and detonate the charge with all marine mammal and sea turtle mitigation measures in place as summarized above. If these attempts failed, the Navy would recover the explosive and disarm it. Only in the case of an extreme emergency (e.g., charge could not be detonated or disarmed) or to safeguard human life would the Navy dispose of the charge at sea. The possibility of disposing the explosive charge at sea is very remote. However, if disposal at sea were necessary, the charge would be disposed in a manner that would not pose a hazard to the public.

2.3 COMPARISON OF ALTERNATIVES

Table 2.7 summarizes the analysis of alternatives with respect to project purpose and need, operational criteria, and environmental impacts. The "no action" alternative (including computer modeling and component testing) is not a reasonable alternative because it would not provide the information and data necessary to assess the survivability of the ship as required by 10 USC 2366.

Table 2.7. Summary of alternatives analysis.

Basis for Comparison	Alternative			
	No Action (Includes Maximum Reasonable Amount of Computer Modeling and Component Testing)	**Shock Testing at an Offshore Location**		
		Mayport Area	Norfolk Area	Pascagoula Area
Meets project purpose and need	No	Yes	Yes	Yes
Meets operational requirements	No further analysis (alternative does not meet project purpose and need)	Yes (Ranked higher, similar to Norfolk)	Yes (Ranked higher, similar to Mayport)	Yes (Ranked lower)
Environmental impacts				
- Marine mammals	No further analysis (alternative does not meet project purpose and need)	Lower risk of impacts (similar to Pascagoula)	Higher risk of impacts than Mayport or Pascagoula	Lower risk of impacts (similar to Mayport)
- Sea turtles	No further analysis (alternative does not meet project purpose and need)	Lower risk of impacts (similar to Pascagoula)	Higher risk of impacts than Mayport or Pascagoula	Lower risk of impacts (similar to Mayport)
- Other	No further analysis (alternative does not meet project purpose and need)	Most other environmental impacts similar at the three areas (**see Table 2.8**)		

The "no action" alternative was not analyzed further, although a "no action" alternative is implicit in the environmental analysis throughout the document.

Alternative areas for the proposed shock trial were evaluated by the Navy according to operational criteria. A location along the East Coast or Gulf of Mexico would best meet operational needs because WINSTON S. CHURCHILL will be homeported on the East Coast. Only three Naval Stations along the East Coast and Gulf of Mexico have sufficient homeported ships to support the shock trial: Naval Station Mayport, Naval Station Norfolk, and Naval Station Pascagoula. Test areas offshore of these three Naval Stations can meet all other operational requirements including water depth of at least 183 m (600 ft), suitable weather/sea state conditions, a manageable volume of commercial ship traffic, and proximity to homeported Navy ships, aircraft, a ship repair facility, and an ordnance loading facility. A detailed analysis concluded that all three test areas could support the shock trial. From an operational perspective, the Norfolk and Mayport test areas rank higher and are about equal, whereas the Pascagoula test area ranks lower and is significantly less suitable for supporting the shock trial.

Potential environmental impacts of conducting a shock trial at the Mayport, Norfolk, and Pascagoula test areas are analyzed in the Environmental Consequences section of the FEIS and summarized in **Table 2.8**. Most environmental impacts of the shock trial would be similar at Mayport, Norfolk, or Pascagoula. These include minor and/or temporary impacts to the physical and biological environments and existing human uses of the test site. However, there are significant differences with respect to potential impacts on marine mammals and sea turtles, as discussed below.

Marine Mammal Impacts. Potential impacts on marine mammals are analyzed in detail in Section 4.1.1 of the FEIS and summarized in **Table 2.9**. Potentially significant direct impacts include mortality, injury, and disruption of hearing-based behaviors. At either Mayport, Norfolk, or Pascagoula, mitigation methods described in Section 5.0 would result in selection of a test site with low densities of marine mammals. In addition, most marine mammals would be detectable during pre-detonation aerial surveys, surface observations, and passive acoustic monitoring, minimizing the risk of death or injury. However, there are differences in risk among the three areas due to differences in marine mammal densities and species composition. The number of marine mammals potentially killed or injured is estimated to be highest at Norfolk and lowest at Pascagoula. The number of marine mammals potentially experiencing disruption of hearing-based behaviors is estimated to be highest at Norfolk and lowest at Mayport. The probability of "clear range" (no marine mammals in the Safety Range) is highest at Mayport and lowest at Norfolk. The probability of "take" (one or more marine mammal groups present and undetected in the Safety Range) is highest at Pascagoula and lowest at Mayport. At Norfolk, there are three endangered species of cetaceans (fin whale, sei whale, and sperm whale) with a probability of "take" greater than 0.01, while at Mayport and Pascagoula, there are none. At both Mayport and Norfolk, pilot whales, which are a "strategic stock," also have a probability of "take" greater than 0.01. Overall, the results indicate that the risk to marine mammals would be higher at Norfolk and lower and about equal at Mayport and Pascagoula.

Table 2.8. Comparison of potential environmental impacts of a shock trial at the Mayport, Norfolk, and Pascagoula test areas.

Environmental Component	Section of FEIS Analyzing Impacts	Description of Potential Impact	Comparison of Alternative Areas
		IMPACTS EVALUATED UNDER EXECUTIVE ORDER 12114 (impacts outside U.S. territorial seas)	
Biological Environment			
Marine mammals	4.1.1	Mitigation will minimize risk, but marine mammals could be killed or injured if not detected within Safety Range. At greater distances, animals may experience disruption of hearing-based behaviors.	Risk of a marine mammal being killed, injured, or experiencing hearing disruption would be higher at Norfolk and lower and about equal at Mayport or Pascagoula.
Sea turtles	4.1.2	Mitigation will minimize risk, but turtles could be killed or injured if not detected within Safety Range. At greater distances, turtles may experience disruption of hearing-based behaviors.	Risk of a sea turtle being killed, injured, or experiencing hearing disruption would be higher at Norfolk and lower and about equal at Mayport or Pascagoula.
Seabirds	4.1.3(a)	Seabirds above the detonation point could be killed or stunned by the plume of water ejected into the air. Other seabirds resting or feeding at the surface could be killed or injured by the shock wave. It is unlikely that more than a few birds would be affected.	Mayport, Norfolk, and Pascagoula similar.
Fish	4.1.3(b)	Pelagic (water column) fish near the detonation point may be killed or injured. Many of the same species occur at all three areas. Demersal (bottom) fish will not be affected.	Mayport, Norfolk, and Pascagoula similar.
Ichthyoplankton and *Sargassum* communities	4.1.3(c)	Floating organisms near the detonation point would be killed, but populations would be rapidly replenished through reproduction and mixing with adjacent waters.	Mayport, Norfolk, and Pascagoula similar.

Table 2.8. (Continued).

Environmental Component	Section of FEIS Analyzing Impacts	Description of Potential Impact	Comparison of Alternative Areas
IMPACTS EVALUATED UNDER EXECUTIVE ORDER 12114 (continued) (impacts outside U.S. territorial seas)			
Benthic communities	4.1.3(d)	No direct effect on benthic organisms is expected. No habitat disturbance is expected. Metal fragments deposited on the seafloor will be colonized by invertebrates and attract fish.	Mayport, Norfolk, and Pascagoula similar.
Socioeconomic Environment			
Commercial and recreational fisheries	4.1.4(a)	Individuals of commercial or recreational fishery species may be killed or injured, but no significant impact on fishery stocks is expected. Commercial and recreational fishing activities within 18.5 km (10 nmi) of the detonation point will be temporarily interrupted.	Mayport, Norfolk, and Pascagoula similar.
Ship traffic	4.1.4(b)	Ship traffic passing within 18.5 km (10 nmi) of the detonation point would need to alter course or be escorted from the area.	Mayport, Norfolk, and Pascagoula similar.
Physical Environment			
Geology and sediments	4.1.5(a)	Metal fragments will be deposited on the seafloor. No cratering or sediment disturbance expected.	Mayport, Norfolk, and Pascagoula similar.
Air quality	4.1.5(b)	Temporary, localized increase in concentrations of explosion products in the atmosphere. No hazard to marine or human life.	Mayport, Norfolk, and Pascagoula similar.
Water quality	4.1.5(c)	Temporary, localized increase in concentrations of explosion products in the ocean. No hazard to marine life.	Mayport, Norfolk, and Pascagoula similar.

Table 2.8. (Continued).

Environmental Component	Section of FEIS Analyzing Impacts	Description of Potential Impact	Comparison of Alternative Areas
		IMPACTS EVALUATED UNDER NEPA [a] (impacts onshore and within U.S. territorial seas)	
Biological Environment	4.2.1	No significant direct or indirect impacts on marine biota, including plankton, pelagic fish, marine mammals, sea turtles, benthic organisms, and seabirds.	Mayport, Norfolk, and Pascagoula similar.
Socioeconomic Environment	4.2.2	No significant direct or indirect impacts on the local economy, including ship traffic and the fishing and tourism industries.	Mayport, Norfolk, and Pascagoula similar.
Physical Environment	4.2.3	No significant direct or indirect impacts on geology and sediments, air quality and noise, or water quality.	Mayport, Norfolk, and Pascagoula similar.

[a] Shore support operations and movement of vessels and aircraft within territorial seas are not unusual or extraordinary and are part of the routine operations associated with the existing shore bases.

Table 2.9. Comparison of test areas with respect to potential impacts on marine mammals and sea turtles. Test areas are ranked from lower to higher risk based on Sections 4.1.1, 4.1.2, and Appendix C. Lower risk corresponds to low mortality, injury, and disruption of hearing-based behavior; high probability of clear range; low probability of delay; and low probability of take.

	Lower Risk	Intermediate	Higher Risk
MARINE MAMMALS			
Number killed	Pascagoula 2.11	Mayport 3.19	Norfolk 6.22
Number injured	Pascagoula 3.75	Mayport 5.65	Norfolk 11.03
Number with disruption of hearing-based behavior	Mayport 2,885	Pascagoula 3,132	Norfolk 14,640
Probability of clear range (no groups in Safety Range)	Mayport 0.16	Pascagoula 0.11	Norfolk 0.02
Probability of delay	Pascagoula 0.25	Mayport 0.51	Norfolk 0.64
Probability of take (one or more groups undetected in Safety Range)	Mayport 0.33	Norfolk 0.34	Pascagoula 0.65
Endangered species with >0.01 probability of take	Mayport (none) Pascagoula (none)	--	Norfolk (fin whale, 0.07 sei whale, 0.04 sperm whale, 0.06)
Other strategic stocks with >0.01 probability of take	Pascagoula (none)	Mayport (pilot whales, 0.01)	Norfolk (pilot whales, 0.29)
SEA TURTLES			
Number killed	Pascagoula 0.54	Mayport 0.61	Norfolk 1.33
Number injured	Pascagoula 0.96	Mayport 1.08	Norfolk 2.36
Number with disruption of hearing-based behavior	Pascagoula 199	Mayport 232	Norfolk 855
Probability of clear range (zero turtles in Safety Range)	Pascagoula 0.33	Mayport 0.29	Norfolk 0.07
Probability of delay	Pascagoula 0.05	Mayport 0.06	Norfolk 0.08
Probability of take (one or more turtles undetected in Safety Range)	Pascagoula 0.62	Mayport 0.65	Norfolk 0.86
Endangered or threatened species with >0.01 probability of take	Pascagoula (leatherback, 0.54)	Mayport (leatherback, 0.46 loggerhead, 0.29)	Norfolk (loggerhead, 0.85 leatherback, 0.02)

Sea Turtle Impacts. Potential impacts on sea turtles are analyzed in detail in Section 4.1.2 of the FEIS and summarized in **Table 2.9**. Potentially significant direct impacts include mortality, injury, and disruption of hearing-based behaviors. At either Mayport, Norfolk, or Pascagoula, mitigation methods described in Section 5.0 would result in selection of a test site with low densities of sea turtles. However, there are differences in risk among the three areas due to differences in sea turtle densities. The number of sea turtles potentially killed, injured, or experiencing disruption of hearing-based behaviors is estimated to be highest at Norfolk and lowest at Pascagoula. The probability of "clear range" (no turtles in the Safety Range) is highest at Pascagoula and lowest at Norfolk. The probability of "take" (one or more turtles present and undetected in the Safety Range) is highest at Norfolk and lowest at Pascagoula. Overall, the results indicate that the risk to turtles would be higher at Norfolk than at either Mayport or Pascagoula. Although Pascagoula ranks the most favorably in each category, differences in risk between Mayport and Pascagoula are small relative to the differences between either of these test areas and Norfolk. The risk to turtles is believed to be similar at Mayport and Pascagoula.

Mitigation would be much less effective for sea turtles than for marine mammals because adult sea turtles are relatively small, do not swim in groups, are rarely on the surface, and do not make sounds. At any of the test areas, mitigation effectiveness is estimated to be about 8%. Leatherback and/or loggerhead turtles make up most of the adult population at each area and are the species most likely to be affected. Juvenile and hatchling sea turtles are unlikely to be affected because detonation would be postponed if large *Sargassum* rafts or debris lines (the preferred habitat of these turtles) were present within the Safety Range.

Conclusion. Most environmental impacts of the shock trial would be similar at the Mayport, Norfolk, or Pascagoula test areas. However, the three areas differ significantly with respect to potential impacts on marine mammals and sea turtles. Overall, based on the best available scientific data, the risk of mortality and injury to marine mammals and turtles would be higher at Norfolk and lower at, and about equal between, Mayport and Pascagoula. Considering all components of the physical, biological, and socioeconomic environment, potential impacts would be less at Mayport or Pascagoula than at Norfolk.

2.4 PREFERRED ALTERNATIVE

Based on the preceding discussion, the preferred alternative is to conduct a shock trial at Mayport between 1 May and 30 September 2001 with mitigation to minimize risk to marine mammals and turtles. Although all three test areas meet minimum operational requirements, the Norfolk and Mayport test areas rank higher operationally, whereas the Pascagoula test area ranks lower and is significantly less suitable for supporting the shock trial. Environmentally, the risk of impacts to marine mammals and turtles is higher in the Norfolk test area, and is lower at, and about equal between, Mayport and Pascagoula. Therefore, considering all other aspects of the three candidate test areas to be about the same, conducting the shock trial at Mayport would meet the project purpose and need, satisfy operational requirements, and minimize environmental impacts.

3.0 EXISTING ENVIRONMENT

This section describes the physical, biological, and socioeconomic environment of potential test areas offshore of Naval Station Mayport, Naval Station Norfolk, and Naval Station Pascagoula. It focuses on aspects of the existing environment that are most relevant to evaluating potential impacts of the proposed action.

3.1 PHYSICAL ENVIRONMENT

The shock trial would not be expected to have significant impacts on the physical environment (Department of the Navy, 1993, 1998a). Therefore, a detailed physical description is not appropriate. However, several aspects of the physical environment strongly affect operations and mitigation. The most important factors are winds, wave height/sea state, and visibility. Ideal and marginal environmental conditions for the shock trial have been summarized in Section 2.2.2(e) and are discussed in the appropriate sections below. General information on the physical environmental setting is also presented.

3.1.1 Bathymetry and Sediments

Because of the operational requirement for water depths of at least 183 m (600 ft), the shock trial is unlikely to have any impacts on bottom sediments or geologic features, other than the deposition of metal fragments from the charge casing (Department of the Navy, 1998a). Therefore, a detailed geological description is not appropriate. However, the geologic setting is indirectly important. Both bathymetry and sediment type affect acoustic calculations. Bathymetry also influences the types of marine organisms present, both in the water column and on the seafloor. Sediment type also strongly influences benthic communities.

(a) Mayport

The Mayport test area lies along the continental margin of the South Atlantic Bight, which extends from Cape Hatteras to Cape Canaveral. The test area is seaward of the continental shelf edge, over the Florida-Hatteras slope and the Blake Plateau (**Figure 3.1**). Water depths within the test area range from 183 to 878 m (600 to 2,880 ft).

The continental shelf is about 80 to 150 km (43 to 80 nmi) wide inshore of the Mayport test area. Offshore northeastern Florida, the shelf break generally occurs in water depths of about 40 to 80 m (130 to 260 ft) (MacIntyre and Milliman, 1970). Offshore of the shelf break where the test area is located, the Florida-Hatteras slope is smooth and uniform, with a seaward slope of about 1° (Tucholke, 1987). Beyond the Florida-Hatteras slope is the Blake Plateau, a broad, flat sedimentary basin ranging in depth from about 700 to 1,100 m (2,300 to 3,600 ft). Although the Blake Plateau generally has a smooth surface, there are numerous terrace-like features and elongate depressions (some with deepwater coral mounds) along the base of the Florida-Hatteras slope (Stetson et al., 1962, 1969; Milliman et al., 1967). The Florida-Hatteras slope and the terraces and depressions on

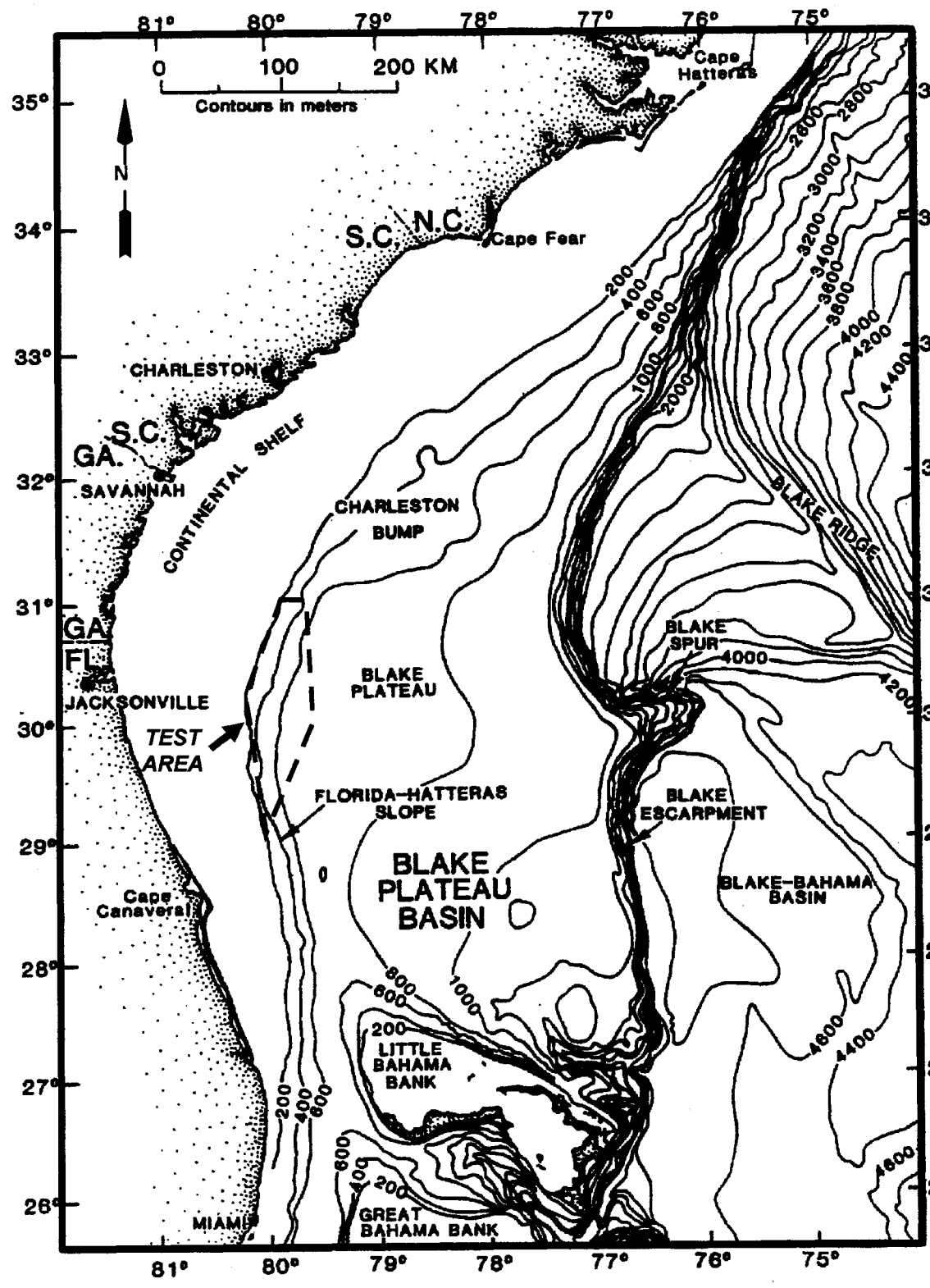

Figure 3.1. Bathymetry and physiography of the South Atlantic Bight (Adapted from: Knott and Wendt, 1985).

the Blake Plateau are believed to have been caused by Gulf Stream erosion (Minerals Management Service [MMS], 1984; Tucholke, 1987).

In the South Atlantic Bight, sediments on the outer shelf tend to be medium to coarse-grained sand (Pilkey et al., 1979). Sediments beneath the Mayport test area, as mapped by Ray et al. (1980), are mainly sand or silty sand. Sediments in the southern portion of the test area are more of an even mixture of sand, silt, and clay.

The Southeast Environmental Assessment and Mapping Program (SEAMAP) database developed by the NMFS provides information on hard bottom features off Florida and Georgia (Van Dolah et al., 1994). A database search indicates no hard bottom points within the Mayport test area and only two at its southern tip. However, most of the SEAMAP survey effort has been on the continental shelf. Other studies have shown extensive banks of coral in depths of 650 to 850 m (2,133 to 2,789 ft) on the Blake Plateau (Stetson et al., 1962, 1969; Milliman et al., 1967; Cairns, 1979; Ayers and Pilkey, 1981). These studies have been cataloged by Knott and Wendt (1985), and data points near the test area were identified in the exclusionary mapping. Two coral points were excluded within the northern part of the test area and one was on the edge.

(b) Norfolk

The Norfolk test area lies on the continental margin of the Mid-Atlantic coast. Water depths within the test area range from 183 to 2,560 m (600 to 8,400 ft). The test area is seaward of the shelf break, over the continental slope and rise (**Figure 3.2**). As is evident from the figure and the depth range, the bottom slope in the Norfolk test area is considerably steeper than at either Mayport or Pascagoula.

The continental shelf is about 55 to 125 km (30 to 68 nmi) wide inshore of the Norfolk test area. The shelf break along the Mid-Atlantic generally occurs at depths of 40 to 160 m (130 to 525 ft) (Tucholke, 1987). Seaward of the shelf break is the continental slope, which has an average gradient between about 3° and 6° (Heezen et al., 1959). The continental rise, a region of lesser seafloor gradient, begins at a depth of about 2,000 m (6,560 ft).

The Mid-Atlantic continental margin north of Cape Hatteras is incised by numerous submarine canyons (Tucholke, 1987). These significant geological features often have unusual benthic communities associated with exposed hard substratum (Hecker et al., 1983). The nearest one, Norfolk Canyon, is located to the north of the Norfolk test area and specifically excluded from it (see Section 2.2.3).

On the Mid-Atlantic continental slope, sediments tend to be silt and clay mixtures with interspersed, localized sandy areas (Milliman et al., 1972; Ray et al., 1980). The seafloor is expected to be predominantly soft bottom. The SEAMAP database developed by the NMFS provides information on hard bottom features off North Carolina (Moser et al., 1995). A search of the database indicates no known or suspected hard bottom areas within 1.85 km (1 nmi) of the Norfolk test area. As noted above, there are few SEAMAP data points in water depths beyond

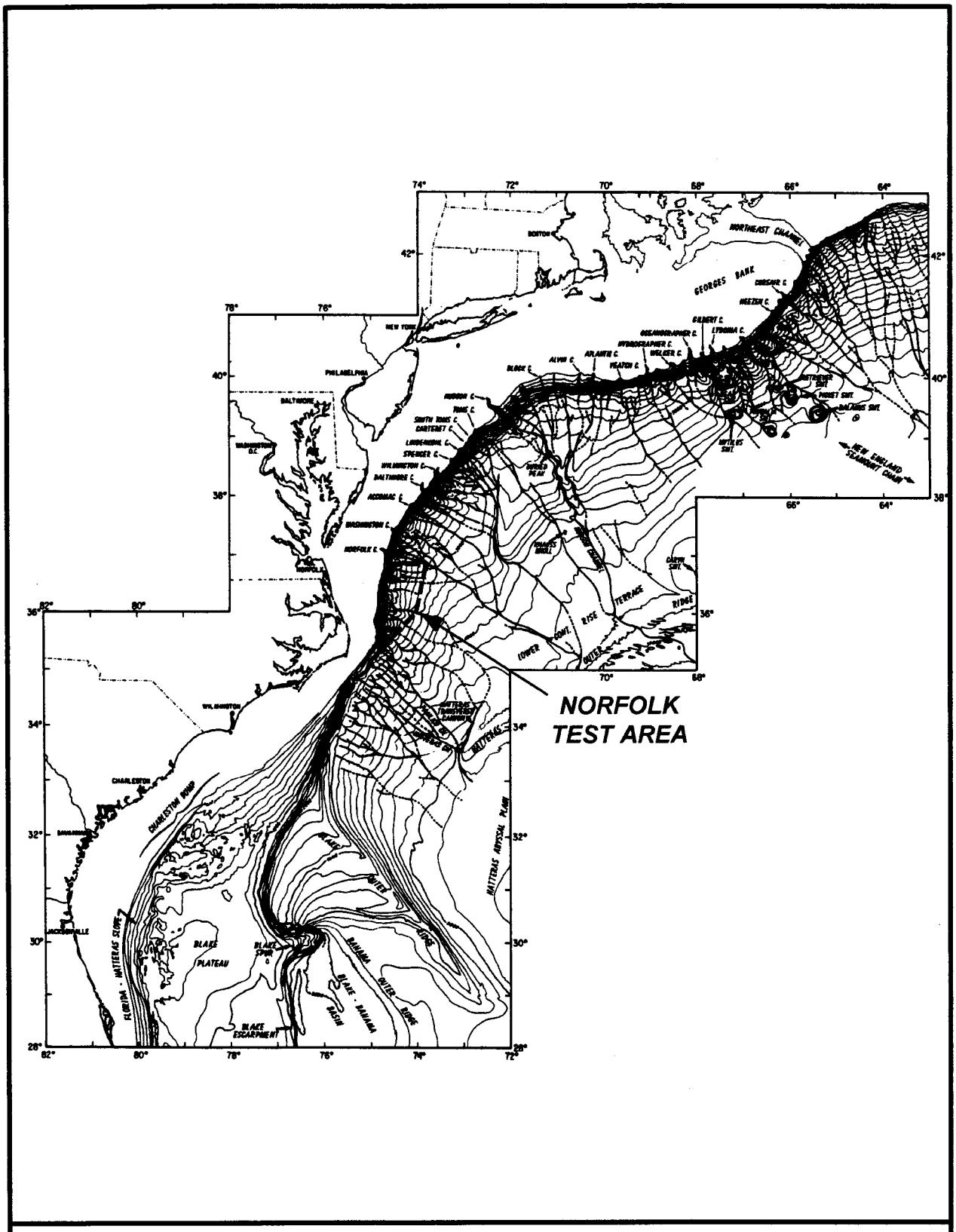

Figure 3.2. Bathymetry and physiography of the Atlantic continental margin (From: Tucholke, 1987). Contour interval is 200 m below 1,000 m water depth and 100 m above 1,000 m. Axes of principal canyons and channels are shown by solid lines (dashed were uncertain or approximate).

200 m (656 ft), as most of the survey effort has been on the continental shelf. Also, the SEAMAP database does not include any data offshore of Virginia.

(c) Pascagoula

The Pascagoula test area is located on the northeastern Gulf of Mexico continental slope along the eastern side of De Soto Canyon (**Figure 3.3**). Water depths within the test area range from 183 to 695 m (600 to 2,280 ft).

Sediments on the continental slope east of De Soto Canyon are predominantly silty clay, with some areas having a more even mixture of sand, silt, and clay (Gallaway and Kennicutt, 1988). Higher percentages of sand are also expected in shallower water depths close to the shelf edge (Ray et al., 1980).

No known hard bottom areas were identified in the Pascagoula test area. There are numerous hard bottom areas in the northeastern Gulf of Mexico (Ludwick and Walton, 1957; Shipp and Hopkins, 1978; Sager et al., 1990; Continental Shelf Associates, Inc., 1992; Benson et al., 1997), but they are located on the continental shelf and shelf edge rather than the continental slope. These hard bottom areas are relict features that developed in warm, shallow waters prior to the most recent sea level rise (Sager et al., 1990).

3.1.2 Weather and Sea State

A general overview of the climate regime is presented below, followed by weather and sea state information for each test area from U.S. Navy climatic studies for the Atlantic coast and Gulf of Mexico (Department of the Navy, 1986a,b, 1989).

The southeastern and Mid-Atlantic coasts of the United States are characterized by a warm, temperate climate strongly influenced by the ocean. Meteorological conditions along the southeastern and Mid-Atlantic coasts are largely influenced by the ocean and the effect of the position of the main semi-permanent pressure centers in the North Atlantic Ocean, the "Bermuda High," and the "Icelandic Low" on regional circulation patterns (Department of the Navy, 1989). The Bermuda High, located in the subtropical gyre of the North Atlantic, produces southwesterly winds during summer and moves to a southerly position during winter. The southerly movement of the Bermuda High produces easterly and southeasterly winds. In conjunction with the seasonal progression of the Bermuda High and Icelandic Low, regional weather patterns are modified by the passage of weather systems (e.g., cold and warm fronts) over two to five days. While there is a large range of changes in air temperature, wind, and barometric pressure between seasons, fluctuations associated with the passage of weather systems may exceed seasonal changes.

The climate of the northeastern Gulf of Mexico has been reviewed by Hamilton et al. (1997). The area is characterized by two distinct seasons: summer (May through October) and winter (December through March), with November and April being transitional months. During winter, the northeastern Gulf of Mexico is often a collision zone between warm, moist maritime and cold, continental polar air masses, resulting in the formation of extratropical cyclones (low pressure

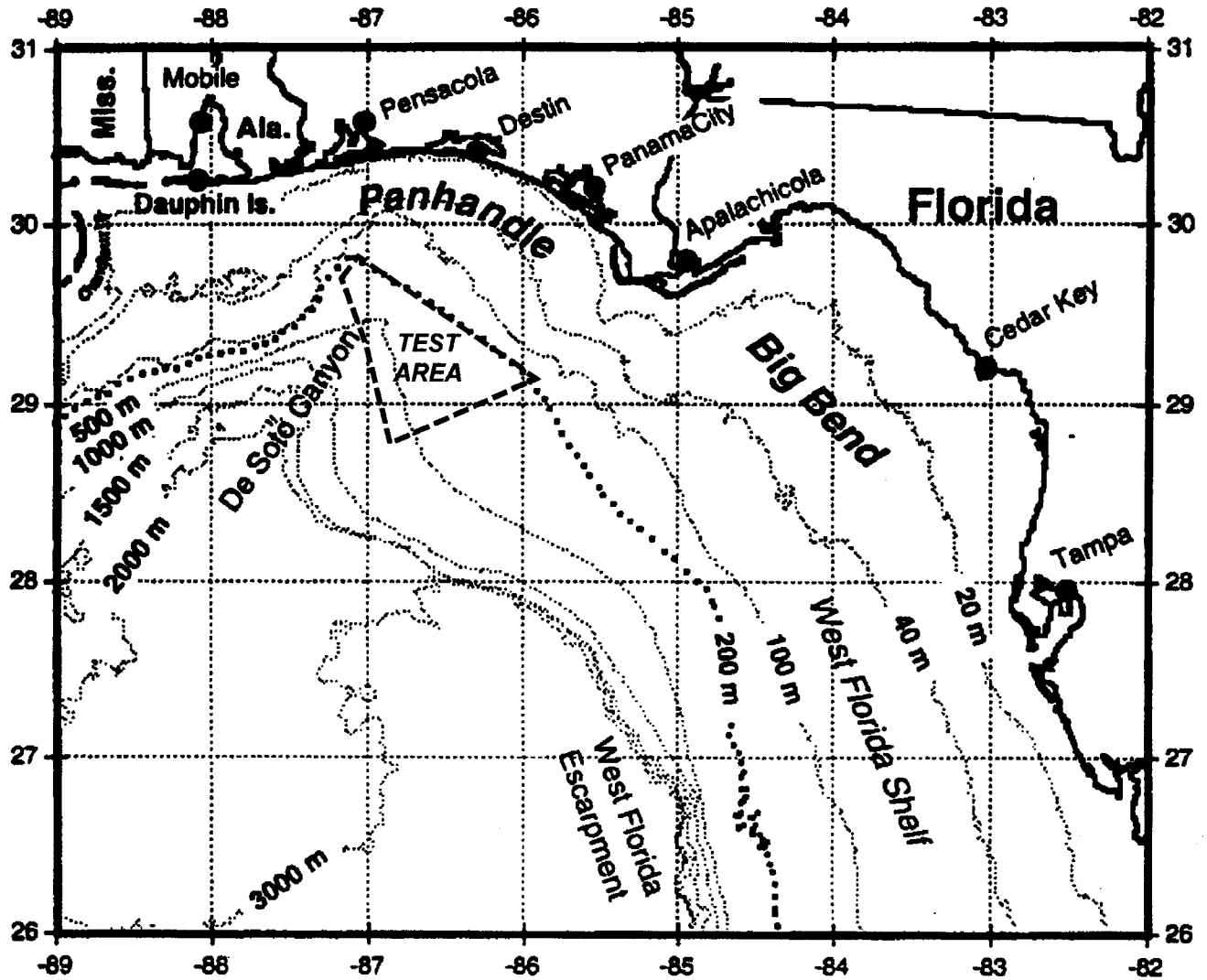

Figure 3.3. Bathymetry and physiography of the northeastern Gulf of Mexico (Adapted from: SAIC, 1997).

centers). During summer, the area is strongly influenced by the northeast trade winds, which can steer tropical storms and hurricanes from the Atlantic into the Gulf of Mexico.

Tropical and extratropical cyclones are significant influences on weather and sea state conditions at all three test areas. Tropical cyclones, which occur during summer and fall, are severe but infrequent, and therefore favorable wind and sea state conditions are likely to prevail much of the time during the May through September period. Extratropical cyclones occur frequently during winter and are likely to produce unfavorable conditions at all three test areas during winter and spring.

Weather and sea state affect the ability to conduct the shock trial and associated mitigation efforts. Ideal test conditions are seas of 0.6 m (2 ft) or less, a light wind, and unlimited visibility (18.5 km [10 nmi]). Conditions become limiting or marginal when seas approach 2 m (6 ft), winds approach 21 mph, and visibility is less than 9.3 km (5 nmi). Mitigation will require visibility of at least 5.6 km (3 nmi) (see Section 5.0), which is less stringent than the marginal visibility criterion listed above. Mitigation involves other specific sea state requirements (see Section 5.0), the frequency of which cannot be estimated directly; however, the marginal conditions are considered to be an index of conditions that would not be suitable for mitigation.

The frequency of occurrence for each of the weather/sea state conditions during each month of the year for the Mayport, Norfolk, and Pascagoula test areas has been previously summarized in **Table 2.2**. These data were derived from observations at sea on ships-of-opportunity. It should be noted that shipboard data are subject to "fair weather bias" because most observations were usually made during periods of fair weather when ships were at sea and ship crews had time to make weather observations. Also, shipboard observations of some parameters include visual measurements that are prone to subjectivity or lack calibration (e.g., estimates of visibility at sea are difficult to make without reference points). The reliability of the information from shipboard observations may also be suspect because most ships purposely avoid potential damage to life and property in the event of rough weather or severe storms.

The table shows that all three test areas have a high percentage of ideal or at least marginal conditions during the May through September time period. Pascagoula generally has the highest, and Norfolk the lowest, incidence of favorable wave heights and visibility during this time period. During winter, all three test areas tend to have a higher incidence of less favorable conditions, particularly wave heights and winds, due to extratropical cyclones as explained above.

3.1.3 Currents and Hydrography

The physical oceanography of the three test areas is strongly influenced by the Gulf Stream system, which includes the Loop Current in the Gulf of Mexico. A composite of Loop Current/Gulf Stream positions from satellite imagery is shown in **Figure 3.4**. The Gulf Stream is introduced briefly below, as the information applies to both Mayport and Norfolk. The Loop Current is discussed in the Pascagoula section.

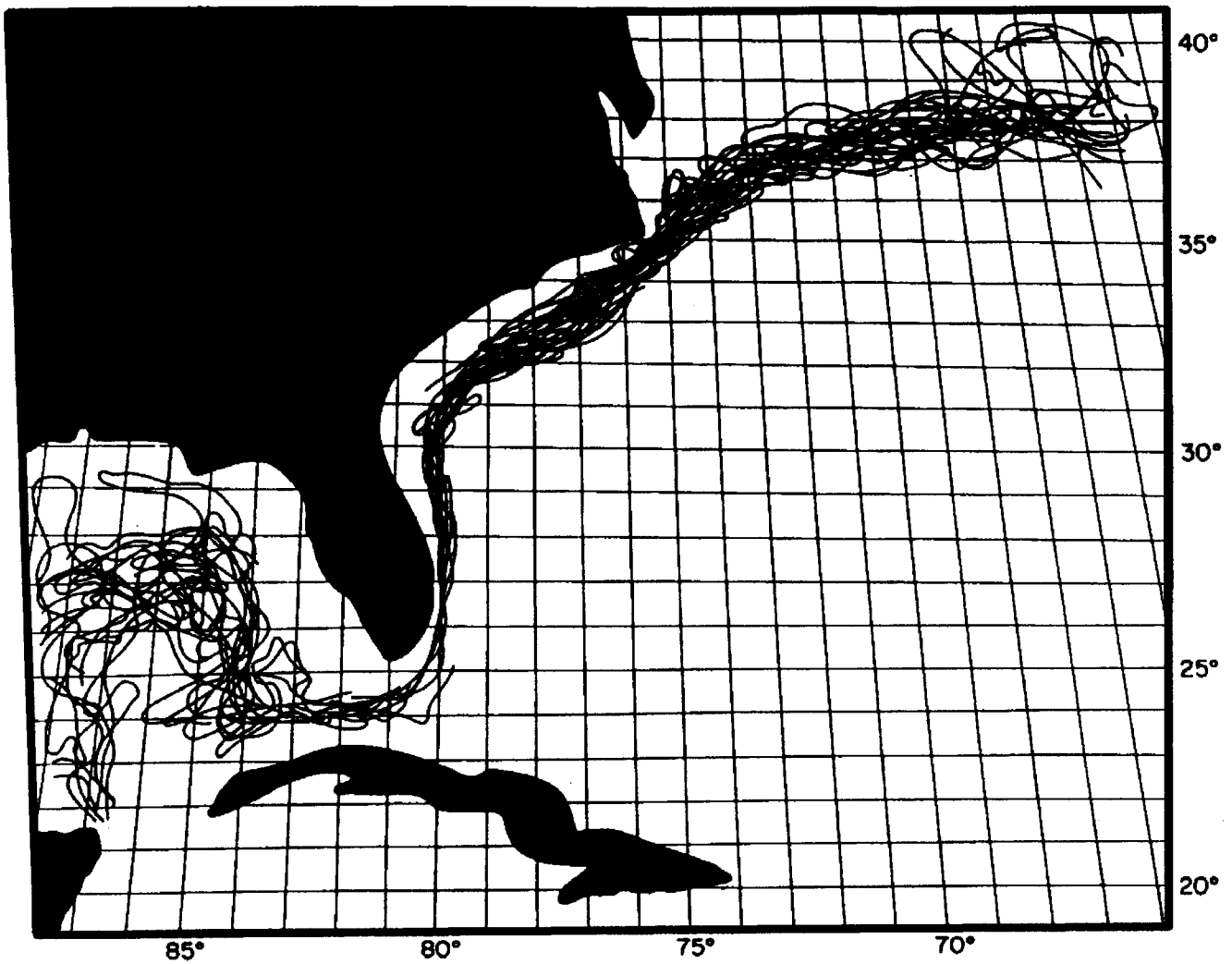

Figure 3.4. Composite of Loop Current (Gulf of Mexico) and Gulf Stream (Atlantic coast) surface frontal positions as determined from satellite data by Legeckis (1979) [Adapted from: Fofonoff (1980) by Schmitz et al. (1987)].

The Gulf Stream is a major influence on the physical oceanography of both the Mayport and Norfolk test areas. At the Mayport test area the Gulf Stream flows northward over the continental slope and generally along the shelf edge, but at the Norfolk test area it veers easterly and flows some distance away from the continental shelf. The northeasterly turn of the Gulf Stream occurs at a feature called the Charleston Bump, located offshore of Charleston, South Carolina. Cape Hatteras is an important point along the path of the Gulf Stream, as this is where it begins its more easterly turn into the North Atlantic and is no longer constrained by the continental shelf and slope. Between the Charleston Bump and Cape Hatteras, the Gulf Stream exhibits features such as rings, meanders, and filaments that can affect shelf waters (Texas Instruments, Inc., 1979; Science Applications International Corporation, 1984; Florida Institute of Oceanography, 1986). A Deep Western Boundary Current flows to the south along the 4,000 m (13,125 ft) depth contour in this region (Schmitz et al., 1987).

(a) Mayport

Currents and water masses at the Mayport test area are mainly influenced by the Gulf Stream's deflections, meanders, and flow. Off northeastern Florida, the Gulf Stream flows consistently northward. Mean current speeds at the Mayport test area range from 180 cm/sec (3.5 kts) near the surface to 40 cm/sec (0.8 kts) near the bottom (Lee and Waddell, 1983). Additional current speed measurements from the region range from 30 cm/sec (0.6 kts) in December to 50 cm/sec (1.0 kts) in July (Department of the Navy, 1986a).

The two main water masses at the Mayport test area are shelf water and the Gulf Stream. On average, the Gulf Stream passes directly through the test area (MMS, 1990a). **Figure 3.5** shows an example from June 1999. Although the Gulf Stream's position remains fairly stable in this region, lateral meandering does occur (Bane et al., 1981; Lee et al., 1981; Department of the Navy, 1995a). Depending on their phase, meanders can cause the Gulf Stream to be shoreward or seaward of the test area. Frontal eddies, filaments, warm core rings, and cold core rings may form during development of a meander and move across the Mayport test area and onto the shelf.

(b) Norfolk

The Gulf Stream flows east away from the shelf/slope boundary at the Norfolk test area, and the zposition of its western wall changes seasonally (Department of the Navy, 1995a). During spring, the average position of the western wall is east of the test area. During fall, the Gulf Stream meanders northward and over the test area (Marine Geosciences Applications, Inc., 1984). The circulation regime in the area is dynamic due to a confluence of several water masses including the Slope Sea Gyre, shelf water, and Gulf Stream. Frontal eddies, filaments, warm core rings, and cold core rings form as the result of Gulf Stream meandering along the shelf and slope (**Figure 3.6**).

Current speeds at the Norfolk test area vary seasonally and are greatly influenced by Gulf Stream meanders. Current speeds average 30 cm/sec (0.6 kts). When the Gulf Stream is displaced in winter (October to January), surface currents range from about 20 to 50 cm/sec (0.4 to 1.0 kts) to the south (Science Applications International Corporation, 1987). When the Gulf Stream returns to its original position, this southerly flow decreases. Oceanographic features associated with the

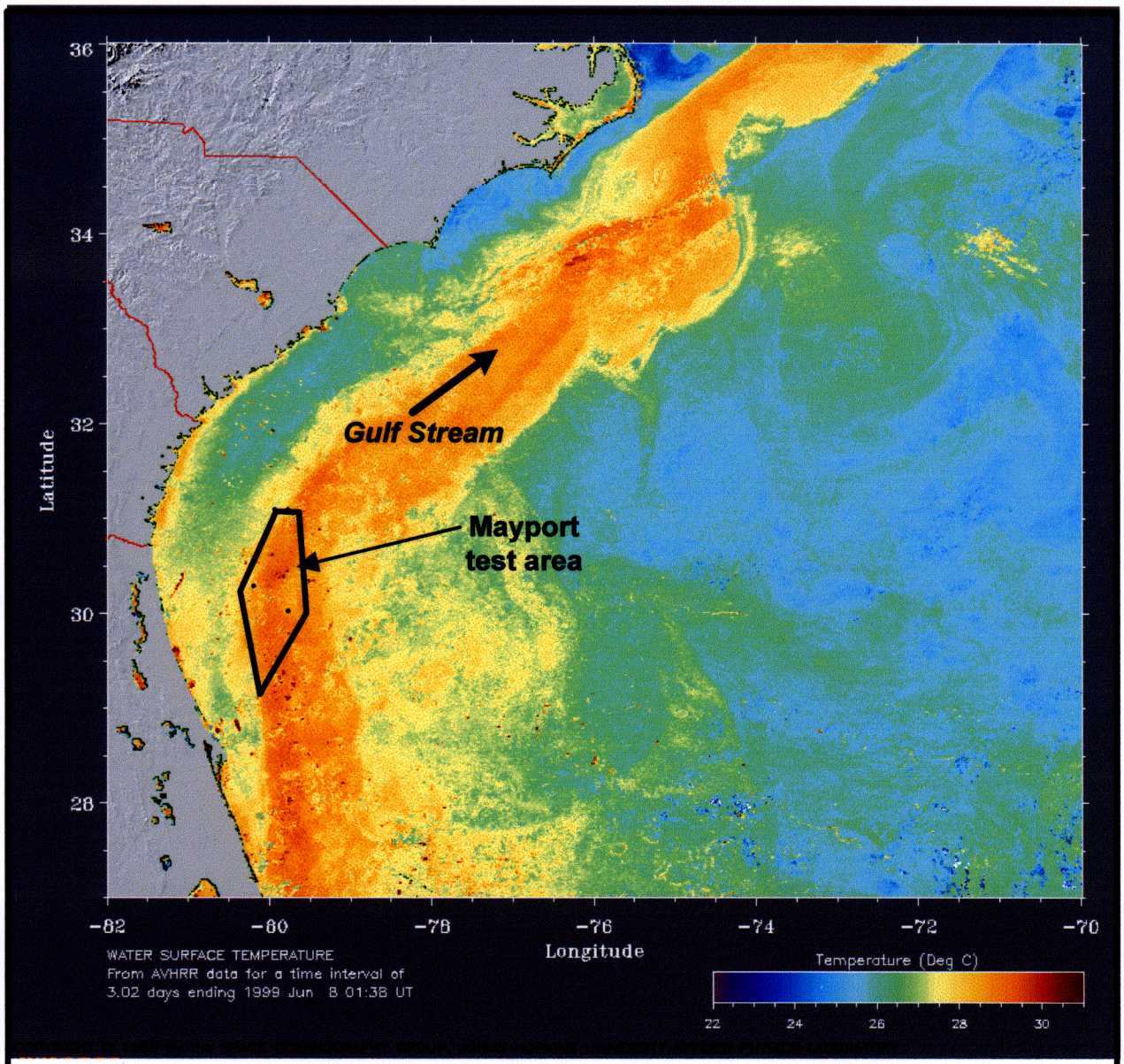

Figure 3.5. Satellite imagery (sea surface temperature) showing the position of the Gulf Stream relative to the Mayport test area in early June 1999 (From: Space Oceanography Group, Johns Hopkins University Applied Physics Laboratory).

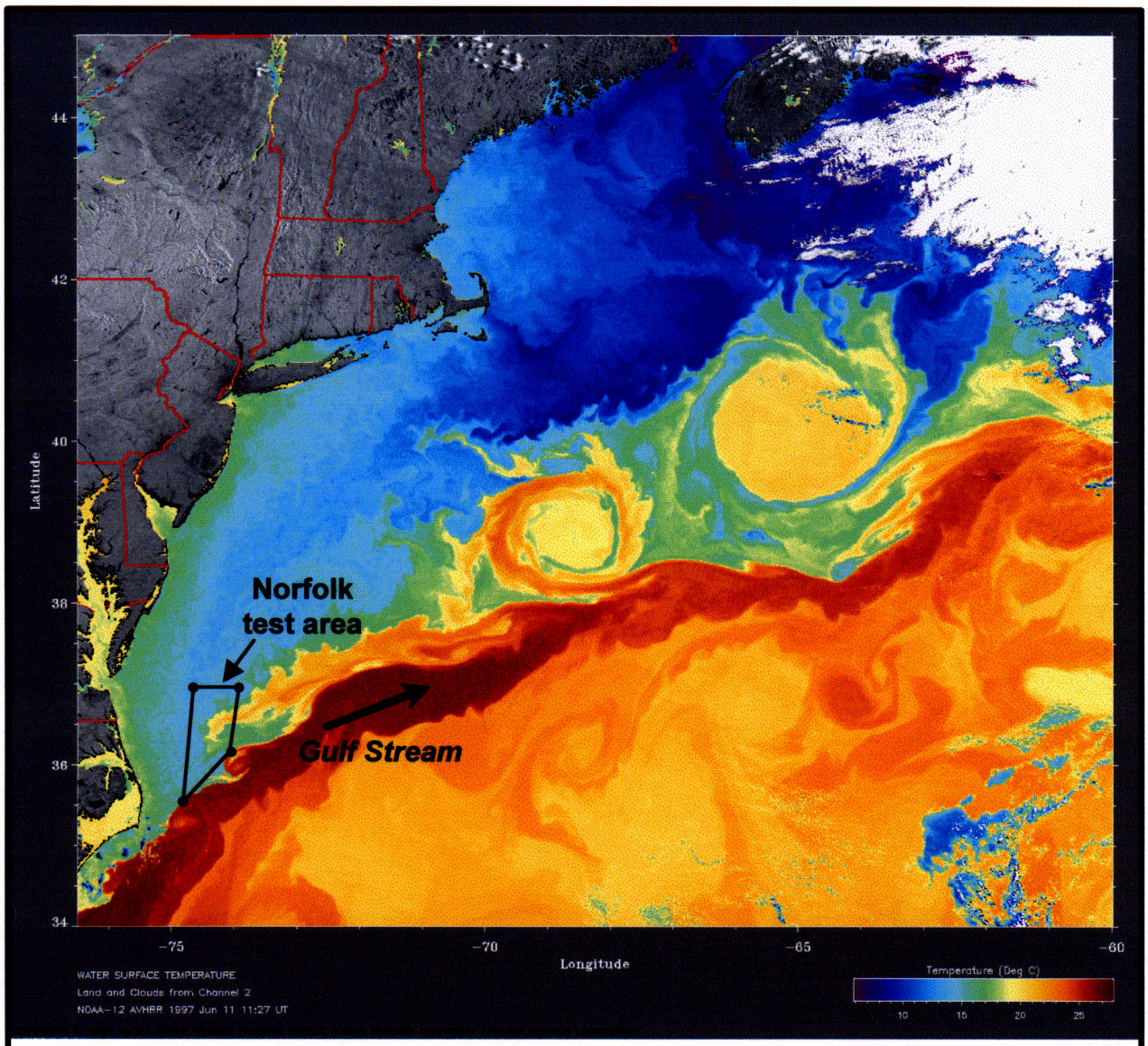

Figure 3.6. Satellite imagery (sea surface temperature) showing the position of the Gulf Stream relative to the Norfolk test area during early June 1997 (From: Space Oceanography Group, Johns Hopkins University Applied Physics Laboratory).

Gulf Stream, such as warm core rings, cold core rings, and filaments may form near this area (see Figure 3.6).

(c) Pascagoula

The Loop Current is a major feature affecting circulation in the Gulf of Mexico. It enters the Gulf through the Yucatan Channel, makes a broad turn or "loop" to the right, and exits through the Florida Straits. Generally, the main boundary of the Loop Current is well to the south of the De Soto Canyon area, but there is considerable variability in its northward extent (Vukovich, 1988). Even when the Loop Current is far to the south, strong current events are still observed on the northeastern Gulf slope. Strong eastward upper level currents (approximately 60 cm/s) can occur between the Mississippi Delta and De Soto Canyon (Molinari and Mayer, 1982; Kelly, 1990). Most of these events are accompanied by higher water temperatures and are attributed to direct impingement of a Loop Current filament or recently shed eddy on the continental slope. Slope areas closer to the Mississippi Delta are more likely to experience these intrusion events than locations further to the east (Hamilton et al., 1997). **Figure 3.7** shows some examples of Loop Current interactions on the shelf and slope in the De Soto Canyon area (Kelly, 1990).

The physical oceanography portion of the Mississippi-Alabama Marine Ecosystems Study (MAMES) (Brooks, 1991) concluded that four primary forcing mechanisms drive the continental shelf and slope waters of this region: synoptic scale wind stress, Loop Current related intrusions, river discharge, and tropical cyclones (Kelly and Guinasso, 1998). The generally mild influence of wind forcing results in a cyclonic shelf-wide circulation pattern. Loop Current intrusions onto the shelf and slope are unpredictable but potentially significant due to their frequency of occurrence, their marked contrast in water mass properties, and the large shelf area affected (Kelly and Guinasso, 1998).

Loop Current eddies (warm core rings) and associated cyclonic eddies (cold core rings) are a significant feature of circulation patterns in the northeastern Gulf (Biggs, 2000). Cold core rings are nutrient-rich, highly productive biological "oases" with dense concentrations of zooplankton and micronekton. The GulfCet II study showed that most cetacean species in the Gulf along the continental slope tend to concentrate in or near cold core rings and in the confluence zones between cold and warm core rings (Davis et al., 2000). Warm core rings are comparative "deserts" and tend to have low cetacean densities. The location of these features varies, but they can persist for several months. With near real-time remote sensing of sea surface altimetry, cold and warm core rings can be tracked to locate areas of low cetacean abundance. Accordingly, remote sensing of oceanographic features has been incorporated into the site selection process as explained in Section 5.0.

3.1.4 Water and Sediment Quality

Because all three test areas are well offshore, water quality is expected to be excellent. Open ocean waters typically have high water clarity, dissolved oxygen concentrations at or near saturation, and low concentrations of nutrients, suspended matter, and contaminants such as trace metals and hydrocarbons (Alexander et al., 1977; Trefry, 1979).

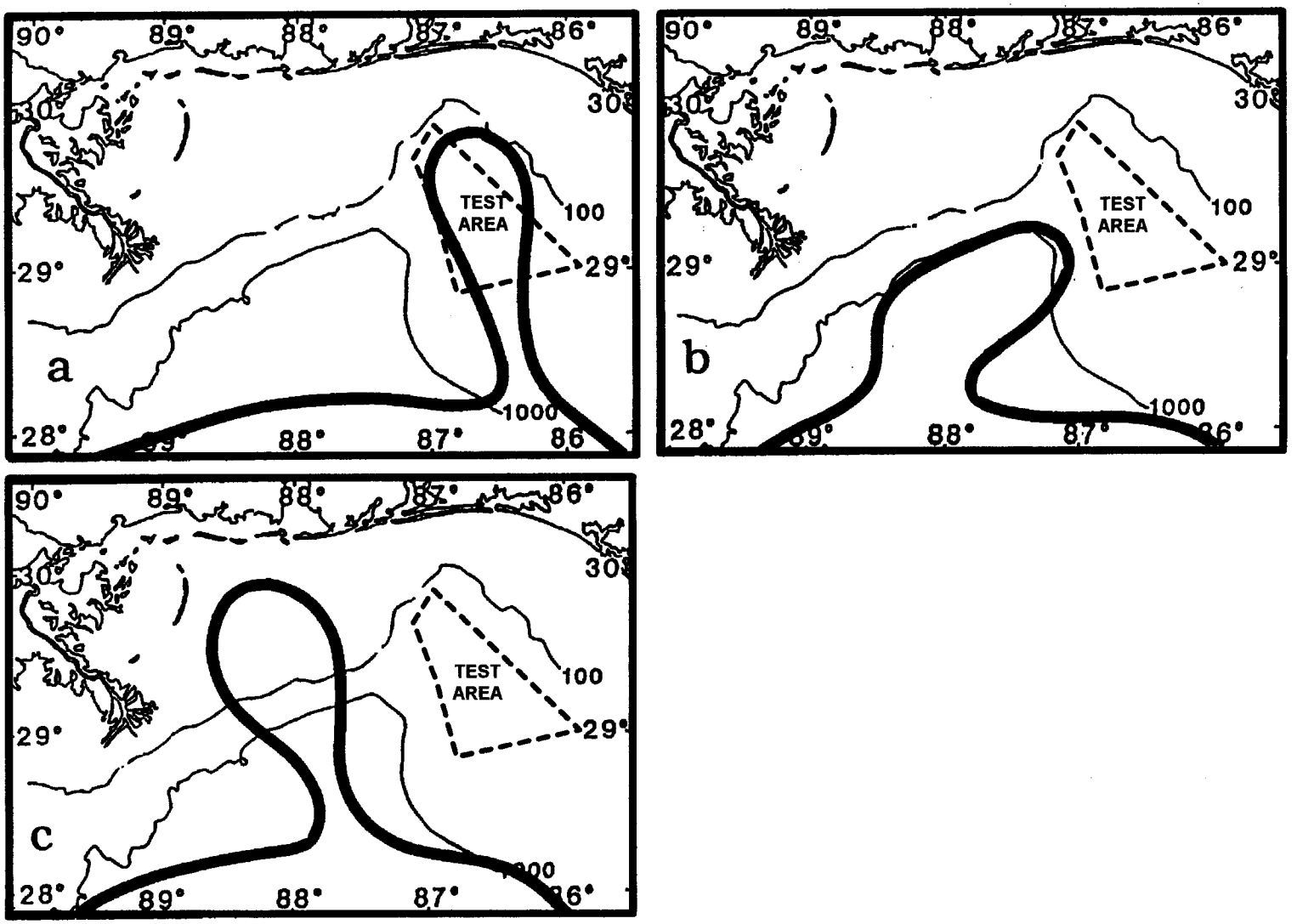

Figure 3.7. Examples of Loop Current behavior in the northeastern Gulf of Mexico (From: Kelly, 1990). (a) intrusion in De Soto Canyon area; (b) entrainment of shelf waters by Loop Current filament over continental slope; and (c) intrusion of filament into shallow shelf region.

Pelagic tar is probably the most common form of contamination present at all of the test areas (Farrington, 1987). While only trace concentrations are found over the continental shelf, higher concentrations tend to be associated with the Loop Current and the Gulf Stream. Tanker operations may be the major source of pelagic tar (Van Vleet et al., 1984).

Sediment hydrocarbon and metal concentrations at the test areas are expected to be within the normal range for marine sediments (Ruddell et al., 1979; Texas Instruments, Inc., 1979; Gallaway and Kennicutt, 1988). Metal and hydrocarbon concentrations on the continental slope tend to be higher than on the shelf due to the greater proportions of silt and clay in slope sediments (Gallaway and Kennicutt, 1988; Brooks, 1991).

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 Marine Mammals

Marine mammals potentially occurring at the Mayport, Norfolk, and Pascagoula test areas are listed in **Table 3.1**. The table indicates the status of each species and its potential presence based on historical sightings and strandings. Species descriptions are provided in **Appendix B**. In the discussion of species presence below, the text refers to various aerial and shipboard surveys that are described further in **Appendix B**.

(a) Overview

Mayport. At the Mayport test area, up to 29 marine mammal species may be present, including 7 mysticetes and 22 odontocetes. All of the mysticetes are considered unlikely to occur at Mayport during the May through September time period. The odontocetes that may be present include sperm whale, dwarf and pygmy sperm whale, 4 species of beaked whales, and 15 species of dolphins and porpoises. Of the latter, four species (common dolphin, Fraser's dolphin, killer whale, and melon-headed whale) are considered unlikely to occur at Mayport based on the low frequency of sightings.

Norfolk. At the Norfolk test area, up to 35 marine mammal species may be present, including 7 mysticetes, 27 odontocetes, and 1 pinniped. Of the mysticetes, the fin whale is most likely to occur in the test area based on numerous sightings along the shelf edge during aerial and ship surveys (see **Appendix B**). The other mysticetes, while more likely to occur off Norfolk than off Mayport or Pascagoula, are usually found farther to the north during the test period. Among the odontocetes, the northern bottlenose whale, Sowerby's beaked whale, Atlantic white-sided dolphin, Fraser's dolphin, killer whale, melon-headed whale, and harbor porpoise are also considered unlikely to be present at the Norfolk test area based on geographic and/or depth ranges and low frequency of sightings. The pinniped is the harbor seal, primarily a coastal/shelf species (Jefferson et al., 1993) that is unlikely to be present in the test area.

Table 3.1. Species of marine mammals potentially occurring at the Mayport, Norfolk, and Pascagoula test areas. Key: (**X**) presence likely; (**o**) presence possible but unlikely due to geographic range, water depth, season, or uncommon occurrence; (--) presence not expected.

Scientific Name	Common Name	Status[a]	Presence		
			Mayport	Norfolk	Pascagoula
SUBORDER MYSTICETI	**BALEEN WHALES**				
Family Balaenidae	**Right and Bowhead Whales**				
Eubalaena glacialis	Northern right whale	E, S	o	o	o
Family Balaenopteridae	**Rorquals**				
Balaenoptera musculus	Blue whale	E, S	o	o	o
Balaenoptera edeni	Bryde's whale	none	o	o	X
Balaenoptera physalus	Fin whale	E, S	o	X	o
Megaptera novaeangliae	Humpback whale	E, S	o	X	o
Balaenoptera acutorostrata	Minke whale	none	o	X	o
Balaenoptera borealis	Sei whale	E, S	o	X	o
SUBORDER ODONTOCETI	**TOOTHED WHALES**				
Family Physeteridae	**Sperm whales**				
Kogia simus	Dwarf sperm whale	none	X	X	X
Kogia breviceps	Pygmy sperm whale	none	X	X	X
Physeter macrocephalus	Sperm whale	E, S	X	X	X
Family Ziphiidae	**Beaked whales**				
Mesoplodon densirostris	Blainville's beaked whale	S	X	X	X
Ziphius cavirostris	Cuvier's beaked whale	S	X	X	X
Mesoplodon europaeus	Gervais' beaked whale	S	X	X	X
Hyperoodon ampullatus	Northern bottlenose whale	none	--	o	--
Mesoplodon bidens	Sowerby's beaked whale	S	--	o	o
Mesoplodon mirus	True's beaked whale	S	X	X	--
Family Delphinidae	**Dolphins and porpoises**				
Stenella frontalis	Atlantic spotted dolphin	none	X	X	X
Lagenorhynchus acutus	Atlantic white-sided dolphin	S	--	o	--
Tursiops truncatus	Bottlenose dolphin	none	X	X	X
Stenella clymene	Clymene dolphin	none	X	X	X
Delphinus delphis	Common dolphin	S	o	X	--
Pseudorca crassidens	False killer whale	none	X	X	X
Lagenodelphis hosei	Fraser's dolphin	none	o	o	o
Orcinus orca	Killer whale	none	o	o	o
Peponocephala electra	Melon-headed whale	none	o	o	o
Stenella attenuata	Pantropical spotted dolphin	none	X	X	X
Feresa attenuata	Pygmy killer whale	none	X	X	X
Globicephala macrorhynchus	Short-finned pilot whale	S	X	X	X
Globicephala melas	Long-finned pilot whale	S	--	X	--
Grampus griseus	Risso's dolphin	none	X	X	X
Steno bredanensis	Rough-toothed dolphin	none	X	X	X
Stenella longirostris	Spinner dolphin	none	X	X	X
Stenella coeruleoalba	Striped dolphin	none	X	X	X
Family Phocoenidae					
Phocoena phocoena	Harbor porpoise	C,S	--	o	--
SUBORDER PINNIPEDIA	**SEALS, SEA LIONS**				
Zalophus californianus	California sea lion	none	--	--	o
Phoca vitulina	Harbor seal	none	--	o	--

[a] Status: E = endangered and C = candidate for listing under the Endangered Species Act of 1973; S = strategic stock under the Marine Mammal Protection Act of 1972, as indicated by Waring et al. (1999).

Pascagoula. In the offshore waters of the northern Gulf of Mexico, up to 29 marine mammal species may occur, including 7 mysticetes, 21 odontocetes, and 1 exotic pinniped. This listing is based on an extensive review of sightings and stranding reports for the Gulf of Mexico (Jefferson and Schiro, 1997). With the exception of Bryde's whale (which has been sighted near the Pascagoula test area), all of the mysticetes are considered extralimital in the Gulf and are unlikely to occur there. Odontocetes that may be present include sperm whale, dwarf and pygmy sperm whale, four species of beaked whales, and 14 species of dolphins and porpoises. Of the latter, three species (Fraser's dolphin, killer whale, and melon-headed whale) are considered unlikely to occur based on infrequent sightings. One exotic pinniped species, the California sea lion, is also present in the northern Gulf but is unlikely to be found in the test area. These animals exist in the northern Gulf as feral individuals that probably escaped from or were released from marine parks (Schmidly, 1981). Another pinniped formerly known from the Gulf of Mexico (the Caribbean monk seal) is now believed to be extinct (Schmidly, 1981).

(b) Listed Species

Six of the cetaceans potentially occurring at the three test areas are listed as endangered under the Endangered Species Act of 1973 (ESA). These are the blue whale, fin whale, humpback whale, northern right whale, sei whale, and sperm whale. In addition to their endangered status, all of these are classified as "strategic stocks" by the NMFS. Of these, the sperm whale is the most likely to be present at any of the test areas. The Gulf of Mexico is outside the normal range of all of the endangered mysticetes (Jefferson and Schiro, 1997), which therefore would be unlikely to occur in the Pascagoula test area. The endangered mysticetes are also unlikely to be present at Mayport during the May through September period due to their range and migratory habits. These species generally inhabit northern feeding grounds during spring, summer, and early fall (Winn, 1982). Fin whales and possibly other endangered mysticetes are more likely to occur at the Norfolk test area.

In addition to these listed cetaceans, one additional species potentially occurring at Norfolk (the harbor porpoise) is a candidate for listing as a threatened species. Candidate species do not receive substantive or procedural protection under the ESA. The candidate species list serves to notify the public that NMFS has concerns regarding these species that may warrant listing in the future. The harbor porpoise is near the southern extent of its range at Norfolk and is not expected to occur at Mayport or Pascagoula.

One endangered sirenian, the West Indian manatee (*Trichechus manatus*) occurs in Florida and the northern Gulf of Mexico. The manatee is a coastal species (U.S. Fish and Wildlife Service [USFWS], 1996) that is not expected to occur within or near any of the test areas. However, manatees commonly occur in the entrance channel near Naval Station Mayport (USFWS, 1999). Further information on manatees is provided in **Appendix B**.

Mayport. The sperm whale is the only endangered cetacean that is likely to be present at the Mayport test area during the May through September time period. Fritts et al. (1983) observed sperm whales off eastern Florida during all seasons; all but one were observed beyond the 200 m (656 ft) isobath. The sperm whale was the only endangered species seen during the Navy's SEAWOLF aerial surveys at Mayport (two individuals were sighted during both 1995 and 1997).

However, none were seen during June and August 1999 aerial surveys of the Mayport test area (see **Appendix B**), and none were sighted off Mayport during the summer 1998 *Relentless* cruise (Roden, 1998). These results indicate that sperm whales may occur in the area, but infrequently or at low densities.

Although not likely to be present in summer, northern right whales are of special concern because of their highly endangered status; only about 300 individuals remain (Knowlton et al., 1994). Critical habitat for the northern right whale is located off northeastern Florida but is at least 87 km (47 nmi) inshore of the Mayport test area (see **Appendix B**). Two northern right whale strandings did occur in northeast Florida in September 1989, but sightings and stranding data indicate that the possibility of a northern right whale being present in the Mayport test area during the potential test period (May through September) is remote. Northern right whales generally occur off Mayport from November/early December to April, with peak abundance between January and March (Kraus et al., 1993). Of 401 northern right whale sightings between 1950 and 1995, none occurred during May through September (Kenney, 1995). No northern right whales were seen during the Navy's SEAWOLF aerial surveys (April through September 1995 and May through September 1997) (Department of the Navy, 1995b, 1998b). None were seen during June and August 1999 aerial surveys at the Mayport test area (see **Appendix B**).

<u>Norfolk</u>. Sperm whales and fin whales are the most likely endangered cetaceans to occur at the Norfolk test area (Winn, 1982). These species as well as endangered humpback and sei whales were observed during the April through July 1995 SEAWOLF surveys near the Norfolk test area (Department of the Navy, 1995b). Sperm whales are likely to be more abundant in deeper waters of the test area, based on frequent sightings during ship surveys (see **Appendix B**). In shelf-edge waters covered by the SEAWOLF surveys, fin whales were more abundant and sperm whales were second. While there have been numerous humpback whale strandings in Virginia and North Carolina in recent years (Wiley et al., 1995), these occur primarily during non-summer months and humpback whales are typically found in depths shallower than the test area (Winn, 1982). No critical habitat for endangered marine mammals is located near the Norfolk test area.

The harbor porpoise, which may occur at Norfolk, is a candidate for listing as a threatened species. As the name implies, harbor porpoises are typically found in shallow water, most often in bays and harbors, although they occasionally travel over deeper offshore waters (Jefferson et al., 1993). Harbor porpoises were the most common odontocete species sighted on the continental shelf during CETAP (Winn, 1982). However, they were primarily concentrated in New England waters, well to the north of the Norfolk test area (Winn, 1982).

<u>Pascagoula</u>. The Gulf of Mexico is outside the normal range of all of the endangered mysticetes, which are likely to be represented only by occasional strays (Jefferson and Schiro, 1997). Therefore, the sperm whale is the only endangered cetacean likely to occur near the Pascagoula test area. There is a resident population of sperm whales in the northern Gulf of Mexico. The sperm whales are most abundant in Mississippi Canyon just south of the Mississippi River Delta, about 200 km (110 nmi) west-southwest of the Pascagoula test area (Würsig et al., 1999). The GulfCet II program included numerous sightings of sperm whales in the northeastern Gulf,

including the Pascagoula test area (Mullin and Hoggard, 2000). No designated critical habitat for endangered marine mammals is located near the Pascagoula test area.

Another endangered species formerly known from the Gulf of Mexico (the Caribbean monk seal, *Monachus tropicalis*) is now believed to be extinct (Schmidly, 1981). The last reliable sighting of a Caribbean monk seal occurred in 1952, and many scientists believe that the species has been extinct since the early 1950s. Although the species is still listed as endangered, no recovery effort is being made due to its apparent extinction.

(c) Non-Listed Species: Mysticetes

Two non-listed mysticetes may be present at any of the test areas: Bryde's whale and minke whale.

Mayport. Both Bryde's whales and minke whales could occur at the Mayport test area. However, Fritts et al. (1983) observed no Bryde's or minke whales off eastern Florida during summer months. Similarly, neither species was sighted near the test area during the Navy's SEAWOLF surveys (April through September 1995 and May through September 1997) (Department of the Navy, 1995b, 1998b), during June and August 1999 aerial surveys (see **Appendix B**), or during the 1998 *Relentless* cruise (Roden, 1998). Stranding records for the months of May through September for the southeast coast from 1990 through 1995 include a few Bryde's whales and no minke whales (Odell, 1996).

Norfolk. The Cetacean and Turtle Assessment Program (CETAP) aerial surveys indicate Bryde's whales and minke whales could occur in the Norfolk test area (Winn, 1982). During the Navy's 1995 SEAWOLF aerial surveys, a few minke whales and possible Bryde's whales were seen (Department of the Navy, 1995b). One minke whale was sighted in July 1998 near the Norfolk test area during the *Relentless* cruise (Roden, 1998). Stranding records for the months of May through September for the Mid-Atlantic coast from 1990 through 1995 include a few minke whales but no Bryde's whales (Potter, 1996).

Pascagoula. The Gulf of Mexico is outside the normal range for the minke whale and it would only be represented by occasional strays (Jefferson and Schiro, 1997). Bryde's whale is the only mysticete occurring regularly in the Gulf of Mexico, though it is not frequently sighted. There were four Bryde's whale sightings in the eastern Gulf of Mexico during GulfCet II (Mullin and Hoggard, 2000). All of the sightings were along the shelf edge and two of them were in the De Soto Canyon area (near the Pascagoula test area) (Mullin and Hoggard, 2000).

(d) Non-Listed Species: Dwarf and Pygmy Sperm Whales (Physeteridae)

Dwarf and pygmy sperm whales may occur at any of the three test areas. These "cryptic" species may be missed during cetacean surveys because they dive in response to survey vessels and aircraft (Würsig et al., 1996), but their presence is indicated by frequent strandings (Schmidly, 1981; Odell, 1996).

Mayport. Both the dwarf sperm whale and pygmy sperm whale could occur at the Mayport test area. None were seen during either the 1995 and 1997 SEAWOLF aerial surveys or during the June and August 1999 aerial surveys of the Mayport test area, but both species appear in the May through September 1990 through 1995 stranding records for the southeastern U.S. (Odell, 1996). Schmidly (1981) also reports frequent strandings off the Florida east coast and Fritts et al. (1983) reported seeing one pygmy sperm whale in a water depth of 461 m (1,513 ft) off eastern Florida during October. The *Relentless* cruise reported a few dwarf/pygmy sperm whale sightings during July/August in the South Atlantic Bight (Roden, 1998).

Norfolk. Both the dwarf sperm whale and pygmy sperm whale could occur at the Norfolk test area. None were seen during 1995 SEAWOLF aerial surveys, but both species appear in the May through September 1990 through 1995 stranding records for the Mid-Atlantic region (Potter, 1996). During CETAP, one dwarf or pygmy sperm whale was seen off the Delaware coast in June, in a water depth of 2,560 m (8,400 ft) (Winn, 1982). The *Relentless* cruise reported several dwarf/pygmy sperm whale sightings during July/August off the Mid-Atlantic coast (Roden, 1998). In addition, deepwater sightings were recorded during the 1995 *Abel-J* and *Pelican* cruises (see **Appendix B**).

Pascagoula. Both dwarf and pygmy sperm whales could occur at the Pascagoula test area. There are numerous stranding records from the Gulf for both species, but until the recent GulfCet program there were few sightings (Jefferson and Schiro, 1997). During GulfCet, most of the dwarf sperm whale sightings were east of the Mississippi Delta including the De Soto Canyon area (i.e., close to the Pascagoula test area). In contrast, pygmy sperm whales were not sighted east of the Mississippi Delta (Hansen et al., 1996). Several dwarf/pygmy sperm whale sightings were made in and near the Pascagoula test area during GulfCet II surveys (Mullin and Hoggard, 2000).

(e) Non-Listed Species: Beaked Whales (Ziphiidae)

Beaked whales include several species of the genus *Mesoplodon*, as well as *Ziphius cavirostris* (Cuvier's beaked whale). Beaked whales are rarely seen and difficult to distinguish at sea. All of the beaked whales are classified by the NMFS as "strategic stocks."

Mayport. Four species of beaked whales may occur at the Mayport test area: Blainville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, and True's beaked whale. No beaked whales were seen during the 1995 and 1997 SEAWOLF aerial surveys (Department of the Navy, 1995b, 1998b) and only one (Cuvier's beaked whale) appears in the 1990 through 1995 stranding records (Odell, 1996). Fritts et al. (1983) sighted one Cuvier's beaked whale and several unidentified *Mesoplodon* off eastern Florida. Roden (1998) reported sightings of *Mesoplodon* and unidentified beaked whales in the South Atlantic Bight during the 1998 *Relentless* cruise.

Norfolk. Six species of beaked whales may occur at the Norfolk test area: Blainville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, the northern bottlenose whale, Sowerby's beaked whale, and True's beaked whale. The northern bottlenose whale and Sowerby's beaked whale are unlikely to be present because they are usually found farther north. The other four beaked whale species appear in the May through September 1990 through 1995 stranding records (Potter, 1996) for the Mid-Atlantic region, but only Cuvier's beaked whale was seen at Norfolk

during 1995 SEAWOLF aerial surveys (Department of the Navy, 1995b). During CETAP, both Cuvier's beaked whale and unidentified *Mesoplodon* were seen (Winn, 1982). Roden (1998) reported sightings of *Mesoplodon* and unidentified beaked whales off the Mid-Atlantic coast during the *Relentless* cruise. Both Cuvier's beaked whale and unidentified *Mesoplodon* spp. were sighted during the 1995 *Abel-J* and *Pelican* cruises (see **Appendix B**).

Pascagoula. Four species of beaked whales may occur at the Pascagoula test area: Blainville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, and Sowerby's beaked whale. Cuvier's is the most common beaked whale in the Gulf of Mexico and was sighted several times during GulfCet and GulfCet II surveys (Hansen et al., 1996; Mullin and Hoggard, 2000). Of the other three (all in the genus *Mesoplodon*), Gervais' beaked whale is the most common in the Gulf and Sowerby's beaked whale is represented only by occasional strays (Jefferson and Schiro, 1997).

(f) Non-Listed Species: Dolphins and Porpoises (Delphinidae and Phocoenidae)

A similar suite of delphinid species may occur at all three test areas (**Table 3.1**). Species that may occur at any of the three test areas include Atlantic spotted dolphin, bottlenose dolphin, clymene dolphin, false killer whale, pantropical spotted dolphin, pygmy killer whale, short-finned pilot whale, Risso's dolphin, rough-toothed dolphin, spinner dolphin, and striped dolphin. Fraser's dolphin, killer whale, and melon-headed whale could also occur at any of the test areas but are relatively uncommon based on aerial and shipboard surveys.

There are a few notable differences in the delphinid fauna of the three test areas:

- Based on a recent review of sightings and strandings, it is believed that the common dolphin does not occur in the Gulf of Mexico (Jefferson and Schiro, 1997) and therefore would not be present at the Pascagoula test area. The presence of common dolphins at Mayport is considered possible but unlikely because there were no sightings during the Fritts et al. (1983) aerial surveys, the SEAWOLF aerial surveys (Department of the Navy, 1995b, 1998b), the *Relentless* cruise (Roden, 1998), or the June and August 1999 aerial surveys, and no strandings during the summer 1990 through 1995 period (Odell, 1996). The common dolphin is classified by the NMFS as a "strategic stock."
- Although long-finned pilot whales and short-finned pilot whales are difficult to distinguish in aerial surveys, the southern extent of the range for long-finned pilot whales is believed to be in the New Jersey to Cape Hatteras area (Blaylock et al., 1995). Therefore, although both species could occur at Norfolk, it is assumed that all pilot whales at Mayport and Pascagoula would be short-finned pilot whales. Both species are classified by the NMFS as "strategic stocks."
- The Atlantic white-sided dolphin is primarily a northern species and Norfolk is near the southern end of its range (Winn, 1982; Blaylock et al., 1995). Therefore, it is assumed this species could occur at Norfolk, but not at Mayport or Pascagoula. This species is classified by the NMFS as a "strategic stock."

(g) Non-Listed Species: Pinnipeds

Mayport. There are no pinnipeds likely to be present at or near the Mayport test area.

Norfolk. Harbor seals are widely distributed from temperate to polar regions of the Northern Hemisphere. Along the eastern U.S. they are found from the Canadian Arctic to the Mid-Atlantic (Jefferson et al., 1993). At sea, they are mainly found in coastal waters of the continental shelf and slope. Although the range of this species includes the Mid-Atlantic, it is unlikely to be found so far offshore. It would not be present at Mayport or Pascagoula.

Pascagoula. One pinniped species, the California sea lion, is present in the northern Gulf but is unlikely to be found in the Pascagoula test area. These animals exist in the northern Gulf as feral individuals that probably escaped or were released from marine parks (Schmidly, 1981). Another pinniped formerly known from the Gulf of Mexico (the Caribbean monk seal, *Monachus tropicalis*) is now extinct (Schmidly, 1981).

(h) Sources of Abundance Data

For impact calculations in the EIS, it is necessary to develop density estimates for marine mammals in the proposed test areas. While regional sources such as broad-scale surveys and stranding records are useful for determining which species may be present during the test period, site-specific data are needed to estimate densities within the test areas. Sources of quantitative survey data have been discussed in **Appendix B** and are summarized below.

Mayport. After reviewing historical data sources and conferring with NMFS scientists, the Navy concluded that additional aerial surveys were needed to provide coverage of the Mayport test area during the appropriate season. Surveys were conducted during June and August 1999 using standard aerial survey methodology (Department of the Navy, 1999b; see **Appendix B**). Data from the 1995 and 1997 SEAWOLF surveys at Mayport were reanalyzed and used as a secondary source for comparison and context.

Norfolk. After reviewing historical data sources and conferring with NMFS scientists, the Navy concluded that existing data are sufficient to estimate marine mammal abundance at the Norfolk test area. Data from the 1995 SEAWOLF aerial surveys were reanalyzed and used as the primary source. In addition, unpublished data from two 1995 NMFS ship surveys (*Abel-J* and *Pelican*) were analyzed for context and comparison (see **Appendix B**). Data from the Cetacean and Turtle Assessment Program (CETAP) as reported by Kenney et al. (1985) were also used as a secondary source.

Pascagoula. Data are available from both aerial and shipboard observations during the GulfCet II program to estimate the abundance of marine mammals in and near the Pascagoula test area (Mullin and Hoggard, 2000). Aerial surveys conducted during two successive summers (1996 and 1997) provided the best coverage of the test area during the appropriate time period. Standard aerial survey methods were used, which were nearly identical to those of the 1999 Mayport surveys and the 1997 SEAWOLF surveys. After reviewing these data and conferring with NMFS scientists,

the Navy concluded that a subset of the GulfCet II aerial survey data would be appropriate to represent the Pascagoula test area. A copy of the data set was obtained from the NMFS, and a subset was constructed and reanalyzed for this EIS (see **Appendix B**). Other GulfCet II data were used for comparison and context.

Conclusions. **Table 3.2** summarizes the review of historical data sources for marine mammal abundance at the Mayport, Norfolk, and Pascagoula test areas.

Table 3.2. Data sources for marine mammal densities.

	Mayport	Norfolk	Pascagoula
Principal data source	• New aerial surveys (June and August 1999)	• SEAWOLF aerial surveys (Apr-Sept 1995)	• GulfCet II aerial surveys (July-August 1996 and 1997) (subset for Pascagoula)
Secondary source(s) (for comparison and context)	• SEAWOLF aerial surveys (Apr-Sept 1995 and May-Sept 1997)	• Unpublished data from two NMFS cruises (*Abel-J* and *Pelican*, July-August 1995) • CETAP aerial surveys (summer 1979-1981)	• Other GulfCet data for the region

(i) Density Comparisons

Table 3.3 summarizes density estimates for marine mammals for the Mayport, Norfolk, and Pascagoula test areas. Mean group densities (groups sighted/100 km^2) were 3.596 at Norfolk, 2.094 at Mayport, and 1.004 at Pascagoula. Individual densities (individuals/100 km^2) were 50.970 at Norfolk, 18.480 at Pascagoula, and 18.033 at Mayport. Although group densities at Pascagoula were only about half those at Mayport, the difference was offset by larger average group sizes, producing nearly identical individual density estimates.

Mayport. Eight cetacean taxa were sighted during the Navy's June and August 1999 surveys. These were Atlantic spotted dolphin, bottlenose dolphin, bottlenose/Atlantic spotted dolphin, false killer whale, pilot whale, Risso's dolphin, unidentified dolphin, and unidentified odontocete. Mean group and individual densities were 2.094 groups/100 km^2 and 18.033 individuals/100 km^2. The most frequently sighted (groups/100 km^2) were bottlenose dolphin (1.326) and Risso's dolphin (0.655). These two taxa accounted for 95% of the total group and individual densities. No mysticetes were seen.

During the 1995 and 1997 SEAWOLF surveys, the species list was similar, but mammal densities were generally lower. Total group densities during the 1995 and 1997 surveys were 0.592 and 1.300 groups/100 km^2, respectively. Total individual densities during 1995 and 1997 were 6.877 and 9.212 individuals/100 km^2. Identified taxa with the highest group densities (groups/100 km^2) during the 1995 surveys were bottlenose dolphin (0.105) and pantropical spotted dolphin (0.068).

Table 3.3. Marine mammal densities for the three test areas based on aerial and shipboard surveys.

	MAYPORT			PASCAGOULA			NORFOLK		
	Navy Aerial Surveys June and August 1999			GulfCet II Aerial Surveys (subset) July-August 1996 and 1997			SEAWOLF 1995 Aerial Surveys Monthly April-September 1995		
	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size
MYSTICETES									
Fin whale	--	--	--	--	--	--	0.304	0.101	3.00
Fin/sei whale	--	--	--	--	--	--	--	--	--
Humpback whale	--	--	--	--	--	--	0.009	0.009	1.00
Minke whale	--	--	--	--	--	--	0.051	0.051	1.00
Sei whale	--	--	--	--	--	--	0.098	0.049	2.00
Sei/Bryde's whale	--	--	--	--	--	--	0.035	0.035	1.00
Balaenoptera sp.	--	--	--	--	--	--	0.056	0.021	2.67
ODONTOCETES									
Atlantic spotted dolphin	0.095	0.016	6.00	0.263	0.022	12.00	9.534	0.672	14.19
Beaked whales*	--	--	--	--	--	--	--	--	--
Bottlenose dolphin	10.126	1.326	7.64	4.420	0.370	11.93	6.862	0.380	18.08
Bottlenose/Atl.spotted dolphin	0.160	0.018	8.67	0.344	0.031	11.00	0.343	0.043	8.00
Clymene dolphin	--	--	--	8.357	0.056	150.00	--	--	--
Common dolphin	--	--	--	--	--	--	0.360	0.002	155.00
Dwarf/pygmy sperm whale	--	--	--	0.524	0.384	1.36	--	--	--
False killer whale	0.047	0.006	8.00	--	--	--	--	--	--
Pantropical spotted dolphin	--	--	--	0.682	0.013	50.78	2.116	0.030	70.00
Pilot whale	0.420	0.034	12.33	--	--	--	16.173	1.552	10.42
Pygmy killer whale	--	--	--	--	--	--	--	--	--
Risso's dolphin	7.000	0.655	10.69	0.146	0.017	8.50	1.947	0.065	29.75
Rough-toothed dolphin	--	--	--	--	--	--	--	--	--
Sperm whale	--	--	--	0.034	0.024	1.40	0.040	0.030	1.33
Spinner dolphin	--	--	--	1.575	0.009	170.66	6.792	0.030	225.00
Striped dolphin	--	--	--	2.136	0.076	28.00	0.230	0.010	24.00
Stenella spp.**	--	--	--	--	--	--	1.424	0.063	22.50
Unidentified dolphin	0.179	0.033	5.40	--	--	--	4.581	0.436	10.52
Unidentified odontocete	0.005	0.005	1.00	--	--	--	--	--	--
Unidentified small whale	--	--	--	--	--	--	--	--	--
UNDETERMINED									
Unidentified large whale	--	--	--	--	--	--	0.017	0.017	1.00
TOTAL	**18.033**	**2.094**		**18.480**	**1.004**		**50.970**	**3.596**	

*includes *Mesoplodon* spp. and/or *Ziphius cavirostris*.

**includes clymene, spinner, and striped dolphins.

Table 3.3. (Continued).

	MAYPORT (secondary)			MAYPORT (secondary)			NORFOLK (secondary)		
	SEAWOLF 1997 Aerial Surveys Monthly May-September 1997			SEAWOLF 1995 Aerial Surveys Monthly April-September 1995			*Pelican* & *Abel-J* Cruises July-August 1995		
	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size
MYSTICETES									
Fin whale	--	--	--	--	--	--	--	--	--
Fin/sei whale	--	--	--	--	--	--	0.326	0.163	2.00
Humpback whale	--	--	--	--	--	--	--	--	--
Minke whale	--	--	--	--	--	--	--	--	--
Sei whale	--	--	--	--	--	--	--	--	--
Sei/Bryde's whale	--	--	--	--	--	--	--	--	--
Balaenoptera sp.	--	--	--	--	--	--	--	--	--
ODONTOCETES									
Atlantic spotted dolphin	0.240	0.022	11.14	1.049	0.059	17.82	0.263	0.006	42.40
Beaked whales*	--	--	--	--	--	--	0.648	0.278	2.33
Bottlenose dolphin	4.069	0.595	6.84	0.966	0.105	9.22	7.696	0.639	12.05
Bottlenose/Atl.spotted dolphin	1.378	0.205	6.73	0.377	0.065	5.80	--	--	--
Clymene dolphin	--	--	--	--	--	--	--	--	--
Common dolphin	--	--	--	--	--	--	0.027	0.001	42.00
Dwarf/pygmy sperm whale	--	--	--	--	--	--	0.026	0.013	2.00
False killer whale	--	--	--	--	--	--	--	--	--
Pantropical spotted dolphin	0.005	0.001	4.00	1.391	0.068	20.33	--	--	--
Pilot whale	0.228	0.011	20.00	--	--	--	3.324	0.319	10.43
Pygmy killer whale	--	--	--	--	--	--	0.015	0.008	2.00
Risso's dolphin	1.870	0.261	7.16	0.519	0.023	23.00	1.325	0.131	10.10
Rough-toothed dolphin	0.002	0.0004	6.50	--	--	--	--	--	--
Sperm whale	0.035	0.017	2.00	--	--	--	2.396	1.116	2.15
Spinner dolphin	0.030	0.003	9.00	0.737	0.015	50.00	--	--	--
Striped dolphin	--	--	--	--	--	--	28.780	0.510	56.39
Stenella spp.**	0.102	0.004	29.00	0.347	0.024	14.25	0.022	0.007	3.19
Unidentified dolphin	1.254	0.180	6.96	1.491	0.233	6.39	10.080	0.380	26.55
Unidentified odontocete	--	--	--	--	--	--	0.016	0.016	1.00
Unidentified small whale	--	--	--	--	--	--	0.180	0.091	1.98
UNDETERMINED									
Unidentified large whale	--	--	--	--	--	--	0.122	0.075	1.63
TOTAL	**9.212**	**1.300**		**6.877**	**0.592**		**55.247**	**3.751**	

*includes *Mesoplodon* spp. and/or *Ziphius cavirostris*.
**includes clymene, spinner, and striped dolphins.

During the 1997 surveys, bottlenose dolphin (0.595) and Risso's dolphin (0.261) had the highest group densities and only a few pantropical spotted dolphins were seen. False killer whale was the only species seen during 1999 surveys that was not observed during either 1995 or 1997 SEAWOLF surveys. Species observed during SEAWOLF surveys but not seen during 1999 included sperm whale, pantropical spotted dolphin, rough-toothed dolphin, spinner dolphin, and clymene/spinner/striped dolphin [*Stenella* spp.]). The additional species sighted during the 1997 surveys may partly reflect the greater trackline mileage of the five combined SEAWOLF surveys.

No sperm whales were seen during the 1999 surveys, but single sightings of two individuals each were made during both the 1995 and 1997 SEAWOLF surveys. No sperm whales were seen near the Mayport test area during the *Relentless* cruise (Roden, 1998). These results indicate that sperm whales may occur in the area, but infrequently or at low densities. Due to this species' endangered status and its occurrence on the two SEAWOLF surveys, sperm whale densities from the SEAWOLF 1997 surveys (0.017 groups/100 km^2) were used for impact calculations.

<u>Norfolk</u>. Nineteen cetacean taxa were sighted during the Navy's April-September 1995 SEAWOLF surveys at the Norfolk test area. Mean group and individual densities were 3.596 groups/100 km^2 and 50.970 individuals/100 km^2. The most frequently sighted (groups/100 km^2) were pilot whales (1.552), Atlantic spotted dolphin (0.672), unidentified dolphin (0.436), and bottlenose dolphin (0.380). These four taxa accounted for 85% of groups sighted. The most abundant taxa (individuals/100 km^2) were pilot whales (16.173), Atlantic spotted dolphin (9.534), bottlenose dolphin (6.862), and spinner dolphin (6.792), which together accounted for 77% of the total. Large mean group sizes were observed for spinner dolphin (225), common dolphin (155), and pantropical spotted dolphin (70). Sperm whales and several species of mysticetes (fin, humpback, minke, sei, and possibly Bryde's whales) were seen. Fin whales were the most abundant of the large whales (0.101 groups/100 km^2).

Sixteen taxa were sighted during the 1995 *Abel-J* and *Pelican* cruises. Mean group and individual densities were 3.751 groups/100 km^2 and 55.247 individuals/100 km^2. The most frequently sighted (groups/100 km^2) identified taxa were sperm whale (1.116), bottlenose dolphin (0.639), striped dolphin (0.510), and pilot whale (0.319). These four taxa plus unidentified dolphins accounted for about 80% of the total group densities. Due to its large group sizes, striped dolphin had the highest individual density (28.780 individuals/100 km^2), accounting for about half of the total, followed by bottlenose dolphin (7.696 individuals/100 km^2).

Neither the *Abel-J* and *Pelican* cruises nor the SEAWOLF aerial surveys provided complete coverage of the test area, with the shipboard data derived mainly from transects to the north and east of the test area and the SEAWOLF data from the shallow, western edge of the test area. The shipboard observations are likely to be more representative for deepwater species due to the greater water depths covered, particularly during the *Pelican* cruise. For example, both sperm whales and striped dolphins were much more abundant in the shipboard data than in the SEAWOLF aerial surveys, which were limited to the shelf edge. Sperm whales were in fact the most frequently sighted species during both shipboard surveys (especially *Pelican*, which covered deeper waters). Numerous sperm whales were also sighted near the Norfolk test area during the NMFS *Relentless* cruise, which extended into deep, continental slope waters (Roden, 1998). For this reason, sperm

whale densities from the ship surveys were used for impact calculations. All other species were represented by the SEAWOLF aerial data.

Marine mammal density data are also available from the two CETAP survey blocks overlapping the Norfolk test area (Kenney et al., 1985). Block H_z overlaps with the northern part of the test area and Block I_z overlaps with the southern part. Total densities during the summer season were 111 individuals/100 km^2 in Block H_z and 102 individuals/100 km^2 in Block I_z. These densities are about twice those estimated from the SEAWOLF data or the *Abel-J* and *Pelican* cruises. However, relatively few taxa were seen. In Block H_z, the most abundant species (individuals/100 km^2) were "striped or spotted dolphin" (55.09), bottlenose dolphin (19.19), pilot whale (14.06), Risso's dolphin (11.14), and common dolphin (10.99). Sperm whales were also seen, with a density of 0.44 individuals/100 km^2. In Block I_z, the only taxa sighted were "unidentified dolphin" and "unidentified dolphin not Risso's dolphin."

Pascagoula. Ten cetacean taxa were sighted during the summer 1996 and 1997 GulfCet II surveys in the Pascagoula test area. Mean group and individual densities were 1.004 groups/100 km^2 and 18.480 individuals/100 km^2. The most frequently sighted (groups /100 km^2) were dwarf/pygmy sperm whale (0.384) and bottlenose dolphin (0.370). These two taxa accounted for 75% of all sightings. Sperm whales were the only large whales seen. The most abundant taxa were clymene dolphin, bottlenose dolphin, and striped dolphin, together accounting for 81% of individuals sighted. Spinner dolphin, clymene dolphin, and pantropical spotted dolphin had large average group sizes (171, 150, and 51 respectively).

In comparison, total marine mammal densities in the eastern Gulf of Mexico during the GulfCet II program (all continental slope transects, summer 1996 and 1997 combined) were 1.698 groups/100 km^2 and 50.080 individuals/100 km^2 (Mullin and Hoggard, 2000). The most frequently sighted species were bottlenose dolphin, pantropical spotted dolphin, and dwarf/pygmy sperm whale. In terms of numbers of individuals, pantropical spotted dolphins were the most abundant cetacean on the continental slope, followed by spinner dolphin and bottlenose dolphin. The Pascagoula test area, then, had lower than average group and individual densities, and the most abundant slope species in the northern Gulf (pantropical spotted dolphin) was infrequently sighted there.

The only large whale seen at the Pascagoula test area was the sperm whale. A resident population of sperm whales occurs in the northern Gulf, concentrated primarily just south of the the mouth of the Mississippi River (Würsig et al., 1999). This "focal point" is located about 200 km (110 nmi) west-southwest of the Pascagoula test area.

Bryde's whale is the only other large whale potentially occurring at Pascagoula, but it was not sighted during aerial surveys there. This is the only mysticete occurring regularly in the Gulf of Mexico, and there were two sightings of this whale during GulfCet ship surveys during spring months (Mullin and Hoggard, 2000). The mean density of Bryde's whale on the continental slope, based on the shipboard surveys, was 0.041 individuals/100 km^2.

(j) Other Comparisons

Table 3.4 summarizes selected characteristics of marine mammal populations at the Mayport, Norfolk, and Pascagoula test areas. In addition to the density differences discussed previously, the test areas differ with respect to the likely presence of mysticetes, endangered and threatened species, and strategic stocks. The Norfolk test area is likely to have more marine mammals in each of these categories than the other two test areas. Also by virtue of its greater water depth and more northerly location, the Norfolk test area supports a more diverse cetacean fauna than the other two test areas, including several additional species that are at or near their southern limit in the mid-Atlantic region. Species occurring primarily in deep water (e.g., sperm whales, striped dolphin) are likely to be more abundant there than at Mayport or Pascagoula.

Critical habitat for endangered marine mammals is not a concern at any of the test areas. Only in the region of the Mayport test area has critical habitat been designated. The southeastern critical habitat for the northern right whale is located along the Florida/Georgia coast, but it is at least 87 km (47 nmi) inshore of the test area and is not occupied during the May through September test period.

Oceanographic features such as the Gulf Stream or Loop Current and associated warm and cold core rings are potential major influences on the local distribution of cetaceans at each of the test areas. The preference of cetaceans for cold core rings and confluence zones between cold and warm core rings has been most thoroughly documented in the northeastern Gulf of Mexico during the GulfCet II program (Davis et al., 2000). In addition, the association of sperm whales with the edges of warm core rings in the North Atlantic has been documented (Griffin, 1999). With near real-time remote sensing of sea surface altimetry, cold and warm core rings can be tracked to locate areas of low cetacean abundance. Accordingly, remote sensing of oceanographic features has been incorporated into the site selection process for all of the test areas as explained in Section 5.0.

3.2.2 Sea Turtles

(a) Species Presence

Five species of sea turtles may occur at any of the three test areas. All are protected under the ESA. The hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's ridley sea turtle (*Lepidochelys kempii*), and leatherback sea turtle (*Dermochelys coriacea*) are endangered species. The loggerhead sea turtle (*Caretta caretta*) is a threatened species. The Atlantic green sea turtle (*Chelonia mydas*) is threatened, except for the Florida breeding population, which is endangered. Species descriptions are provided in **Appendix B**.

Because of their pelagic distribution, leatherbacks and loggerheads are the most likely species to be present as adults. The three other turtles (green, hawksbill, and Kemp's ridley) are typically inshore species that are unlikely to be found on the continental slope. (Kemp's ridley adults are likely to be present only in the Gulf of Mexico.) Leatherbacks are considered the most pelagic of the sea turtles (Marquez, 1990) and they are the most abundant turtle on the continental slope in

Table 3.4. Selected characteristics of marine mammal populations at the three test areas. Species not likely to occur at the test areas (as indicated on Table 3.1) are not included.

Characteristic	Mayport	Norfolk	Pascagoula
Mean group density (groups/100 km^2):	2.094	3.596	1.002
Mean individual density (individuals/100 km^2):	18.033	50.970	18.480
Mysticetes present:	None expected during test period	Fin whale Humpback whale Minke whale Sei whale	Bryde's whale
Endangered and threatened species present:	Sperm whale	Sperm whale Fin whale Humpback whale Sei whale	Sperm whale
Strategic stocks present:	Sperm whale Beaked whales Pilot whales	Sperm whale Fin whale Humpback whale Sei whale Beaked whales Common dolphin Pilot whales	Sperm whale Beaked whales Pilot whales
Critical habitat present:	Southeastern critical habitat for northern right whale is located off Florida/Georgia coast, but at least 87 km (47 nmi) inshore of test area and not occupied during test period	None	None
Influential oceanographic features	Gulf Stream, including meanders and warm and cold core rings	Gulf Stream, including meanders and warm and cold core rings	Loop Current, including warm and cold core rings
Other considerations:	--	Deepest test area, more likely to encounter deepwater species (e.g., sperm whale, striped dolphin) Most northerly test area, more likely to encounter mysticetes and some other species at southern end of their range	Sperm whales tend to congregate in a "focal point" located about 200 km (110 nmi) WSW of test area, south of Mississippi River Delta Test area is one of few locations in Gulf of Mexico where Bryde's whale has been sighted

the northern Gulf of Mexico (Hansen et al., 1996). In contrast, surveys along the Atlantic coast that have extended into deep water indicate that loggerhead adults are more abundant than leatherbacks and that both species are more abundant over the continental shelf (Winn, 1982; Fritts et al., 1983; Thompson and Huang, 1993). Therefore, loggerheads are expected to be the most common adult turtle at the Mayport and Norfolk test areas, but leatherbacks are more likely to be encountered at the Pascagoula test area.

All five of the turtle species could also be present at any of the test area as hatchlings or juveniles associated with *Sargassum*. *Sargassum* is often found along convergence zones such as the western edge of the Gulf Stream, and it plays a vital role in the early stages of life for green, hawksbill, Kemp's ridley, and loggerhead sea turtles. Once hatchlings reach the ocean from their nesting beach, they swim out to the floating weed mats. The floating mats provide a wide variety of food and provide cover, helping to increase their chance of survival at this very vulnerable stage in life.

(b) Sources of Abundance Data

Sources of sea turtle abundance data for the potential test areas are discussed in detail in **Appendix B** and summarized below.

Mayport. There have been several aerial surveys of sea turtles offshore the southeastern U.S. that are applicable to the Mayport test area. However, most of the previous effort has concentrated on the continental shelf (<200 m or 656 ft). New aerial surveys conducted by the Navy in June and August 1999 provide the best site-specific coverage of the test area. Other sources for context and comparison include the Navy's SEAWOLF aerial surveys in 1995 and 1997, which were along the 152 m (500 ft) depth contour on the western edge of the test area (Department of the Navy, 1995b, 1998b); and the Southeast Turtle Surveys (SETS) conducted by the NMFS in 1982 and 1983 between Cape Hatteras and Key West (Thompson, 1984; Thompson and Huang, 1993).

Norfolk. The Navy's 1995 SEAWOLF surveys (Department of the Navy, 1995b) provide the main source of turtle abundance data for the Norfolk test area. The earlier CETAP aerial surveys (Winn, 1982) were used as a secondary source for context and comparison. Both surveys included some coverage of the continental slope in this area. The NMFS Southeast Turtle Surveys did not extend north of Cape Hatteras and focused on the continental shelf (Thompson, 1984; Thompson and Huang, 1993). Several other aerial surveys have been conducted off Virginia and/or North Carolina (Musick et al., 1994; Epperly et al., 1995; Keinath et al., 1996), but they focused on nearshore or shelf waters.

Pascagoula. After reviewing historical data and conferring with NMFS scientists, the Navy concluded that a subset of the GulfCet II aerial survey data would be appropriate to represent the Pascagoula test area. A copy of the GulfCet II data was obtained from the NMFS, and a subset was constructed and reanalyzed for this EIS (see **Appendix B**). There have been several other recent surveys of turtles in the northern Gulf of Mexico, sponsored by the MMS. These include studies of turtle associations with petroleum platforms (Lohoefener et al., 1990) and aerial surveys during the GulfCeT program (Davis and Fargion, 1996). However, the GulfCet II program is the best source of

turtle abundance data for the northeastern Gulf continental slope and includes coverage of the Pascagoula test area (Mullin and Hoggard, 2000).

Conclusions. **Table 3.5** summarizes the review of historical data sources for turtle abundance at the Mayport, Norfolk, and Pascagoula test areas.

Table 3.5. Summary of data sources for sea turtle densities.

	Mayport	Norfolk	Pascagoula
Principal data source	• New Navy aerial surveys (June and August 1999)	• SEAWOLF aerial surveys (1995)	• GulfCet II aerial survey data from summer 1996/97 (subset reanalyzed for EIS)
Other sources (for context and comparison)	• SEAWOLF aerial surveys (1995 and 1997) • NMFS Southeast Turtle Surveys (SETS) (1982-83)	• CETAP aerial surveys (1979-81)	• other GulfCet II and GulfCet I data

(c) Density Comparisons

Table 3.6 summarizes density estimates for sea turtles for the Mayport, Norfolk, and Pascagoula test areas. Mean densities (turtles/100 km^2) were highest at Norfolk (0.633) and about equal at Mayport (0.288) and Pascagoula (0.258). Green, hawksbill, and Kemp's ridley turtles were not seen during aerial surveys of any test area. One hawksbill turtle was sighted during the *Abel-J* cruise north of the Norfolk test area, but no turtle density estimates were developed from shipboard sightings.

Mayport. Two turtle species, leatherback and loggerhead, were sighted during the June and August 1999 surveys. Unidentified turtles were also sighted. Leatherbacks and loggerheads accounted for 56% and 30%, respectively, of the total density of 0.288 turtles/100 km^2.

The 1999 Mayport densities were considerably lower than those estimated previously during 1995 and 1997 SEAWOLF surveys (0.830 and 1.780 turtles/100 km^2, respectively). However, the SEAWOLF surveys covered only the shallowest portion of the current test area and the higher densities may be related to the position of the Gulf Stream western wall. Previous observations by Fritts et al. (1983) and Thompson (1984) show that turtles are concentrated inshore of the western wall, with very low densities in the Gulf Stream itself. The position of the western wall varies but is generally inshore of the test area. Satellite imagery of sea surface temperature taken during both June and August 1999 surveys show the Gulf Stream flowing directly over the Mayport test area.

Table 3.6. Sea turtle densities for the three test areas based on aerial surveys.

	MAYPORT	PASCAGOULA	NORFOLK
	Navy Aerial Surveys	**GulfCet II Aerial Surveys**	**SEAWOLF Aerial Surveys**
	June & August 1999	**July-August 1996 and 1997**	**Monthly April-September 1995**
	Mean No. Turtles/ 100 km^2	Mean No. Turtles/ 100 km^2	Mean No. Turtles/ 100 km^2
Leatherback turtle	0.162	0.203	0.006
Loggerhead turtle	0.086	--	0.608
Unidentified turtle	0.040	0.055	0.018
TOTAL	**0.288**	**0.258**	**0.633**

	MAYPORT (secondary)	MAYPORT (secondary)
	SEAWOLF 1997 Aerial Surveys	**SEAWOLF 1995 Aerial Surveys**
	Monthly May-September 1997	**Monthly April-September 1995**
	Mean No. Turtles/ 100 km^2	Mean No. Turtles/ 100 km^2
Leatherback turtle	0.423	0.023
Loggerhead turtle	1.208	0.783
Unidentified turtle	0.149	0.023
TOTAL	**1.780**	**0.830**

Loggerhead turtles were by far the most abundant in the Mayport SEAWOLF data, whereas leatherbacks were more abundant in the Mayport 1999 surveys (although one loggerhead and no leatherbacks were seen in June). Higher abundance of leatherbacks offshore is consistent with the more "pelagic" nature of leatherback distribution and is also observed in the GulfCet II data where loggerheads dominate on the continental shelf while leatherbacks dominate on the slope.

Some turtle densities observed during the Southeast Turtle Surveys (SETS) conducted in 1982 and 1983 were 20 to 40 times higher than those observed in the Mayport test area during 1999 aerial surveys (Thompson, 1984; Thompson and Huang, 1993). The SETS densities are not representative of the Mayport test area because the surveys were generally limited to the continental shelf (defined by the western edge of the Gulf Stream). The only observations in the Gulf Stream were mainly to the south of the test area, offshore of southeast Florida nesting beaches where high turtle abundances are common.

Although the 1999 aerial surveys show low turtle densities in the Mayport test area, both the SEAWOLF and SETS data show that much higher turtle densities can be encountered nearby. These data indicate that if the Mayport test area is selected, a test site should be located in deep water seaward of the Gulf Stream western wall (i.e., within or east of the Gulf Stream). The site selection process described in Section 5.0 of the FEIS includes both aerial surveys and a review of satellite imagery to aid in selecting a test site with low turtle densities.

Norfolk. Loggerhead, leatherback, and unidentified turtles were sighted during the April through September 1995 SEAWOLF surveys at Norfolk. Loggerhead turtles accounted for 96% of the total density of 0.633 turtles/100 km^2.

Mean turtle densities reported from CETAP (Winn, 1982) for the mid-Atlantic continental slope were 1.12 turtles/100 km^2 for loggerheads and 0.14 turtles/100 km^2 for leatherbacks. These are higher than the Norfolk SEAWOLF numbers and considerably higher than mean turtle densities calculated for the Mayport and Pascagoula test areas. However, they are comparable to higher turtle densities seen at Mayport during 1995 and 1997 SEAWOLF surveys.

Pascagoula. Leatherback and unidentified turtles were sighted during the July-August 1996 and 1997 GulfCet II surveys in the Pascagoula test area. Leatherbacks had the higher density, accounting for 79% of the total of 0.258 turtles /100 km^2.

Mean densities from GulfCet II summer surveys over the eastern Gulf of Mexico continental slope were 0.327 turtles/100 km^2 for leatherbacks, 0.034 turtles/100 km^2 for loggerheads, and 0.048 turtles/100 km^2 for unidentified turtles (Mullin and Hoggard, 2000). Therefore, total turtle densities in the Pascagoula test area are somewhat lower than the overall GulfCet II average.

(d) Other Comparisons

Table 3.7 summarizes selected characteristics of turtle populations at the Mayport, Norfolk, and Pascagoula test areas. In addition to the density differences discussed previously, the test areas differ with respect to the relative abundance of leatherbacks and loggerheads, proximity to nesting

Table 3.7. Selected characteristics of sea turtle populations at the three test areas.

Characteristic	Mayport	Norfolk	Pascagoula
Mean density (turtles/100 km^2):	0.288	0.633	0.258
Endangered or threatened species potentially present	Atlantic green Hawksbill Kemp's ridley Leatherback Loggerhead	Atlantic green Hawksbill Kemp's ridley Leatherback Loggerhead	Atlantic green Hawksbill Kemp's ridley Leatherback Loggerhead
Species likely to be most abundant:	Leatherback Loggerhead	Loggerhead Leatherback	Leatherback
Proximity to nesting beaches:	• Major loggerhead nesting beaches are located along southeast Florida coast; leatherback and Atlantic green turtles also nest there	• Minor loggerhead nesting occurs along Mid-Atlantic coast	• Minor loggerhead nesting occurs in Florida Panhandle area
Oceanographic influences:	• Turtles are much more abundant inshore of Gulf Stream western wall; site must be selected in the Gulf Stream	• Gulf Stream is offshore of entire test area, less likely to affect site selection within test area	• Leatherback association with a water mass boundary has been reported in De Soto Canyon area (indicates such boundaries should be avoided)

beaches, and the possible importance of oceanographic features. Leatherbacks are likely to be the most abundant species at Mayport and Pascagoula, whereas loggerheads are expected to dominate at Norfolk. Although limited turtle nesting occurs in the northeastern Gulf and along the Mid-Atlantic coast, only the Mayport test area is close to major loggerhead and leatherback nesting beaches (located along the Florida east coast).

Oceanographic features are potentially significant influences on local turtle distribution. This is most relevant at the Mayport test area, where high turtle densities can be found inshore of the Gulf Stream western wall. Available data indicate that if the Mayport test area is selected, a test site should be located in deep water seaward of the Gulf Stream western wall (i.e., within or east of the Gulf Stream). Unlike the situation at Mayport, the Gulf Stream is usually to the east of the entire Norfolk test area. Therefore, there is no reason to expect that turtle densities in the Norfolk test area would be lower than those observed along its western edge during the SEAWOLF surveys. Near the Pascagoula test area, Collard (1990) reported sighting several leatherback turtles in association with a coastal/subtropical water mass boundary; the turtles were apparently feeding on concentrations of jellyfish. For all test areas, the site selection process described in Section 5.0 of the FEIS includes both aerial surveys and a review of satellite imagery of oceanographic features to aid in selecting a test site with low turtle densities.

3.2.3 Seabirds

A variety of seabirds may occur in the pelagic environment of the potential test areas (Clapp et al., 1982a,b, 1983). Seabirds are birds that spend much of their lives offshore over the open ocean, except during breeding season when they nest along the coast. In addition, other birds such as waterfowl, marsh birds, and shorebirds may occasionally be present over open ocean areas (Peake, 1996). Seabird densities over the open ocean are typically low, e.g., <10 birds/km^2 (Powers, 1987).

(a) Listed Species

Several bird species along the Atlantic coast and in the Gulf of Mexico are listed under the ESA, including the Bermuda Petrel (*Pterodroma cahow*), Brown Pelican (*Pelecanus occidentalis*), Roseate Tern (*Sterna dougallii*), and Least Tern (*Sterna antillarum*). However, of these species, only the Bermuda Petrel is likely to occur within a potential test area (Norfolk). Listed land and shore birds such as the Bald Eagle (*Haliaeetus leucocephalus*), Piping Plover (*Charadrius melodus*), and Southeastern Snowy Plover (*Charadrius alexandrius tenuirostris*) are not discussed as they would not ordinarily be expected to occur far offshore.

The Bermuda Petrel (also known as the Cahow) is an endangered species. It was once a relatively numerous breeder on Bermuda but was driven to near extinction by the introduction of mammals during the 1500s and 1600s. The species was rediscovered in this century and is making a slow comeback. The total world population was estimated at less than 200 individuals in 1996. Nesting is restricted to cliffs on small islets in Castle Harbor, Bermuda in the western North Atlantic. When not nesting, the birds forage over the open ocean. There are a few recent sightings from the Gulf Stream off North Carolina in an area known as "The Point" located south of the Norfolk test area offshore of Cape Hatteras (Wingate et al., 1998).

The Brown Pelican is an endangered species, but this designation does not apply to populations inshore of the potential test areas (in Alabama, Florida, or along the U.S. Atlantic coast). In addition, Louisiana has requested the removal of its Brown Pelican population from the endangered species list (MMS, 1997). Brown Pelicans could be present along the coast inshore of any of the test areas, but they generally do not venture far offshore. Fritts and Reynolds (1981) observed them only within about 40 km (22 nmi) of the shoreline, and only one was seen over the northern Gulf of Mexico continental slope during the GulfCet surveys (Peake, 1996).

The Roseate Tern is endangered in the northeastern and Mid-Atlantic states including Virginia, and threatened in North and South Carolina, Georgia, and Florida. Roseate Tern breeding colonies are located off the northeastern U.S. and in the Florida Keys; this species does not breed or winter near any of the test areas and would be present only during migrations (Clapp et al., 1983; Hoopes et al., 1994). None were seen during aerial surveys offshore of the Florida east coast (Fritts et al., 1983) or in the Gulf of Mexico (Fritts et al., 1983; Peake, 1996; Hess and Ribic, 1999).

The Least Tern is also listed as endangered, but this designation applies only to interior populations and not those along the coast. Although Least Terns could be present in coastal areas of the Gulf and Atlantic coasts, they are inshore species that would not be common at any of the test areas. Only a few Least Terns were sighted during aerial surveys offshore of the Florida east coast (Fritts et al., 1983) and in the Gulf of Mexico (Fritts et al., 1983; Peake, 1996; Hess and Ribic, 1999).

(b) Non-Listed Species

Common seabirds found offshore of the Mid-Atlantic and southeastern U.S. and northern Gulf of Mexico include representatives of the orders Procellariiformes (albatrosses, petrels, shearwaters, storm petrels), Pelecaniformes (tropicbirds, boobies, gannets, pelicans, cormorants, and frigatebirds), and Charadriiformes (phalaropes, jaegers, skuas, gulls, and terns) (Clapp et al., 1982a,b, 1983; Fritts et al., 1983; Lee, 1984, 1985, 1986; Lee and Socci, 1989; Hoopes et al., 1994; Peake, 1996; Ribic et al., 1997). These seabirds include seasonal migrants and year-round residents, and they may feed on or below the sea surface. Seabird species that could be present at the potential test areas during the May through September time period are listed in **Table 3.8.** Additional information about seabirds listed in the table is presented in **Appendix B.**

Coastal and offshore waters of the eastern U.S. and Gulf of Mexico also serve as a major migratory corridor for many other species of birds, such as shorebirds of the order Charadriiformes (plovers, sanderlings, sandpipers, willets) and coastal and terrestrial birds (National Geographic Society, 1987; Lee and Horner, 1989). These include, but are not restricted to, the following groups: Anseriformes (ducks, geese), Ciconiiformes (egrets, herons, ibises), Falconiformes (falcons, hawks, ospreys), Gruiformes (coots, gallinules, rails), Passeriformes (crows, flycatchers, kinglets, sparrows, swallows, warblers, wrens), Pelicaniformes (cormorants, pelicans), and Podicepideformes (grebes). Most of these species are typically found inshore and do not feed or rest on the sea surface.

Table 3.8. Seabird species potentially present at the test areas during the May through September time period. Potential presence (**X**) is based on Clapp et al. (1982a,b, 1983), Fritts et al. (1983), MMS (1990a); Hoopes et al. (1994); and Peake (1996).

Scientific Name	Common Name	Status	Pascagoula	Mayport	Norfolk
Order Procellariiformes					
Family Procellariidae					
Fulmarus glacialis	Northern Fulmar	none	--	--	X
Pterodroma cahow	Bermuda (Cahow) Petrel	E	--	--	X
Pterodroma hasitata	Black-capped Petrel	none	--	X	X
Calonectris diomedea	Cory's Shearwater	none	X	X	X
Puffinus gravis	Greater Shearwater	none	X	X	X
Puffinus griseus	Sooty Shearwater	none	X	X	X
Puffinus puffinus	Manx Shearwater	none	--	X	X
Puffinus lherminieri	Audubon's Shearwater	none	X	X	X
Family Hydrobatidae					
Oceanites oceanicus	Wilson's Storm-Petrel	none	X	X	X
Pelagodroma marina	White-faced Storm-Petrel	none	--	--	X
Oceanodroma leucorhoa	Leach's Storm-Petrel	none	X	X	X
Oceanodroma castro	Band-Rumped Storm-Petrel	none	--	--	X
Order Pelecaniformes					
Family Phaethontidae					
Phaethon lepturus	White-tailed Tropicbird	none	X	X	X
Phaethon aethereus	Red-billed Tropicbird	none	X	X	X
Family Sulidae					
Sula dactylatra	Masked Booby	none	X	X	--
Sula leucogaster	Brown Booby	none	X	X	--
Morus bassanus	Northern Gannet	none	X	X	X
Family Pelecanidae					
Pelecanus erythrorhynchus	American White Pelican	none	X	X	--
Pelecanus occidentalis	Brown Pelican	E[a]	X	X	X
Family Phalacrocoracidae					
Phalacrocorax auritus	Double-crested Cormorant	none	--	X	--
Family Fregatidae					
Fregata magnificens	Magnificent Frigatebird	none	X	X	X
Order Charadriiformes					
Family Scolopacidae					
Phalaropus lobatus	Red-necked Phalarope	none	X	X	X
Phalaropus fulicaria	Red Phalarope	none	X	X	X
Family Laridae					
Subfamily Stercorariinae					
Stercorarius pomarinus	Pomarine Jaeger	none	X	X	X
Stercorarius parasiticus	Parasitic Jaeger	none	X	X	X
Stercorarius longicaudus	Long-tailed Jaeger	none	X	X	X
Subfamily Larinae					
Larus atricilla	Laughing Gull	none	X	X	X
Subfamily Sterninae					
Sterna caspia	Caspian Tern	none	X	X	X
Sterna maxima	Royal Tern	none	X	X	X
Sterna sandvicensis	Sandwich Tern	none	X	X	X
Sterna dougallii	Roseate Tern	E,T[b]	--	X	X
Sterna hirundo	Common Tern	none	X	X	X
Sterna paradisaea	Arctic Tern	none	--	--	X
Sterna forsteri	Forster's Tern	none	X	X	X
Sterna antillarum	Least Tern	E[c]	X	X	X
Sterna anaethetus	Bridled Tern	none	X	X	X
Sterna fuscata	Sooty Tern		X	X	X
Chlidonias niger	Black Tern	none	X	X	X
Subfamily Rynchopinae					
Rynchops niger	Black Skimmer	none	X	X	X

Status: (E) = endangered and (T) = threatened under the Endangered Species Act of 1973.

[a] Although the Brown Pelican is an endangered species, the designation does not apply to populations inshore of the proposed test areas (e.g., in Alabama, Florida, or along the U.S. Atlantic coast).

[b] The Roseate Tern is endangered in northeast and Mid-Atlantic states including Virginia; threatened in North & South Carolina, Georgia, Florida.

[c] Only the interior population of the Least Tern is listed as endangered. Populations along the coast are not endangered.

3.2.4 Pelagic Fish

Pelagic (water column) fish are often grouped by their water mass preference. Species preferring shelf waters are classified as coastal pelagic, and those preferring oceanic waters seaward of the shelf break are classified as oceanic pelagic. A third group, the mesopelagic fish, spend the daytime in depths of 200 to 1,000 m (656 to 3,280 ft) but migrate vertically at night into food rich, near surface waters. Oceanic pelagic and mesopelagic fish are likely to be the most common groups at all three test areas.

Oceanic pelagic fish include a number of well known commercially and/or recreationally sought species. Information on commercial and recreational fisheries is provided in **Section 3.3.1**. Mesopelagic fish, while less commonly known, are important ecologically because they transfer significant amounts of energy between mesopelagic and epipelagic zones over each daily cycle. Many species in both groups have gas-filled swimbladders and schooling behavior that make them susceptible to impacts from underwater detonations.

(a) Mayport

Because the Mayport test area is dominated by the Gulf Stream, fish found there are primarily oceanic pelagic. Pelagic sharks occurring in the area include makos, threshers, oceanic whitetip, and blue. Bony fishes include highly migratory species such as dolphinfish, blue marlin, white marlin, sailfish, swordfish, tunas, and wahoo. In general, oceanic pelagic species associate with the western edge of the Gulf Stream and travel near this edge as they migrate through the area. Flotsam accumulates along the Gulf Stream/shelf water interface where downwelling occurs (Carr, 1986). Dolphinfish, tunas, and wahoo feed on small fish and invertebrates associated with drifting *Sargassum* and other flotsam (Manooch et al., 1983; Manooch and Mason, 1984; Morgan et al., 1985).

Although coastal pelagic fish normally occur inshore of the area, some species may occasionally occur near the Mayport test area during migratory movements or extreme lateral (eastward) deflections of the Gulf Stream. Spanish mackerel, king mackerel, little tunny, jacks, requiem sharks, and cobia represent the larger predatory members of the coastal pelagic group found in this area. Smaller coastal pelagic fish include Atlantic menhaden, round scad, dwarf herring, butterfish, and chub mackerel. Wenner et al. (1980) collected dwarf herring, round scad, and butterfish in trawl samples taken just north of the Mayport test area offshore of Savannah, Georgia between a water depth of 110 to 183 m (361 to 600 ft).

Off the Atlantic coast, the Gulf Stream forms the boundary between two distinct assemblages of mesopelagic fish: the Slope Water assemblage and the Northern Sargasso Sea assemblage (Backus, 1987). Slope Water representatives include predominantly temperate and subpolar-temperate species, whereas Northern Sargasso Sea water supports tropical and subtropical species. Slope Water assemblages are numerically dominated by *Benthosema glaciale*, with three other species *Ceratoscopelus maderensis*, *Hygophum hygomii*, and *Lobianchia dofleini*, accounting for most of the rest. A variety of other mesopelagic fishes occurring in Slope Water are broadly distributed in the tropical and subtropical Atlantic and reflect inputs by warm core rings from the Gulf Stream

(Backus, 1987). Abundant species in the Northern Sargasso Sea assemblage include *Ceratoscopelus warmingii*, *Argyropelecus hemigymnus*, *C. maderensis*, *Bolinichthys indicus*, and *Hygophum hygomii*. *Ceratoscopelus maderensis* is the only temperate species in this group and it occurs in the Sargasso Sea due to transport in cold core rings. Much of the time, the Mayport test area is within the Gulf Stream, which tends to have an intermediate assemblage. Due to its southern latitude, the Mayport test area is likely to have a more tropical-subtropical assemblage than the Norfolk test area.

(b) Norfolk

Highly migratory forms such as yellowfin tuna, bigeye tuna, bluefin tuna, white marlin, spearfish, blue marlin, sailfish, swordfish, wahoo, and dolphinfish comprise the oceanic pelagic species group at the Norfolk test area. All life stages (eggs, larvae, juveniles, adults) of these species are closely associated with the Gulf Stream and could occur in the area. Some species, particularly dolphinfish, tunas, and wahoo feed upon small fish attracted to *Sargassum* and other flotsam (Manooch et al., 1983; Manooch and Mason, 1984; Morgan et al., 1985). Oceanic pelagic fish are present year round in the area, with billfish, dolphinfish, and tunas reaching peak abundances during spring, summer, and fall months.

Grosslein and Azarovitz (1982) reported that sharks were the most well represented group of coastal pelagic fish in the vicinity of the Norfolk test area. Although primarily migrants or strays from outside their principal range, 47 shark species were reported from the coastal and oceanic waters near the Norfolk test area (Grosslein and Azarovitz, 1982). About a dozen of the shark species caught were large, and all were seasonal migrants. Most of these sharks did not normally occur in large numbers. Among the five most commonly encountered species in the depth of the Norfolk test area, the sandbar shark is generally restricted to shelf waters. Other commonly encountered sharks were the blue shark, dusky shark, mako sharks, and hammerheads. Although occasionally found in relatively shallow water, these sharks usually frequent deep ocean waters and are considered oceanic pelagic. Other pelagic sharks potentially occurring in the area include thresher sharks, porbeagle, and oceanic whitetip.

A small number of bony, coastal pelagic fish were reported from the approximate depth of the Norfolk test area (Grosslein and Azarovitz, 1982). As with the sharks, most of these species were migrants, and not found in the area during the entire year. The predominant species were the Atlantic mackerel, bluefish, Atlantic menhaden, alewife, and butterfish. Holland and Keefe (1977) also reported bycatch of chub mackerel during trawling out to 380 m (1,247 ft) off Virginia. Other coastal pelagic species potentially occurring near the Norfolk test area include little tunny, king mackerel, Spanish mackerel, and cobia. These species are usually more abundant inshore, but could venture into the area.

As noted above under Mayport, the Gulf Stream forms the boundary between two distinct assemblages of mesopelagic fish: the Slope Water assemblage and the Northern Sargasso Sea assemblage (Backus, 1987). Characteristic mesopelagic fish in each assemblage have been cited previously. Due to its northern latitude, the Norfolk test area is likely to have a more temperate

mesopelagic fish assemblage than the Mayport test area. However, the Norfolk test area is near the Gulf Stream, which is a source of tropical and subtropical species (Backus, 1987).

(c) Pascagoula

In the Gulf of Mexico, common oceanic pelagic species include tunas, marlins, sailfish, swordfish, dolphinfish, wahoo, and mako sharks. In addition to these large, predatory species, there are halfbeaks, flyingfish, and driftfish. Lesser known oceanic pelagic fish are opah, snake mackerels, ribbonfish, and escolar.

Oceanic pelagic fish in the Gulf are reportedly associated with mesoscale hydrographic features such as fronts and eddies. Fishermen contend that yellowfin tuna aggregate near sea surface temperature boundaries or frontal zones; however, Power and May (1991) found no correlation between longline catches of yellowfin tuna and sea surface temperature in the Gulf of Mexico. The occurrence of bluefin tuna larvae in the Gulf of Mexico associated with the Loop Current boundary and the Mississippi River discharge plume is evidence that these species spawn in the Gulf (Richards et al., 1989). Many of the oceanic species associate with drifting *Sargassum*, which provides forage areas and/or nursery refuge.

Mesopelagic fish assemblages in the Gulf of Mexico are numerically dominated by myctophids (lanternfish), with gonostomatids (bristlemouths) and sternoptychids (hatchetfish) common but less abundant in collections. Assemblages have been studied in the eastern Gulf of Mexico by Backus et al. (1977), Hopkins and Lancraft (1984), and Gartner et al. (1987). Lanternfish were most common in the catches by Backus et al. (1977) and Hopkins and Lancraft (1984). Backus et al. (1977) analyzed lanternfish distribution in the western Atlantic Ocean and recognized the Gulf of Mexico as a distinct zoogeographic province. Species with tropical and subtropical affinities were most prevalent in the Gulf of Mexico lanternfish assemblage. This was particularly true for the eastern Gulf, where Loop Current effects on species distribution were most pronounced. Gartner et al. (1987) sampled three stations in the northeastern Gulf, including one near De Soto Canyon (29°01'N, 87°01'W). Forty-two of the 49 lanternfish species collected from all stations were taken from the northeastern stations. The most abundant were similar to those for the entire eastern Gulf. Ichthyoplankton collections from oceanic waters yielded high numbers of mesopelagic larvae as compared with larvae of other species (Richards et al., 1989). Lanternfish of the eastern Gulf generally spawn year-round, with peak activity in spring and summer (Gartner, 1993). Some lanternfish were reported by Darnell and Kleypas (1987) in trawl collections from near the rim of De Soto Canyon.

3.2.5 Ichthyoplankton

Potential impacts of the shock trial on phytoplankton, primary productivity, and zooplankton are likely to be negligible due to short life cycles, recolonization from adjacent areas, and rapid recovery of the populations to normal levels (Department of the Navy, 1998a). Therefore, these topics are not covered here. However, ichthyoplankton is included due to the importance of commercial and recreational fisheries in the region. Additional information on plankton communities at the Mayport and Norfolk test areas has been summarized by the Department of the

Navy (1995a). Additional discussion of plankton communities for the northeastern Gulf of Mexico is presented by Barry A. Vittor & Associates, Inc. (1985) and Collard and Way (1997).

Most fish inhabiting the Atlantic Ocean have eggs and larvae that become part of the planktonic community for about 10 to 100 days (depending on the species). Variability in survival and transport of ichthyoplankton (fish eggs and larvae) is thought to be an important factor affecting the size of adult fish populations (Underwood and Fairweather, 1989; Doherty and Fowler, 1994).

(a) Mayport

Fish eggs and larvae found in the South Atlantic Bight are mainly from warm temperate and tropical regions (Powles and Stender, 1976). The warm temperate species are spawned within the Bight, whereas the tropical eggs and larvae are carried into the area from more southerly spawning locations. Several of the region's commercially important species including Atlantic menhaden, Atlantic croaker, spot, summer flounder, and southern flounder migrate from nearshore shelf waters to the shelf edge to spawn (Miller et al., 1984). The larvae of these species are transported back across the shelf and eventually into inshore/estuarine nursery areas.

Within the South Atlantic Bight, fish eggs and larvae are generally distributed in an onshore/offshore pattern (Powles and Stender, 1976). Depending on the position of the Gulf Stream front, the ichthyoplankton at the Mayport test area is likely to be a mixture of slope and shelf/slope groups. The slope group is typified by lanternfish throughout the year. During spring, mackerel larvae reach peak abundance. Members of the slope group at other times of the year include inshore species such as gobies, wrasses, and flounders. The shelf/slope group includes fish such as lefteye flounders, jacks, mullets, bluefish, filefish, goatfish, and sea basses; several of these are economically important species. The composition and abundance of ichthyoplankton at any particular time will depend upon the position of the Gulf Stream front (Govoni, 1993).

(b) Norfolk

Fish eggs and larvae found in the Mid-Atlantic Bight come from warm temperate, cold temperate, and boreal regions (Doyle et al., 1993). In general, the most abundant fish eggs and larvae found during winter months are those of cold temperate species originating in more northerly waters. During spring, summer, and fall months the ichthyoplankton is dominated by warm temperate species originating from more southerly waters.

Within the Mid-Atlantic Bight, fish eggs and larvae are generally distributed in an onshore/offshore pattern including inner shelf, outer shelf, and slope/oceanic groups (Doyle et al., 1993). Factors such as temperature, salinity, frontal boundary positions, and locations of adult spawning sites contribute to the formation and maintenance of these groups (Grosslein and Azarovitz, 1982; Cowen et al., 1993). Depending on the position of the Gulf Stream front, the outer shelf and slope/oceanic groups would be the most likely to occur at the Norfolk test area. The lanternfish *Benthosema glaciale* and *Ceratoscopelus maderensis* define the slope/oceanic group (Doyle et al., 1993). *Benthosema glaciale* reaches peak abundance in winter and spring, whereas *C. maderensis* is most abundant in spring, summer, and fall. The slope/oceanic group also includes shelf species whose

distribution extends somewhat into the slope/oceanic areas. In spring, Atlantic mackerel larvae are abundant, and in summer silver hake and some flatfish larvae occur with *C. maderensis*. The outer shelf group includes witch flounder, silver hake, Atlantic bonito, cusk-eels, and species from more southerly waters such as razorfish, lefteye flounders, and gobies (Hare and Cowen, 1991; Cowen et al., 1993; Doyle et al., 1993).

(c) Pascagoula

Richards (1990) estimates that there are 200 families with more than 1,700 species whose early life stages may occur in the Gulf of Mexico. In addition to the resident fauna, many eggs, larvae, and juveniles may be advected into the Gulf from the Caribbean Sea via the Loop Current. In their study of the Loop Current front, Richards et al. (1993) identified 237 taxa representing 100 families. This remarkable diversity was attributed to a mix of fauna from tropical and warm temperate oceanic, mesopelagic, and coastal demersal and pelagic species. Larval sampling surveys by Houde et al. (1979) yielded over 200 taxa from 91 families in the eastern Gulf of Mexico. Ditty et al. (1988) summarized information from over 80 ichthyoplankton studies from the northern Gulf of Mexico (north of 26°N) and reported 200 coastal and oceanic fish from 61 families. Preliminary SEAMAP cruises collected 137 genera and species from 91 families (Sherman et al., 1983). The 10 most abundant families collected in the eastern Gulf by Houde et al. (1979) were clupeids (herrings), gobiids (gobies), bregmacerotids (codlets), carangids (jacks), synodontids (lizardfish), myctophids (lanternfish), serranids (seabasses), ophidiids (cusk eels), and labrids (wrasses). These families contributed 64% of the total taxa collected by Houde et al. (1979).

In the northeastern Gulf, two of the most important hydrographic features are the Mississippi River discharge plume and the Loop Current. A series of investigations have shown that ichthyoplankton aggregate at the frontal zone of the Mississippi River discharge plume (Govoni et al., 1989; Grimes and Finucane, 1991; Govoni and Grimes, 1992). Hydrodynamic convergence and the continually reforming turbidity fronts associated with the discharge plume probably account for the concentration of larval fish at the front. These investigators hypothesized that frontal waters provide feeding and growth opportunities for larvae. Bothids, carangids, engraulids, exocoetids, gobiids, sciaenids, scombrids, synodontids, and tetraodontids were the 10 most frequently caught taxa in the plume/shelf samples off the Mississippi River delta (Grimes and Finucane, 1991).

Richards et al. (1989, 1993) examined the distribution of larval fish along eight transects across the Loop Current boundary, as defined from satellite imagery of sea surface temperature. Most of the samples were off the continental shelf in water depths exceeding 200 m (656 ft). Although 100 fish families were identified, only 25 families were represented by >0.5 individuals/sample. Of these, the lanternfish were most abundant. A cluster analysis of the 25 most abundant families resolved three assemblages: oceanic, shelf, and frontal. The oceanic assemblage consisted of mesopelagic families such as hachetfish (sternoptichyids), lanternfish (myctophids), and bristlemouths (gonostomatids). The shelf group was subdivided into two groups including demersal taxa (e.g., sciaenids and bothids) and coastal pelagic taxa (e.g., carangids and scombrids) and widely dispersing reef species (e.g., labrids, scarids, and scorpaenids). The frontal group consisted of both oceanic and shelf taxa. These studies suggest that water temperature is a major influence on the structure of larval fish assemblages (Richards et al., 1993).

3.2.6 Sargassum Communities

An important component of the planktonic community is the floating brown alga *Sargassum*, a seaweed that permanently drifts at the surface in warm waters (Fine, 1970). It has been estimated that *Sargassum* covers nearly two million square miles at a density of two to five tons per square mile (Dooley, 1972).

Sargassum normally occurs in scattered individual clumps ranging in size from 10 to 50 cm (4 to 20 inches) in diameter. Clumps may be spaced several hundred meters apart (Butler et al., 1983). Accumulation of *Sargassum* and other flotsam in lines is often an indicator of a convergence zone between water masses. Convergence zones are sites of considerable biological activity, and many species including juvenile sea turtles and pelagic fish will gather along these zones whether *Sargassum* or other flotsam is present or not (Carr, 1986). Fishermen also use flotsam as visual cues to find convergence zones.

Over 100 different species have been identified as associated with floating *Sargassum* (Morris and Mogelberg, 1973), although the number of routine resident species within a typical *Sargassum* community is considerably lower (Butler et al., 1983). *Sargassum* is also important as cover for many temporary associates such as juvenile fish and sea turtles. Some of the temporary associates are seasonal residents, whereas others are intermittent residents or accidental strays (Butler et al., 1983).

As many as 54 fish species are closely associated with floating *Sargassum* at some point in their life cycle, but only two spend their entire lives there: the sargassumfish and the sargassum pipefish (Adams, 1960; Dooley, 1972; Bortone et al., 1977). Most fish associated with *Sargassum* are temporary residents, such as juveniles of jacks, triggerfishes, and filefishes, which reside in shelf or coastal waters as adults (McKenney et al., 1958; Dooley, 1972; Bortone et al., 1977; Moser et al., 1998). However, several larger species of recreational or commercial importance including dolphinfish, yellowfin tuna, blackfin tuna, skipjack tuna, Atlantic bonito, little tunny, and wahoo feed on the small fish and invertebrates attracted to *Sargassum* (Morgan et al., 1985). The abundance and diversity of fishes associated with *Sargassum* is related to size and morphology of the floating mat (Moser et al., 1998).

Sargassum plays a vital role in the early stages of life for green, hawksbill, and loggerhead sea turtles. Once hatchlings reach the ocean from their nesting beach, they swim out to the floating mats of *Sargassum*. The floating mats provide a wide variety of food and provide cover, helping to increase their chance of survival at this very vulnerable stage in life. Kemp's ridley turtles could also be present in *Sargassum;* although they do not nest near any of the test areas, *Sargassum* containing these hatchlings could be carried through the Florida Straits and along the east coast in the Gulf Stream.

(a) Mayport and Norfolk

The Gulf Stream provides a fairly constant input of drifting weed and its associated fauna to the Atlantic community. *Sargassum* communities at the Mayport and Norfolk test areas should be generally similar. However, *Sargassum* communities off Virginia are less diverse than those off the Florida coast (Stoner and Greening, 1984).

In the last few years, commercial fishermen operating along the U.S. east coast have begun to harvest *Sargassum* for use as fertilizer and a cheap additive to livestock feed (South Atlantic Fishery Management Council, 1998). Until recently, there have been no real regulations on the harvest of this resource. However, the South Atlantic Fisheries Management Council, the governmental body that oversees commercial fishing regulations, recently voted to ban the harvest and possession of *Sargassum* effective 1 January 2001 (South Atlantic Fishery Management Council, 1999).

(b) Pascagoula

Net productivity within *Sargassum* communities appears to be lower in the Gulf of Mexico than in the South Atlantic, but this may be an artifact of different measuring techniques and sampling periods (Blake and Johnson, 1976). Species diversity is lower in northern Gulf of Mexico *Sargassum* communities than in *Sargassum* communities from similar latitudes in the South Atlantic. The *Sargassum* community in the Gulf of Mexico apparently depends upon receiving both its substrate (*Sargassum*) and its associated fauna from the Sargasso Sea area via the Caribbean Current and the variable Gulf Loop Current. Because of the long dispersal route and the reduced opportunities for community faunal exchange, the Gulf community is dominated by a less diverse assemblage of species better adapted for long dispersal periods. Atlantic *Sargassum* communities are more diverse, perhaps because they are closer to sources of colonizing biota and are supported by the large, geographically constant Gulf Stream (Bortone et al., 1977).

3.2.7 Benthic Communities

Because of the operational requirement for water depths of at least 183 m (600 ft), the shock trial is unlikely to have any impacts on benthic communities, other than the deposition of metal fragments from the charge casing (Department of the Navy, 1998a). Therefore, a detailed description of benthic communities is not appropriate. However, a brief overview is presented here, including likely differences among test areas.

Benthic communities can be divided into infauna (animals that live within the sediment) and epifauna (animals that live on the seafloor, including demersal fish). Continental slope infauna are typically categorized by size into macroinfauna (retained on a 0.3 mm sieve) and meiofauna (passing through a 0.3 mm sieve, retained on a 0.063 mm sieve). Because epifaunal studies have focused mostly on large organisms visible in photographs, these are often referred to as megafauna. Strong bathymetric zonation of infaunal and epifaunal assemblages is typical on the continental slope, with various zonation schemes posed by investigators (George and Menzies, 1972; Pequegnat, 1983; Gallaway et al., 1988; Blake and Grassle, 1994).

Unusual conditions exist off Cape Hatteras, which may affect the southern portion of the Norfolk test area. While continental slope infauna tend to have lower densities and higher diversity than those of the continental shelf, studies off Cape Hatteras have shown unusually high infaunal densities and low diversity (Blake et al., 1987; Blake and Hilbig, 1994). Elevated densities of megafauna, particularly of a large anemone and three demersal fish (two eelpouts and the witch flounder) occur on the middle slope off Cape Hatteras (Hecker, 1994). These differences have been attributed to the narrow width of the shelf off Cape Hatteras and funneling of organic matter from the Chesapeake Bay and other estuaries across the shelf to the slope (Rhoads and Hecker, 1994). Demersal fish in this area are unusually small, a result attributed to episodic hypoxia caused by influx of organic matter (Sulak and Ross, 1996).

Benthic communities at similar depths at Mayport and Norfolk are likely to be different due to the existence of a zoogeographical barrier at about 34°N off Cape Lookout, North Carolina (Cutler, 1975; Hilbig, 1994). The barrier has been attributed to the effect of bottom currents on larval dispersion (Cutler, 1975). A barrier may exist for certain groups (e.g., cumaceans, many polychaetes), but not others (e.g., bivalve mollusks) (Hilbig, 1994).

In general, there is little information on benthic community structure for the continental slope in the South Atlantic Bight near the Mayport test area (Knott and Wendt, 1985). A few studies have reported the existence of deepwater coral banks in depths of 650 to 850 m (2,133 to 2,789 ft) on the Blake Plateau (Stetson et al., 1962, 1969; Milliman et al., 1967; Cairns, 1979; Ayers and Pilkey, 1981). These studies have been cataloged by Knott and Wendt (1985), and data points near the test area were included in the exclusionary mapping. Two coral areas were excluded within the northern part of the test area and one was on the edge. It has been reported that individual banks average 0.8 km (0.4 nmi) in diameter and occur in groups of 200 or more (Stetson et al., 1962); relief varies from <10 m (33 ft) to over 100 m (328 ft) (Pinet et al., 1981). The deepwater corals associated with these features are "ahermatypic," lacking the symbiotic zooxanthellae present in shallow-water, reef building forms. Most of the corals are solitary, but a few colonial species (e.g., *Lophelia prolifera*, *Solenosmilia variabilis*, and *Enallopsammia profunda)* form the framework of the coral banks.

Significant differences in benthic abundance and diversity are expected when comparing the Pascagoula test area with the Mayport and Norfolk test areas. Deepwater benthos of the Gulf of Mexico tend to be less abundant and diverse than comparable communities along the Atlantic seaboard (Rowe and Menzel, 1971; Gallaway et al., 1988). This result may reflect the oligotrophic (nutrient-poor, low productivity) waters of the Gulf (Rowe and Menzel, 1971).

Unusual "chemosynthetic" communities are found along the continental slope in the northern Gulf of Mexico (Brooks et al., 1988; MacDonald, 1992). They are defined as persistent, largely sessile assemblages of marine organisms that depend on chemosynthetic bacteria as their main food source (MacDonald, 1992). These communities are considered by the MMS to be sensitive resources, and lease stipulations have been developed to protect them during offshore oil and gas operations. However, chemosynthetic communities are distributed primarily off Louisiana and Texas, with none known in the vicinity of the Pascagoula test area (MMS, 1997). Gallaway et al. (1988) reported finding small *Vesicomya* sp., indicative of possible chemosynthetic communities in the eastern Gulf near the Pascagoula test area at depths of about 850 m (2,790 ft), but noted that there are no observations of megafaunal *Vesicomya* or chemosynthetic communities in the area.

3.3 SOCIOECONOMIC ENVIRONMENT

3.3.1 Commercial and Recreational Fisheries

Commercial and recreational fisheries are very important to the economies of the coastal states adjacent to the potential test areas. In 1997, commercial fishery landings in the South Atlantic subregion, which includes Georgia, Florida, and the Mayport test area, were 299 million pounds worth $213 million (NMFS, 1998). In the Mid-Atlantic subregion, which includes Virginia, North Carolina, and the Norfolk test area, total landings amounted to 237 million pounds worth $200 million (these values do not include the Chesapeake Bay). The Gulf coast subregion, including Louisiana, Mississippi, Alabama, the Florida west coast, and the Pascagoula test area, is second only to the Pacific coast with total landings of 1,790 million pounds worth $759 million.

Of the states adjacent to the potential test areas, Louisiana led in total landings and value in 1997 with 1,426 million pounds landed worth $319 million (NMFS, 1998). Virginia was second with landings of 612 million pounds worth $105 million, followed by North Carolina with landings of 230 million pounds worth $102 million. Mississippi was next in landings (178 million pounds worth $42 million), but Florida's landings were of greater value (115 million pounds worth $209 million). Alabama, Georgia, and South Carolina's fishery landings each totaled less than 25 million pounds for each state and were worth less than $40 million each.

Table 3.9 summarizes the types of commercial and recreational fishing activities expected at each test area. Individual test areas are discussed in subsections below.

(a) Mayport

Most commercial and recreational fisheries such as shrimp trawling, reef fishing, and king mackerel fishing take place well inshore of the test area. However, certain species, particularly oceanic pelagic and deep reef fish known to occur in the vicinity of the Mayport test area, are sought by commercial and recreational fishers.

Commercial fishers work the offshore waters of northeastern Florida for sharks, swordfish, and tunas. These species are caught with surface drifting longlines fished in the water column offshore of the shelf break. Longlines are set near the western edge of the Gulf Stream often with the aid of sophisticated onboard temperature sensors, depth finders, and positioning equipment. Longline sets can measure between 1.85 and 64.8 km (1 and 35 nmi) with well over 1,000 hooks per set. Bottom longlining for golden tilefish also occurs off Mayport. Bottom longlines average about 18.5 km (10 nmi) in length. Drifting gillnets are also set for sharks in Federal waters offshore of northeast Florida (Trent et al., 1997).

Shrimp trawling is a highly commercialized activity off northeastern Florida. However, the Mayport area lies well offshore of designated east coast shrimp beds, which are in near coastal waters (CFR 46-31.0156, 1995).

Recreational anglers who fish near the Mayport test area are seeking oceanic pelagic fish and to a lesser extent deep reef species. Despite the considerable minimum distance to the test area from

Table 3.9. Commercial and recreational fishing activities occurring at or near the Mayport, Norfolk, and Pascagoula test areas.

Fishing Method	Species Sought		
	Mayport	Norfolk	Pascagoula
Commercial Fishing			
Surface longlining	Sharks, swordfish, tunas	Sharks, swordfish, tunas	Tunas, sharks, swordfish
Bottom longlining	Golden tilefish	Golden tilefish (mainly north of the test area)	Snowy grouper, yellowedge grouper, tilefishes
Bottom trawling	---	Summer flounder, black seabass, butterfish, hake, squid (trawling occurs mainly during winter)	Royal red shrimp
Gillnet	Sharks	Little tunny, bonito	---
Recreational Fishing			
Trolling	Billfishes, dolphinfish, tunas, wahoo	Billfishes, dolphinfish, tunas, wahoo	Billfishes, dolphinfish, tunas, wahoo

Mayport, some private and charter sport fishers regularly venture this far offshore to troll for billfish, dolphinfish, tunas, and wahoo. Most fishing occurs between the depths of 91 to 305 m (300 to 1,000 ft) (Furr, 1995).

Some groupers and snappers form spawning aggregations. However, most members of the snapper-grouper species complex are unlikely to be present given that the shock trial would be conducted in water depths greater than 183 m (600 ft). The most notable species capable of forming spawning aggregations in water depths of the Mayport test area would be the snowy grouper (*Epinephelus niveatus*). This species spawns from April to July and occurs in water depths ranging from 61 to 262 m (Parker and Mays, 1998). Wyanski et al. (2000) collected spawning adults off North and South Carolina in water depths 189 to 302 m. These authors also provided circumstantial evidence that snowy groupers may aggregate to spawn in depths of 180 to 316 m offshore North Carolina, South Carolina, and Georgia. Snowy groupers are found associated with natural and artificial hard bottom areas of the outer shelf and upper slope (Wyanski, et al. 2000; Parker and Mays, 1998). Because snowy groupers are always associated with hard substrata, avoiding such habitats (Section 2.2.3) minimizes the chance of encountering this species.

(b) Norfolk

Bottom trawling and surface longlining are the major commercial fisheries expected in the vicinity of the Norfolk area. Although the trawl fishery targets summer flounder, there is considerable bycatch of other species including black seabass, butterfish, and hake (Ross et al., 1988). This fishery takes place in fall and winter months in outer shelf waters from 40 to 100 m (131 to 328 ft) deep, just inshore of the Norfolk area. Squid (short-finned and long-finned), also taken by trawl, are fished in inner-shelf waters during spring and summer and outer-shelf waters during winter. Surface longlining produces sharks, swordfish, and tunas from waters of the shelf edge and seaward depending upon oceanic conditions (Taniguchi, 1987). Bottom longlining for golden tilefish also occurs in the area, but mainly to the north of the area (from Norfolk Canyon north). A small gillnet fishery targets bonito and little tunny (NMFS, 1999).

Recreational anglers seeking oceanic gamefish (e.g., billfish and tunas) may fish the waters near the Norfolk area (Richards, 1965; Figley, 1988). In 1983, there were 455 vessels (415 private, 40 charter) in Virginia's marlin and tuna sportfishing fleet. Figley (1988) reported that most Mid-Atlantic offshore fishermen restricted their activities to the area from Norfolk Canyon (which is north of the Norfolk area) northward to Block Canyon. Another fishing area popular with offshore sport fishermen is known as "The Point" and is located off Cape Hatteras just south of the test area (MMS, 1990a).

Charter and private boat fishermen operating off Virginia's eastern shore (out to the 183 m [600 ft] depth contour) catch Atlantic bonito, dolphinfish, little tunny, skipjack tuna, white marlin, and yellowfin tuna (Richards, 1965; Figley, 1988). In addition, blue marlin, swordfish, bigeye tuna, and albacore are also taken. The Norfolk area falls within these ranges and given the depth preferences of these fish, they may periodically be found at the area. Most of the charter boat catch, particularly for the more offshore waters, occurs between late April and mid-October. This is the

period when weather permits the long excursions offshore to fish for these open water fish, and coincides with the occurrence of the fish in the area.

(c) Pascagoula

Eighty percent of the commercial fishing trips in the region target reef and demersal fish. The most common methods used by Florida Panhandle commercial fishers include purse seining, gill netting, hand lining, haul seining, longlining, trapping, and trawling (Continental Shelf Associates, Inc., 1997). Of these, longlining for yellowfin tuna and trawling for royal red shrimp are the only ones expected to occur regularly in the test area.

Recreational fishers in offshore waters of the Florida Panhandle region target primarily reef fish (Continental Shelf Associates, Inc., 1997). Both private and charter vessels are involved. Recreational fishing for reef fish is associated primarily with hard bottom features on the shelf and is unlikely to be concentrated within the Pascagoula test area. Due to the depth of the test area and its distance from shore, the most likely recreational fishing activity would be trolling for gamefish such as billfishes and tunas.

About 80% of all trips made in the Gulf of Mexico for royal red shrimp occur in NMFS Grids 90 and 100, which are located off the Florida panhandle and Alabama and which overlap the northern part of the test area. Trawling for royal red shrimp in these grids occurs in average water depths of 468 m (1,536 ft). The number of royal red shrimp trips per year for 1994 to 1998 period averaged 2.8 in Grid 90 and 58.4 in Grid 100.

The presence of offshore structures and large numbers of artificial reefs in the nearshore areas of the Gulf of Mexico attract recreational fishers who are drawn by the abundant fish populations associated with these structures, but these platforms are located mainly in the central and western Gulf of Mexico. Although some platforms are located off Alabama, there are none offshore Florida where the test area is located. Artificial reefs are also confined to nearshore waters which are distant from the test area.

3.3.2 Shipping Lanes and Traffic

The U.S. Coast Guard (USCG) is responsible for the management of maritime navigation under the Ports and Waterways Safety Act of 1970, as amended. The Act promotes the safety of ports, harbors, waterfront areas, and navigable waters of the U.S. It authorizes the USCG to set up traffic routing measures in areas of high vessel traffic based on Port Access Route Studies. Traffic routing measures are implemented to reduce the chance of collisions between vessels entering or exiting major ports. In areas having a significant amount of waterborne traffic, a primary method of heightening marine safety has been the establishment of shipping safety lanes (fairways), or traffic separation schemes (TSSs). Shipping lanes play an important role in reducing traffic collisions and have proven to be an excellent way of mitigating traffic conflicts (MMS, 1990b).

Commercial ship traffic in the vicinity of the Mayport, Norfolk, and Pascagoula test areas during May to September 1996 and 1997 has been summarized in **Section 2.2.2**. The data indicate that

Pascagoula has the highest level of ship traffic, reflecting the maritime activity associated with the petroleum industry and nearby ports (Mobile and New Orleans). The area off Mayport has the lowest level of commercial ship traffic and Norfolk is intermediate.

In terms of military traffic, Norfolk has considerably higher levels than either Mayport or Pascagoula. However, military traffic is excluded from consideration here because it can be controlled as necessary during the shock trial period.

(a) Mayport

Major ports of commerce in the Mayport area include Charleston, South Carolina; Savannah and Brunswick, Georgia; and Jacksonville and Cape Canaveral, Florida. In addition, there are numerous harbors and marinas that support small commercial vessels and recreational watercraft.

There are no designated shipping lanes near the Mayport test area marked on nautical charts. Short entrance channels exist for the ports of Savannah, New Brunswick, and Kings Bay in Georgia, and Mayport and Cape Canaveral in Florida. A Port Access Route Study for the east coast of the U.S. conducted by the USCG concluded that the magnitude of shipping traffic that occurred in the Mayport area did not justify the need to establish a TSS (Hegy, 1994). However, ship traffic in the vicinity is substantial, particularly in the north-south direction. Commercial vessels plying the east coast routes heading north typically stay within the Gulf Stream to take advantage of the northward current to carry them to Cape Hatteras. When headed south, ships often stay inshore of the Gulf Stream to avoid the current flowing counter to their direction of travel.

(b) Norfolk

Ship traffic in the Norfolk area includes numerous vessels entering and exiting Chesapeake Bay where major ports include Baltimore, Hampton Roads, and Richmond. In addition, several Navy bases are nearby. Ships plying the north-south route along the eastern seaboard also add to the traffic. Like the Mayport test area, there are no offshore shipping lanes near the Norfolk test area, although a TSS is implemented in the approaches into Chesapeake Bay.

(c) Pascagoula

An extensive network of shipping lanes occurs in the Gulf of Mexico providing avenues for passage through the large numbers of petroleum structures offshore between the major ports of Tampa, Panama City, and Pensacola, Florida; Mobile, Alabama; and Pascagoula, Gulfport, and the Passes in Mississippi. Buffer zones (18.5 km or 10 nmi) for shipping lanes overlapping with part of the Pascagoula test area have been excluded (see Section 2.2.3). In addition to the commercial traffic related to maritime trade among ports, there is considerable ship traffic in the northern Gulf of Mexico associated supply boats bringing equipment, supplies, and personnel to offshore oil and gas platforms and drilling rigs.

3.3.3 Marine Sanctuaries

National Marine Sanctuaries were part of the exclusionary mapping process for potential test areas. There are no existing, proposed, or formerly proposed National Marine Sanctuaries at or near the Mayport or Pascagoula test areas. There is one formerly proposed marine sanctuary just north of the Norfolk test area. As explained in Section 2.2.3, a buffer zone of 4.6 km (2.5 nmi) was added to the formerly proposed Norfolk Canyon National Marine Sanctuary, and the part of the buffer zone that overlaps with the test area was excluded (see **Figure 2.7**).

Norfolk Canyon was nominated for National Marine Sanctuary status by the Secretary of Commerce in September 1985. It became an Active Candidate for designation on 28 February 1986. A preliminary Draft EIS and Management Plan was prepared by NOAA in 1992 but this document was not for public distribution. No further significant action toward designation has occurred since then, due to unavailability of resources and other priorities. On 26 August 1997, the nomination of Norfolk Canyon was withdrawn (Federal Register, 1997, Volume 62, Number 165, pages 45,233-45,234).

Norfolk Canyon is located offshore of Virginia approximately 111 km (60 nmi) east of the entrance to Chesapeake Bay. It is the southernmost of a series of deepwater, submarine canyons along the Atlantic continental margin. Most of the formerly proposed Norfolk NMS is in waters deeper than 200 m (656 ft). The sanctuary would have encompassed an area of 899 km^2 (262 nmi^2) next to the northern end of the Norfolk test area.

Norfolk Canyon is a habitat for a distinctive assortment of living marine resources, including gorgonian tree corals. The canyon community is rich in alcyonarid (soft coral) and scleractinid (hard coral) species. It also contains "pueblo villages," areas along the canyon walls where a number of finfish and invertebrate species carve out deep depressions that serve as shelter and nursery grounds. The abundance of nutrients and food resulting from seasonal upwelling and the Chesapeake Bay drainage basin make the canyon an important feeding ground for fish and crustaceans. The canyon supports thriving commercial and recreational fisheries which target dolphin, marlin, and tuna as well as other associated pelagic species. The canyon also provides intermittent habitat for several species of marine mammals and sea turtles.

3.3.4 Ocean Dredged Material and Other Disposal Sites

Ocean dredged material and other disposal sites were part of the exclusionary mapping process for potential test areas. Due to the vessel traffic associated with these areas (e.g., barges carrying dredge spoil), an 18.5 km (10 nmi) buffer was established around each disposal site. All disposal sites identified during exclusionary mapping were well inshore of the test areas, and none of the buffer zones overlapped with the test areas (i.e., no exclusions were necessary).

3.3.5 Active Petroleum Lease Blocks, Pipelines, and Platforms

Active petroleum lease blocks were identified during the exclusionary mapping process, but they were not excluded or assigned a buffer zone. While it is prudent to exclude an 18.5 km (10 nmi) radius around existing platforms because they require routine supply vessel and helicopter traffic, the existence of an active lease *per se* does not warrant exclusion. Offshore petroleum leases in Military Warning Areas include a military stipulation that requires the operator to enter into an agreement with the military commander responsible for controlling vessel and aircraft traffic in the area (MMS, 1997). Before the shock trial is conducted in 2001, the Navy would coordinate with the MMS and the appropriate military commander(s) to determine whether any new platforms, rigs, or activities are planned in the active blocks.

(a) Mayport

There are no active lease blocks, pipelines, or platforms within or near the Mayport test area. On 12 June 1998, President Clinton issued an Executive Order which prohibited leasing in the Atlantic Outer Continental Shelf through 30 June 2012. No further exploratory activities are anticipated in the South Atlantic Planning area due to extension of the moratorium on lease sales in the Atlantic.

(b) Norfolk

At least portions of nine active lease blocks are located within the Norfolk test area, and four others are on the edge. However, there are no oil and gas pipelines or platforms in the area. If the shock trial is conducted at Norfolk, a status update would be requested from the MMS.

(c) Pascagoula

The Pascagoula test area is in the MMS Eastern Gulf of Mexico Planning Area, which extends from Baldwin County, Alabama southward to the Florida Keys. Administrative deferrals and legislative moratoria have limited petroleum activity in the Eastern Planning Area. At least portions of nine active petroleum lease blocks occur in the Pascagoula test area. However, there are no oil and gas pipelines or platforms within the test area. The MMS has announced plans for an upcoming lease sale in the Eastern Gulf of Mexico that includes some blocks near the Pascagoula test area (MMS, 1999). However, most of the blocks are in deeper water outside the test area, and the bid opening would not occur until December 2001, after the proposed shock trial period. If the shock trial is conducted at Pascagoula, a status update would be requested from the MMS.

Chevron U.S.A. and partners have proposed an offshore gas development in the "Destin Dome Unit," a group of lease blocks northwest of the Pascagoula test area. The MMS has issued a Draft Environmental Impact Statement for the proposed development (MMS, 1999). It is possible that development activities such as platform and pipeline installation could be occurring in the Destin Dome Unit by the time of the shock trial in 2001. Some portions of the Destin Dome Unit blocks would be within 10 nmi (the radius of the ship warning zone) if a test site were selected in the northwestern corner of the Pascagoula test area. Therefore, if the Pascagoula test area is selected

for the shock trial, the Navy would contact the MMS and Chevron to determine whether any petroleum industry activities are planned during the period of the shock trial and to coordinate activities.

In addition to petroleum exploration and development activities, two companies are proposing natural gas pipelines running from the Mobile Bay area to Florida that would run through the proposed Pascagoula test area. While only one of these proposed pipeline routes will be permitted by the Federal Energy Regulatory Commission (FERC), both the proposed routes pass through the northeastern edge of the Pascagoula test area. Both companies are currently conducting extensive biological and geophysical surveying along their proposed routes, but it is unlikely that actual pipeline construction will begin before 2001.

3.3.6 Miscellaneous Features

The exclusionary mapping process also identified features such as unused explosives dumpsites, unexploded ordnance, shipwrecks and obstructions, and artificial reefs near the proposed test areas. As explained in Section 2.2.3, a 1.85 km (1 nmi) buffer zone was applied to these features to protect associated fish aggregations and avoid disturbing the contents. Any portion of these features or their buffer zones overlapping the test area was excluded. Since exclusion would avoid impacts to these features, no further description is necessary.

An unused submarine communications cable was identified passing through the Mayport test area. Because the communications cable is no longer in use, no buffer zone or exclusion was applied. There would be no impact to international telecommunications should the cable be damaged (Wargo, 1994).

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter analyzes potential impacts of conducting a shock trial of the WINSTON S. CHURCHILL at one of three alternative test areas: Mayport, Florida; Norfolk, Virginia; or Pascagoula, Mississippi. The discussion focuses on significant issues identified through the scoping process. Issues that do not require detailed analysis are discussed briefly at the beginning of each major subsection.

Because all three test areas are in deep waters well offshore, many potential impacts are similar. To avoid redundancy, separate sections for Mayport, Norfolk, and Pascagoula are not presented. Instead, potential impacts at the three test areas are contrasted within each major subsection.

Impact discussions are divided into separate subsections to distinguish between those aspects of the proposed action evaluated under Executive Order 12114 and those evaluated under the National Environmental Policy Act (NEPA). Executive Order 12114 applies to activities and impacts outside territorial seas, whereas NEPA applies to activities and impacts within U.S. territory. The proposed action includes operations that would occur both within and outside U.S. territory. The shock trial and associated mitigation operations would occur at least 79 km (43 nmi) offshore at the Mayport area, at least 60 km (32 nmi) offshore at the Norfolk area, or at least 50 km (27 nmi) offshore at the Pascagoula area, outside U.S. territorial seas. No impacts from the actual shock trial (detonation of explosives) would occur in U.S. territory. The only operations that would occur within territorial limits are shore support activities and vessel and aircraft movements in territorial waters (i.e., transits between the shore base and the offshore shock trial site). These shore support activities and vessel and aircraft movements are not unusual or extraordinary and are part of the routine operations associated with the existing shore bases.

4.1 IMPACTS UNDER EXECUTIVE ORDER 12114

Potential impacts at and near the test site are summarized in **Table 4.1**. The main issues are the direct impacts of underwater detonations on marine mammals and turtles. These impacts are discussed first, followed by impacts on other components of the biological, socioeconomic, and physical environment.

4.1.1 Marine Mammals

At any of the test areas, shock trial detonations may kill or injure marine mammals. Specifically, marine mammals may be killed or seriously injured if they are present within the Safety Range (radius of 3.7 km [2 nmi]) and not detected during pre-detonation monitoring. At greater distances, up to 32.8 km (17.7 nmi) for odontocetes and 42.6 km (23.0 nmi) for mysticetes depending on the test area and the water depth of the specific test site, marine mammals may experience temporary hearing loss which could lead to temporarily altered behavior. At still greater distances, marine mammals may hear the detonations and some may respond (e.g., startle, orientation to a novel stimulus). It is unlikely that an individual animal would experience more than a single, momentary disturbance.

Table 4.1. Summary of potential impacts and mitigation measures.

Affected Environment	Impact Description	Type	Location	Timing/Duration	Mitigation Included in Proposed Action	Expected Differences among Test Areas
BIOLOGICAL ENVIRONMENT						
Marine mammals	Death or serious injury due to shockwave pressure	Direct	Death: within 0.73 nmi of detonation Injury: within 1.22 nmi of detonation	Immediate; some injuries could heal in days to weeks, others could be permanent	• Select site with low abundance of marine mammals • Conduct aerial, shipboard, and passive acoustic monitoring prior to detonation, postpone until Safety Range is clear of detectable marine mammals	Risk higher at Norfolk due to higher marine mammal densities. Norfolk also has largest number of species affected including several endangered mysticetes
	Minor injuries, e.g., low probability of eardrum rupture and permanent hearing loss	Direct	Beyond Safety Range (2 nmi), out to several nautical miles	Immediate; some injuries could heal in days to weeks; some permanent hearing loss	• Select site with low abundance of marine mammals • Postpone detonation if endangered or threatened mammals detected in Buffer Zone and cannot be reacquired	Risk higher at Norfolk (same as above)
	Disruption of hearing-based behaviors as indicated by temporary threshold shift (TTS), i.e., temporary hearing loss	Direct	Within about 18 nmi of detonation for odontocetes and within about 23 nmi for mysticetes	Immediate, lasting minutes to about a day	• Select site with low abundance of marine mammals	Risk higher at Norfolk due to higher marine mammal densities and deeper water (increases TTS range). Mysticetes, which have greater TTS range, are most likely to be present at Norfolk
	Possible spontaneous behavioral responses to sound	Direct	Tens to hundreds of nautical miles (not reliably predictable)	Timing: seconds to minutes after detonation Duration: momentary (seconds to minutes)	None	--
	Possible alteration in prey abundance, including attraction to fish killed by blast	Indirect	Within about 1 nmi of detonation	Immediate impact but transient (minutes to hours)	None	--

Table 4.1. (continued).

Affected Environment	Impact Description	Type	Location	Timing/Duration	Mitigation Included in Proposed Action	Expected Differences among Test Areas
Sea turtles	Death or serious injury due to shockwave pressure	Direct	Death: within 0.73 nmi of detonation Injury: within 1.22 nmi of detonation	Immediate; some injuries could heal in days to weeks, others could be permanent	• Select site with low abundance of turtles • At Mayport, select site that is seaward of Gulf Stream western wall • Conduct aerial and shipboard monitoring prior to detonation, postpone until Safety Range is clear of detectable turtles, large *Sargassum* rafts, debris lines, and jellyfish concentrations	Risk higher at Norfolk due to higher turtle densities
	Minor injuries	Direct	Beyond Safety Range (2 nmi), out to several nautical miles	Immediate; some injuries could heal in days to weeks; some permanent hearing loss	• Select site with low abundance of turtles • At Mayport, select site that is seaward of Gulf Stream western wall	Risk higher at Norfolk (same as above)
	Disruption of hearing-based behaviors as indicated by temporary threshold shift (TTS), i.e., temporary hearing loss	Direct	Within about 18 nmi of detonation	Immediate, lasting minutes to about a day	• Select site with low abundance of turtles • At Mayport, select site that is seaward of Gulf Stream western wall	Risk higher at Norfolk due to higher turtle densities and deeper water (increases TTS range)
	Possible spontaneous behavioral responses to sound	Direct	Tens to hundreds of nautical miles	Seconds to minutes after detonation	None	--
	Possible alteration in prey abundance (e.g., jellyfish for leatherbacks)	Indirect	Within about 1 nmi of detonation	Immediate impact but transient (minutes to hours)	• Postpone detonation if large jellyfish concentrations seen within Safety Range	--

Table 4.1. (continued).

Affected Environment	Impact Description	Type	Location	Timing/Duration	Mitigation Included in Proposed Action	Expected Differences among Test Areas
Pelagic fish	Death or serious injury due to shockwave pressure; esp. fish with swimbladder and schooling species	Direct	Within about 1 nmi of detonation	Immediate	• Postpone detonation if large schools of fish seen within 1 nmi radius	--
	Possible minor auditory and behavioral effects	Direct	Tens to hundreds of nautical miles	Immediate	None	--
Seabirds	Death or serious injury due to shockwave	Direct	Within about 500 ft of detonation (plume) and for birds diving within about 1 nmi of detonation	Immediate	• Postpone detonation if seabird flocks seen within 1 nmi of detonation	--
	Possible attraction to fish killed by blast (possibly beneficial impact)	Indirect	Within several hundred meters	Immediate and transient (minutes to hours)	None	--
Ichthyoplankton and *Sargassum* communities	Direct physical destruction by blast	Direct	Within several hundred meters	Immediate and transient (minutes to hours)	• Postpone detonation if large *Sargassum* rafts or debris lines seen within Safety Range (to protect juvenile turtles)	--
Benthic communities	Injury and physical habitat disruption due to shockwave pressure	Direct	Immediately beneath detonation point	Immediate	• Avoid hard bottom and coral areas by excluding them plus 1 nmi buffer	--
	Growth of fouling organisms on charge debris(possibly beneficial impact)	Indirect	Immediately beneath detonation point	Timing: minutes Duration: months to years	None	--

Table 4.1. (continued).

Affected Environment	Impact Description	Type	Location	Timing/Duration	Mitigation Included in Proposed Action	Expected Differences among Test Areas
SOCIOECONOMIC ENVIRONMENT						
Commercial and recreational fisheries	Exclusion of fishing vessels from test site during each detonation	Direct	5 nmi radius (exclusion zone)[a] 10 nmi radius (vessels warned)	Beginning 5 to 6 hours prior to detonation; total time up to 12 hours per detonation	• Provide Notice to Mariners	--
	Death/injury to fishery species	Direct	Within about 1 nmi of detonation	Immediate	• Postpone detonation if large schools of fish seen within 1 nmi radius	--
Ship traffic	Exclusion of non-military vessels test site during each detonation	Direct	5 nmi radius (exclusion zone) 10 nmi radius (vessels warned)	Beginning 5 to 6 hours prior to detonation; total time up to 12 hours per detonation	• Provide Notice to Mariners	--
PHYSICAL ENVIRONMENT						
Geology and sediments	Disturbance of bottom sediments	Direct	Immediately beneath detonation point	Immediate	None	--
	Deposition of charge fragments	Direct	Immediately beneath detonation point	Immediate (seconds to a few minutes to reach bottom)	None	--
Air quality and noise	Release of explosion products into atmosphere	Direct	Within a few hundred meters of detonation	Immediate (few minutes to disperse)	None	--
Water quality	Release of explosion products into water	Direct	Within a few hundred meters of detonation	Immediate (few minutes to disperse)	None	--

[a] The ship exclusion zone is an electronic emissions control zone that virtually eliminates the possibility of an inadvertent detonation caused by radio/radar induced electrical current in the explosive firing circuit. It also provides an area of safe maneuvering for the charge-handling vessel and the explosive it is towing.

There are also several minor issues that do not require detailed analysis. Effects of chemical products of the explosions are considered negligible because the initial concentrations are not hazardous to marine life and the products are rapidly dispersed in the ocean [see Section 4.1.5(c)]. Minor increases in vessel and air traffic are not a major concern from the standpoint of marine mammal harassment because of built-in mitigation measures (use of shipboard observers; limited transit speed; and flights at approved altitudes). Indirect impacts to marine mammals through altered prey abundance are discussed briefly.

Incidental Take Request. Because the proposed action may kill, injure, or harass marine mammals, the Navy submitted a request for an "incidental take" authorization from the National Marine Fisheries Service (NMFS) following the release of the DEIS. Section 101(a)(5) of the MMPA allows the incidental (but not intentional) taking of marine mammals upon request if the taking will (1) have a negligible impact on the species or stock(s); and (2) not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. In response to the Navy's incidental take request, the NMFS published a Proposed Rule in the Federal Register in December 2000 (65 FR 77546). The Proposed Rule specifies mitigation, monitoring, and reporting requirements for the shock trial. A Final Rule must be issued before the shock trial can proceed.

Endangered Species Consultation. Because endangered marine mammals under NMFS jurisdiction may be affected by the proposed action, the Navy initiated formal consultation with the NMFS under Section 7 of the Endangered Species Act. The DEIS served as a Biological Assessment that was submitted to the NMFS. Based on this information, the NMFS issued a Biological Opinion taking into account the cumulative impacts of all activities potentially affecting listed marine mammal and turtle populations. The Biological Opinion (which is included in Appendix G of the FEIS) evaluates if the shock trial is likely to jeopardize the continued existence of endangered or threatened species or result in destruction or adverse modification of their critical habitat. The Biological Opinion specifies additional mitigation and monitoring requirements. Formal consultation with the U.S. Fish and Wildlife Service (USFWS) is not required because the Navy has determined (and the USFWS has concurred) that the proposed action would not adversely affect the Florida manatee, an endangered marine mammal that is under USFWS jurisdiction.

Mitigation Included in the Proposed Action. The impact analysis takes into account the marine mammal and sea turtle mitigation/monitoring program described in Section 5.0. The Navy would (1) select an operationally suitable test site that poses the least risk to the marine environment; (2) effectively monitor the site prior to each detonation to ensure that it is free of detectable marine mammals, turtles, large *Sargassum* rafts, debris lines, or jellyfish concentrations, large schools of fish, and flocks of seabirds; and (3) determine the effectiveness of the mitigation efforts by using a Marine Animal Recovery Team (MART) and aerial observers to survey the site for injured or dead animals after each detonation. If post-detonation monitoring showed that marine mammals or turtles were killed or injured as a result of a detonation or if any marine mammals or turtles were detected in the Safety Range immediately following a detonation, testing would be halted until procedures for subsequent detonations could be reviewed and changed as necessary.

The purpose of the Safety Range (3.7 km or 2 nmi) and the Buffer Zone (1.85 km or 1 nmi) is to minimize the risk of killing or injuring a marine mammal or sea turtle. The Safety Range exceeds

the estimated ranges for mortality and injury associated with detonation of a 4,536 kg (10,000 lb) explosive at a depth of 61 m (200 ft). Its radius is approximately 2.7 times the mortality range which is based on onset of extensive lung hemorrhage and 1.6 times the injury range which is based on onset of slight lung hemorrhage. A 1.85 km (1 nmi) Buffer Zone has also been added beyond the Safety Range to account for the possible movement of marine mammals and sea turtles toward the Safety Range. The Buffer Zone would be visually monitored to detect any marine mammals or sea turtles approaching the Safety Range. Detonation would be postponed if listed (endangered or threatened) marine mammals were detected in the Buffer Zone, essentially requiring a 5.6 km (3 nmi) "go/no-go" range for these species. Species-specific protocols have been developed to determine when and how long to postpone a detonation if a marine mammal or sea turtle is detected in the Buffer Zone (see Section 5.0).

The mitigation/monitoring program is based on the Navy's previous experience during the shock trial of the USS JOHN PAUL JONES off Southern California in 1994. That shock trial involved detonation of two 4,536 kg (10,000 lb) charges, and no marine mammal deaths or injuries were detected. Marine mammal densities at the JOHN PAUL JONES shock trial location (Naval Air Warfare Center, 1994) were substantially higher than those estimated in this FEIS for the Mayport, Norfolk, and Pascagoula test areas.

(a) Analytical Approach

Appendix C quantifies the risk of killing or injuring a marine mammal during the shock trial in two ways: (1) in terms of probabilities of mammals occurring in the Safety Range (radius of 3.7 km or 2 nmi); and (2) in terms of numbers of marine mammals expected to be killed or injured, or experience disruption of hearing-based behaviors. The calculations provide a basis for comparing alternative areas in the FEIS, since the same assumptions and methods are used for Mayport, Norfolk, and Pascagoula.

The following discussion frequently refers to groups of marine mammals. Groups are the fundamental unit of marine mammal sightings during aerial and ship surveys. The density of groups (rather than individuals) is the appropriate basis for calculating risk because many cetacean species occur in herds. For example, consider two hypothetical test areas, one with 50 groups of 2 animals and the other with 2 groups of 50 animals. Assume that within each large test area, a small Safety Range (3.7 km [2 nmi] radius) will be selected. The risk of at least one group occurring within the Safety Range would be much greater in the first case because there are many more groups to encounter. Also, in the second case, a group occurring in the Safety Range would be easily detected, since large herds are highly visible. If only individual densities were compared, the two test areas would be considered equivalent, which is clearly not the case. The density of groups, along with mean group size, provides the appropriate basis for calculating risk, and ultimately, estimating numbers of individuals potentially affected by the proposed action.

Ultimately, four quantities are of interest:

1. The probability of zero marine mammal or turtle groups being present in the Safety Range. This is termed "**probability of clear range**" since it means the detonation could occur with no mammals or turtles present in the Safety Range. Presence refers to both detectable and non-detectable (e.g., submerged, silent) groups.

2. The probability of one or more groups being present in the Safety Range, and one or more groups being detected. This is termed "**probability of delay**" since detection of one or more groups would postpone detonation.

3. The probability of one or more groups being present in the Safety Range, but none detected. This is termed "**probability of take**" since it means a detonation could occur with mammals or turtles in the Safety Range.

4. The expected number of mammals (and turtles) within various radii of the detonation point (i.e., zones for mortality, injury, and disruption of hearing-based behaviors) after taking into account pre-detonation monitoring. This quantity is referred to as "**incidental take.**"

In Appendix C, the probability of "clear range" is calculated from densities estimated during aerial and/or shipboard surveys. The numbers are adjusted to account for submerged individuals. Resulting densities are multiplied by the area of the Safety Range to predict expected numbers of groups. Based on the assumption of an approximately random spatial distribution of groups, the probability of zero groups within the Safety Range is calculated.

The probabilities of "take" and "delay" require additional information about the probability of detecting mammal and turtle groups during pre-detonation monitoring. This information comes from the design of the monitoring program (numbers and spacing of transects), as well as published data on sighting probabilities by aerial and shipboard observers. Information about submergence intervals of mammals and turtles is also needed to estimate the proportion of the population that is on the surface and therefore available for visual detection. The probability of "delay" is calculated by multiplying detection probabilities by the probability of one or more groups being present. The probability of "take" is calculated by subtraction, since the probabilities of "clear range," "delay" and "take" must sum to 1.0. Details of the calculations are given in Appendix C.

Numbers of marine mammals potentially killed, injured, or experiencing disruption of hearing-based behaviors as a result of the proposed detonations ("incidental take" numbers) were estimated in Appendix C using a series of steps and assumptions:

1. Ranges for mortality, injury, and disruption of hearing-based behaviors were calculated using criteria and thresholds developed in Appendices D and E. The criteria are listed in **Table 4.2** and explained later in this section. The mortality and injury criteria are based on tests conducted with terrestrial mammals, and the criterion for disruption of hearing-based behaviors is based on temporary threshold shift (TTS) in bottlenose dolphins.

Table 4.2. Marine mammal and turtle impact criteria, thresholds, and ranges.

Impact Category	Criterion	Threshold	Range	
			Odontocetes and Sea Turtles	Mysticetes
Mortality	Onset of extensive lung hemorrhage	Impulse: 52.8 psi-msec (364 Pa-sec)	4,434 ft (1,351 m) (0.73 nmi)	
Injury	Onset of slight lung hemorrhage	Impulse: 25.3 psi-msec (175 Pa-sec)	7,383 ft (2,250 m) (1.22 nmi)	
Disruption of hearing-based behaviors	Temporary threshold shift (TTS)	182 dB energy in any 1/3 octave band or 12 psi peak pressure [a]	Mayport: [b] 13.3 to 25.2 km (7.2 to 13.6 nmi) Norfolk: [b] 16.7 to 32.8 km (9.0 to 17.7 nmi) Pascagoula: [b] 15.9 to 24.6 km (8.6 to 13.3 nmi)	Mayport: [b] 24.1 to 27.8 km (13.0 to 15.0 nmi) Norfolk: [b] 25.9 to 42.6 km (14.0 to 23.0 nmi) Pascagoula: [b] 22.8 to 29.6 km (12.3 to 16.0 nmi)

[a] Both energy and pressure were estimated in each case, with the more conservative of the two being used. In most cases, the 182 dB energy criterion was the determining factor.

[b] Separate onset TTS ranges were calculated using the 182 dB energy criterion for mysticetes vs. odontocetes and sea turtles. The odontocete/sea turtle ranges are based on frequencies ≥100 Hz and the mysticetes ranges are based on frequencies ≥10 Hz. Onset TTS ranges were calculated at three different water depths for each test area; the maximum and minimum ranges are given. Onset TTS range generally increased with water depth (but the maximum was not always at the greatest depth; see Appendix E).

2. These ranges were used to define concentric circles around the detonation point (**Figure 4.1**), and to calculate the area within each circle.

3. Mean densities of each species (from Appendix B) were multiplied by the area of the mortality, injury, and onset TTS to estimate the number of mammals affected "without mitigation" for a single detonation.

4. The estimates for a single detonation were multiplied by four to account for up to four detonations that could occur during the WINSTON S. CHURCHILL shock trial.

5. The probability of detecting each marine mammal species was estimated, taking into account aerial and surface observers and passive acoustic monitoring (see Appendix C).

6. For mortality and injury, the "without mitigation" numbers for each species were then multiplied by (1 minus detection probability). The resulting values are the expected number of undetected groups of each species within the mortality and injury ranges. The number of groups was multiplied by a group size for each species to predict number of individuals affected. Results were summed over all species and then rounded up to the nearest whole number.

7. For disruption of hearing-based behaviors, the "with mitigation" numbers were assumed to be equal to the "without mitigation" numbers, because mitigation (i.e., postponement due to animals in Safety Range) applies to only a small proportion of the TTS area. Species historically present at or near each area but not seen during aerial or shipboard surveys used to estimate densities were each assigned a value of one individual for disruption of hearing-based behaviors. Results for individual species were summed and then rounded up to the nearest whole number.

(b) Probability Analysis

Table 4.3 summarizes the probability analysis for marine mammals at the Mayport, Norfolk, and Pascagoula test areas. The table also lists mean densities, which were the basis for the probability calculations. Details are provided in Appendix C.

<u>Probability of Clear Range</u>. The probability of zero marine mammal groups in the Safety Range is 0.16 at Mayport, 0.11 at Pascagoula, and 0.02 at Norfolk. The lowest probability at Norfolk corresponds to the highest marine mammal densities. Although Pascagoula had the lowest group densities, it did not have the highest probability of clear range. The most frequently sighted cetaceans at Pascagoula are dwarf/pygmy sperm whales, which are assumed to be submerged most of the time. A correction for submerged individuals resulted in higher adjusted densities of dwarf/pygmy sperm whales and a lower probability of clear range at Pascagoula.

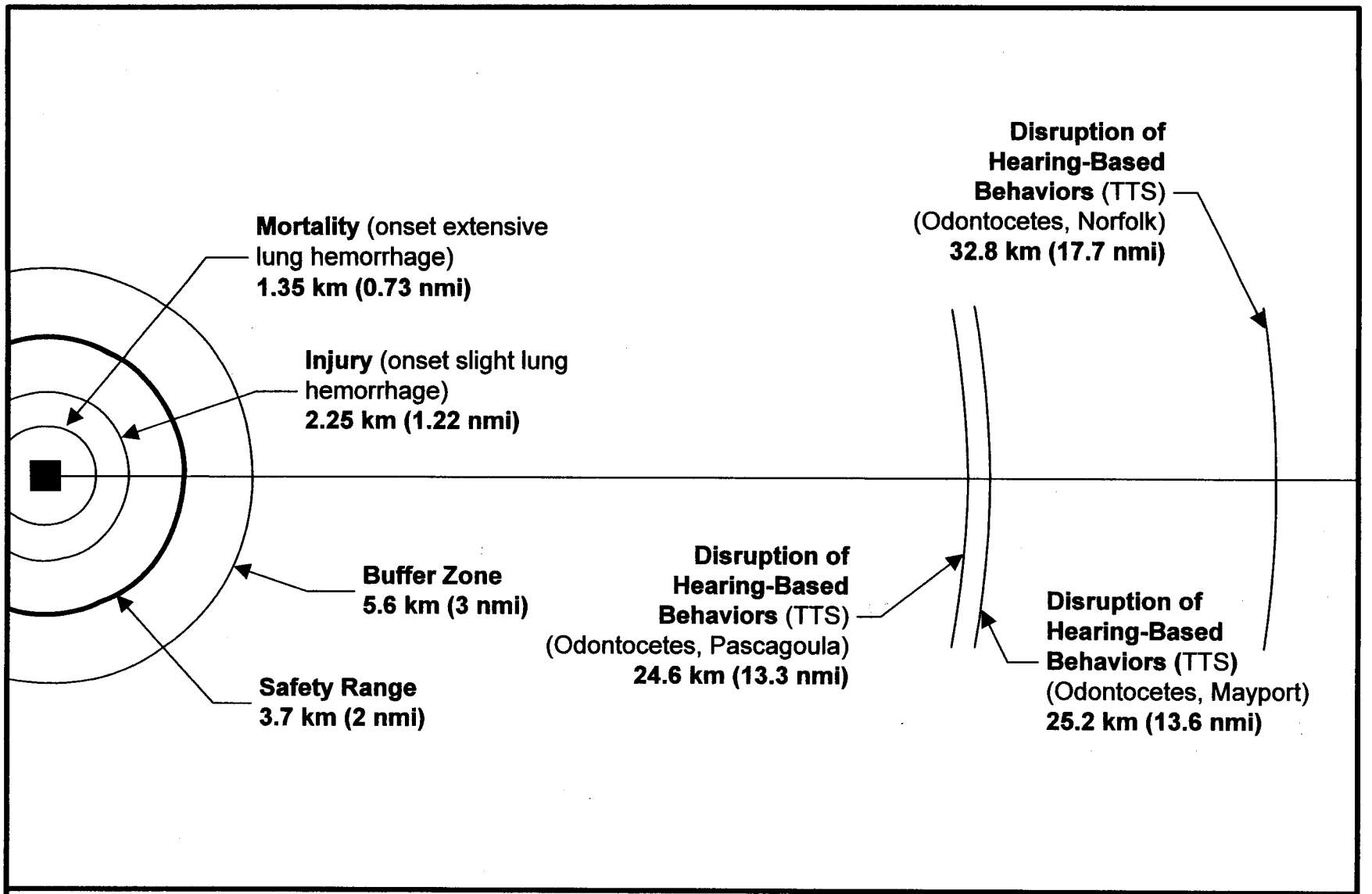

Figure 4.1. Illustration of predicted ranges for various criteria in relation to the detonation point. Odontocete TTS ranges shown are the maximum for each test area regardless of water depth. TTS ranges for mysticetes are not shown (see Table 4.2 for ranges).

Table 4.3. Summary of mean densities, probabilities, and incidental take estimates for marine mammals.

		Mayport	Norfolk	Pascagoula
Mean Densities:				
• Groups/100 km^2		2.094	3.596	1.004
• Individuals/100 km^2		18.033	50.970	18.480
Probabilities:				
• "Clear Range" (zero groups in Safety Range)		0.16	0.02	0.11
• "Delay" (1 or more groups in Safety Range but detected)		0.51	0.64	0.25
• "Take" (1 or more groups in Safety Range but not detected)		0.33	0.34	0.65
Expected Number of Individuals:				
• Killed		4 (3.19)	7 (6.22)	3 (2.11)
• Injured		6 (5.65)	12 (11.03)	4 (3.75)
• Behavioral disruption (due to TTS)		2885	14640	3132
Species affected:	**Status**[a]			
Mysticetes				
Bryde's whale	none	--	•	o
Fin whale	E/S	--	•	--
Humpback whale	E/S	--	o	--
Minke whale	none	--	•	--
Sei whale	E/S	--	•	--
Odontocetes				
Sperm whale	E/S	o	•	o
Atlantic spotted dolphin	none	o	■	•
Bottlenose dolphin	none	■	■	■
Clymene dolphin	none	b	•	•
Common dolphin	S	--	o	--
Dwarf/pygmy sperm whale	none	b/b	b/b	■
False killer whale	none	o	b	b
Pantropical spotted dolphin	none	b	o	o
Pilot whale	S	•	■	b
Pygmy killer whale	none	b	b	b
Risso's dolphin	none	■	•	o
Rough-toothed dolphin	none	b	b	b
Spinner dolphin	none	b	•	o
Striped dolphin	none	b	•	•
Blainville's beaked whale	S	b	b	b
Cuvier's Beaked whale	S	b	b	b
Gervais' beaked whale	S	b	b	b
True's beaked whale	S	b	b	--

Key: ■ = probability of take ≥0.10 and species accounts for ≥10% of all marine mammals estimated to be killed or injured; • = probability of take between 0.01 and 0.10; o = included in mortality injury calculations, but probability of take ≤0.01; b = behavioral disruption (due to TTS) only; (--) = not expected to be present.

[a] Status: E = endangered under the Endangered Species Act of 1973; S = strategic stock under the Marine Mammal Protection Act of 1972, as indicated by Waring et al. (1999).

Probability of Delay. The probability of one or more marine mammal groups occurring in the Safety Range and being detected (thereby causing a delay) is 0.64 at Norfolk, 0.51 at Mayport, and 0.25 at Pascagoula. The high probability of delay at Norfolk reflects, in part, the high group density of sperm whales, which are highly likely to be detected if present. The low probability at Pascagoula reflects both low densities and the relative abundance of dwarf/pygmy sperm whales, which have a low probability of detection.

Probability of Take. The probability of one or more marine mammal groups occurring in the Safety Range and not being detected (potentially resulting in mortality or injury) is 0.65 at Pascagoula, 0.34 at Norfolk, and 0.33 at Mayport. The high take probability at Pascagoula partly reflects the relative abundance of dwarf/pygmy sperm whales, which as noted previously, have a low probability of detection.

(c) Mortality and Injury

There are no detailed experimental results from marine mammals upon which to base a quantitative analysis of the potential effects of a large, underwater detonation. However, the best available data indicate that auditory systems and gas-filled structures of the respiratory and gastrointestinal tract are the the most susceptible to blast damage. By using the results from controlled underwater explosion experiments on small terrestrial mammals (dogs and sheep), reasonable assumptions can be made concerning potential impacts to small marine mammals. Further, terrestrial mammal and marine mammal auditory systems have similarities in structure and function that make it possible to predict impacts from terrestrial studies (Ketten, 1995, 1998). Other anatomical characteristics of marine mammals as contrasted with their terrestrial counterparts were taken into account in the analysis in Appendix D. Because of the uncertainties in extrapolating from terrestrial to marine mammals, effect ranges in Appendix D have been calculated using conservative assumptions that are intended to deliberately overestimate the risk of injury.

Mammals can be killed or injured by underwater explosions due to the response of air cavities, such as the lungs and bubbles in the intestines, to the shock wave (Office of the Surgeon General, 1991). Effects are likely to be most severe in near surface waters above the detonation point where the reflected shock wave creates a region of negative pressure or "cavitation" (**Figure 4.2**). This is a region of near total physical trauma within which no animals would be expected to survive. Based on calculations in Appendix D, the maximum horizontal extent of the cavitation region is estimated to be 683 m (2,240 ft) for the proposed detonations. This region would extend from the surface to a maximum depth of about 23 m (77 ft).

A second criterion for mortality (and the one that is used here) is the **onset of extensive lung hemorrhage.** Extensive lung hemorrhage is considered debilitating and potentially fatal, aside from the immediate embolism or fracture; suffocation caused by lung hemorrhage is likely to be the major cause of marine mammal death from underwater shock waves, based on experiments with terrestrial mammals (see Appendix D). Appendix D presents calculations that estimate the range for the onset of extensive lung hemorrhage to marine mammals. The range varies depending on mammal weight, with the smallest mammals having the greatest potential hazard range. The

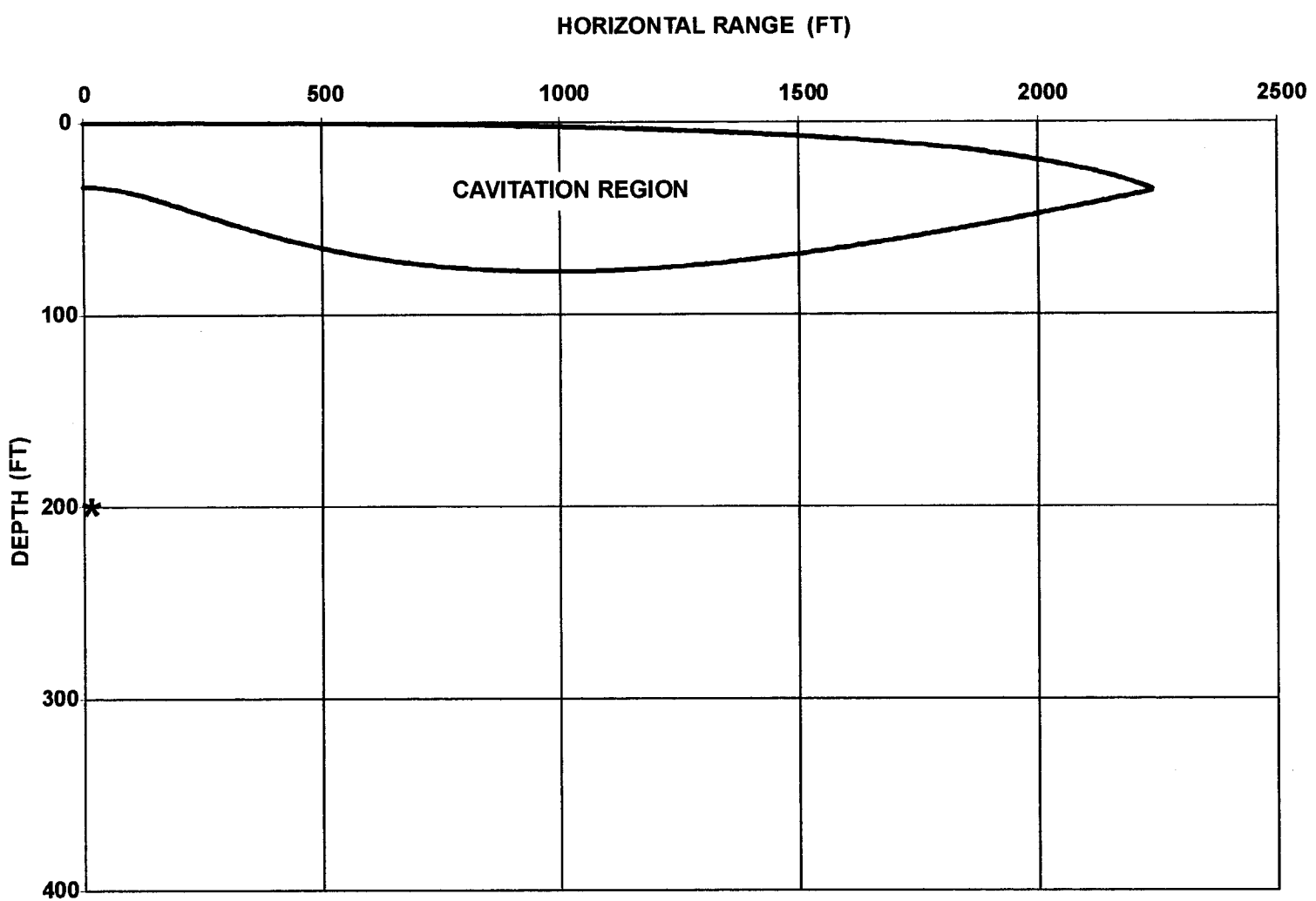

Figure 4.2. Cavitation region for a 10,000 lb (4,536 kg) charge detonated at a depth of 200 ft (61 m).

range that onset of extensive lung hemorrhage is predicted to occur and to kill 1% of small marine mammals (e.g., a dolphin calf) is 1.35 km (0.73 nmi) from the detonation point (**Figure 4.3**). *For purposes of impact analysis, it was assumed that 100% of the marine mammals within this radius would be killed.*

Two criteria for non-lethal injury discussed in Appendix D are **onset of slight lung hemorrhage** and **50% probability of eardrum rupture**. These are injuries from which animals would be expected to recover on their own. The 50% probability of eardrum rupture was considered as an injury criterion because it is a standard, statistically meaningful measure that has been estimated in a variety of mammals (Ketten, 1995, 1998). Although never studied in marine mammals, in terrestrial mammals, 50% incidence of TM rupture is associated with 30% incidence of PTS. The range predicted for the onset of slight lung hemorrhage is 2.25 km (1.22 nmi). The range predicted for 50% probability of eardrum rupture varies with mammal depth in the water column; the highest value of 2.16 km (1.17 nmi) is calculated for a mammal at a depth of 335 m (1,100 ft) (**Figure 4.3**). The criterion with the greater range (onset of slight lung hemorrhage) was used for non-lethal injury. *For purposes of impact analysis, it was assumed that 100% of marine mammals within this radius would be injured.*

However, as noted above, the mortality calculations based on onset of extensive lung hemorrhage assume that 100% of animals within a radius of 1.35 km (0.73 nmi) would be killed. All animals within this radius are assumed to be killed although in reality some number will not be injured.

Table 4.3 summarizes the mortality and injury estimates for the Mayport, Norfolk, and Pascagoula test areas. Results for individual species were summed and then rounded up to the nearest whole number. The calculations predict that Pascagoula would have the lowest incidental take, with up to 3 mammals killed and 4 injured. For Mayport, the predictions are up to 4 killed and 6 injured. Norfolk has the highest incidental take numbers with up to 7 killed and 12 injured.

Mayport. For Mayport, the predictions are up to 4 killed and 6 injured. Taxa presumed to have some chance of being killed or injured include all eight cetacean taxa sighted during the Navy's June and August 1999 surveys as well as the sperm whale (not sighted in 1999, but seen during both 1995 and 1997 Mayport aerial surveys). In order of group densities, these are: bottlenose dolphin, Risso's dolphin, pilot whale, unidentified dolphin, bottlenose/Atlantic spotted dolphin, sperm whale, Atlantic spotted dolphin, false killer whale, and unidentified odontocete.

Bottlenose dolphin and Risso's dolphin accounted for 95% of the groups and individuals sighted and are the only two species with greater than 0.10 probability of take (i.e., being present but undetected in the Safety Range). The probability is 0.27 for bottlenose dolphin and 0.17 for Risso's dolphin (see Appendix C). For bottlenose dolphin, the estimated numbers for four detonations are 1.84 individuals killed and 3.26 individuals injured. For Risso's dolphin, the estimated numbers for four detonations are 1.19 individuals killed and 2.11 individuals injured. Additional taxa with a take probability of 0.01 or greater are pilot whales (0.01) and unidentified odontocetes (0.02).

The only endangered marine mammal likely to be present at Mayport is the sperm whale. The estimated numbers for four detonations are <0.01 individuals killed and 0.01 individuals injured.

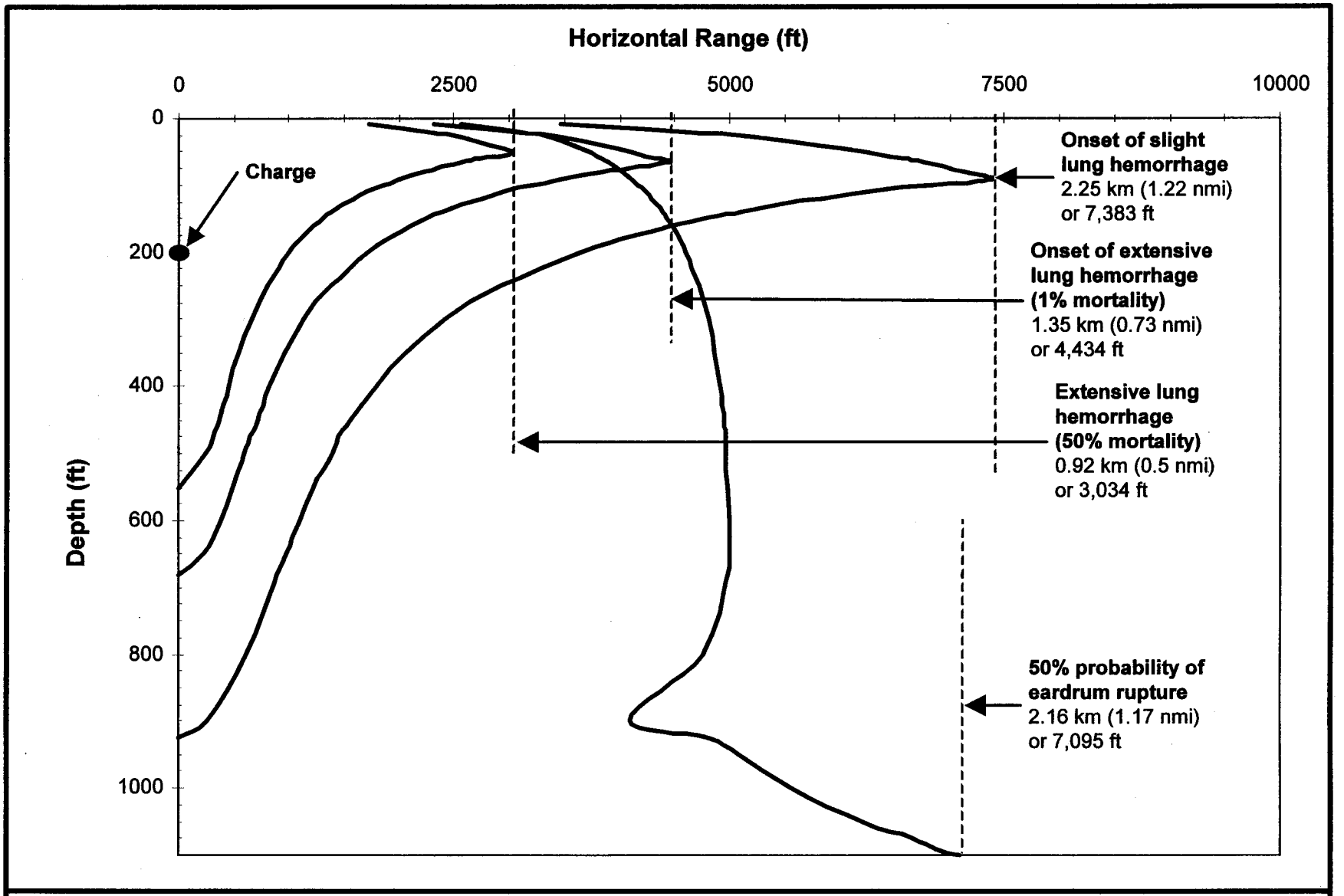

Figure 4.3. Calculated injury contours for a calf dolphin (12.2 kg or 27 lb) for a 4,536 kg (10,000 lb) HBX-1 charge detonated at a depth of 61 m (200 ft).

The probability of one or more sperm whale groups being present in the Safety Range and not detected is <0.01 (see Appendix C). Therefore, it is highly unlikely that any sperm whales would be killed or injured. Sperm whales produce distinctive clicked vocalizations (Jefferson et al., 1993) and are very likely to be detected (if present) using the passive acoustic monitoring system described in Section 5.0. The other endangered marine mammals (blue, fin, humpback, sei, and northern right whales) potentially occurring at Mayport generally inhabit northern feeding grounds during the period proposed for the shock trial and were never observed off Mayport during the 1995, 1997, or 1999 aerial surveys. It is assumed none would be killed or injured by the proposed action.

Northern right whales are of special concern because of their highly endangered status; only about 300 individuals remain (Blaylock et al., 1995). The possibility of a right whale being present in the Mayport area during the potential test period (May through September) is remote. Northern right whales generally occur off Mayport from November/early December to April, with peak abundance between January and March (Kraus et al., 1993). Of 401 northern right whale sightings between 1950 and 1995, none occurred during May through September (Kenney, 1995). No northern right whales were seen during the April-September 1995, May-September 1997, or June and August 1999 aerial surveys. If a northern right whale were present, it would almost certainly be detected by pre-detonation monitoring, as described in Section 5.0. According to recent aerial observations in the Mayport area during the calving season, northern right whales spend 15-87% of their time on the surface, with averages of 36% for single juveniles, 72% for mother/calf pairs, and 79% for surface active groups (Hain and Ellis, 1996). Similarly, Swartz (1999) reported that a right whale cow and calf monitored with a radio transmitter spent 45% of their time on the surface. Therefore, during the 2.5 hours preceding detonation, a northern right whale could be on the surface for a total of 22 minutes to over 2 hours. Mean dive times are a few minutes. The probability of at least one aerial or surface observer detecting large animals which spend so much time at the surface is near 100%.

Norfolk. For Norfolk, the predictions are up to 7 marine mammals killed and 12 injured. Taxa presumed to have some chance of being killed or injured include all 19 taxa sighted during the Navy's April-September 1995 SEAWOLF surveys at the Norfolk test area. In order of group densities, these are: pilot whales, sperm whale, Atlantic spotted dolphin, unidentified dolphin, bottlenose dolphin, fin whale, Risso's dolphin, *Stenella* spp., minke whale, sei whale, bottlenose/Atlantic spotted dolphin, sei/Bryde's whale, pantropical spotted dolphin, spinner dolphin, *Balaenoptera* sp., unidentified large whale, striped dolphin, humpback whale, and common dolphin.

Four taxa at Norfolk had greater than 10% probability of take (i.e., being present but undetected in the Safety Range) and represented at least 10% of the total mortality and injury. These are (with estimated numbers for four detonations): Atlantic spotted dolphin (1.22 killed, 2.16 injured), bottlenose dolphin (0.69 killed, 1.22 injured), pilot whales (2.81 killed, 4.99 injured), and unidentified dolphin (0.74 killed, 1.30 injured). Additional species with greater than 0.01 probability of being present but undetected in the Safety Range are Bryde's whale (0.03), fin whale (0.07), minke whale (0.04), sei whale (0.04), sperm whale (0.06), Risso's dolphin (0.02), and *Stenella* spp. (0.02) (includes clymene, spinner, and striped dolphins).

Sperm whales are the most abundant endangered whale likely to be present at Norfolk. However, they are highly detectable. Estimated incidental take numbers are 0.09 killed and 0.16 injured. The probability of one or more sperm whale groups occurring undetected in the Safety Range is estimated to be 0.06. Therefore, there is a small, but non-negligible chance that a sperm whale would be killed or injured if the shock trial were conducted at Norfolk.

Fin whales are the second most abundant endangered cetacean at Norfolk. Estimated incidental take numbers are 0.13 individuals killed and 0.23 individuals injured. The probability of one or more fin whale groups occurring undetected in the Safety Range is estimated to be 0.07. Therefore, there is a small, but non-negligible chance that a fin whale would be killed or injured if the shock trial were conducted at Norfolk.

For the endangered sei whale, combining with the category identified during aerial surveys as "sei or Bryde's whale," incidental take numbers are 0.06 killed and 0.10 individuals injured. The probability of a group occurring undetected in the Safety Range is 0.04 for sei whale and 0.03 for sei/Bryde's whale. Therefore, there is a small, but non-negligible chance that a sei whale would be killed or injured if the shock trial were conducted at Norfolk.

For humpback whale, incidental take numbers are <0.01 killed and 0.01 individuals injured. The probability of a humpback whale group occurring undetected in the Safety Range is 0.01. Therefore, it is highly unlikely that a humpback whale would be killed or injured at Norfolk.

Two other endangered species, the blue whale and the northern right whale, generally inhabit (or are migrating to) northern feeding grounds during the period proposed for the shock trial and were not observed off Norfolk during the 1995 SEAWOLF surveys or the *Abel-J* and *Pelican* cruises; therefore, they are assumed to have no mortalities or injuries.

Pascagoula. For Pascagoula, the calculations predict up to 3 marine mammals killed and 4 injured. Cetaceans presumed to have some chance of being killed or injured include all 10 taxa sighted during the summer 1996 and 1997 GulfCet II surveys in the Pascagoula test area. In order of group densities, these were: dwarf/pygmy sperm whale, bottlenose dolphin, striped dolphin, clymene dolphin, bottlenose/Atlantic spotted dolphin, sperm whale, Atlantic spotted dolphin, Risso's dolphin, pantropical spotted dolphin, and spinner dolphin.

Dwarf/pygmy sperm whale and bottlenose dolphin accounted for 75% of all sightings and are the only species with greater than 0.10 probability of take (i.e., being present but undetected in the Safety Range). The probability is 0.69 for dwarf/pygmy sperm whale and 0.11 for bottlenose dolphin (see Appendix C). For dwarf/pygmy sperm whale, the estimated numbers for four detonations are 1.02 individuals killed and 1.81 individuals injured. For bottlenose dolphin, the estimated numbers for four detonations are 0.67 individuals killed and 1.19 individuals injured. Additional species with probabilities greater than 0.01 were bottlenose/Atlantic spotted dolphin (0.01), clymene dolphin (0.02) and striped dolphin (0.02).

Sperm whales were the only endangered whales likely to be present at Pascagoula. The estimated incidental take numbers for four detonations are <0.01 individuals killed and 0.01 individuals injured. The probability of one or more sperm whale groups being present in the Safety Range and not detected is 0.01 (see Appendix C). Therefore, it is highly unlikely that any sperm whales would be killed or injured. The Gulf of Mexico is outside the normal range of all of the endangered mysticetes, which are likely to be represented only by occasional strays (Jefferson and Schiro, 1997). It is assumed none would be killed or injured by the proposed action.

(d) Mortality and Injury Compared with Stock Sizes

Table 4.4 compares mortality and injury estimates with marine mammal population sizes. For each test area, the table includes only those cetacean species that had a "take" probability greater than 0.01 (from Appendix C). Minimum population sizes were obtained from the latest available stock estimates prepared by the NMFS (Blaylock et al., 1995; Waring et al., 1999, 2000). Mortality and injury estimates for each species were summed, rounded up to the nearest whole number, and divided by the minimum population size. Because minimum population sizes stated by NMFS are reported to three or four digits, proportions of the population affected are calculated to three decimal places.

The calculations show that the numbers of marine mammals potentially killed or injured during the shock trial would represent a small fraction of the total population. The proportion of the minimum population affected is 0.001 or less for almost every species, and the highest value is only 0.011 (dwarf/pygmy sperm whale at Pascagoula).

Even small numbers killed or injured can be significant for species designated by the NMFS as "strategic stocks" because their total annual mortality from human activities exceeds the annual loss that the population can sustain (potential biological removal, or PBR). Endangered, threatened, and depleted marine mammals are automatically strategic stocks even if annual mortality does not exceed PBR.

The only strategic stocks likely to be present at Mayport are sperm whale, pilot whales, and beaked whales. Of these, only pilot whales are included in the table because their take probability slightly exceeds 0.01. Calculations predict 0.062 killed and 0.110 injured. Summing these and rounding up yields a total of 1 pilot whale potentially killed or injured. This would represent <0.001 of the minimum population estimate of 8,148 pilot whales. Given the low probability of take for pilot whales at Mayport, it is highly unlikely that any deaths or injuries of a strategic stock would occur there.

Strategic stocks likely to be present at Norfolk are fin whale, humpback whale, sei whale, sperm whale, beaked whales, common dolphin, and pilot whales. Of these, only the fin whale, sei whale, sperm whale, and pilot whales have take probabilities exceeding 0.01. Proportions of the minimum population affected would be 0.001 or less for each of these strategic stocks.

Table 4.4. Comparison of predicted mortality and injury with stock size for cetacean species with greater than 1% probability of take. Probability of take and estimated numbers killed and injured are from Tables C.8 through C.13. Minimum population, total annual mortality from all human sources, and the loss the population can sustain (potential biological removal, PBR) are from Waring et al. (1999, 2000) except where indicated otherwise. Strategic stocks are indicated (i.e., those for which total annual mortality exceeds PBR; endangered, threatened, and depleted species are automatically designated as strategic stocks even if annual mortality does not exceed PBR).

	Probability of "Take"	Estimated Number of Individuals		Minimum Population Estimate	Proportion of Population Affected [a]	Total Annual Mortality from All Human Sources (individuals)	Potential Biological Removal (PBR) (individuals)	Strategic Stock?
		Killed	Injured					
MAYPORT								
Bottlenose dolphin	0.269	1.835	3.256	20,642	<0.001	5.3	206	No
Pilot whale	0.011	0.062	0.110	8,148	<0.001	146	78	Yes
Risso's dolphin	0.170	1.187	2.106	22,540	<0.001	13	216	No
NORFOLK								
Fin whale	0.073	0.130	0.231	1,803	0.001	0.5	3.6	Yes
Minke whale	0.039	0.022	0.039	3,097	<0.001	2.7	31	No
Sei whale	0.037	0.057 [b]	0.100 [b]	870 [c]	0.001	0.0	N/A	Yes
Atlantic spotted dolphin	0.174	1.218	2.161	23,699	<0.001	7.8	236	No
Bottlenose dolphin	0.110	0.688	1.220	20,642	<0.001	5.3	206	No
Pilot whale	0.291	2.813	4.990	8,148	<0.001	146	78	Yes
Risso's dolphin	0.022	0.119	0.210	22,540	<0.001	13	216	No
Sperm whale	0.059	0.092	0.162	3,400	<0.001	0.0	6.8	Yes
PASCAGOULA								
Bottlenose dolphin	0.108	0.672	1.191	4,530 [d]	<0.001	2.8 [d]	45 [d]	No
Clymene dolphin	0.019	0.102	0.181	4,120 [d]	<0.001	0.0 [d]	41 [d]	No
Dwarf/pygmy sperm whale	0.687	1.019	1.808	273 [e]	0.011	0.0	N/A	No
Striped dolphin	0.025	0.140	0.248	3,409 [d]	<0.001	0.0 [d]	34 [d]	No

[a] Mortality and injury estimates were summed and rounded up to the nearest whole number, then divided by the minimum population estimate.
[b] Includes animals identified as sei/Bryde's whale.
[c] Minimum population not estimated by Waring et al. (1999, 2000). Used minimum population estimate by Mitchell and Chapman (1977).
[d] From Blaylock et al. (1995).
[e] Minimum population not estimated by Waring et al. (1999, 2000) or Blaylock et al. (1995). Used lower confidence limit of abundance estimate for the oceanic northern Gulf of Mexico population by Mullin and Hoggard (1999).

Strategic stocks likely to be present at Pascagoula are sperm whale, beaked whales, and pilot whales. None of these have a take probability greater than 0.01. It is highly unlikely that any deaths or injuries of a strategic stock would occur at Pascagoula.

(e) Harassment

Harassment, as defined in the 1994 amendments to the Marine Mammal Protection Act of 1972, is "any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild" (Level A harassment); or "(ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering" (Level B harassment). Level A harassment is injury, which is addressed by the injury calculations discussed above.

Although the 1994 amendments to the Marine Mammal Protection Act define harassment, they do not define threshold noise levels sufficient to cause it. The NMFS has not formally defined a threshold for harassment, but has cited temporary threshold shift (TTS) as an example (60 FR 28379, 31 May 1995). TTS is a change in the threshold of hearing (the quietest sound that the animal can hear), which could temporarily affect an animal's ability to hear calls, echolocation sounds, and other ambient sounds. In this FEIS, TTS is used as a criterion for Level B harassment of marine mammals as explained below.

A difference between this FEIS and the SEAWOLF FEIS (Department of the Navy 1998a) is in the interpretation of TTS as harassment. The SEAWOLF FEIS stated (and the NMFS accepted in its Final Ruling – 63 FR 66069, December 1, 1998) that TTS meets the definition of both Level A and Level B harassment because, "on a cellular level, TTS could be considered a very slight 'injury' in the sense of damage to the hair cells in the ear." However, a recent extensive reanalysis of the literature on the physiological effects of TTS indicates that cells are not destroyed or lost and the distortion and dysfunction of sensory tissue observed during TTS are only temporary and fully reversed upon recovery from the TTS (see Appendix E, Section E.3.2). Further, human damage risk criteria – of the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) were designed to detect and prevent "material hearing impairment" or permanent threshold shift (PTS) rather than TTS. The more conservative NIOSH recommended only annual tests for substantial threshold shift during the work-exposure day and then, only as an indicator for subsequent testing for possible PTS (Criteria for a Recommended Noise Standard, rev. 1998). The OSHA standard requires only annual tests that are taken at least 14 hours away from the noise source (or equivalent ear protecton) before testing for possible shifts that, if found, require rigorous verification. That is, TTS *per se* is not considered injurious. In summary, TTS with no death or loss of cellular tissue is different than injury normally associated with Level A where such loss is present. That is the basis for not viewing TTS as Level A harassment. That characteristic allows the tissue and function to fully recover, and those features, together with the view of TTS in human damage risk criteria just described, support the view of TTS as non-injurious. The disruption of hearing-based behaviors during TTS is the basis for continuing to view TTS as a Level B harassment as was done in SEAWOLF. That is, the reanalysis indicates that TTS is more appropriate to Level B harassment and not Level A.

Because TTS is temporary hearing loss, it leads to temporary "disruption of behavioral patterns" (see Appendix E) as specified in the statutory definition of Level B harassment. That is, hearing is a

component of various behaviors that link an animal to its environment. During the period of TTS, those hearing-based behaviors will be disrupted to the degree of the current TS. Moreover, TTS provides a measurable basis for a Level B harassment criterion for the proposed shock trial. Other possible "disruption(s) of behavioral patterns" were considered and are discussed in section (f) Behavioral Responses of this chapter. In summary, the other possible disruptions were found to be either of zero or very low probability of occurrence, negligible in their impact or unknown to exist in the species under consideration. Whereas behavioral responses to the pulse may be noted after the shock trial, those of very low or unknown probability of occurrence cannot be reliably predicted in advance. Therefore, a Level B harassment criterion based on them would be, at best, highly speculative. At this time, impairment of hearing-related behavior during periods of TTS is the most reliable and meaningful estimate of Level B harassment for the proposed shock trial.

In Appendix E, a dual criterion for onset-TTS has been developed: (1) an energy-based TTS criterion of 182 dB re 1 $\mu Pa^2 \cdot$ sec in any 1/3 octave band, derived from experiments in which TTS was induced in the bottlenose dolphin and white whale using high amplitude 1-second pure-tone bursts (Ridgway et al., 1997; Schlundt et al., 2000); and (2) 12 psi peak pressure, cited by Ketten (1995) as associated with "a safe outer limit for the 10,000 lb charge for minimal, recoverable auditory trauma" (i.e., TTS). The range for onset-TTS is the minimum distance at which neither threshold is exceeded. The 182 dB energy criterion was usually the determining factor in the calculated ranges (Appendix E).

As explained in Appendix E, these criteria were used to estimate onset-TTS ranges for the proposed detonations. Site-specific hydrographic data from the Mayport, Norfolk, and Pascagoula test areas were used to calculate the ranges. Separate ranges were calculated for odontocetes and mysticetes based on their probable differing sensitivity to low frequencies. For odontocetes, which are "high frequency specialists," all frequencies greater than or equal to 100 Hz were included. For mysticetes, which are "low frequency specialists," the frequency range was extended down to 10 Hz.

Water depth is an important factor in the calculation of the onset-TTS range. Since the shock trial may occur at any point within each test area, three water depths were chosen to be geographically representative of each test area. For all three test areas, the shallowest water depth considered was 183 m (600 ft), the minimum depth at which the shock trial would be conducted. Two other depths were chosen in each test area to represent (approximately) the geographic middle and the deepest part of the test area, respectively. The depths at each test area were as follows:

	Shallow	**Middle**	**Deep**
Mayport	183 m (600 ft)	366 m (1,200 ft)	701 m (2,300 ft)
Norfolk	183 m (600 ft)	1,829 m (6,000 ft)	2,347 m (7,700 ft)
Pascagoula	183 m (600 ft)	366 m (1,200 ft)	671 m (2,200 ft)

Corresponding TTS ranges are listed in **Table 4.2.** For onset-TTS calculations, the highest values were chosen (i.e., regardless of water depth). Expected numbers of marine mammals within these radii were calculated using mean densities from Appendix B, adjusted to account for submerged

(undetectable) individuals. Because nearly all of the TTS area would be outside the Safety Range, the "with mitigation" and "without mitigation" numbers were assumed to be equal.

Because the onset-TTS range is much larger than the mortality or injury range, more individuals and more species could be affected. Therefore, species historically present at or near each area but not seen during aerial surveys used to develop density estimates were taken into account in these calculations. This includes, for example, species such as beaked whales (*Mesoplodon* spp. and *Ziphius cavirostris*) and dwarf and pygmy sperm whales (*Kogia* spp.) which are rarely seen at sea. Each species was assigned a value of 1 individual per 4 detonations. The results for individual species were summed and then rounded up to the nearest whole number.

Table 4.3 summarizes the TTS estimates for the three test areas. Estimated numbers of marine mammals affected vary from 14,640 individuals at Norfolk to 3,132 individuals at Pascagoula and 2,885 individuals at Mayport. The higher numbers at Norfolk reflect the fact that it has not only the highest marine mammal densities, but also the largest onset-TTS ranges. It is the deepest test area, and onset-TTS range tends to increase with increasing water depth (see Appendix E). Also, onset-TTS range is greater for mysticetes than for odontocetes (due to consideration of frequencies down to 10 Hz for mysticetes), and Norfolk is the test area where mysticetes are most likely to be present during the test period.

(f) Behavioral Responses

At distances greater than the TTS range, marine mammals may detect the sound of the detonations and some may respond (Richardson et al., 1995). Such behavioral responses could be the basis for "disruption of behavioral patterns."

However, certain responses would have zero probability of occurrence with single shock-trial pulses occurring at weekly intervals. Escape or movement away from the pulse-source during the shock event to reduce or eliminate aversive stimulation is precluded due to the very short duration of the single pulse. These responses are not considered. Other responses would have only negligible probability of occurrence. Conditioned avoidance or movement away on some prior cue to avoid the pulse entirely or minimize its effect would occur only if an animal associated the ship activity prior to the pulse as the cue for the impending shot. With only 3 or 4 shots at weekly intervals, the likelihood of the same animals experiencing all of these events and forming such associations in those few experiences is negligible. The evidence for this is found in their movement patterns to be described. These responses are not considered further. Still other responses such as orienting responses to novel stimuli have a higher probability of occurrence, but those would be very brief in duration and negligible in terms of disrupting ongoing behaviors. Finally there are startle responses, panic responses, post-shot departure and post-shot sensitization to other environmental stimuli. While these responses are possible, the probabilities of such responses in the species under consideration are unknown. They are not considered further since any predictions of their existence and estimates of their degrees and duration would be only conjecture and speculation. Given the difficulties of measurement and interpretation, these latter responses to single isolated pulses may be unknowable.

Richardson et al. (1995) summarized the research on such behavioral reactions of marine mammals to impulsive noise. Although some controlled experiments have been conducted, most of the available information is anecdotal, with no data on the sound levels at the source and the receiver. Moreover, most data have been collected in the context of either continuous sound (e.g., industrial noise) or repeated impulses (e.g., airgun arrays) which are not relevant to the shock trial scenario of a single detonation per week (see the descriptions of movement responses during and before single pulses already described). Behavioral responses to sounds produced by underwater explosions and airgun arrays can include movement away from the source during operation, altered patterns of surfacing and respiration, and interruptions in calling. Richardson et al. (1995) concluded that "some baleen whales show no strong behavioral reaction to noise pulses from distant explosions. They also show considerable tolerance of similar noise pulses from nonexplosive seismic exploration. However, strong seismic pulses elicit movement away from the source, suggesting that explosives may sometimes do so as well." Todd et al. (1996) found that humpback whales in a coastal embayment showed little behavioral reaction to underwater detonations in terms of residency, overall movements, or general behavior, but increased entrapment rates in fishing nets. Long-term effects of exposure to numerous detonations may have influenced that entrapment rate.

There is not as much information available on the behavioral responses of toothed whales and dolphins (Richardson et al., 1995). Movement away from the source and/or interruptions in calling have been documented in sperm whales at great distances from airgun arrays (Bowles et al., 1994; Mate et al., 1994a). Goold (1996) documented movements away from nearby airgun arrays by common dolphins. These observations are not relevant to the shock trial in which, as noted previously, movement away from the source is precluded due to the very short duration of the pulse. Small explosive charges have often been used, with mixed success, to influence movement of dolphins (e.g., "seal bombs" used during purse-seining for yellowfin tuna).

As mentioned above, the one-week intervals make it very unlikely that any individual animal would be affected by more than one detonation. Cetaceans are highly mobile; tagging studies and repeated sightings of photoidentified individuals have shown that marine mammals can travel 100 km or more during a day (Evans, 1971, 1974; Würsig and Würsig, 1977; Mate et al., 1987, 1994b). Surveys of the Mayport, Norfolk, and Pascagoula test areas have not indicated that the test areas have "resident" cetacean populations. Therefore, it is unlikely that an individual animal would experience more than a single, momentary disturbance.

(g) Indirect Impacts

Shock trial detonations will kill fish and invertebrates near the detonation point, thereby indirectly affecting marine mammals which feed on these organisms. Some marine mammals may be attracted to the area to feed on the dead fish and invertebrates. This would be a short term impact (minutes to hours). Over the long term, there would be no lasting impact on prey availability because only a small area would be affected and prey populations would be rapidly replenished. The test areas are not known to be preferred marine mammal feeding grounds.

Toothed whales feed primarily upon mesopelagic and benthic fish. Sperm whales, pygmy sperm whales, and dwarf sperm whales prey primarily on squid; pygmy and dwarf sperm whales also feed on fish, octopus, and crustaceans. The main prey for pilot and beaked whales includes squid and fish (e.g., mackerel). Dolphins routinely consume squid and/or fish. Killer whales prey on a variety of marine organisms, including fish, sea turtles, seabirds, pinnipeds, and other marine mammals. Among the baleen whales, humpback whales feed primarily on euphausiids and small fish (e.g., mackerel, herring).

Pelagic fish and invertebrates within the cavitation region at the time of detonation are expected to be killed or injured. The maximum horizontal extent of the cavitation region is estimated to be 683 m (2,240 ft). This region would extend from the surface to a maximum depth of about 23 m (77 ft). Calculations for Pelagic Fish [Section 4.1.3(b)] predict a mortality radius extending from a few tens of meters to about 1.7 km (0.9 nmi) depending on the species and individual fish size. Prey availability could be altered for a few hours before fish and invertebrate nekton (e.g., squid) from surrounding areas repopulated the area. Plankton populations would be replenished through turbulent mixing with adjacent waters and population growth of each plankton species. Given that test site selection would be based on the low abundance of marine mammals, including both toothed and baleen whales, and given that the test areas do not represent recognized feeding grounds for marine mammals, the potential for significant indirect impacts is low.

(h) Conclusions

At any of the test areas, marine mammals may be killed or seriously injured if they are present within the Safety Range and not detected by visual or passive acoustic monitoring. Incidental take calculations predict that conducting the shock trial at Pascagoula would result in up to 3 marine mammals killed and 4 injured. For Mayport, the predictions are up to 4 killed and 6 injured. For Norfolk, the estimates are up to 7 killed and 12 injured. These numbers mainly reflect differing marine mammal densities among the test areas. To some extent, they also reflect differences in relative abundance of species with different probabilities of detection. Although the predictions are based on recent marine mammal surveys, the actual numbers of marine mammals present in a test site on the test day may vary. Also, if pre-detonation monitoring is completely successful, no mammals would be killed or seriously injured.

At Mayport, it is unlikely that any individuals of an endangered cetacean species or a strategic stock would be killed or injured. Sperm whales could be present, but in low densities, and the probability of one being killed or injured is less than 0.01. No other endangered whales are expected to occur at Mayport during the May through September time period. Other strategic stocks potentially present at Mayport are pilot whales and beaked whales. There is a low probability of a pilot whale being present and undetected in the Safety Range (0.011). No mortalities or injuries are predicted for beaked whales.

At Norfolk, several endangered cetacean species and strategic stocks may be present. The sperm whale is the most abundant of the endangered whales at Norfolk but is highly detectable. Calculations indicate there is a small but non-negligible chance that a sperm whale, fin whale, or sei whale could be killed or injured at Norfolk. Other strategic stocks potentially occurring there

are common dolphin, pilot whales, and beaked whales. No mortalities or injuries are predicted for beaked whales, and the probability of a common dolphin being killed or injured is less than 0.01. The probability that a pilot whale would be present and undetected in the Safety Range is 0.291. The mortality and injury estimates for pilot whales are 2.813 killed and 4.990 injured.

At Pascagoula, it is unlikely that any individuals of an endangered cetacean species or a strategic stock would be killed or injured. Sperm whales could be present, but in low densities, and the probability of one being killed or injured is less than 0.01. No other endangered whales are expected to occur at Pascagoula. Other strategic stocks potentially occurring there are pilot whales and beaked whales, and no mortalities or injuries are predicted for these species.

Large numbers of marine mammals could experience disruption of hearing-based behaviors due to TTS at any of the test areas. Ranges extend up to 32.8 km (17.7 nmi) for odontocetes and 42.6 km (23.0 nmi) for mysticetes depending on the test area and water depth of the specific test site. Estimated numbers of marine mammals affected vary from **14,640** individuals at Norfolk to **3,132** individuals at Pascagoula and **2,885** individuals at Mayport. Norfolk numbers are highest because this test area has the highest marine mammal densities and the largest onset-TTS ranges. It is the deepest test area, and onset-TTS range tends to increase with increasing water depth (see Appendix E). Also, the onset-TTS range is greater for mysticetes than for odontocetes, and Norfolk is the test area where mysticetes are most likely to be present during the test period.

Pre-detonation monitoring would not affect these numbers, since most of the onset-TTS range is outside the Safety Range. The impact would be minimized by selecting a test area (and a specific test site within it) having low mammal density (see Section 5.0).

4.1.2 Sea Turtles

At any of the test areas, shock trial detonations may kill or injure sea turtles. Specifically, turtles may be killed or seriously injured if they are present within the Safety Range (radius of 3.7 km [2 nmi]) and not detected during pre-detonation monitoring. At greater distances, up to 32.8 km (17.7 nmi) depending on the test area and water depth of the specific test site, sea turtles may experience temporary hearing loss. At still greater distances, turtles may hear the detonations and may (or may not) respond.

In addition to the main effects discussed here, there are several minor issues that do not require detailed analysis. Effects of chemical products of the explosions are considered negligible because the initial concentrations are not hazardous to marine life and the products are rapidly dispersed in the ocean [see Section 4.1.5(c)]. Minor increases in vessel and air traffic are not a major concern from the standpoint of sea turtle harassment because of built-in mitigation measures (use of shipboard observers; limited transit speed; and flights at approved altitudes). Indirect impacts to sea turtles through altered prey abundance are discussed briefly.

<u>Endangered Species Consultation</u>. Because endangered sea turtles under NMFS jurisdiction may be affected by the proposed action, the Navy initiated formal consultation with the NMFS under Section 7 of the Endangered Species Act. The DEIS served as a Biological Assessment that was

submitted to the NMFS. Based on this information, the NMFS issued a Biological Opinion taking into account the cumulative impacts of all activities potentially affecting listed turtle populations. The Biological Opinion (which is included in Appendix G of the FEIS) evaluates if the shock trial is likely to jeopardize the continued existence of endangered or threatened species or result in destruction or adverse modification of their critical habitat. The Biological Opinion specifies additional mitigation and monitoring requirements.

Mitigation Included in the Proposed Action. The impact analysis takes into account the marine mammal and sea turtle mitigation/monitoring program described in Section 5.0. This program has been summarized briefly under Marine Mammals and is not repeated here.

(a) Analytical Approach

Appendix C quantifies the risk of killing or injuring a sea turtle during the shock trial in two ways: (1) in terms of probabilities of turtles occurring in the Safety Range (radius of 3.7 km or 2 nmi); and (2) in terms of numbers of turtles expected to be killed, injured, or experiencing temporary disruption of hearing-based behaviors. The calculations provide a basis for comparing alternative areas in the FEIS, since the same assumptions and methods are used for Mayport, Norfolk, and Pascagoula. Methods are explained in detail in Appendix C and have been summarized previously under Marine Mammals. The main difference is that because adult turtles are solitary, densities of individuals are the basis for calculations rather than densities of groups as for marine mammals.

(b) Probability Analysis

Table 4.5 summarizes the probability analysis for sea turtles at the Mayport, Norfolk, and Pascagoula test areas. The table also lists mean densities of sea turtles at the three test areas, since these were the basis for the probability calculations. Details are provided in Appendix C.

Probability of Clear Range. The probability of zero turtles in the Safety Range is 0.33 at Pascagoula, 0.29 at Mayport, and 0.07 at Norfolk. The order reflects the mean group densities at the three test areas, with higher densities corresponding to low probabilities of "clear range."

Probability of Delay. The probability of "delay" for sea turtles is 0.08 at Norfolk, 0.06 at Mayport, and 0.05 at Pascagoula. Since most turtles are submerged, they are not expected to be detected and therefore the probability of a turtle-related delay is low at all three test areas.

Probability of Take. The probability of "take" for sea turtles is 0.86 for Norfolk, 0.65 for Mayport, and 0.62 for Pascagoula. The relatively high probability of "take" (as compared with the marine mammal numbers) reflects the low detectability of turtles due to most of the population being submerged.

Table 4.5. Summary of mean densities, probabilities, and incidental take estimates for sea turtles.

		Mayport	Norfolk	Pascagoula
Mean Densities:				
• Turtles/100 km^2		0.288	0.633	0.258
Probabilities:				
• "Clear Range" (zero turtles in Safety Range)		0.29	0.07	0.33
• "Delay" (1 or more turtles in Safety Range but detected)		0.06	0.08	0.05
• "Take" (1 or more turtles in Safety Range but not detected)		0.65	0.86	0.62
Expected Number of Turtles:				
• Killed		1 (0.61)	2 (1.33)	1 (0.54)
• Injured		2 (1.08)	3 (2.36)	1 (0.96)
• Behavioral disruption (due to TTS)		232	855	199
Species potentially affected:	**Status:**[a]			
Leatherback sea turtle	E	■	•	■
Loggerhead sea turtle	T	■	■	b
Green sea turtle	E/T	b	b	b
Hawksbill sea turtle	E	b	b	b
Kemp's ridley sea turtle	E	b	b	b

Key: ■ = probability of take ≥0.10 and species accounts for ≥10% of all the turtles estimated to be killed or injured; • = probability of take between 0.01 and 0.10; b = behavioral disruption (due to TTS) only.

[a] Status: E = endangered, T = threatened under the Endangered Species Act of 1973. Green sea turtles are listed as threatened except for Florida where breeding populations are endangered. Due to inability to distinguish between the two populations away from the nesting beach, green sea turtles are considered endangered wherever they occur in U.S. waters.

(c) Mortality and Injury

Field observations have shown that sea turtles can be killed or injured by underwater explosions (O'Keeffe and Young, 1984; Klima et al., 1988). Effects are likely to be most severe in near surface waters above the detonation point where the reflected shock wave creates a region of negative pressure (see Figure 4.2). This is a region of near total physical trauma within which no animals would be expected to survive. Beyond the cavitation region, animals could still receive serious or minor injuries depending on distance from the detonation point.

The concept of a "Safety Range" has been discussed in Section 5.0 and summarized previously under Marine Mammals. The same Safety Range of 3.7 km (2 nmi) would be used for both sea turtles and marine mammals. Although the Safety Range was calculated based on estimated ranges for marine mammal mortality and injury (Appendix D), it is identical to the predicted safe range for sea turtles calculated using an equation developed by Young (1991). With the Safety Range in place, sea turtles may be killed or injured only if they are not detected during pre-detonation monitoring. Detonation would not occur until there are no sea turtles, marine mammals, large *Sargassum* rafts, debris lines, or large jellyfish concentrations detected within the Safety Range. *Sargassum* rafts and debris lines are included in the pre-detonation monitoring to protect juvenile turtles which live in these features. Large jellyfish concentrations are included because leatherback turtles feed on them.

Visual and passive acoustic monitoring is not very effective for sea turtles because they are small, stay submerged for extended periods, do not make visual displays (like dolphins leaping and spinning, or whales blowing) and do not make sounds. Mitigation effectiveness for juvenile turtles is assumed to be equal to that for adult turtles. Although juveniles are smaller, they are often associated with *Sargassum* mats and debris lines, and the presence of these features would cause detonation to be postponed. Also, animals at the sea surface (such as juvenile turtles in *Sargassum* rafts and debris lines) are unlikely to be affected unless they are very close to the detonation point (see Figure 4.3).

To estimate how many sea turtles could be killed or injured, the same methods and assumptions were used as described above under Marine Mammals. There is comparatively little experimental or theoretical data upon which to base mortality and injury ranges for sea turtles (O'Keeffe and Young, 1984; Young, 1991). Therefore, the corresponding ranges for marine mammals were used. These ranges were developed based on experiments with mammals (see Appendix D), but it was assumed that sea turtle lungs and other gas-containing organs would be similarly affected by shock waves (O'Keeffe and Young, 1984). Calculations in Appendix D show that observed effects of underwater explosions on sea turtles are consistent with predictions of the modified Goertner (1982) lung injury model that was used to develop mortality and injury criteria for marine mammals.

Table 4.5 summarizes the mortality and injury estimates for the Mayport, Norfolk, and Pascagoula test areas. Results were summed over all species and then rounded up to the nearest whole number. Calculations predict that conducting the shock trial at Pascagoula would result in 1 turtle killed and 1 injured. For Mayport, the predictions are 1 killed and 2 injured. For Norfolk, the

estimates are 2 killed and 3 injured. At all three test areas, leatherbacks and loggerheads are the only species likely to be present as adults. Leatherbacks are the most abundant species at Pascagoula and Mayport, whereas loggerheads dominate at Norfolk. The loggerhead is a threatened species and the leatherback is an endangered species.

The three other sea turtle species (green, hawksbill, and Kemp's ridley) are primarily inshore species which were not seen during aerial surveys. Therefore, no mortalities or injuries of these species are expected. They are included later in the behavioral disruption calculations.

Mayport. For Mayport, the predictions are up to 1 turtle killed and 2 injured. Only leatherback and loggerhead turtles were sighted during the aerial surveys and these are the species most likely to be killed or injured.

For leatherback turtles at Mayport, the estimated numbers for four detonations are 0.34 individuals killed and 0.60 individuals injured. The probability of one or more leatherback turtles being present in the Safety Range and not detected is 0.46 (see Appendix C). For loggerhead turtles, the estimated numbers for four detonations are 0.18 individuals killed and 0.32 individuals injured. The probability of one or more loggerhead turtles being present in the Safety Range and not detected is 0.29 (see Appendix C).

Norfolk. At Norfolk, it is estimated that up to 2 turtles would be killed and 3 injured. Only loggerhead and leatherback turtles were sighted during the aerial surveys at Norfolk, and loggerheads were by far the most abundant.

For loggerhead turtles at Norfolk, the estimated numbers for four detonations are 1.28 individuals killed and 2.27 individuals injured (see Appendix C). The probability of one or more loggerhead turtles being present in the Safety Range and not detected is 0.85. For leatherback turtles at Norfolk, the estimated numbers for four detonations are 0.01 individuals killed and 0.02 individuals injured. The probability of one or more leatherback turtles being present in the Safety Range and not detected is 0.02.

Pascagoula. At Pascagoula, it is estimated that up to 1 turtle would be killed and 1 injured. Leatherbacks are by far the most abundant turtle at Pascagoula, accounting for about 79% of the sightings. The rest were unidentified turtles (no loggerheads were seen).

For leatherback turtles at Pascagoula, the estimated numbers for four detonations are 0.43 individuals killed and 0.76 individuals injured (see Appendix C). The probability of one or more leatherback turtles being present in the Safety Range and not detected is 0.54.

(d) Disruption of Hearing-Related Behaviors

An underwater explosion produces pressure pulses that have the potential for harassing sea turtles or damaging their hearing. In contrast to marine mammals, little is known about the role of sound and hearing in sea turtle survival. However, it is assumed that such an exposure could lead to TTS

that could temporarily disrupt turtle behavior patterns. Therefore, TTS is used here as a criterion for disruption of hearing-based behaviors of sea turtles.

There are no data for TTS in sea turtles. Therefore, the TTS criterion developed for odontocete marine mammals has been applied to sea turtles. Ridgway et al. (1969) reported maximal sensitivity for green sea turtles occurred at 300 to 400 Hz, with a rapid decline in sensitivity for lower and higher tones. Similarly, Moein et al. (1994) reported a hearing range of about 250 to 1,000 Hz for loggerhead sea turtles, and Lenhardt (1994) stated that maximal sensitivity in sea turtles generally occurs in the range from 100 to 800 Hz. Calculated in-water hearing thresholds within the useful range appear to be high (e.g., about 160 to 200 dB re 1 μPa; Lenhardt, 1994). Based on this information, the TTS range predicted for odontocetes using frequencies $\geq$100 Hz should be conservative for sea turtles.

To estimate how many sea turtles could experience TTS, the same methods and assumptions were used as described above under Marine Mammals. Species historically present at or near each area but not seen during aerial surveys used to develop density estimates (i.e., green, hawksbill, and Kemp's ridley turtles) were taken into account in the calculations. Each species was assigned a value of 1 individual per 4 detonations.

Table 4.5 summarizes the results of the TTS calculations for sea turtles at the Mayport, Norfolk, and Pascagoula test areas. For four detonations, estimated numbers of sea turtles affected are 232 at Mayport, 855 at Norfolk, and 199 at Pascagoula. The higher numbers at Norfolk reflect the fact that it has not only the highest sea turtle densities, but also the largest TTS ranges. It is the deepest test area, and onset-TTS range tends to increase with increasing water depth (see Appendix E).

(e) Behavioral Responses

Behavioral responses could occur at distances beyond the estimated TTS range discussed above. Sea turtles are thought to be capable of hearing low frequency sounds; however, according to Ridgway et al. (1969), sensitivity falls off significantly below 200 Hz. It is assumed that sea turtles may hear the brief acoustic signal created by the proposed underwater detonations. This could result in behavioral effects, such as swimming toward the surface, abrupt movements, slight retractions of the head, and limb extension during swimming (Lenhardt et al., 1983; Lenhardt, 1994).

Each detonation would be a single, momentary disturbance. Because the four detonations would occur at about one-week intervals, it is very unlikely that any individual sea turtle would be affected by more than one detonation. Tagging studies have shown that sea turtles can travel many kilometers per day in the open ocean (Keinath et al., 1996). Therefore, it is unlikely that an individual animal would experience more than a single, momentary disturbance.

(f) Indirect Impacts

Two indirect ways in which sea turtles could be affected are through (1) death and injury to prey species and (2) destruction of juvenile habitat (*Sargassum* rafts and debris lines). Both impacts are unlikely to be significant at any of the three test areas.

Adult loggerheads feed primarily on benthic molluscs and crustaceans. It is not known if loggerheads present at the Mayport and Norfolk areas feed there; however, even if they do, any benthic impacts of the detonations would affect only a small portion of the available benthic prey. Leatherbacks (the most abundant turtle at the Mayport and Pascagoula test areas) are pelagic feeders, preferring coelenterates (jellyfish). In order to protect sea turtles, detonation would be postponed if large concentrations of jellyfish were detected within the Safety Range (see Section 5.0). Therefore, although some jellyfish may be killed during the blast, it is unlikely that prey availability would be significantly reduced. Coelenterates from surrounding areas would quickly repopulate the small area affected. Given that test site selection and scheduling would be based on the low abundance of sea turtles, and given that the test areas do not represent recognized feeding grounds for loggerhead or leatherback sea turtles, the potential for significant indirect effects is low.

Sargassum rafts and debris lines, which may serve as habitat for juveniles of several turtle species, are easily detected by aerial observers. The mitigation plan includes procedures to avoid these features during site selection. Pre-detonation monitoring would include aerial observations to identify large *Sargassum* rafts and debris lines that could drift into the Safety Range prior to detonation. Finally, detonation would be postponed if any large *Sargassum* rafts or debris lines were present in the Safety Range. Therefore, no significant impacts on juvenile turtle habitat are expected.

(g) Conclusions

At any of the test areas, sea turtles may be killed or seriously injured if they are present within the Safety Range and not detected by visual or passive acoustic monitoring. Incidental take calculations predict that conducting the shock trial at Pascagoula would result in 1 turtle killed and 1 injured. For Mayport, the predictions are 1 killed and 2 injured. For Norfolk, the estimates are 2 killed and 3 injured. These numbers mainly reflect differing sea turtle densities among the test areas. Although the predictions are based on recent surveys, the actual numbers of sea turtles present in a test site on a test day may vary. Also, if turtle densities are low and pre-detonation monitoring is completely successful, no turtles would be killed or seriously injured.

The number of sea turtles killed and injured is determined mainly by turtle density, because the probability of detecting turtles during pre-detonation monitoring is low. Sea turtle densities are highest at Norfolk and lower at Mayport and Pascagoula. Accordingly, the probability of "clear range" (zero turtles in the Safety Range) is lower at Norfolk (0.07) than at Pascagoula (0.33) or Mayport (0.29). A critical point not evident in these comparisons is that turtle densities just inshore of the Mayport test area can be higher than those estimated for any of the three test areas (see Appendix B). The tendency of turtles to remain inshore of the Gulf Stream western wall is well

documented and presumably explains the very low turtle densities observed during June and August 1999 Mayport surveys. If Mayport is selected as the test area, satellite imagery would be reviewed prior to each detonation to ensure that any specific test site selected is within the Gulf Stream (i.e, seaward of the western wall) (see Section 5.6.1).

Large numbers of sea turtles could experience temporary disruptions of hearing-based behavior at any of the test areas. Ranges extend up to 32.8 km (17.7 nmi) depending on the test area and water depth of the specific test site. Estimated numbers of sea turtles affected vary from 855 at Norfolk to 232 at Mayport and 199 at Pascagoula. Norfolk numbers are highest because this test area has the highest turtle densities and the largest TTS ranges. It is the deepest test area, and TTS range tends to increase with increasing water depth (see Appendix E).

Pre-detonation monitoring would not affect these numbers, since most of the TTS range is outside the Safety Range. The impact would be minimized by selecting a test area (and a specific test site within it) having low turtle density (see Section 5.0).

At distances well beyond the TTS range, sea turtles may hear the detonations and may respond. It is unlikely that an individual animal would experience more than a single, momentary disturbance.

4.1.3 Other Components of the Biological Environment

(a) Seabirds

As part of the mitigation plan, the Navy would postpone detonation if flocks of seabirds were present within the Safety Range (see Section 5.0). This would avoid any large mortality of seabirds. Monitoring following detonation of two 4,536 kg (10,000 lb) charges for the shock trial of the USS JOHN PAUL JONES in 1994 detected no deaths or injuries of seabirds (Naval Air Warfare Center, 1994).

It is possible that a few seabirds on the water surface or in the air immediately above the detonation point could be killed or stunned by the plume of water ejected into the air. This could happen if birds were attracted to surface floats at the detonation point, as observed by Stemp (1985) during seismic testing using underwater explosives in offshore waters. The radius of the plume is estimated to be 165 to 195 m (540 to 640 ft) (Young, 1995b).

At greater distances, seabirds resting or feeding at the surface could also be killed or injured by the shock wave. Most of the seabirds that could occur at Mayport, Norfolk, or Pascagoula during May through September are surface or near-surface feeders. Safe ranges for these birds can be approximated using mortality and injury criteria developed by Yelverton et al. (1973). The calculations predict that no deaths or injuries beyond a distance of 457 m (1,500 ft) (Young, 1995b). This is approximately the same as the maximum horizontal range of the cavitation region shown in Figure 4.2. It is unlikely that more than a few seabirds would be affected.

Each detonation would release chemical products into the atmosphere. As described in Section 4.1.5(b), these products would disperse rapidly and would not pose a health threat to marine life, including seabirds.

There are no endangered or threatened bird species expected to present at or near the Mayport or Pascagoula test areas (see Section 3.2.3). One endangered seabird, the Bermuda Petrel, may occur near the Norfolk test area. This species nests only in Bermuda, but a few individuals have been sighted foraging in a highly productive ocean area known as "The Point" located off Cape Hatteras, south of the test area. "The Point" is a highly productive area due to the confluence of the Gulf Stream with other water masses. If the shock trial is conducted at Norfolk, all observers would be trained to recognize Bermuda Petrels (see Section 5.0). In addition, because highly productive areas such as water mass boundaries would be avoided during the site selection process (see Section 5.0), and because detonation would be postponed if seabird flocks were present, it is unlikely that Bermuda Petrels would be significantly affected by the proposed action.

(b) Pelagic Fish

The proposed underwater detonations could have two main effects on pelagic (water column) fish. First, fish within a certain radius would be killed or injured by the resulting shock waves. A large fish kill would not be expected because detonation would be postponed if large schools of fish were observed within 1.85 km (1 nmi) of the detonation point (see Section 5.0). Second, fish at greater distances may react behaviorally to sound impulses from the blasts. Effects of chemical products of the explosions are considered negligible because the initial concentrations are not hazardous to marine life and the products are rapidly dispersed in the ocean [see Section 4.1.5(c)]. Potential impacts on demersal (bottom) fish are discussed separately under Benthic Communities [Section 4.1.3(d)]. No adverse effects on managed fishery species or essential fish habitat are expected (see Appendix H).

Mortality and Injury. Effects of underwater explosions on fish have been studied extensively (Yelverton et al., 1975; O'Keeffe and Young, 1984; Young, 1991; Goertner et al., 1994). Studies have shown that the fish most vulnerable to death and injury are those with swimbladders. A swimbladder is a gas-filled organ used to control buoyancy. Most commercial and recreational fishery species are in this category. Fish without swimbladders, such as sharks and flatfish, generally are very resistant to explosions (Goertner et al., 1994). Vulnerability also depends on fish size and shape; smaller fish and those that are laterally compressed are more susceptible to injury.

Based on theoretical models and experimental evidence, Young (1991) developed equations to predict a 10% mortality range for fish (i.e., a distance beyond which at least 90% of fish would survive). **Table 4.6** lists the 10% mortality range for pelagic fish expected to occur at the Mayport and Norfolk areas. Most species could occur at both areas, so the impacts should be similar. The distances range from 22 m (73 ft) for non-swimbladder fish to over 914 m (3,000 ft) for some of the small swimbladder fish. The latter species, such as dwarf herring, round scad, Atlantic menhaden, alewife, chub mackerel, butterfish, and bluefish are the ones most likely to be injured or killed by the blasts if they are present at the site during testing.

Table 4.6. Estimated 10% mortality range for pelagic fish at the Mayport, Norfolk, and Pascagoula test areas. The 10% mortality range is the distance from the detonation point beyond which 90% or more of the fish would survive. Calculations are based on Young (1991), assuming a 4,536 kg (10,000 lb) charge detonated at 61 m (200 ft) below the sea surface.

Common Name	Occurrence			Swim Bladder	Schooling	Fish Weight	10% Mortality Range
	Mayport	Norfolk	Pascagoula			(lb)	(ft)
Oceanic Pelagic Fish							
Dolphin	X	X	X	Yes	Yes	10	2,978
Wahoo	X	X	X	Yes	Occasionally	20	2,722
Sailfish	X	X	X	Yes	No	40	2,487
White marlin	X	X	X	Yes	No	50	2,415
Tunas	X	X	X	Yes (reduced in some)	Yes	60	2,359
Swordfish	X	X	X	Yes	No	150	2,094
Blue marlin	X	X	X	Yes	No	250	1,960
Sharks	X	X	X	No	Some species	100	73
Coastal Pelagic Fish							
Dwarf herring	X	--	X	Yes	Yes	0.1	5,419
Round scad	X	--	X	Yes	Yes	0.25	4,811
Atlantic menhaden	X	X	--	Yes	Yes	0.5	4,396
Gulf menhaden	--	--	X	Yes	Yes	0.5	4,396
Alewife	--	X	--	Yes	Yes	0.5	4,396
Chub mackerel	X	X	--	Yes	Yes	1	4,017
Butterfish	X	X	X	Yes	Yes	1.75	3,736
Bluefish	X	X	X	Yes	Yes	2-20	2,722-3,671
Jacks	X	X	X	Yes	Yes	8	3,066
Cobia	X	X	X	Yes	Yes	20	2,722
Atlantic mackerel	X	X	--	No	No	2	73
Spanish mackerel	X	X	X	No	Yes	2	73
Little tunny	X	X	X	No	Yes	9	73
King mackerel	X	X	X	No	Yes	15	73
Requiem sharks	X	X	X	No	Yes	50	73

Schooling and non-schooling fish may differ in vulnerability. Non-schooling species are usually widely dispersed, and few individuals are likely to be present at the test site. Most oceanic pelagic fish are non-schooling; exceptions are dolphinfish, tunas, and occasionally wahoo. For schooling fish, it is more likely that either several or none could be killed. Most coastal pelagic fish, including the small swimbladder species, are schooling fish. However, detonation would be postponed if large schools of fish were observed within 1.85 km (1 nmi) of the detonation point (see Section 5.0).

It is not possible to accurately estimate the number of fish that would be within the 10% mortality range, because the abundance of fish in the open ocean is extremely variable. Monitoring following detonation of a 4,536 kg (10,000 lb) charge for the shock trial of the USS JOHN PAUL JONES revealed about 100 dead fish (Naval Air Warfare Center, 1994). Previous observations following explosives testing near Key West, Florida have shown "very few" floating dead fish (Department of the Navy, 1981).

Although the number of fish that would be killed or injured is not known, overall impacts on individual species are expected to be insignificant based on the relatively small area affected. The area within the 10% mortality range would represent only a small percentage of the pelagic fish habitat. The Mayport test area, after environmental exclusions, is 7,856 km^2 (2,294 nmi^2). The Norfolk test area is 6,393 km^2 (1,867 nmi^2). The Pascagoula test area is 5,480 km^2 (1,600 nmi^2). From Table 4.6, the maximum radius of the 10% mortality range is 1.42 km (4,653 ft, or 0.77 nmi). The area within this radius is 6.32 km^2 (1.84 nmi^2), which is about 0.1% of each test area.

The distances listed in Table 4.6 apply to fish near the surface, where the reflected shock wave produces a region of negative pressure (see Appendix D for a description of the cavitation region). Pelagic fish in deeper water or near the bottom could survive much closer to the blast. These fish would experience only the direct, positive pressure wave and reflections from the bottom. Under these conditions, there would not be much difference in survival between swimbladder and non-swimbladder species. Effects on demersal (bottom) fish are discussed separately in Section 4.1.3(d).

<u>Behavioral Responses</u>. Fish can hear and react to sounds (Popper and Fay, 1993). Hearing ability (frequency range and sensitivity) differs greatly among species. Fish with a swimbladder connected to the inner ear, such as herring, or other anatomical adaptations generally have the best hearing.

Effects of low-frequency sound pulses on fish have been reviewed by BBN Systems and Technologies (1993). The review included several studies of airgun blasts (Chapman and Hawkins, 1969; Dalen and Raknes, 1985; Pearson et al., 1992; Skalski et al., 1992). Such sound pulses have been shown in some species to produce behavioral responses such as avoidance, alarm, and startle reactions, and may temporarily affect schooling behavior. The review concluded that sound pulses at received levels of 160 dB re 1 μPa (pressure) may cause subtle changes in behavior, and stronger pulses (180 dB) could cause more noticeable changes. For a 4,536 kg (10,000 lb) charge, sound pressure levels of 160 dB could extend tens to hundreds of nautical miles from the detonation point.

Similar pelagic fish species occur at the three test areas, so the effects should be similar. Any behavioral responses to low-frequency sounds from the underwater explosions would be short term and reversible. Unlike the airgun blasts cited above, detonations during the WINSTON S. CHURCHILL shock trial would be four single events occurring at about one-week intervals. No lasting effect on schooling behavior is expected.

(c) Ichthyoplankton and Sargassum Communities

Plankton at any of the test areas would be affected mainly by the physical force of the shock wave from the proposed detonations. Effects of chemical products of the explosions are considered negligible because the initial concentrations are not hazardous to marine life and the products are rapidly dispersed in the ocean [see Section 4.1.5(c)].

Physical effects would be most severe in near surface waters above the detonation point where the reflected shock wave creates a region of negative pressure or "cavitation" (Figure 4.2). This is a region of near total physical trauma within which no organisms would be expected to survive. The maximum lateral extent of the cavitation region is estimated at 683 m (2,240 ft) for the proposed detonations (see Appendix D). This region would extend from the surface to a maximum depth of about 23 m (77 ft). Due to the rapid replenishment of plankton through population growth and/or turbulent mixing with adjacent waters, no lasting impacts on plankton communities are expected at the Mayport, Norfolk, or Pascagoula test area.

Sargassum communities (described in Section 3.2.6) are an important component of the plankton because this seaweed provides habitat for juvenile sea turtles. Although plankton is not a main focus of mitigation efforts, detonation would be postponed if large rafts of *Sargassum* or debris lines were present within the Safety Range, in order to protect juvenile and hatchling sea turtles (see Section 5.0).

(d) Benthic Communities

Two types of potential impacts on benthic organisms are (1) direct effects of the shock wave on organisms and their seafloor habitat; and (2) indirect effects of debris deposited on the bottom. In either case, no significant impact to benthic communities is expected at the Mayport, Norfolk or Pascagoula test area. Hard bottom and coral areas have been avoided through an exclusionary mapping process, and no effects on such habitats are anticipated.

Benthic organisms are unlikely to be killed or injured by the detonations. Most of the mortalities during underwater explosions occur in near surface waters above the detonation point where the reflected shock wave creates a region of negative pressure or "cavitation." Benthic organisms, in contrast, would experience only the direct, positive pressure wave and reflections from the bottom. Bottom features that develop a dense epifauna, such as artificial reefs, hard bottom areas, and shipwrecks, have been avoided through environmental mapping and establishment of buffer zones (see Section 2.2.3).

Experimental studies have shown that benthic invertebrates, including crabs, lobsters, and bivalves are very resistant to underwater explosions (Aplin, 1947; Chesapeake Biological Laboratory, 1948; Linton et al., 1985). Based on these studies, Young (1991) developed equations which predict a Safety Range of 22 m (73 ft) for benthic organisms exposed to a 4,536 kg (10,000 lb) charge. That is, organisms more than this distance from the detonation point would not be killed. Because the blast would be 122 m (400 ft) above the bottom, no benthic organisms are likely to be killed or injured.

Demersal (bottom dwelling) fish are unlikely to be killed or injured by the detonations. The distances listed in Table 4.6 apply to fish near the surface, where the reflected shock wave produces a region of negative pressure. Fish in deeper water or on the bottom could survive much closer to the blast. These fish would experience only the direct, positive pressure wave and reflections from the bottom. Under these conditions, there would not be much difference in survival between swimbladder and non-swimbladder species. Bottom features that attract large numbers of demersal fish, such as artificial reefs, hard bottom areas, and shipwrecks, have been avoided through environmental mapping and establishment of buffer zones (see Section 2.2.3).

Golden tilefish is a demersal species present at all three test areas. A calculation of tilefish mortality contours for a 4,536 kg (10,000 lb) charge detonated at a depth of 61 m (200 ft) was made for a previous environmental assessment (Department of the Navy, 1981). Only the 10% mortality contour approaches the bottom and only in the shallowest water depth of 183 m (600 ft). Therefore, few if any tilefish or other bottom dwelling fish would be killed by the detonations.

Some deepwater groupers form spawning aggregations. However, the available information does not indicate that spawning aggregations of any deepwater groupers could occur at any of the test areas or that these aggregations would extend well into the water column. Most members of the snapper-grouper species complex are unlikely to be affected given that the shock trial would be conducted in water depths greater than 183 m (600 ft). The most notable species capable of forming spawning aggregations in water depths of the Mayport test area would be the snowy grouper (*Epinephelus niveatus*). Because snowy groupers are always associated with hard substrata (including hard bottom areas and artificial reefs), avoiding such habitats (see Section 2.2.3) minimizes the chance of encountering this species. Even if grouper aggregations were present and extended some distance into the water column, few if any are likely to be killed based on the tilefish mortality calculations cited above.

Similarly, the shock wave is not expected to affect the benthic habitat. No cratering of the seafloor is expected [see Section 4.1.5(a)].

The seafloor at both the Mayport and Norfolk areas is predominantly sand bottom. Fragments of steel charge casings that settle to the bottom would provide hard substrate for epibiota and would attract fish (Marine Resources Research Institute, 1984). The largest possible fragment from each explosion would be the top plate and crossbar, which together weigh 204 kg (450 lb). Gradually the materials would corrode, and any solubilized material would be quickly diluted by the surrounding water and not significantly alter the general chemistry of the water column nor bottom sediments. Therefore, there would be no significant impacts on benthic biota.

The likelihood of a charge not detonating is remote and only in the case of extreme emergency or to safeguard human life would the Navy dispose of the charge at sea. If the charge were released, it would sink to the bottom but would not be expected to have significant adverse impacts on bottom communities. Studies of munitions dumping areas have shown no contamination from explosive materials and little or no adverse impact on benthic communities (Hoffsommer et al., 1972; Wilkniss, 1973).

4.1.4 Socioeconomic Environment

(a) Commercial and Recreational Fisheries

The explosion shock wave may kill or injure individual fish that are targets of commercial and recreational fisheries. However, a large fish kill would not be expected during the WINSTON S. CHURCHILL shock trial because detonation would be postponed if large schools of fish were observed within 1.85 km (1 nmi) of the detonation point (see Section 5.0). Due to the large populations and wide geographic distribution of the species present near the proposed test areas and the limited area affected, the explosions would not be expected to have a significant impact on fishery stocks. Potential effects on managed fishery species and essential fish habitat are discussed further in Appendix H.

Effects of explosions on fish have been discussed previously in Section 4.1.3(b). Small fish with swimbladders are the ones most likely to be killed or injured if present in surface waters within about 1,400 m (4,600 ft) of the detonation point. This category includes species such as dwarf herring, round scad, Atlantic menhaden, and chub mackerel. Some of these are commercially important species, although they are not fished within the test areas.

The main targets of commercial and recreational fishing at all three test areas are large oceanic pelagic species such as billfish, dolphinfish, tunas, wahoo, and sharks (see Table 3.9). Because sharks do not have a swimbladder, they are unlikely to be affected unless they are very close to the detonation point (within about 22 m or 73 ft). The other large species all have swimbladders and may be affected within a radius of about 762 m (2,500 ft) (see Section 4.1.3(b). Most of the oceanic pelagic fish are non-schooling, and large fish kills of these species are therefore unlikely. Schooling species such as dolphinfish, tunas, and (occasionally) wahoo are also unlikely to have significant numbers killed because detonation would be postponed if large schools were present within 1.85 km (1 nmi) of the detonation point.

Demersal (bottom dwelling) fish and invertebrates are unlikely to be killed or injured by the detonations, as explained in Section 4.1.3(d). Demersal fishery species are golden tilefish at both Mayport and Norfolk and summer flounder, black seabass, butterfish, hake, and squid at Norfolk only. Due to the water depth (152 m or 500 ft), the shock wave is not expected to affect these species or their habitat. Previous calculations of tilefish mortality contours for a 4,536 kg (10,000 lb) charge indicate that few if any tilefish or other bottom dwelling fish would be affected (Department of the Navy, 1981). No sediment resuspension or cratering of the seafloor is expected [see Section 4.1.5(a)].

Fishing vessels would be excluded from the test site for about 12 hours during each detonation. Types of fishing most likely to be affected are surface and bottom longlining and trolling (see Table 3.9). Demersal trawling at the Norfolk area occurs primarily during winter months, so the shock trial is unlikely to interrupt this activity. Bottom longlining for golden tilefish occurs off both Mayport and Norfolk, but most tilefishing off Norfolk occurs from Norfolk Canyon north, an area which is excluded from testing. Surface longlining by commercial fishers and trolling by recreational anglers may occur at any of the test areas. Various recreational fishing tournaments occur during the May through September period, but these activities are primarily concentrated in coastal and continental shelf waters inshore of the test areas. Due to the distance from shore, the relatively small area of the exclusion zone, the short duration of each detonation, and the advance warning provided through *Notices to Airmen and Mariners*, the temporary interruption is not expected to significantly affect commercial or recreational fishing activity.

(b) Ship Traffic

There would be no direct impacts of detonations on non-test ships because they would be excluded from the test site. An exclusion zone of 9 km (5 nmi) radius would be established around the test site to exclude all non-test ship, submarine, and aircraft traffic. Any traffic within an 18.5 km (10 nmi) radius would be warned to alter course or would be escorted from the site. *Notices to Airmen and Mariners* would be published in advance of each test. Traffic would be excluded from the site for a period of about 12 hours for each detonation.

Diversion of non-test ships would occur. There are no shipping lanes near the Mayport or Norfolk test areas. Portions of the Pascagoula test area within 18.5 km (10 nmi) of shipping lanes were excluded. Although shipping lanes have been avoided, commercial and military ship traffic is present to varying degrees. Few, if any, recreational boats are likely to be present due to the distance from shore. Military traffic is excluded from consideration here because it can be controlled as necessary during the shock trial. As explained in Section 2.2.2(e), Pascagoula has the highest level of commercial ship traffic, reflecting the maritime activity associated with the petroleum industry and nearby ports (Mobile and New Orleans). The area off Mayport has the lowest level of commercial ship traffic and Norfolk is intermediate.

(c) Other Socioeconomic Issues

There are no ocean disposal sites within 18.5 km (10 nmi) of the Mayport, Norfolk, or Pascagoula test areas. Since this is the radius within which ships would be warned to alter course, testing would not conflict with use of any ocean disposal site. There are no communications cables at the Norfolk or Pascagoula areas, and the one cable identified off Mayport is no longer in use (Department of the Navy, 1995a). There would be no impact to international telecommunications should the cable be damaged (Wargo, 1994).

Chevron U.S.A. and partners have proposed an offshore gas development in the "Destin Dome Unit," a group of lease blocks northwest of the Pascagoula test area (MMS, 1999). It is possible that development activities such as platform and pipeline installation could be occurring in the

Destin Dome Unit by the time of the shock trial in 2001. Some portions of the Destin Dome Unit blocks would be within 10 nmi (the radius of the ship warning zone) if a test site were selected in the northwestern corner of the Pascagoula test area. Therefore, if the Pascagoula test area is selected for the shock trial, the Navy would contact the MMS and Chevron to determine whether any petroleum industry activities are planned during the period of the shock trial and to coordinate activities. It is assumed that significant impacts on petroleum industry activities would be avoided through this coordination.

A large fish kill would not be expected during the WINSTON S. CHURCHILL shock trial because detonation would be postponed if large schools of fish were observed within 1.85 km (1 nmi) of the detonation point (see Section 5.0). Large fish kills have not been seen following previous similar detonations (Department of the Navy, 1981; Naval Air Warfare Center, 1994). Due to the distance from shore and the strong currents, it is highly unlikely that dead fish would reach shore. No significant onshore or nearshore impacts from fish kills are expected.

4.1.5 Physical Environment

(a) Geology and Sediments

All three test areas are predominantly sand bottom at this water depth. Potential impacts at the three areas should be similar.

Calculations based on the size of the explosive (4,536 kg or 10,000 lb), the depth of burst (61 m or 200 ft), and the total water depth (at least 183 m or 600 ft) indicate there would be no cratering of the seafloor (Young, 1995b). The shock wave would reach the seafloor and be reflected from it, but would have no significant impact on bottom structure or form. The reflected wave would probably carry some resuspended sediment which would settle to the seafloor. The detonations would have no impacts on local and regional geology including seismic events, sediment slumping, or petroleum seepage.

Fragments of steel charge casings would settle to the bottom, but would have no significant impact on bottom structure or form. The largest possible fragment from each explosion is the top plate and crossbar, which together weigh 204 kg (450 lb). Due to low oxygen levels in bottom sediments, the steel fragments would likely corrode very slowly and would not be expected to significantly affect sediment metal concentrations.

The likelihood of a charge not detonating is remote and only in the case of extreme emergency or to safeguard human life would the Navy dispose of the charge at sea. If the charge were released, it would sink to the bottom but would not be expected to have significant adverse impacts on bottom sediments. Studies of munitions dumping areas have shown no contamination from explosive materials (Hoffsommer et al., 1972; Wilkniss, 1973).

(b) Air Quality and Noise

The alternative areas (Mayport, Norfolk, and Pascagoula) are well offshore and are located in an area that is not classified for priority pollutants under the Clean Air Act. Therefore, a Clean Air Act General Conformity Review is not applicable. Ambient air quality and impacts are expected to be similar at the two areas.

The spherical bubble produced by each explosion would expand to a maximum radius of 19 m (62.3 ft) (Young, 1995a). The bubble would migrate upward and collapse beneath the surface, where it would re-expand and emerge into the atmosphere. The water that is ejected would form a roughly hemispherical mass of plumes with an estimated maximum height of 165 m (540 ft). It is estimated that 90% of the gaseous explosion products would become airborne.

Airborne explosion products are assumed to stabilize in a spherical form and move downwind, with concentrations remaining the same for the first 30 m (100 ft) (Young, 1995a). This "cloud" would not be visible. Then, the airborne cloud would continue to move at the speed of the wind and become diluted and dispersed by atmospheric turbulence.

Table 4.7 lists initial and downwind concentrations of explosion products in the atmosphere. The calculations assume that the products would be uniformly mixed at the time of stabilization and that the cloud would expand as a result of natural turbulence (Young, 1995a).

There are no air quality standards developed specifically for underwater explosions. For comparison, limits used by the Occupational Safety and Health Administration (OSHA), the American Conference of Governmental Industrial Hygienists (ACGIH), and the National Institute for Occupational Safety and Health (NIOSH) can be used (Table 4.7). Relevant standards include the Ceiling Concentration (CL), which cannot be exceeded at any time; and the Short-Term Exposure Limit (STEL), which is usually a 15-minute time-weighted average. Limits are not given for asphyxiants, which are non-toxic gases that exclude oxygen from the lungs when present in high concentrations.

All of the predicted initial concentrations (except for carbon monoxide and ammonia) are below the OSHA, ACGIH, and NIOSH limits. For safety reasons, no personnel would be near the detonation point where the highest concentrations would occur. The initial concentrations would disperse rapidly in the atmosphere; all predicted concentrations would be well below the limits at 305 m (1,000 ft) downwind, a point which would be reached within a few minutes after detonation depending on wind speed (e.g., within 2 minutes in a 5-kt wind). Because of the low initial concentrations and rapid dispersion of explosion products, there would not be any risk to human health or marine life in the test site.

(c) Water Quality

Ambient water quality at the three potential test areas is similar because all are located in deep oceanic waters. Impacts of the shock trial on water quality would be similar at the three areas.

Table 4.7. Predicted atmospheric concentrations of explosion products compared with atmospheric exposure standards (Adapted from: Young, 1995a).

Explosion Product	Concentration (ppm)			Exposure Standard (ppm except where noted)		
	Initial	305 m (1,000 ft) Downwind	1,524 m (5,000 ft) Downwind	OSHA PEL	ACGIH TLV	NIOSH REL
Carbon dioxide (CO_2)	37.9	1.2	0.107	--[a]	STEL: 30,000	CL: 30,000
Carbon monoxide (CO)	672	21.2	1.90	--[a]	STEL: 400	CL: 200
Ammonia (NH_3)	86.4	2.73	0.245	--[a]	STEL: 35	CL: 50
Ethane (C_2H_6)	100	3.16	0.283	Asphyxiant	Asphyxiant	Asphyxiant
Propane (C_3H_8)	19.6	0.619	0.0555	--[a]	Asphyxiant	--
Hydrogen cyanide (HCN)	7.06	0.223	0.0200	--[a]	CL: 10	CL: 5 mg CN/m^3/10M
Methane (CH_4)	5.03	0.159	0.0142	Asphyxiant	Asphyxiant	Asphyxiant
Methyl alcohol (CH_3OH)	0.205	0.0065	0.0006	--[a]	STEL: 250	CL: 800/15M
Formaldehyde (CH_2O)	0.108	0.0034	0.0003	--[a]	--[a]	--
Acetylene (C_2H_2)	0.161	0.0051	0.0005	CL: 2,500	Asphyxiant	CL: 2,500
Phosphine (PH_3)	0.171	0.0054	0.0005	--[a]	STEL: 1	--

Abbreviations:
OSHA = Occupational Safety and Health Administration; PEL = permissible exposure limit.
ACGIH = American Conference of Governmental Industrial Hygienists; TLV = threshold limit value.
NIOSH = National Institute for Occupational Safety and Health; REL = recommended exposure limit.
CL = ceiling concentration; STEL = short-term exposure limit.

[a] The only limit specified is a time-weighted average for an 8-hr day, 40-hr work week. This would not be relevant to the proposed detonations.

Chemical products of deep underwater explosions are initially confined to a thin, circular area called the surface pool. It is estimated that 100% of the solid explosion products and 10% of the gases remain in the pool (Young, 1995a). This surface pool is fed by an upwelling current of water entrained by the rising bubble produced by the detonation. After the turbulence of the explosion has dispersed, the pool stabilizes and chemical products become uniformly distributed. The surface pool is usually not visible after about five minutes. As the pool continues to grow, the chemical products are diluted and become undetectable. Because of continued dispersion and mixing, there would be no buildup of explosion products in the water column.

Table 4.8 lists predicted water column concentrations of explosion products in the surface pool at the time of stabilization (Young, 1995a). The table compares the concentrations with water quality criteria developed to protect marine or human life. The Environmental Protection Agency (1986) has published water quality criteria for ammonia and cyanide, but not for the other explosion products. The two solids, carbon and aluminum oxide, are both found in nature and are not hazardous materials. For the other products, criteria to protect marine life (Suter and Rosen, 1988) or humans (Sittig, 1985) were used. All of the predicted concentrations are below the criteria, indicating no hazard to marine life.

4.2 IMPACTS UNDER NEPA

4.2.1 Physical Environment

Shore support operations and movement of vessels and aircraft within territorial limits are not unusual or extraordinary and are part of the routine operations associated with the existing shore bases. Impacts of these existing operations on geology and sediments, air quality, and water quality are minimal, and no additional direct impacts are expected at either Mayport, Norfolk, or Pascagoula.

Chemical byproducts of the detonations would be rapidly dispersed at the test site (see Sections 4.1.5(b) and 4.1.5(c) and therefore would not affect coastal water quality or air quality.

Due to the water depth of the explosion (61 m or 200 ft) and the distance from nearest shore [at least 83 km (45 nmi) for Mayport, 61 km (33 nmi) for Norfolk, and 52 km (28 nmi) for Pascagoula], the detonations are expected to be virtually inaudible to human populations onshore, except in the event of unusual atmospheric conditions such as thermal inversions and low clouds. An underwater explosion generates the most noise when it takes place just below the surface. According to O'Keeffe and Young (1984), a reasonable assumption is that one can disregard the noise from explosions at reduced depths equal to or greater than 2.0 $ft/lb^{1/3}$, which in this case yields a depth of 13 m (43 ft), much less than the depth of the proposed detonations.

4.2.2 Biological Environment

Shore support operations and movement of vessels and aircraft within territorial limits are not unusual or extraordinary and are part of the routine operations associated with the existing shore bases. Impacts of these existing operations on marine biota, including plankton, pelagic fish,

Table 4.8. Predicted concentrations of explosion products in seawater, compared with permissible concentrations. Predicted concentrations are for the surface pool at the time of stabilization (Young, 1984). Permissible concentrations are based on reference standards for marine life (Environmental Protection Agency, 1986; Suter and Rosen, 1988). In cases where marine life criteria have not been established, values for humans were used (Sittig, 1985).

Explosion Product	Predicted Concentration (mg/L)	Permissible Concentration (mg/L)
Carbon dioxide (CO_2)	0.00262	1.0[a]
Carbon monoxide (CO)	0.0293	0.552
Ammonia (NH_3)	0.00230	0.092[b]
Ethane (C_2H_6)	0.00469	120
Propane (C_3H_8)	0.00135	120
Hydrogen cyanide (HCN)	0.000298	0.001[b] 0.036[c]
Methane (CH_4)	0.000126	120
Methyl alcohol (CH_3OH)	0.0000107	3.60
Formaldehyde (CH_2O)	0.00000534	0.0414
Carbon (C)	0.143	NA
Acetylene (C_2H_2)	0.00000668	73
Phosphine (PH_3)	0.00000935	0.0055
Aluminum oxide (Al_2O_3)	0.434	NA

[a] 1.0 mg/L produces avoidance by fish.

[b] Water quality criterion from U.S. Environmental Prc.ection Agency (1986).

[c] Maximum acceptable toxicant concentration for fish exposed to cyanide (Suter and Rosen, 1988).

marine mammals, sea turtles, benthic organisms, and seabirds are minimal, and no additional direct or indirect impacts are expected at either Mayport, Norfolk, or Pascagoula.

4.2.3 Socioeconomic Environment

Shore support operations and movement of vessels and aircraft within territorial limits are not unusual or extraordinary and are part of the routine operations associated with the existing shore bases. Impacts of these existing operations on commercial and recreational fisheries and ship traffic are minimal, and no additional direct or indirect impacts are expected at either Mayport, Norfolk, or Pascagoula.

Existing facilities at Naval Station Mayport, Naval Station Norfolk, or Naval Station Pascagoula would provide most services in support of the shock trial. The only additional facilities required would be temporary offices, an instrumentation trailer, and possibly a small supply trailer (cable, spare parts, etc.). Additional space would be leased outside the base, if required. No significant direct or indirect impacts on the local economy are expected at Mayport, Norfolk, or Pascagoula.

Due to the small area affected and the short duration of the shock trial, the proposed action would not have significant impacts on commercial or recreational fishery stocks or fishing activities [see Section 4.1.4(a)]. Therefore, no significant impacts on the coastal fishing industry are expected.

Shrimp trawling is a highly commercialized activity in coastal waters off northeastern Florida. However, because the Mayport area lies well offshore of designated east coast shrimp beds, no direct or indirect impacts on shrimping would be expected.

A large fish kill would not be expected during the WINSTON S. CHURCHILL shock trial because detonation would be postponed if large schools of fish were observed within 1.85 km (1 nmi) of the detonation point (see Section 5.0). Large fish kills have not been seen following previous similar detonations (Department of the Navy, 1981; Naval Air Warfare Center, 1994). Due to the distance from shore and the strong currents, it is highly unlikely that dead fish would reach shore. No significant onshore or nearshore impacts from fish kills are expected.

5.0 MITIGATION AND MONITORING

The proposed action includes the following mitigation and monitoring measures: (1) environmental buffer zones to avoid impacts to certain environmental features; (2) a vessel exclusion zone for operational security; (3) measures to deal with unexploded ordnance in the unlikely event of a misfire; and (4) a marine mammal and sea turtle mitigation plan to minimize the risk of impacts to marine life.

5.1 ENVIRONMENTAL BUFFER ZONES

Detailed exclusionary mapping was conducted to determine whether portions of the test areas needed to be excluded from testing. Environmental features that were included in the exclusionary mapping were as follows:

- Active petroleum lease blocks;
- Artificial reef sites and areas;
- Communications cables;
- Critical habitats;
- Data buoys;
- Explosives dumpsites;
- Hard bottom and coral areas;
- Marine sanctuaries;
- Navigation aids;
- Ocean dredged material, acid waste, and sewage sludge disposal sites;
- Pipelines (oil and gas);
- Platforms (oil and gas);
- Shipping lanes;
- Towers (communications or navigation);
- Unexploded ordnance; and
- Wrecks and obstructions.

Buffer zones were added to appropriate environmental features with the goal of protecting resources or avoiding conflicts at the time of the shock trial. Various buffer distances were used, depending on the type of environmental feature. At Mayport, environmental features within or on the edge of the test area that were excluded were an explosives dumpsite, three unexploded ordnance sites, five hard bottom areas, and three wrecks. Environmental features excluded at Norfolk were one explosives dumpsite, part of the buffer zone for the formerly proposed Norfolk Canyon National Marine Sanctuary, one unexploded ordnance site, and four wrecks. Environmental features excluded at Pascagoula were part of an explosives dumpsite and buffer zones for shipping lanes. Details are provided in Section 2.2.3.

5.2 VESSEL EXCLUSION ZONE

An exclusion zone of 9.3 km (5 nmi) radius would be established around the detonation point to exclude all non-test ship, submarine, and aircraft traffic for up to 12 hours per detonation. This exclusion zone is an electronic emissions control zone that virtually eliminates the possibility of an inadvertent detonation caused by radio/radar induced electrical current in the explosive firing circuit. The exclusion zone also provides an area of safe maneuvering for the charge-handling vessel and its explosive tow. The charge-handling vessel has severely restricted maneuvering capability once the explosive charge is deployed and under tow some 610 m (2,000 ft) astern. Any traffic within an 18.5 km (10 nmi) radius would be warned to alter

course or would be escorted from the site. Since the WINSTON S. CHURCHILL and the operations vessel would be moving, these zones around the detonation point would also be moving. *Notices to Airmen and Mariners* would be published in advance of each test. An immediate "hold" on the test would be ordered if any unauthorized craft entered the exclusion zone and could not be contacted. The "hold" would continue until the exclusion zone was clear of unauthorized vessels. The size of the exclusion zone is necessary for operational security and to allow large vessels sufficient time to change course.

5.3 UNEXPLODED ORDNANCE

The probability of a charge not detonating during a test is remote. Should a charge fail to explode, the Navy would attempt to identify the problem and detonate the charge with all marine mammal and sea turtle mitigation measures in place as described below. If these attempts failed, the Navy would recover the explosive and disarm it. Only in the case of an extreme emergency (e.g., charge could not be detonated or disarmed) or to safeguard human life would the Navy dispose of the charge at sea. The possibility of disposing the explosive charge at sea is very remote. However, if disposal at sea were necessary, the charge would be disposed in a manner that would not pose a hazard to the public.

5.4 MARINE MAMMAL AND SEA TURTLE MITIGATION PLAN

A detailed marine mammal and sea turtle mitigation plan has been developed to minimize the impact of the shock trial on these animals. All components of the mitigation plan, including aerial and shipboard visual observers as well as the acoustic monitoring system, must be in place on the day of the test or the test will be postponed. The mitigation plan is modeled after the same type of mitigation and monitoring efforts successfully used during the shock trial of the USS JOHN PAUL JONES (DDG 53) conducted in 1994 off the coast of southern California. Marine mammal population densities off the coast of southern California are about 3 times higher than those estimated in this FEIS for the Norfolk area and about 9 times higher than those estimated for the Mayport and Pascagoula test areas. The JOHN PAUL JONES shock trial consisted of two 4,536 kg (10,000 lb) detonations and no deaths or injuries of marine mammals were detected. All animals observed after the two detonations appeared to behave normally (Naval Air Warfare Center, 1994). This plan is also modeled after the mitigation plan defined in the USS SEAWOLF shock test EIS, which was adopted by NMFS in their final rule.

The potential test areas for the WINSTON S. CHURCHILL shock trial have been evaluated in Section 2.0 based on the Navy's operational requirements. The analysis indicates that only the Norfolk, Mayport, and Pascagoula areas meet all of the Navy's operational requirements. As discussed in Section 5.2, environmentally sensitive areas within the Norfolk and Mayport test areas were excluded. Finally, the impact analysis in Section 4.0 (Environmental Consequences) was used to compare the risk of impacts to marine mammals and turtles among test areas.

The mitigation plan would build upon these efforts to avoid and further reduce potential environmental impacts. One primary and two secondary test sites would be selected within

the test area where marine mammal and turtle populations are the lowest, based on the results of aerial surveys to be conducted one to two days prior to the first detonation. This would ensure that the final test site selected for the shock trial poses the least possible risk to the marine environment. Pre-detonation monitoring would be conducted on the day of the shock trial to evaluate the test site and verify that the Safety Range and Buffer Zone are free of visually and acoustically detectable marine mammals; sea turtles; large *Sargassum* rafts, debris lines, and/or concentrations of jellyfish (all are possible indicators of turtle presence); large schools of fish; and flocks of seabirds. Finally, post-detonation monitoring would be conducted to determine the effectiveness of the mitigation efforts. A ship-based Marine Animal Recovery Team (MART) and aerial observers would monitor the test site and surrounding waters for injured or dead animals after each detonation. Communications with stranding network personnel would be maintained throughout the shock trial period.

The mitigation plan provides the best possible effort, considering logistical and safety constraints, at minimizing adverse effects on marine mammals and sea turtles. Visual monitoring from two different platforms combined with acoustic monitoring is still not guaranteed to be 100% effective, since there are too many uncontrollable factors that can lead to possible negative impacts. For example, sea turtles that are submerged and marine mammals that are submerged and silent will not be detected visually or acoustically. In addition, even experienced visual observers may not see animals that are on the surface (see **Appendix C**). Sea turtles and some marine mammals are cryptic and difficult to see, particularly from a vessel. However, by combining several complementary mitigation components similar to those used during the JOHN PAUL JONES shock trial, this plan should be extremely effective.

5.4.1 Safety Range

The concept of a Safety Range is an integral part of the mitigation plan. The area within the Safety Range would be monitored by all components of the mitigation team and detonation would not occur until it is clear of detectable marine mammals and sea turtles, as well as indicators of sea turtle presence such as large *Sargassum* rafts, debris lines, and jellyfish aggregations. The purpose of the Safety Range is to prevent deaths and serious injuries to marine mammals and sea turtles. The Safety Range radius of 3.7 km (2 nmi) around the detonation point exceeds the estimated ranges for mortality and injury to a marine mammal or sea turtle associated with detonation of a 4,536 kg (10,000 lb) explosive. Based on the analysis presented in **Appendix D**, the maximum range for mortality (onset of extensive lung injury) is 1.35 km (0.73 nmi) and the maximum range for injury (onset of slight lung injury) is 2.25 km (1.22 nmi). These are conservative ranges, and take into account the worst-case depth effects. The Safety Range extends well beyond these ranges to encompass the maximum area that can be effectively monitored both visually and acoustically. Its radius is approximately 2.7 times the onset mortality range and 1.6 times the range for onset of slight lung injury.

5.4.2 Buffer Zone

For mitigation monitoring purposes, a 1.85 km (1 nmi) Buffer Zone has also been added to the 3.7 km (2 nmi) Safety Range to account for the possible movement of marine mammals and sea turtles towards the Safety Range. Specifically, the area encompassed within a 5.6 km (3 nmi) radius from the detonation point would be visually monitored to detect any marine mammals or sea turtles approaching the 3.7 km (2 nmi) Safety Range. As detailed below, species-specific protocols have been developed to determine when and how long to postpone a detonation if a marine mammal or sea turtle is detected in the Buffer Zone.

5.4.3 Weather Limitations

Weather that supports the ability to sight small marine life (e.g., sea turtles) is required to mitigate the test site effectively. Wind, visibility, and the surface conditions of the ocean are the most critical factors affecting mitigation operations for the WINSTON S. CHURCHILL shock trial. Higher winds typically increase wave height and create "white cap" conditions, both of which limit an observer's ability to locate surfacing marine mammals. To maximize the capability of detecting marine mammals and turtles, while minimizing the number of days that tests may be suspended by sighting conditions, tests would be conducted in sea states no greater than No. 3 based on the following sea state scale:

0 = flat calm, no waves or ripples
1 = small wavelets, few if any whitecaps
2 = whitecaps on 0%-33% of surface; 0.3 to 0.6 m (1 to 2 ft) waves
3 = whitecaps on 33%-50% of surface; 0.6 to 0.9 m (2 to 3 ft) waves
4 = whitecaps on greater than 50% of surface; greater than 0.9 m (3 ft) waves

Visibility is also a critical factor for observation capabilities and safety-of-flight issues. A minimum ceiling of 305 m (1,000 ft) and visibility of 5.6 km (3 nmi) is required to support mitigation and safety-of-flight concerns.

5.5 MITIGATION COMPONENTS/TEAMS

As illustrated in **Figure 5.1**, the mitigation plan includes four components: (1) pre-detonation aerial surveys/monitoring; (2) pre-detonation shipboard monitoring from the WINSTON S. CHURCHILL and the MART vessel; (3) pre-detonation passive acoustic monitoring; and (4) post-detonation aerial and shipboard monitoring. The term "survey" refers to site selection surveys and "monitoring" refers to pre-detonation site clearance to locate and identify marine animals and sea turtles in or near the test site and post-detonation site evaluation. The aerial and shipboard monitoring teams would identify and locate cetaceans and sea turtles on the ocean surface. The acoustic monitoring team would detect and locate calls from surfaced and submerged cetaceans. All three teams would have a leader who is responsible for communicating visual or acoustic detections to the Lead Scientist onboard the WINSTON S.

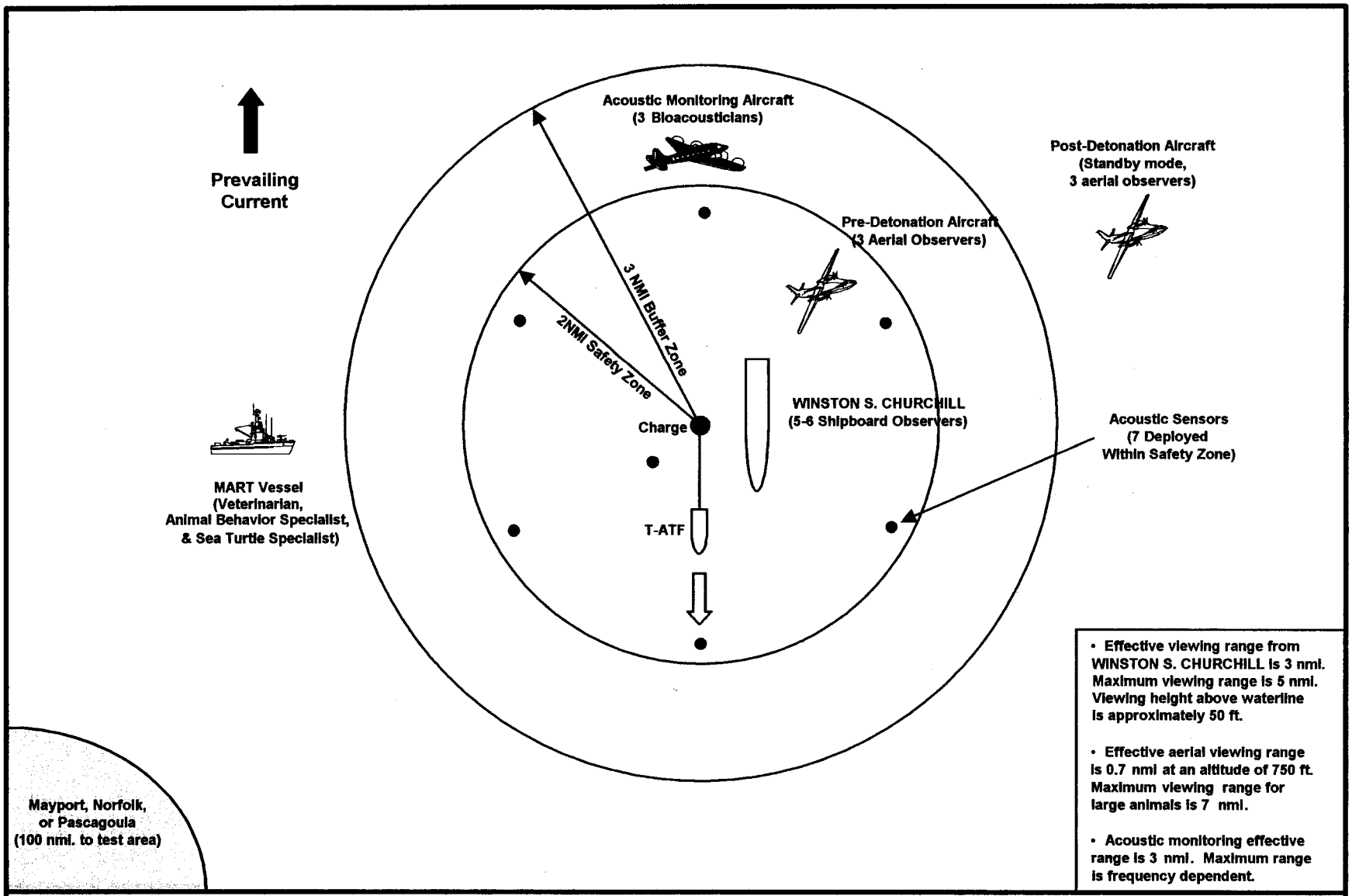

Figure 5.1. WINSTON S. CHURCHILL shock trial mitigation components.

CHURCHILL. The lines of communication between the various monitoring teams and WINSTON S. CHURCHILL are discussed in the following section.

A marine animal tracking and sighting program would be used by the Lead Scientist onboard the WINSTON S. CHURCHILL to track all marine animals and sea turtles spotted by the shipboard/aerial survey team and detected by the acoustic tracking system. The program allows immediate plotting of an animal's position relative to the detonation point and depicts the safety range and buffer zone as concentric circles around the moving detonation point. The Lead Scientist would enter into the program the species, location, swim direction, and time of sighting of every animal detected. The program, which contains dive time and swim speed information about some species, would be useful in predicting where animals will most likely resurface and help in reidentifying sightings outside of the safety and buffer zones.

The mitigation team members would be qualified, experienced professionals. The Lead Scientist must have a Master's degree in biology, zoology, wildlife management, or a related field, with a minimum of 10 years experience in marine mammal field work including at least five field seasons in marine mammal/sea turtle vessel or aerial surveys. The marine animal veterinarian must have a Doctorate in Veterinary Medicine (D.V.M.) with a minimum of 3 years experience with marine mammals. The veterinarian would be assisted by a sea turtle specialist. Minimum qualifications for aerial and shipboard observers are as follows:

Primary Observer/ID Specialist. A minimum of five field seasons of experience in marine mammal/sea turtle vessel and/or aerial surveys; at least two field seasons experience in the Atlantic Ocean/Gulf of Mexico; and at least two field seasons experience with species identification. A minimum of two primary observers would be on each visual observation platform.

Secondary Observer/Data Recorder. The secondary observer position requires a minimum of two field seasons experience with marine mammal/sea turtle vessel and/or aerial surveys OR a minimum of two field seasons experience as a veterinary assistant familiar with marine animal necropsy procedures.

If the shock trial is conducted at Norfolk, all observers would be trained to recognize Bermuda Petrels, an endangered seabird species possibly occurring at this test area (see Section 3.2.3).

5.5.1 Pre-Detonation Aerial Survey/Monitoring Team

The aerial survey/monitoring team would consist of three observers and a pilot familiar with flying marine mammal/turtle aerial surveys. The survey aircraft would be a Partenavia or similar, with bubble windows allowing for 90° downward visibility and centerline viewing. A second aircraft of similar configuration and crew of observers would also be available on shot day to relieve the primary aircraft when the primary aircraft needs to refuel. In consideration of safety-of-flight issues, only one observation aircraft would be allowed in the airspace over the test site at any one time (Naval Air Warfare Center, 1994). Each aerial observer would be experienced in marine mammal surveying and familiar with species that may occur in the area.

One of the observers on each aircraft would be a NMFS representative. Each aircraft would have a data recorder who would be responsible for relaying the location (latitude and longitude), species, and the number of animals sighted to the Lead Scientist onboard the WINSTON S. CHURCHILL. The Lead Scientist would enter this information into the marine animal tracking and sighting program, and relay this information to the Shock Test Director and the Officer in Tactical Command (OTC). The aerial monitoring team would also identify to the Lead Scientist any large accumulations of *Sargassum* and debris lines that could potentially drift into the Safety Range.

Standard line transect aerial surveying methods, as developed by NMFS (Blaylock and Hoggard, 1994; Buckland et al., 1993) would be used for all mitigation aerial surveys and monitoring. All surveys and monitoring would be flown at an altitude of 229 m (750 ft) and a speed of 110 kts. Lower altitudes (152 m or 500 ft) are preferable for turtle aerial surveys, particularly for identifying turtles to species level. However, since the aircraft will have bubble windows to allow for centerline viewing directly below the aircraft and since turtles do not necessarily need to be identified to species for mitigation, a higher altitude (229 m or 750 ft) will be maintained to maximize area coverage. Aerial surveys flown at this altitude in the Mayport test area in summer 1999 and near the Mayport and Norfolk test areas in 1995 and 1997 (Mayport only) were successful in detecting numerous loggerhead and leatherback turtles (see **Appendix B**). The site selection surveys would cover the entire test area initially and at fairly broad scale (transects spaced ~7 nmi apart), then focus more specifically on those regions with the fewest marine animals noted. From this effort, a primary and two secondary test sites would be chosen. Pre-detonation monitoring on the day of the test would be conducted in the primary test site, and secondary test sites if necessary. Based on the shock trial of the USS JOHN PAUL JONES (Naval Air Warfare Center, 1994) and prior survey efforts off Mayport and Norfolk, aerial observers are expected to have good to excellent sighting conditions at sunrise to 1.85 km (1.0 nmi) maximum on either side of the aircraft within the weather limitations noted previously. Observed marine mammals and turtles would be identified to species or the lowest possible taxonomic level and their relative positions recorded. Detonations would occur no earlier than three hours after sunrise and no later than three hours prior to sunset to ensure adequate daylight for pre- and post-detonation monitoring.

5.5.2 Pre-Detonation Shipboard Monitoring Team

Shipboard monitoring would be staged from the shock trial ship, the WINSTON S. CHURCHILL, and the MART vessel. The Lead Scientist would be located on the shock trial ship with the OTC, as well as the Mitigation Team Coordinator and at least six observers experienced in shipboard surveys and familiar with the marine life of the area. The WINSTON S. CHURCHILL would be outfitted with at least two sets of 25X power binoculars (Bigeyes), which would allow the observers to sight surfacing mammals from as far as 9.3 km (5 nmi) and provide 360° overlapping coverage. Two observers would monitor the test site with the vessel-mounted 25X power binoculars, with two additional observers monitoring with hand-held binoculars. The fifth observer would rotate with the other observers to allow each observer to rest their eyes as needed. The sixth observer would be the Team Leader, responsible for reporting sighting locations from the observers to the Lead Scientist. Sighting locations would be based

on bearing and distance. Bearing would be measured relative to the bow of the vessel using a calibrated collar at the base of the yoke of the 25X power binoculars. Distance would be measured using a calibrated reticle in the oculars of the binoculars. As with the aerial monitoring team sightings, the Lead Scientist would enter this information into the marine animal tracking and sighting program. The species, number of animals sighted, and swim direction would also be recorded. The Lead Scientist would ensure that the OTC and the Shock Test Director are aware of all animals in or approaching the test site.

The MART vessel would provide preliminary visual evaluation of the primary test site, particularly first thing in the morning prior to the arrival of the aerial monitoring team and shock trial ship. Observers onboard the MART vessel would assess the primary test site for suitability, and relay that information to the Lead Scientist onboard the shock trial ship. This information would give the Lead Scientist and OTC the capability to move the trial to a secondary test site, if necessary.

5.5.3 Pre-Detonation Passive Acoustic Monitoring System

A passive marine mammal acoustic monitoring system to detect and locate calling marine mammals, similar to the type of system that was used successfully during the USS JOHN PAUL JONES shock trial, would be used during the trial. The acoustic monitoring system is a portable, rapidly deployable digital signal processing system that would be used to detect and localize transient acoustic sources produced by calling marine mammals. The acoustic monitoring system would consist of Navy passive sonobuoys dropped from a P-3 aircraft for acoustic detection and a digital signal processing system to locate the position of the animals and allow a team of three bioacousticians onboard the aircraft to listen to the calls to identify the species. The processing system would be capable of calculating the latitude and longitude of the animal, which would then be communicated to the Lead Scientist onboard the WINSTON S. CHURCHILL.

A hexagonal array of seven sonobuoys would be deployed around the earliest detonation point in the test site. The distance between sonobuoys would be 2 nmi, which would provide call localization out to at least 3 nmi from the detonation point. Call localization may be possible at even greater distances depending on propagation loss characteristics in the test area. Additional sonobuoys would be deployed to extend the acoustically monitored region in the event of delays. All buoy positions will be marked by the P-3 crew, who would also track the drift of the deployed sonobuoys and their relative positions to the detonation point. Sonobuoy signals would be received via P-3 antenna and sonobuoy receivers. Receiver outputs would be conditioned as necessary and digitized at a sampling rate of 48 kHz for demultiplexing by software routines coded for digital signal processing circuitry. This will permit immediate processing of acoustic information.

Acoustic data received from the buoys would be displayed as strip spectrograms showing frequency and duration of the call, polar displays of bearing-time and bearing-frequency and a navigation display to determine call positions (latitude and longitude) as well as relative positions to sonobuoys and vessels (**Figure 5.2**). Data would also be monitored aurally using

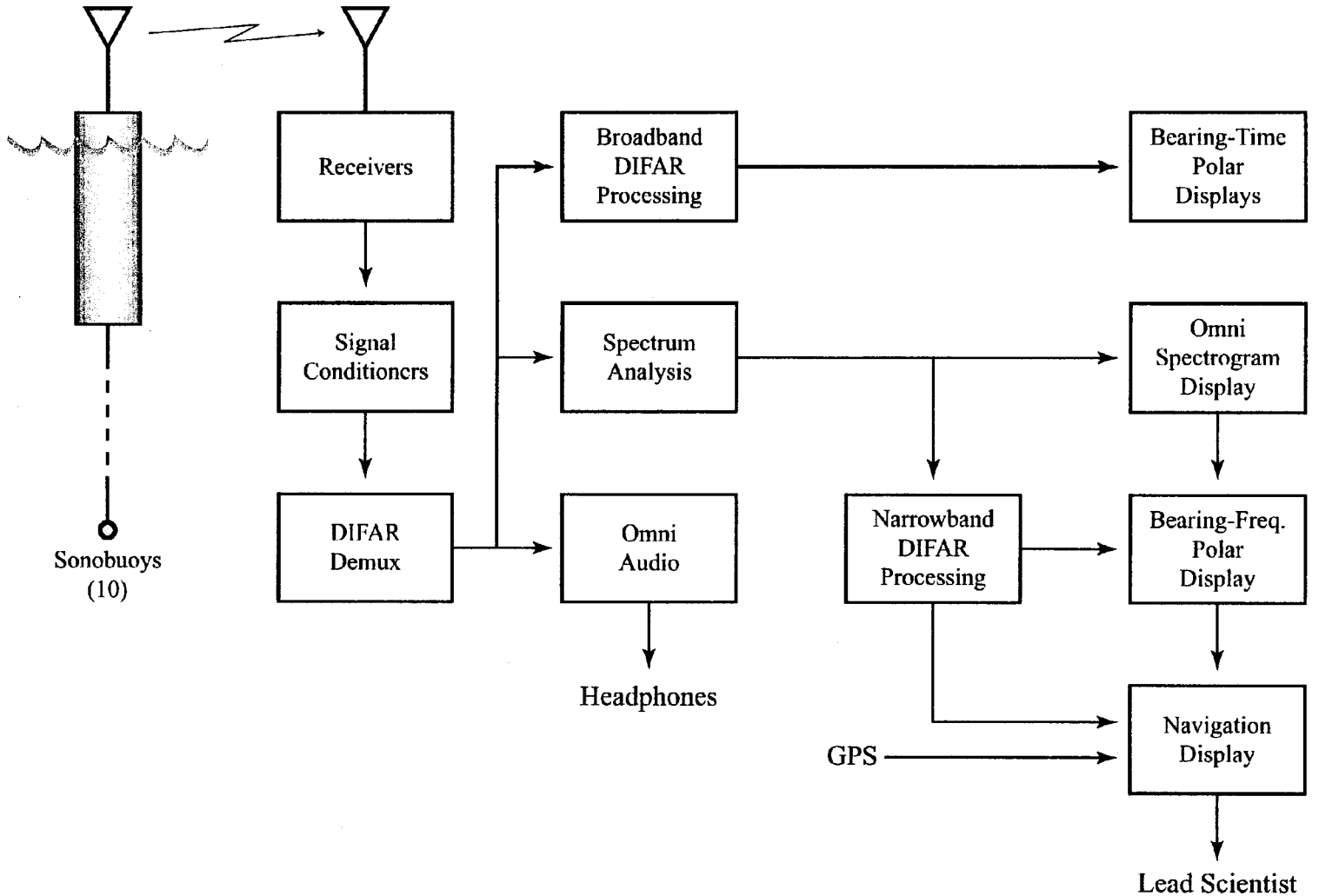

Figure 5.2. Schematic diagram of passive acoustic monitoring system.

automatic noise reduction (ANR) headsets. Low frequency sounds (10-200 Hz) would be shifted upwards by 100 Hz, while higher frequency sounds (up to 4 kHz) would be monitored with no shifting. Call locations and species would be radioed to the Lead Scientist onboard the WINSTON S. CHURCHILL.

The acoustic monitoring system would complement the other mitigation efforts. This system cannot detect animals that are not calling, or sea turtles since they do not vocalize. The bioacousticians would monitor the frequency bandwidths between 10 Hz and 4 kHz. This frequency range covers the vast majority of calls produced by all mysticetes and sperm whales (Richardson et al., 1995), including the six species of endangered whales which may be found within the Norfolk, Mayport and/or Pascagoula offshore areas. These cetacean species are more difficult to visually detect at the surface either because they tend to be solitary (mysticetes) or because they are deep divers (sperm whales). Therefore, acoustic monitoring of these species would provide one additional level of mitigation. There are other odontocetes that are deep divers (e.g., pygmy and dwarf sperm whales, beaked whale) that would not be acoustically monitored, since they do not typically produce sounds loud enough and in frequency bands that can be detected by an acoustic monitoring system (Barlow et al., 1997). Smaller odontocetes that may occur in the test area also would not be acoustically monitored, but most of these species (including pantropical, spinner and striped dolphins) are highly social and nearly always seen in large groups so they would be detected visually by observers onboard the WINSTON S. CHURCHILL and the monitoring aircraft.

5.5.4 Post-Detonation Aerial and Shipboard Monitoring

Post-detonation monitoring would commence immediately following each detonation. Post-detonation monitoring is designed to determine the effectiveness of pre-detonation mitigation by reporting any sightings of dead or injured marine mammals or sea turtles. Dead animals would be retrieved, if possible, to determine the cause of death. Injured sea turtles would be collected and held for observation and assessment. After each detonation, an aerial monitoring team would resume transects in the area of the detonation and continue monitoring for at least three hours on shot day. Aerial monitoring would also take place for two days immediately following the detonation, for a minimum of three hours at and down current from the detonation site. The aerial monitoring team would be assisted by the MART based onboard a separate vessel. The MART would consist of a veterinarian, a marine mammal behavior specialist, and a sea turtle expert. The MART would remain in the area of and down current from the detonation for 48 hours after each detonation (and for seven days following the last detonation) to allow sufficient time for a dead animal to submerge and resurface due to a buildup of decomposition gases. The MART would regularly reposition down current, based on information from a drogue deployed to measure bottom current. If any animals are observed in the general area during the post-detonation monitoring period, the location, number, species, and behavior would be recorded.

5.6 MITIGATION PHASES

The mitigation plan would consist of three phases, to occur sequentially. The first two phases were designed to minimize the possibility of marine mammals or turtles being present the day of each detonation. The third phase evaluates the effectiveness of the first two phases.

Test Site Selection Surveys – selecting one primary and two secondary test sites that pose the least risk to the marine environment.

Pre-Detonation Monitoring – effectively monitoring the selected test site immediately prior to each detonation to assess its overall suitability (low incidence of marine mammals, sea turtles, *Sargassum* rafts and debris lines) and closely monitoring the Safety Range and Buffer Zone to verify that it is free of visually or acoustically detectable marine mammals, as well as visible turtles, large *Sargassum* rafts and debris lines, large jellyfish concentrations, large schools of fish, and flocks of seabirds.

Post-Detonation Monitoring – determining the effectiveness of the mitigation efforts via aerial and shipboard monitoring for dead or injured animals.

5.6.1 Phase One: Test Site Selection Surveys

The purpose of the test site selection surveys is to identify sites within the test area having the fewest marine mammals and turtles. Using the data from these surveys, the Navy would select a primary and two secondary test sites. Each of these sites would be 18.5 km (10 nmi) x 27.8 km (15 nmi) in size, based on the logistics of the test. The WINSTON S. CHURCHILL and T-ATF (with towed explosive) would be moving at a maximum speed of 7.5 kts using the parallel tow method, as shown previously in **Figure 2.1**. This means that the 5.6 km (3 nmi) radius Safety Range and Buffer Zone around the detonation point would also be moving. The earliest detonation point within the test site is therefore 5.6 km (3 nmi) in to encompass the Safety Range and Buffer Zone. The detonation is planned to occur in the primary test site, but as a backup, the two secondary test sites would also be monitored in case the detonation is delayed.

Two days prior to the shock trial, a single aerial survey would be conducted over the selected test area (i.e., Norfolk, Mayport, or Pascagoula) to identify potential test sites with the lowest density of marine mammals and turtles. The aerial survey would be conducted along transects spaced 13 km (7 nmi) apart and flown at an altitude of 229 m (750 ft) and a speed of 110 kts. The selected area would be surveyed by flying east-west transects (for Norfolk or Mayport) or north-south transects (for Pascagoula) as illustrated in **Figures 5.3, 5.4, and 5.5**. The sightings data would be analyzed to determine the areas of lowest marine mammal and sea turtle abundance. The Navy would also use satellite imagery of sea surface temperature, as well as other oceanographic data and aerial survey indicators such as *Sargassum* rafts and debris lines, water color changes, Coast Watch Data, etc. to identify current boundaries expected to be highly productive. At Mayport, test sites would be within the Gulf Stream and no closer than 3.7 km (2 nmi) from its western boundary, which appears to be a seaward boundary for

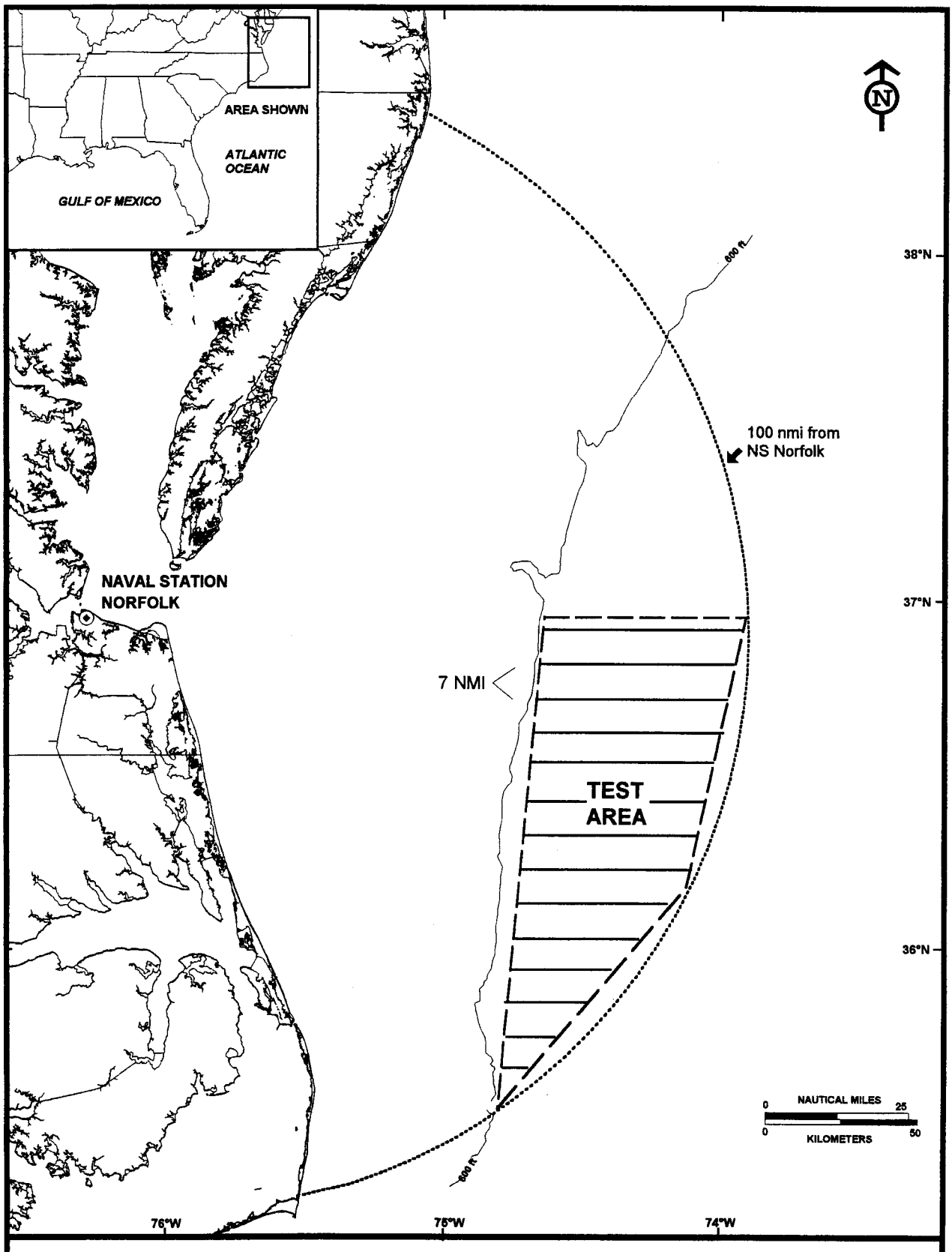

Figure 5.3. Flight plan for site selection one to two days prior to detonation (Norfolk).

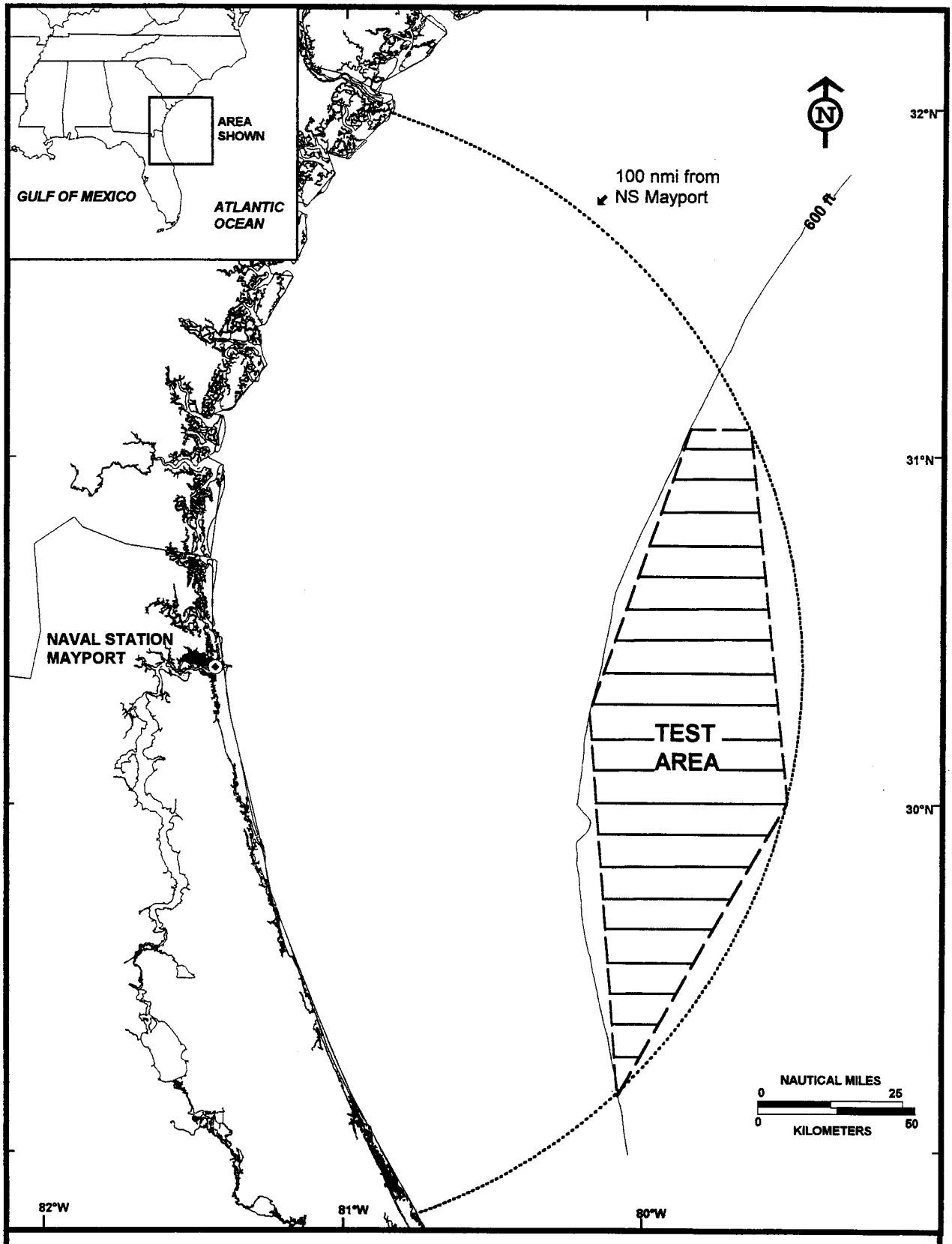

Figure 5.4. Flight plan for site selection one to two days prior to detonation (Mayport).

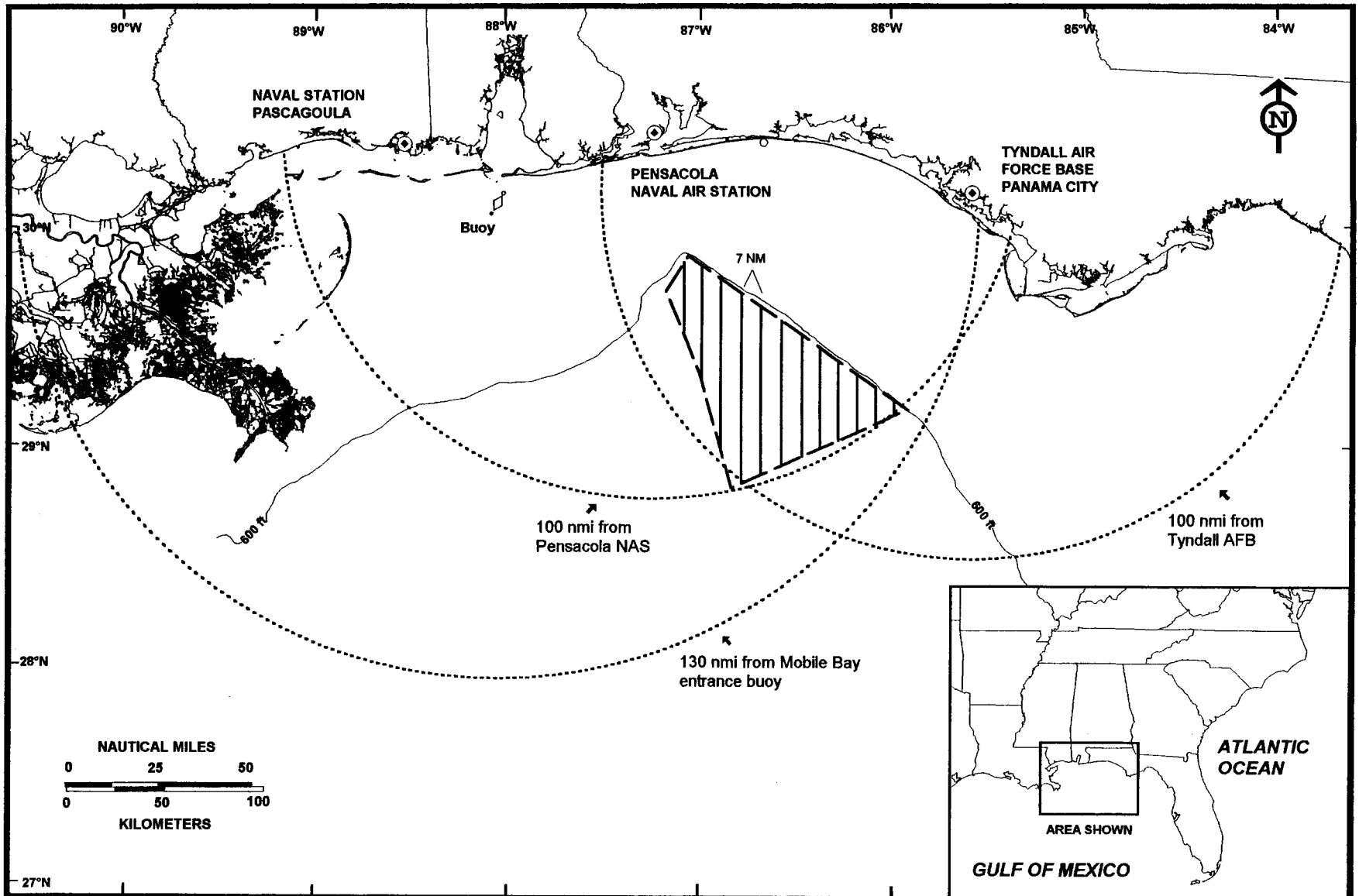

Figure 5.5. Flight plan for site selection one to two days prior to detonation (Pascagoula).

aggregated hatchlings and pelagic immature and adult sea turtles. At all sites, cold core rings would also be avoided since marine mammal sightings are generally higher near them (Davis et al., 2000). In addition, frontal zones at the edges of both warm and cold core rings would be avoided, as these can also be productive regions with higher marine mammal densities (Griffin et al., 1999; Davis et al., 2000). Near-real time updates of ocean elevation indicating cold core rings are available from the Colorado Center for Astrophysics Research website.

One day prior to the shock trial, those regions that have the lowest abundance of marine mammals and sea turtles would be resurveyed at the same altitude and speed, but along transects spaced 1.85 km (1 nm) apart. From these sightings data, one primary and two secondary test sites would be selected based primarily on the lowest relative abundance of marine mammals and turtles. If possible, the primary and secondary test sites would be adjacent to each other to minimize the maneuvering of the WINSTON S. CHURCHILL and tow vessel once the detonation countdown has commenced.

5.6.2 Phase Two: Pre-Detonation Monitoring

The purpose of pre-detonation monitoring is to (1) evaluate the test site for environmental suitability for the shock trial (e.g., relatively low numbers of marine mammals and turtles, few or no patches of *Sargassum*, etc.), and (2) verify that the Safety Range and Buffer Zone are free of visually and acoustically detectable marine mammals; sea turtles; large *Sargassum* rafts, debris lines, and/or concentrations of jellyfish (all are possible indicators of turtle presence); large schools of fish; and flocks of seabirds at the time of detonation. The morning of the test, the Lead Scientist would confirm that the primary and secondary test sites can still support the shock trial and weather is adequate to support mitigation.

(a) Five Hours Prior to Detonation

Approximately five hours prior to detonation, or at daybreak, the MART vessel will be on-site in the primary test site near the location of the earliest planned detonation point. Observers onboard the MART vessel will assess the suitability of the test site, based on visual observations of marine mammals and sea turtles, presence of large *Sargassum* rafts and debris lines, and overall environmental conditions (visibility, sea state, etc.). This information will be relayed to the Lead Scientist onboard the shock trial vessel. Should there be a high likelihood of the primary test site remaining environmentally fouled over the course of the day, the Lead Scientist and OTC would be able to decide early on to move the test to one of the secondary test sites. At that point, the WINSTON S. CHURCHILL, the tow vessel, all mitigation efforts and other shipshock support would focus on the secondary test site.

(b) Two and One-Quarter Hours Prior to Detonation

Two and one-quarter hours prior to each detonation, aerial monitoring would commence within the 18.5 x 27.8 km (10 x 15 nmi) test site to evaluate the test site for environmental suitability, as illustrated in **Figure 5.6**. Aerial monitoring transect spacing shall be 1.85 km

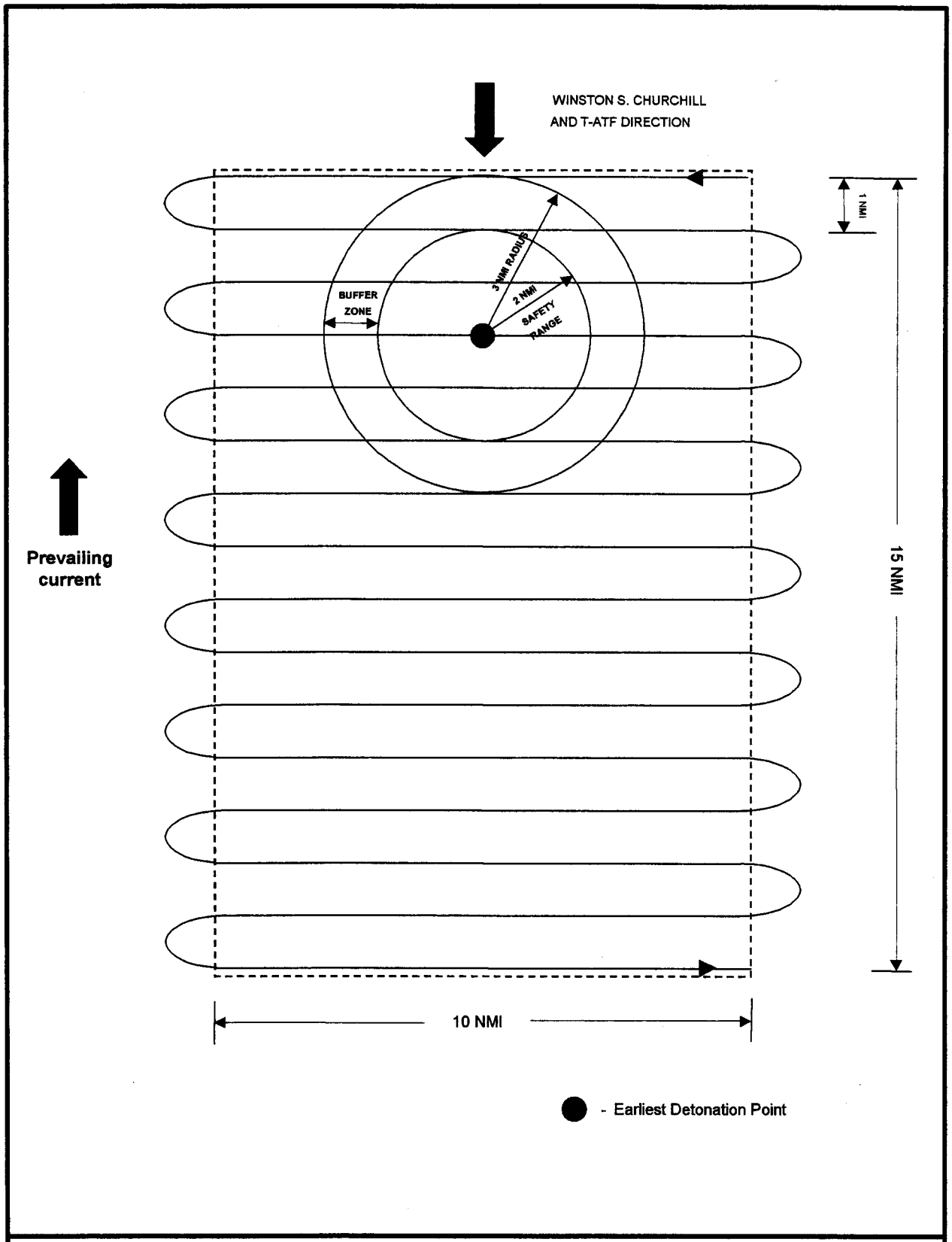

Figure 5.6. Pre-detonation monitoring flight plan two and one-quarter hours prior to detonation.

(1 nmi). Monitoring would commence at the same end of the test site that the WINSTON S. CHURCHILL would be entering. Evaluation of the entire test site would take approximately 1 hour 35 minutes to complete. Shipboard observers on the WINSTON S. CHURCHILL would monitor the area around the ship using 25x power binoculars and hand-held binoculars. The Lead Scientist would enter all marine mammal and sea turtle sightings, including time of sighting, into the marine animal tracking and sighting program.

(c) One and One-Half Hours Prior to Detonation

One and one-half hours prior to each detonation, an aircraft would drop a field of sonobuoys in the primary test site and the acoustic monitoring system instrumentation would be calibrated. Sonobuoy drop patterns would take into account prevailing currents. The aircraft would also carry additional sonobuoys that would be deployed to replace those buoys that might drift out of the primary test site and to cover additional fields in the secondary test sites, if needed. Three bioacousticians with extensive marine mammal call identification experience would begin to monitor the system's receivers onboard the aircraft. All marine mammal signals would be interpreted to identify the species and the location, and the information would be relayed to the Lead Scientist onboard the WINSTON S. CHURCHILL. Due to safety of flight concerns, the acoustic monitoring aircraft would remain at the highest altitude possible but not less than 457 m (1,500 ft), except when deploying sonobuoys.

(d) Forty Minutes Prior to Detonation

Forty minutes prior to each detonation, the aerial monitoring team would begin monitoring the Safety Range and Buffer Zone directly preceding the WINSTON S. CHURCHILL, as illustrated in **Figure 5.7**. The shipboard monitoring and acoustic monitoring teams would combine with the aerial team to monitor the area immediately around the ship, including both the Safety Range and Buffer Zone. The WINSTON S. CHURCHILL and T-ATF (with towed explosive) would enter the test site moving into the current at a maximum speed of 7.5 kts. By the time the WINSTON S. CHURCHILL enters the test site, the aerial monitoring team will be approximately 3.7 km (2 nmi) ahead of the WINSTON S. CHURCHILL. The aerial survey aircraft would maintain its position approximately 3.7 km (2.0 nm) ahead of the WINSTON S. CHURCHILL by flying 11.1 km (6 nmi) transects centered on the WINSTON S. CHURCHILL at a transect spacing of 0.9 km (0.5 nmi). By flying this pattern, the aerial monitoring team would be able to monitor 75% of the entire safety zone immediately prior to earliest detonation. At 7.5 kts, it would take the WINSTON S. CHURCHILL and T-ATF approximately 24 minutes to reach the earliest possible detonation point, 5.6 km (3 nmi) within the test site. When the WINSTON S. CHURCHILL is 0.9 km (0.5 nmi) from the earliest possible detonation point, the aerial monitoring team would divert back to the transect directly ahead of the detonation point, and therefore be positioned as close to the center of the Safety Range as safely possible at the time of detonation.

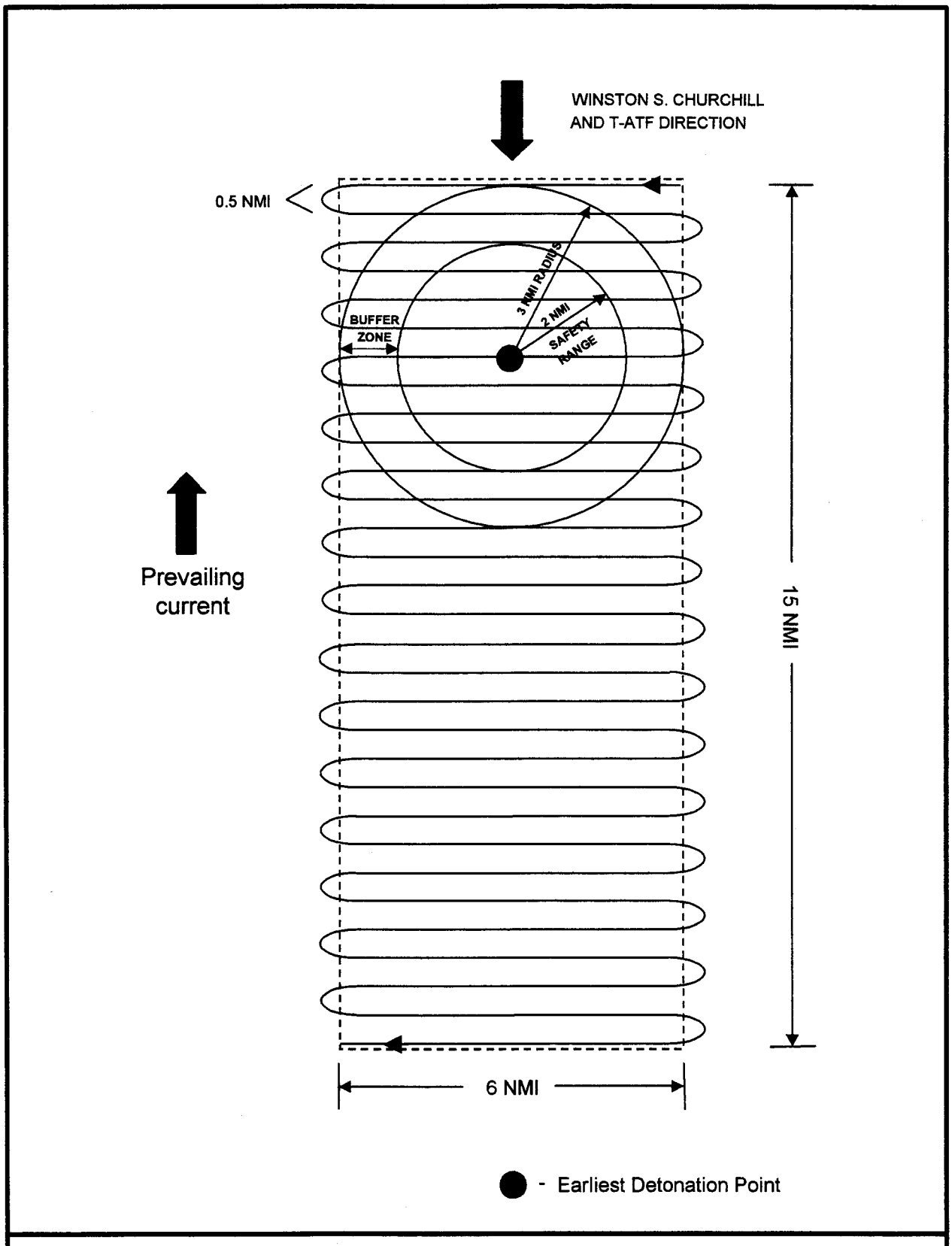

Figure 5.7. Pre-detonation monitoring flight plan one-half hour prior to detonation.

(e) Go/No-Go Decision Process

The Lead Scientist would plot and record sightings and acoustic position and bearing for all marine animals detected. The output of the marine mammal tracking program would depict animal sightings relative to the charge, and concentric circles indicating the Safety Range and Buffer Zone. The Lead Scientist would have the authority to declare the range fouled and recommend a "hold detonation" until monitoring indicates that the Safety Range is and will remain clear of detectable animals prior to the detonation. There are a series of operational checks in the shock trial schedule including those at 3 minutes and 1 minute prior to detonation. The Lead Scientist also would have the authority to declare a fouled range anytime in the 1 minute prior to detonation, which would result in a "hold detonation" command by the OTC, unless personal safety or an operational emergency dictated detonating the charge.

Detonation would be postponed if:

(1) Any marine mammals or sea turtles are visually detected within the Safety Range (i.e., within 3.7 km [2 nmi] of the detonation point). The "hold detonation" would continue until the marine mammal or sea turtle that caused the postponement is confirmed to be outside of the Safety Range either due to the animal swimming out of the Safety Range or due to the Safety Range moving to beyond the animal's last verified location.

(2) Any marine mammals are acoustically detected within 4.16 km (2.25 nmi) of the detonation point (it would be assumed that the animal is within the 3.7 km [2 nmi] Safety Range). The "hold detonation" would continue until the marine mammal that caused the postponement is confirmed to be outside of the Safety Range either due to the animal swimming out of the Safety Range or due to the Safety Range moving to beyond the animal's last verified location.

(3) Any listed (endangered or threatened) marine mammal is visually or acoustically detected within the Buffer Zone and subsequently cannot be reacquired. Unidentified sightings that could be listed species (e.g., unidentified large whale, unidentified Balaenoptera) would be considered to be listed species unless confirmed otherwise. The shot would not occur until the last verified location is outside of the moving Safety Range and Buffer Zone, so that the new detonation point would be 5.56 km (3 nmi) from that location. Sighting and acoustic teams would continue to attempt to reacquire the animal.

(4) Any northern right whale is detected within the Safety Range or Buffer Zone. The shot would not occur until the right whale is positively reacquired outside of the Buffer Zone and no other right whales are detected visually or acoustically during subsequent monitoring of the entire 5.6 km (3 nmi) radial area. If the right whale cannot be positively reacquired, the shot will be postponed until the following day.

(5) Large *Sargassum* rafts, debris lines, or large concentrations of jellyfish are observed within the Safety Range (i.e., within 3.7 km [2 nmi] of the detonation point). The "hold

detonation" would continue until the *Sargassum* rafts, debris lines, or jellyfish that caused the postponement are confirmed to be outside of the Safety Range either due to the current moving the *Sargassum*, debris, and/or jellyfish or the Safety Range moving away from their last verified location.

(6) Large schools of fish, flocks of seabirds, or any Bermuda Petrels (the latter applying to Norfolk only) are observed within 1.85 km (1 nmi) of the detonation point. The "hold detonation" would continue until the seabirds or large fish schools are confirmed to be more than 1.85 km (1 nmi) from the detonation point either due to the fish or birds moving out of this radius or the radius moving away from their last verified location.

(7) Any sea turtle or non-listed marine mammal is detected with the Buffer Zone (i.e., from 3.7 km to 5.6 km [2 to 3 nmi] of the detonation point) moving toward and could enter the Safety Range prior to detonation. The "hold detonation" would continue until the marine mammal or turtle is no longer heading towards the Safety Range due to either the animal or the ship changing course.

In the event of a postponement, pre-detonation monitoring would continue as long as weather and daylight hours allow. Aerial monitoring is limited by fuel and the on-station time of the monitoring aircraft, which is approximately 4 to 5 hours depending on the exact location of the test site. To prevent delays due to aircraft refueling, the second survey aircraft would commence evaluating the secondary test site for environmental suitability (transect lines spaced 1.85 km [1 nmi] apart) while the primary survey aircraft continues pre-detonation monitoring of the primary site. The two survey aircraft would maintain a separation of at least 9.3 km (5 nmi), and the primary survey aircraft would depart the test area once it is apparent that the detonation will not occur in the primary test site. The second survey aircraft would then commence the monitoring of the Safety Range and Buffer Zone surrounding the WINSTON S. CHURCHILL while the primary aircraft returned to refuel. Unless marine mammal or turtle detections persisted in the Safety Range for several hours, the detonation would not be cancelled for the day, only delayed until animals are clear of the Safety Range.

5.6.3 Phase Three: Post-Detonation Monitoring

Post-detonation monitoring would be conducted by the MART vessel for a period of 48 hours after each detonation. The MART vessel would be assisted by the aerial mitigation team for a minimum of 3 hours per day for the same 48 hour time period. After the last detonation, post-test mitigation would continue for seven days.

Aerial and shipboard monitoring is intended to locate and identify dead and injured animals. Any marine mammals or turtles killed by the blast would likely suffer lung rupture, which would cause them to float to the surface due to air in the blood stream. Animals that were not killed instantly but were mortally wounded would likely resurface within a few days, although this will depend on size and type of animal, fat stores, depth and temperature of the water and other variables. The MART would attempt to document any marine mammals or turtles that were killed or injured as a result of the shock test and, if practicable, recover and examine any

dead animals. The MART would also attempt to collect any sea turtles that appear injured. The species, number, location, and behavior of any animals observed by the MART and the aerial team would be documented and reported to the Lead Scientist.

If all detonations are conducted in roughly the same area, the pre-detonation mitigation effort for each subsequent shot would also serve as post-detonation mitigation for each previous detonation. If detonations are conducted in more than one area, the extended post-detonation monitoring following the last test would provide some additional coverage of each site. Over the planned 21 days from the first detonation until the final post-detonation day, the mitigation team would be onsite in surface vessels and/or aircraft for 14 days.

(a) Immediately Following Detonation

The aerial team would monitor the area of the test (3.7 km [2 nmi] radius) immediately following each detonation and report any sightings of dead or severely injured marine mammals or turtles to the MART. The aerial team would also report any sightings of sea turtles at the surface to the MART for further investigation. After completing this initial monitoring of the test site, the aerial team would survey an 11.1 km (6.0 nmi) radius area from the detonation point, starting at the up current end and continuing down current. Aerial monitoring, with transects spaced 0.9 km (0.5 nmi) apart, would continue down current for at least three hours after the detonation, or until sighting conditions became unsuitable.

The MART vessel would move to the detonation point immediately following the detonation to search for dead animals and injured turtles and deploy a drogue to measure bottom currents to better estimate where dead submerged animals might resurface. Based on the current information, MART would continue to search for any animals that have drifted with the current. The MART vessel would commence a racetrack pattern to attempt to intercept any dead marine animals drifting with the current. After one hour, the MART vessel would reposition further downcurrent of the detonation point and commence the same racetrack pattern for another hour. The MART vessel would continue to reposition in this manner until nightfall. The MART would immediately break away from the racetrack pattern to investigate any sightings of dead or injured marine mammals or turtles reported by the aerial monitoring team.

(b) Post-Detonation MART Action Plan

Any dead sea turtles and small marine mammals (<5 m or 15 ft) would be lifted aboard the MART vessel, weather permitting, and immediately necropsied by the veterinarian assisted by the sea turtle specialist. Tissues collected would include the head, heart, and samples of both lungs (cranial, middle, caudal). On larger whales, if it is not possible to collect the entire head, eardrums, tympanic bulla, and samples from the brain will be collected. The tissues would be preserved onboard the MART vessel and sent to the Armed Forces Institute of Pathology (AFIP) for analyses of effects from blast injury once the MART returns to port. Large marine mammals (>5 m or 15 ft) that are dead would be pulled alongside the MART vessel and necropsied as possible (weather permitting). The preserved tissues would also be sent to AFIP. Marine mammals that appear to be lethally injured, based on observations by the veterinarian and the marine mammal behavioral specialist, would be collected by MART and euthanized. These

animals would also be immediately necropsied, with tissues preserved and sent to AFIP for analysis. Marine mammals that appear to be injured but not lethally would be observed by the marine mammal behavior specialist, who would note identifying marks (if any) and take photographs. Sea turtles that appear to be injured would be collected by MART. Injured sea turtles would be kept on the deck of the MART vessel in a cool and shaded area, and observed for extent of injury. Turtles that appear to be lethally injured, based on observations by the veterinarian and the sea turtle specialist, would be euthanized. These animals would be immediately necropsied, with tissues preserved and sent to AFIP for analysis. Turtles that appear to recover from temporary injury would be tagged and released at sea. Turtles that appear to be more seriously, but not lethally, injured would be retained on board MART and transported to an onshore rehabilitation center when MART returns to port. Marine mammal and sea turtle stranding networks would be notified (see following sections).

(c) Post-Detonation Days 1 and 2

Monitoring by the aerial team and the MART would continue on post-detonation days 1 and 2 to detect potentially injured or dead animals moving in the predominant direction and speed of the prevailing current. Drogues or lighted buoys deployed by the MART vessel would determine surface and bottom current attributes. Satellite imagery may also be used to further refine current speed and direction estimates. The aerial team would monitor for at least three hours each day with transects spaced 1.85 km (1 nmi) apart at the up current end of the buffer zone. Transects would be 18.5 km (10 nmi) in length, encompassing the test site, as shown in **Figure 5.8**. Aerial monitoring would correspond to the position of the MART vessel and move progressively down current.

As its first task on post-detonation days 1 and 2, the aerial team supporting the MART would return to the detonation point to observe and document the behavior of any animals in the area, after which they would move down current to continue their observations. The MART vessel would continue a racetrack pattern throughout the day, moving down current each hour. The MART would immediately break away from the racetrack pattern to investigate any sightings of potentially injured or dead marine animals reported by the aerial monitoring team. At the end of post-detonation day 1, the MART would deploy another drogue or lighted buoy to determine current direction and speed. The area to be monitored on post-detonation day 2 would be determined based on the results of the drift.

In total, the MART would continuously monitor the area around the detonation site and areas down current for at least 24 of the 48 hours following each detonation. The aerial team is expected to monitor as much as 1,833 km (990 nmi) during the same 48 hour period, based on a maximum of nine hours on station (i.e., three hours immediately after detonation, three hours each on post-detonation days 1 and 2) and an average air speed of 110 kts. If the post-detonation monitoring determines that injurious or lethal takes have occurred, a review and change of test procedures and monitoring methods would be made as necessary.

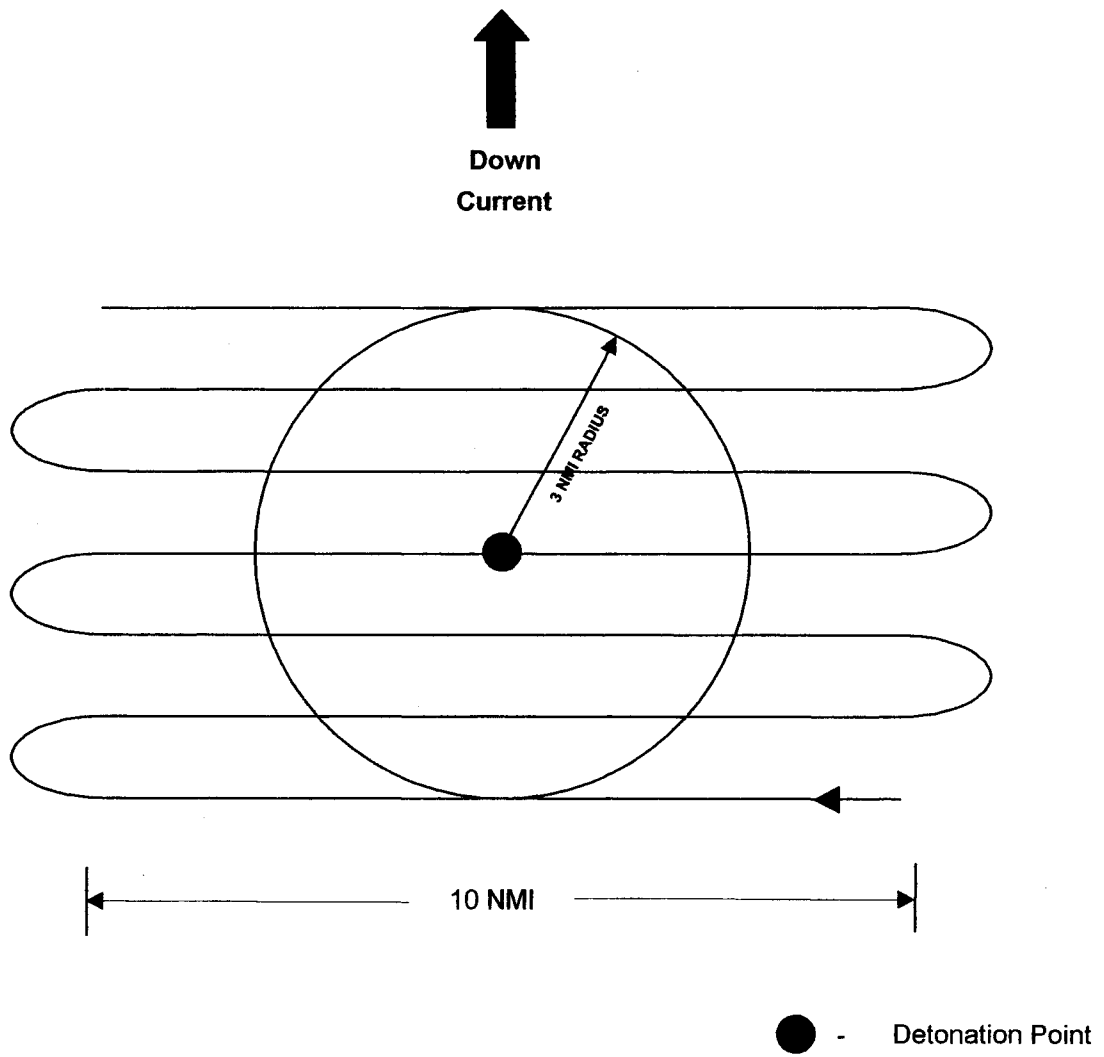

Figure 5.8. Post-detonation monitoring flight plan on post-detonation days 1 and 2.

(d) After the Last Detonation

Following the last detonation, monitoring by the aerial team and the MART would continue for seven days to attempt to detect any potentially injured or dead animals moving in the predominant direction and speed of the prevailing current. For the first two days following the final detonation, the MART and the aerial team would monitor the detonation area in the same manner as for previous detonations. Over the next five days, the aerial team would monitor the entire area encompassing all of the detonation sites for three hours each day, weather permitting. The exact design of this final aerial monitoring effort would depend on where the detonations have taken place and the predominant direction of the current.

Monitoring would start at the detonation site that is farthest up current and continue past the site that is farthest down current. The frequency with which any particular area is monitored during this five-day period would depend on the spacing of the detonation sites. All sightings of marine mammals and sea turtles would be included in the report to the NMFS. The locations of any dead marine mammal or sea turtle would be reported to the appropriate stranding network coordinator.

5.7 COORDINATION WITH MARINE ANIMAL STRANDING NETWORK(S)

The NMFS coordinates regional stranding networks along the northeast (Maine to Virginia) and southeast (North Carolina to Texas, Puerto Rico, and the U.S. Virgin Islands) coasts to collect and disseminate information about marine mammal and sea turtle strandings. The Lead Scientist would contact the designated coordinators of the appropriate stranding networks prior to the beginning of the shock test and again after each detonation and report any observations of injured or killed marine mammals or turtles that cannot be recovered by the MART. Communications with stranding network personnel would be maintained throughout the WINSTON S. CHURCHILL shock trial period.

A brief description of plans to coordinate with the stranding networks is provided below. Protocols have been established in coordination with the NMFS Southeast Fisheries Science Center (SEFSC) and Northeast Fisheries Science Center (NEFSC) to recover stranded animals and collect and analyze critical tissues to determine the cause of death, including those tissues necessary to determine if death could be blast related. The necropsy protocols would be published in the Newsletter of the Southeast U.S. Marine Mammal Stranding Network at least twice prior to the planned detonation. A description of the turtle necropsy protocol would be published in the Marine Turtle Newsletter at least twice prior to the planned detonation. The NMFS stranding coordinators would also email announcements to regional stranding centers. The stranding networks have personnel trained to conduct marine mammal and sea turtle necropsies. The tissue samples would be forwarded to the Armed Forces Institute of Pathology (AFIP).

5.7.1 Marine Mammal Stranding Network Protocol

Dead marine mammals that cannot be recovered by the MART would be tagged using either flagging tape inscribed with indelible ink and including information on location, date of discovery, and identification number, or with tags that embed into the blubber. This information would be relayed to the Lead Scientist and Mitigation Team Coordinator. The Lead Scientist would contact the NMFS-SEFSC and NMFS-NEFSC marine mammal stranding network coordinators. The coordinator would contact the appropriate stranding network representative (based on the animal's possible point of landfall given the prevailing current). Each network has qualified technicians who have been trained at NMFS-sponsored workshops in correct necropsy and preservation techniques, using the National Stranding Format and NMFS Collection Protocol. Any tagged marine mammal that strands would be necropsied under the direction of a veterinarian with knowledge of blast effects, and a Marine Mammal Stranding Report would be completed and forwarded to both the NMFS stranding coordinator and the AFIP. Tissues would be sent to AFIP for analyses. The AFIP would attempt to provide the MART veterinarian a preliminary report on their findings prior to subsequent detonations. AFIP results would be incorporated into subsequent shot day protocols, as possible. Specific information about the stranding would be relayed from the coordinator to the Lead Scientist for inclusion in reports.

5.7.2 Sea Turtle Stranding Network Protocol

Dead sea turtles that cannot be recovered would be tagged with flipper tags coordinated through the Archie Carr Center for Sea Turtle Research and the information relayed from the MART to the Lead Scientist and Mitigation Team Coordinator. The Lead Scientist would contact the NMFS turtle stranding network coordinator. The turtle stranding network is coordinated on a statewide basis with volunteers reporting to a statewide coordinator. The coordinator would alert statewide coordinators to the possibility of a tagged turtle stranding, and request that they inform the coordinator if/when that happens. During this time of year, numerous turtles strand due to various causes; necropsies on stranded turtles are normally carried out only on those that are fresh enough for viable tissue collection. Data regarding any collected tagged strandings would be relayed from the coordinator to the Lead Scientist for inclusion in reports.

6.0 CUMULATIVE IMPACTS

Cumulative impacts are those resulting from the incremental effects of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of which agency or person undertakes them. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over time.

As described in the Environmental Consequences section, the main impacts of the proposed shock testing would include release of chemical products into the ocean and atmosphere; deposition of metal fragments on the seafloor; mortality and injury of plankton and fish near the detonation point; possible mortality, injury, and disruption of hearing-based behaviors of marine mammals and sea turtles; and possible interruption of commercial and recreational fishing activity in the test area. All three test areas are in deep, oceanic waters where the explosion products would be rapidly dispersed and mixed. Gases released into the atmosphere would also be rapidly dispersed and mixed. Metal fragments from the explosions would accumulate on the seafloor but would not be expected to produce adverse impacts; they would provide a substrate for growth of epibiota and attract fish. Because of the short-term nature of the proposed action and the localized and transient nature of the environmental effects, the potential for incremental or synergistic impacts in combination with present or reasonably foreseeable future uses of the Mayport, Norfolk, or Pascagoula test area is minimal.

6.1 ONGOING AND REASONABLY FORESEEABLE ACTIVITIES

6.1.1 Other Shock Trials

The Navy's Live Fire Test and Evaluation Plan for the LPD 17 (San Antonio Class) includes a ship shock trial in 2004 or 2005. The technical and operational requirements for the LPD 17 shock trial would be similar to those for the DDG 81 and therefore, the Mayport, Norfolk, and Pascagoula test areas may be considered. Other than the LPD 17 shock trial, there are no ongoing, planned, or reasonably foreseeable Navy actions that could have similar impacts on the marine environment at the Mayport, Norfolk, or Pascagoula test areas. No other shock trials have been proposed for these test areas.

<u>Potential for Cumulative Impacts</u>. Potential impacts of a future shock trial would be similar to those estimated for the DDG 81 shock trial. Because the impacts of each detonation would be localized and transient and the shock trials would be several years apart, the potential for incremental or synergistic effects is negligible.

6.1.2 Other Activities - Mayport

(a) Routine Ship Traffic

As explained in Section 3.3.2, there are no designated shipping lanes near the Mayport test area. However, there is considerable north-south ship traffic in the vicinity. Commercial vessels heading north typically stay within the Gulf Stream to take advantage of the northward current to carry them to Cape Hatteras. When headed south, ships often stay inshore of the Gulf Stream to avoid the current flowing counter to their direction of travel. Non-military, commercial ship traffic passing through the Mayport test area from May through September is estimated to average 74.7 ships per month (see Section 2.2.2). This does not include small coastal trade ships and private or pleasure vessels. Since the Mayport test area lies well offshore, these last two types of vessels are not expected to contribute significantly to the cumulative vessel traffic in the area.

Potential for Cumulative Impacts. Ship traffic produces underwater noise and introduces some potential for ship strikes (collisions with marine mammals or turtles). Because the ship traffic associated with the shock trial would represent only a small fraction of the routine ship traffic during the shock trial period and because Navy ships are designed to minimize noise, the shock trial would not produce a significant incremental increase in underwater noise. Mitigation measures included in the proposed action, especially use of aerial and shipboard observers, would make the probability of a ship strike negligible during the shock trial.

(b) Commercial and Recreational Fishing

As explained in Section 3.3.1, most commercial and recreational fisheries such as shrimp trawling, reef fishing, and king mackerel fishing take place well inshore of the Mayport test area. However, there are certain species, particularly oceanic pelagic and deep reef fish known to occur in the vicinity of the Mayport test area, that are sought after by commercial and recreational fishers.

Commercial fishers work the offshore waters of northeastern Florida for sharks, swordfish, and tunas. These species are caught with surface drifting longlines fished in the water column offshore of the shelf break. Longlines are set near the western edge of the Gulf Stream often with the aid of sophisticated onboard temperature sensors, depth finders, and positioning equipment. Bottom longlining for golden tilefish also occurs off Mayport. Drifting gillnets are also set for sharks in Federal waters offshore of northeast Florida. Despite the considerable minimum distance to the test area from Mayport, a few private and charter sport fishers regularly venture this far offshore to troll for billfish, dolphinfish, tunas, and wahoo.

Potential for Cumulative Impacts. The types of ongoing fishing activities that may occur at the Mayport test area are not expected to significantly affect marine mammal or turtle populations in the area. Shrimp trawling is a significant source of turtle mortality but is conducted well inshore of the test area. Some of the fish species potentially affected by shock trial detonations are targets of commercial and/or recreational fishing. However, since the proposed shock trial includes mitigation to minimize the chances of a large fish kill, the potential for significant incremental or synergistic impacts on commercial or recreational fishery populations is minimal. No adverse impacts on essential fish habitat are expected (see Appendix H).

(c) Other Military Activities

Naval Station Mayport is currently home to over 20 Navy combat ships. In addition to the Navy ships homeported at Naval Station Mayport, several non-Mayport based ships per year may be briefly assigned there for training. Ship crew training exercises that take place offshore of Mayport are scheduled and managed by the Afloat Training Group, Mayport (ATGM). The types of ship and aircraft training exercises coordinated and managed by ATGM include precision anchorage; swept channel; damage control; man overboard; abandon ship; underway rescue and assistance; tow and be towed; underway replenishment; helicopter flight training; vertical replenishment; helicopter inflight refueling; and helicopter crash drills.

Gunnery exercises are also scheduled and supervised by ATGM and these take place in specifically designated Gunnery Ranges. Types of gunnery exercises include long and short range gunnery practice (only "blind load and plugged" shells are used for these exercises -- i.e., not live shells); close-in weapons systems practice; small arms practice; and helicopter gunnery practice.

Additional military activities that take place near the Mayport test area include tactical aircrew combat training for Navy and Marine aircraft in specifically designated Tactical Aircrew Combat Training Systems (TACTS) ranges. The offshore air space above the Charleston-Jacksonville Naval Operating Area (OPAREA) is part of the South Atlantic Control Area. Fleet Area Control and Surveillance Facility at Jacksonville (FACSFACJAX) is responsible for air traffic control and for coordinating all Navy air and surface operations in the Charleston-Jacksonville OPAREA. Aircraft exercises include precision flying and aircrew training exercises. Missile exercises include air-to-air, air-to-surface, surface-to-air, and surface-to-surface exercises. All missile exercises are scheduled through FACSFACJAX.

The Kings Bay Submarine Base is the Atlantic Fleet homeport for Ohio Class fleet ballistic missile submarines (SSBNs). Although other types of submarines and Navy ships occasionally visit the Kings Bay Submarine Base, only Ohio Class ballistic missile submarines are permanently based at this facility. There are 10 Ohio Class SSBNs currently based at Kings Bay. These submarines make an estimated 140 transits of the Charleston-Jacksonville OPAREA per year. While they do not conduct any test or training exercises specifically in this area, they do use their sonars and other electronic navigational equipment.

The National Aeronautics and Space Administration (NASA) uses portions of the continental shelf off northeastern Florida (Charleston-Jacksonville OPAREA) for rocket and space shuttle launches. These launches are controlled from the John F. Kennedy Space Center at Cape Canaveral, Florida.

<u>Potential for Cumulative Impacts</u>. Potential impacts of ongoing and reasonably foreseeable military activities near the Mayport test area include ship strikes from vessel traffic and underwater noise from ships, submarines, and sonars. Since this is not a "live fire" test range, there would be no underwater detonations similar to the proposed shock trial. The shock trial would constitute only a small fraction of the routine military ship traffic during the shock trial year and would represent a small incremental impact. The potential for significant cumulative impacts is minimal.

(d) Petroleum Industry

There are no active lease blocks, pipelines, or platforms within or near the Mayport test area. On 12 June 1998, President Clinton issued an Executive Order which prohibited leasing in the Atlantic Outer Continental Shelf through 30 June 2012. No further exploratory activities are anticipated in the South Atlantic Planning area.

Potential for Cumulative Impacts. None.

6.1.3 Other Activities - Norfolk

(a) Routine Ship Traffic

Non-military shipping traffic near the Norfolk test area is estimated to average 117.5 ships per month (see Section 2.2.2). Ship traffic in the Norfolk area includes numerous vessels entering and exiting Chesapeake Bay where major ports include Baltimore, Hampton Roads, and Richmond. Ships plying the north-south route along the eastern seaboard also add to the traffic. Like the Mayport test area, there are no offshore shipping lanes near the Norfolk test area.

Potential for Cumulative Impacts. Ship traffic produces underwater noise and introduces some potential for ship strikes (collisions with marine mammals or turtles). Because the ship traffic associated with the shock trial would represent only a small fraction of the routine ship traffic during the shock trial period and because Navy ships are designed to minimize noise, the shock trial would not produce a significant incremental increase in underwater noise. Mitigation measures included in the proposed action, especially use of aerial and shipboard observers, would make the probability of a ship strike negligible during the shock trial.

(b) Commercial and Recreational Fishing

As explained in Section 3.3.1, bottom trawling and surface longlining are the major commercial fisheries expected in the vicinity of the Norfolk area. Surface longlining produces sharks, swordfish, and tunas from waters of the shelf edge and seaward depending upon oceanic conditions. Bottom longlining for golden tilefish also occurs mainly to the north of the test area (from Norfolk Canyon north). A small gillnet fishery targets bonito and little tunny.

Recreational anglers seeking oceanic gamefish (e.g., billfish and tunas) may fish the waters near the Norfolk area. This activity generally occurs from Norfolk Canyon (which is north of the Norfolk test area) northward to Block Canyon. Another fishing area popular with offshore sport fishermen is known as "The Point" and is located off Cape Hatteras just south of the test area. Charter and private boat fishermen from Virginia's eastern shore may fish at or near the Norfolk test area on occasion. Most of the charter boat catch, particularly for the more offshore waters, occurs between late April and mid-October. This is the period when weather permits the long excursions offshore to fish for these open water fish, and coincides with the occurrence of the fish in the area.

Potential for Cumulative Impacts. The types of ongoing fishing activities that may occur at the Norfolk test area are not expected to significantly affect marine mammal or turtle populations in the area. Some of the fish species potentially affected by shock trial detonations are targets of commercial and/or recreational fishing. However, since the proposed shock trial includes mitigation to minimize the chances of a large fish kill, the potential for significant incremental or synergistic impacts on commercial or recreational fishery species is minimal. No adverse impacts on essential fish habitat are expected (see Appendix H).

(c) Other Military Activities

Military ship traffic in the Norfolk test area is considered high due primarily to the large number of Naval facilities in the general areas. Major Naval facilities in the Norfolk area include Naval Station Norfolk, Norfolk, Virginia; Naval Amphibious Base Little Creek, Norfolk, Virginia; Naval Air Station Oceana, Virginia Beach, Virginia; Norfolk Naval Shipyard, Norfolk, Virginia; and the Naval Weapons Station, Yorktown, Virginia.

Use of the Warning Areas off the Virginia Capes are scheduled by FACSFAC VACAPES. Military activities/facilities include the Oceana Tactical Aircrew Combat Training System (TACTS) and the Cherry Point TACTS. These Warning Areas are also scheduled for Research, Development, Test and Evaluation (RDT&E) activities by Naval Air Warfare Center, Aircraft Division (NAWCAD) Patuxent River. The Wallops Flight Facility, Wallops Island, Virginia is located in the Virginia Capes area. The AEGIS Combat Systems Center located on the Wallops Flight Facility is available to participate in exercises in that area.

Potential for Cumulative Impacts. Potential impacts of ongoing and reasonably foreseeable military activities near the Norfolk test area include ship strikes from vessel traffic and underwater noise from ships, submarines, and sonars. There would be no underwater detonations similar to the proposed shock trial at the test area. The proposed shock trial would constitute only a small fraction of the routine military ship traffic during the shock trial year and would represent a small incremental impact. The potential for significant cumulative impacts is minimal.

(d) Petroleum Industry

At least portions of nine active lease blocks are located within the Norfolk test area, and four others are on the edge. However, there are no oil and gas pipelines or platforms in the area and no pending plans for exploration or development. If the shock trial is conducted at Norfolk, a status update would be requested from the Minerals Management Service (MMS).

Potential for Cumulative Impacts. None.

6.1.4 Other Activities - Pascagoula

(a) Routine Ship Traffic

An extensive network of shipping lanes occurs in the Gulf of Mexico providing avenues for passage through the large numbers of petroleum structures offshore between the major ports of Tampa, Panama City, and Pensacola, Florida; Mobile, Alabama; and Pascagoula, Gulfport, and the Passes in Mississippi. The Pascagoula test area has the highest level of ship traffic of any of the potential test areas, averaging 231.2 ships per month over the survey period (see Section 2.2.2).

Buffer zones (18.5 km or 10 nmi) for shipping lanes overlapping with part of the Pascagoula test area have been excluded (see Section 2.2.3). In addition to the commercial traffic related to maritime trade among ports, there is considerable ship traffic in the northern Gulf of Mexico associated with supply boats bringing equipment, supplies, and personnel to offshore oil and gas platforms and drilling rigs.

Potential for Cumulative Impacts. Ship traffic produces underwater noise and introduces some potential for ship strikes (collisions with marine mammals or turtles). Because the ship traffic associated with the shock trial would represent only a small fraction of the routine ship traffic during the shock trial period and because Navy ships are designed to minimize noise, the shock trial would not produce a significant incremental increase in underwater noise. Mitigation measures included in the proposed action, especially use of aerial and shipboard observers, would make the probability of a ship strike negligible during the shock trial.

(b) Commercial and Recreational Fishing

As explained in Section 3.3.1, about 80% of the commercial fishing trips in the Pascagoula region target reef and demersal fish. The most common methods used by Florida Panhandle commercial fishers include purse seining, gill netting, hand lining, haul seining, longlining, trapping, and trawling Of these, longlining for yellowfin tuna and trawling for royal red shrimp are the only ones expected to occur regularly in the test area. About 80% of all trips made in the Gulf of Mexico for royal red shrimp occur off the Florida panhandle and Alabama.

Recreational fishers in offshore waters of the Florida Panhandle region target primarily reef fish. Both private and charter vessels are involved. Recreational fishing for reef fish is associated primarily with hard bottom features on the shelf and is unlikely to be concentrated within the Pascagoula test area. Due to the depth of the test area and its distance from shore, the most likely recreational fishing activity would be trolling for gamefish such as billfish and tunas.

The presence of offshore structures and large numbers of artificial reefs in the nearshore areas of the Gulf of Mexico attract recreational fishers who are drawn by the abundant fish populations associated with these structures, but these platforms are located mainly in the central and western Gulf of Mexico. Although some platforms are located off Alabama, there are none offshore Florida where the test area is located. Artificial reefs are also confined to nearshore waters that are distant from the test area.

Potential for Cumulative Impacts. The types of ongoing fishing activities that may occur at the Pascagoula test area are not expected to significantly affect marine mammal or turtle populations in the area. Trawling for brown shrimp is the major fishing activity affecting turtles in the Gulf of Mexico, but it is not expected to be a common activity at or near the Pascagoula test area. Some of the fish species potentially affected by shock trial detonations are targets of commercial and/or recreational fishing. However, since the shock trial includes mitigation to minimize the chances of a large fish kill, the potential for significant incremental or synergistic impacts on fish populations is minimal. No adverse impacts on essential fish habitat are expected (see Appendix H).

(c) Other Military Activities

Military activities in the eastern Gulf of Mexico consist of various air-to-air, air-to-surface, and surface-to-surface fleet training exercises. There are no designated TACTS in the Pascagoula area for Naval aircraft training, but the Navy does use this area for shakedown cruises on newly-built ships, and for ships completing overhaul or extensive repairs in Gulf shipyards such as those located in Pascagoula, Mississippi. No aircraft carriers are currently stationed in the Gulf, but carriers may from time-to-time conduct flight operations there.

Of the nine special use airspace Warning Areas in the eastern Gulf of Mexico area, seven are designated by the U.S. Air Force for conducting various testing and training missions and two are designated by the Navy. Air Force operations are controlled by the Eglin Military Complex located in northwest Florida. The offshore Eglin Gulf Test Range (EGTR) lies adjacent to the proposed Pascagoula test area. Although air-to-surface training is currently accomplished on the Eglin land ranges, the Air Force is planning to reopen the offshore EGTR for high explosive gunnery training.

Potential for Cumulative Impacts. Potential impacts of ongoing and reasonably foreseeable military activities near the Pascagoula test area include ship strikes from vessel traffic, underwater noise from ships, sonars, and small underwater detonations associated with the Air Force's air-to-surface gunnery training. There would be no large underwater detonations similar to the proposed shock trial (i.e., none having the potential to kill or injure marine mammals or turtles). The proposed shock trial would constitute only a small fraction of the routine military ship traffic during the shock trial year and would represent a small incremental increase in ship noise. Mitigation measures included in the proposed action, especially use of aerial and shipboard observers, would make the probability of a ship strike negligible. The potential for significant cumulative impacts is minimal.

(d) Petroleum Industry

The Pascagoula test area is in the MMS Eastern Gulf of Mexico Planning Area, which extends from Baldwin County, Alabama southward to the Florida Keys. Administrative deferrals and legislative moratoria have limited petroleum activity in the Eastern Planning Area. At least portions of nine active petroleum lease blocks occur in the Pascagoula test area. However, there are no oil and gas pipelines or platforms within the test area.

Chevron U.S.A. and partners are planning a gas development project in the Destin Dome 56 Unit, a group of lease blocks located northeast of the Pascagoula test area (**Figure 6.1**). The MMS has prepared a Draft EIS for the project (MMS, 1999), and it is possible that activities such as drilling and platform and pipeline installation could be occurring there by the time of the shock trial. While the Destin Dome Unit blocks do not overlap the test area, portions of them are within 10 nmi of the northeast corner of the test area. That is, if a test site were selected in the northeast corner of the Pascagoula test area, the 10 nmi ship warning zone could affect petroleum industry operations in the Destin Dome Unit. If the Pascagoula test area is selected for the shock trial, the Navy would contact the MMS and Chevron for an update and would coordinate with them to avoid interference.

The MMS has also announced plans for an upcoming lease sale in the Eastern Gulf of Mexico which includes some blocks near the Pascagoula test area (MMS, 1999). Most of the blocks are in deeper water outside the test area, and the bid opening would not occur until December 2001, after the proposed shock trial period; however, there is the potential for seismic exploration to be taking place in and around the test area prior to that date. If the shock trial is conducted at Pascagoula, a status update would be requested from the MMS.

In addition to petroleum exploration and development activities, two companies are proposing natural gas pipelines running from the Mobile Bay area to Florida which would run through the proposed Pascagoula test area. While only one of these proposed pipeline routes will be permitted by the Federal Energy Regulatory Commission (FERC), both the proposed routes pass through the northeastern edge of the Pascagoula test area. It is unlikely that the selected company will begin actual pipeline construction before 2001, however both companies are currently conducting extensive biological and geophysical surveying along their proposed routes.

Potential for Cumulative Impacts. The possibility of oil and gas development in the region may lead to increased ship traffic and associated underwater noise. In particular, geophysical activities (e.g., seismic surveys using airguns) represent a source of impulsive noise in the marine environment. The Gulf-wide effects of geophysical activities on marine mammals, turtles, and fish are currently being evaluated by the MMS in a programmatic environmental assessment (W. Lang, 2000, personal communication, MMS). In comparison to the background of underwater noise from ship traffic and geophysical surveys, the proposed shock trial would involve only a few pulses at one-week intervals and would represent a negligible contribution to levels of underwater noise in the area.

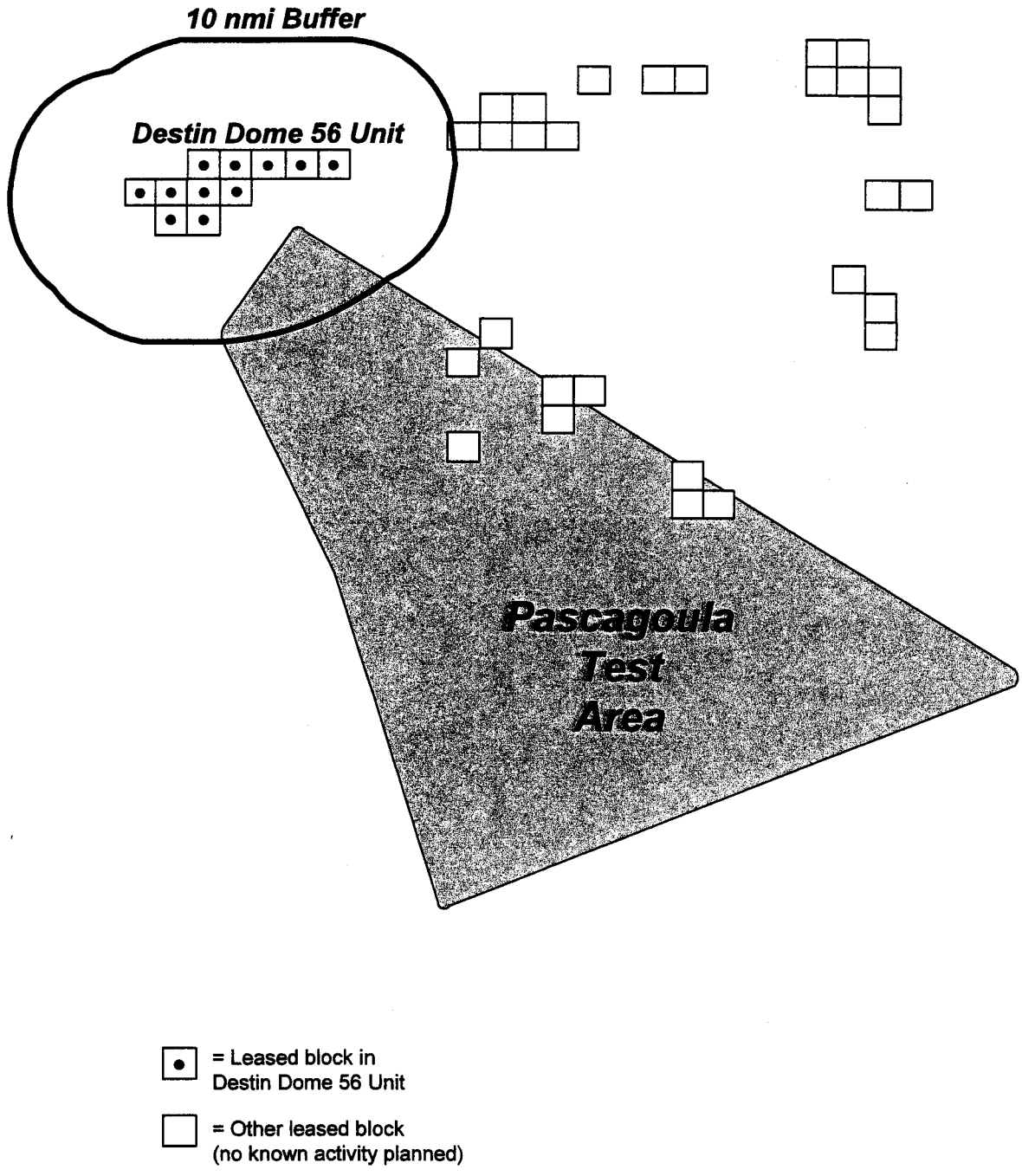

Figure 6.1. Location of the Destin Dome 56 Unit (site of offshore gas development proposed by Chevron U.S.A. and partners) relative to the Pascagoula test area.

6.2 CUMULATIVE IMPACTS ON STRATEGIC STOCKS

As discussed in Section 4.1.1 and Appendix C, the numbers of marine mammals potentially killed or injured during the shock trial represent only a small fraction of the stock sizes for these animals and are minor in comparison with other sources of human-caused mortality such as fishing. From the standpoint of cumulative impacts, the main concern is "strategic stocks" designated by the NMFS -- those marine mammal species for which all sources of human-caused mortality exceed the number of deaths that the population can sustain (their potential biological removal, PBR). Marine mammals listed as endangered, threatened, or depleted are automatically strategic stocks.

The only strategic stocks likely to be present at Mayport and Pascagoula are sperm whale, pilot whales, and beaked whales. At Mayport, the probability of these species being present but undetected in the Safety Range (i.e., having the potential to be killed or injured) is estimated to be 0.005 for sperm whale, 0.011 for pilot whales, and essentially zero for beaked whales. At Pascagoula, the probabilities are 0.006 for sperm whale and essentially zero for pilot whale and beaked whales. Therefore, it is highly unlikely that any deaths or injuries of a strategic stock would occur at Mayport or Pascagoula.

Strategic stocks likely to be present at Norfolk are fin whale, humpback whale, sei whale, sperm whale, beaked whales, common dolphin, and pilot whales. Probabilities of these species being present but undetected in the Safety Range are estimated to be 0.073 for fin whale, 0.007 for humpback whale, 0.037 for sei whale, 0.059 for sperm whale, 0.001 for common dolphin, and 0.291 for pilot whales. These calculations indicate there is a non-negligible chance that an individual of a strategic stock (particularly a pilot whale or sperm whale) may be killed or injured if the shock trial were conducted at Norfolk.

7.0 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Unavoidable impacts of the proposed shock trial include release of chemical products into the ocean and atmosphere, deposition of metal fragments on the seafloor, mortality and injury of plankton and fish near the detonation point, disruption of hearing-based behaviors of marine mammals and sea turtles, and possible interruption of commercial and recreational fishing activity in or near the test site.

Underwater explosions would release chemical products into the ocean and atmosphere and deposit metal fragments on the seafloor. Due to the low initial concentrations and rapid dispersion of the chemical products, they would pose no hazard to marine or human life. The metal fragments would not be expected to produce adverse impacts; they should provide a substrate for growth of epibiota and attract fish.

Fish near the detonation point would be killed or injured. A large fish kill would not be expected because detonation would be postponed if large schools of fish were observed within 1.85 km (1 nmi) of the detonation point. No impact on fish populations, including commercial and recreational species, is expected because the fish found at the test areas are abundant and widely distributed. Plankton and other small marine life near the detonation point would also be affected but would be rapidly replenished through population growth and mixing with adjacent waters.

Most potential impacts to marine mammals and sea turtles would be avoidable due to the mitigation procedures described in Section 5.0. Because detonations would not occur if any marine mammals or turtles were detected within the Safety Range, mortality or injury is unlikely. However, because no method of detection can be 100% effective, some marine mammals and/or sea turtles could be killed or injured if present within the Safety Range. Also, marine mammals or turtles up to about 20 nautical miles from the detonation point could experience temporary threshold shift (reversible hearing loss) due to the acoustic characteristics of the detonations. Animals many nautical miles away could hear the detonations and perhaps be momentarily startled. However, no lasting impacts on marine mammals or turtles beyond the Safety Range is expected.

Fishing vessels and other ship traffic would be excluded from the test site before, during, and after each detonation. Due to the short duration of shock trial operations and advance warning through *Notices to Airmen and Mariners*, the interruption is not expected to significantly affect commercial or recreational fisheries or other ship traffic.

8.0 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

The shock trial would require expenditure of energy in the form of fuel consumed by ships and aircraft. Fuel would be used by the WINSTON S. CHURCHILL, by other ships and aircraft associated with the shock trial, and by ships and aircraft involved in mitigation and clearing the site. Because the shock trial site would be located near required Navy facilities, energy consumed by ships and aircraft would be conserved by minimizing transit distances and keeping the time at sea to a minimum.

9.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The shock trial would result in commitments of labor and capital along with use of non-renewable materials. Fuel used by ships and aircraft during the shock trial, as well as non-recyclable materials used for engine maintenance, are irretrievable resources. Mitigation will minimize the effects of the proposed action on the marine environment, and no irreversible or irretrievable commitment of marine resources is expected.

10.0 RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The proposed action would allow the Navy to assess the survivability of Flight IIA ships of the ARLEIGH BURKE class in accordance with 10 USC 2366. Shock trial operations would have no significant long-term impacts on the environment. The shock trial of the WINSTON S. CHURCHILL is being proposed as a short-term action that would include up to four detonations between 1 May and 30 September 2001. Short-term commitments of labor and capital along with use of non-renewable materials for machine power and maintenance would result from the proposed action. No long-term commitments of resources would be required. The location of the test site in offshore waters would minimize biological effects because productivity is expected to be lower than in nearshore waters. Mitigation monitoring using visual and passive acoustic surveillance techniques would minimize the effects of the proposed action on marine resources. The only long-term effect from the shock trial would be a limited distribution of small steel fragments from the charge container on the seafloor. Although the fragments could slightly enhance benthic productivity by increasing available substrate for the attachment of marine invertebrates, this effect is considered insignificant. All other effects would be temporary in nature; individual marine organisms may be killed or injured as a result of underwater detonations, but there should be no lasting impact on population levels of any species. Therefore, the activities should have no significant adverse or beneficial long-term impacts on the maintenance and enhancement of long-term biological productivity.

11.0 RELATIONSHIP WITH FEDERAL, STATE, AND LOCAL PLANS, POLICIES, AND CONTROLS

11.1 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) of 1969, as amended, contains policy and guidance to ensure that potential impacts from proposed federal actions are assessed using a systematic and interdisciplinary approach. This FEIS has been prepared in accordance with Section 102(2)(c) of NEPA, the Council on Environmental Quality (CEQ) regulations on implementing NEPA procedures (40 CFR 1500-1508), and Department of the Navy regulations on implementing NEPA procedures (32 CFR 775).

11.2 EXECUTIVE ORDER 12114

Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions," requires analysis of environmental impacts of Federal agency actions that could significantly affect the global commons, the environment of a foreign nation, or impacts on protected global resources. Executive Order 12114 is based on independent authority but furthers the purpose of NEPA. Because the proposed action could result in environmental impacts outside of U.S. territorial seas, this FEIS has been prepared in accordance with Executive Order 12114. Impact discussions in this FEIS (Section 4.0, Environmental Consequences) are divided into separate subsections to distinguish between those operations that are evaluated under NEPA and those that are evaluated under Executive Order 12114.

11.3 EXECUTIVE ORDER 12898

Consistent with Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," it is the Navy's policy to identify and address disproportionately high and adverse human health or environmental effects on members of minority and low-income populations. The shock trial and associated mitigation operations would occur well offshore and would result in minor and/or temporary impacts to the environment at the test site with no significant direct or indirect impacts on the human population. Chemical byproducts of the detonations would be rapidly dispersed at the test site [Sections 4.1.5(b) and 4.1.5(c)] and therefore would not affect coastal water quality or air quality.

Due to the small area affected and the short duration of the shock trial, the proposed action would not have significant impacts on commercial or sport fishery stocks, fishing activities (including subsistence fishing), or the coastal fishing industry [Section 4.1.4(a)]. Existing and temporary facilities would provide all services in support of the shock trial, and no significant direct or indirect impacts on the local economy are expected (Section 4.2.2). The shore-based operations and transit of ships and aircraft from shore support facilities to the test site are of the same type routinely conducted by the Navy and would not involve any unusual or extraordinary activities which could have impacts on coastal resources or the coastal economy. Therefore, the proposed action would not have any disproportionately high and adverse environmental or health impacts specific to any minority or low-income populations.

11.4 EXECUTIVE ORDER 13089

The purpose of Executive Order 13089, "Coral Reef Protection," is to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment. In addition to establishing a Coral Reef Task Force, Executive Order 13089 requires Federal agencies to (a) identify their actions that may affect U.S. coral reef ecosystems; (b) utilize their programs and authorities to protect and enhance the conditions of such ecosystems; and (c) to the extent permitted by law, ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems. Exceptions are provided (a) during time of war or national emergency; (b) when necessary for reasons of national security, as determined by the President; (c) during emergencies posing an unacceptable threat to human health or safety or to the marine environment and admitting of no other feasible solution; or (d) in any case that constitutes a danger to human life or a real threat to vessels, aircraft, platforms, or other man-made structures at sea, such as cases of force majeure caused by stress of weather or other act of God. Federal agencies whose actions affect U.S. coral reef ecosystems, shall, subject to the availability of appropriations, provide for implementation of measures needed to research, monitor, manage, and restore affected ecosystems, including, but not limited to, measures reducing impacts from pollution, sedimentation, and fishing.

As explained in Section 3.2.7, scattered banks of deepwater coral are present on the Blake Plateau in and near the Mayport test area. The deepwater corals associated with these features are mostly solitary and "ahermatypic" (non-reef building), and are not coral reefs as defined in Executive Order 13089. Moreover, due to the water depth in which the coral banks occur -- 650 to 850 m (2,133 to 2,789 ft) -- impacts on corals and associated fauna are highly unlikely [see Section 4.1.3(d)]. Finally, known coral areas have been excluded from the Mayport test area, along with a 1.85 km (1 nmi buffer) (see Section 2.2.3). The proposed action is consistent with Executive Order 13089 because (a) the Navy has evaluated potential impacts and determined that corals are unlikely to be affected, and (b) known coral areas would be protected (by exclusion) from testing.

11.5 ENDANGERED SPECIES ACT

The Endangered Species Act of 1973, as amended, empowers the Secretary of the Interior to establish a listing of endangered and threatened species and critical habitats designated for protection. The Act prohibits jeopardizing endangered and threatened species or adversely modifying critical habitats essential to their survival. Section 7 of the Act requires consultation with NMFS and/or USFWS if the applicant has reason to believe that an endangered or threatened species may be present in the area affected by the project and that implementation of the proposed action will likely affect such species. Copies of the Department of the Navy informal consultation letters and responses from the NMFS and the USFWS are provided in **Appendix F.** Formal consultation with the NMFS is necessary because there are several species of listed marine mammals and turtles under NMFS jurisdiction that may be affected by the proposed action. Formal consultation with the USFWS is not required because the Navy has determined (and the USFWS has concurred) that no endangered or threatened species under its jurisdiction are likely to be affected by the proposed action if conducted at Mayport or Pascagoula. The DEIS served as a Biological Assessment which the Navy submitted to the NMFS to initiate formal consultation. In response, the NMFS has issued a Biological Opinion, which is included in Appendix G of the FEIS.

11.6 MARINE MAMMAL PROTECTION ACT

The Marine Mammal Protection Act of 1972, as amended, establishes a national policy designed to protect and conserve marine mammals and their habitats. This policy is established to prevent the reduction of population stocks beyond the point at which they cease to be a functioning element in the ecosystem, or the reduction of species below their optimum sustainable population.

Section 101(a)(5) of the Marine Mammal Protection Act directs the Secretaries of Commerce and the Interior to allow, upon request, the incidental (but not intentional) taking of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and regulations are issued. Permission may be granted by the Secretary for the incidental take of marine mammals if the taking will (1) have a negligible impact on the species or stock(s); and (2) not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. Regulations must be issued setting forth the permissible methods of taking and the requirements for monitoring and reporting such taking.

In January 2000, following the release of the DEIS, the Navy submitted an incidental small take application to the NMFS. Based on this application, the NMFS published a Proposed Rule in December 2000 (65 FR 77546). The Proposed Rule specifies take limits as well as mitigation, monitoring, and reporting requirements for the shock trial. A Final Rule must be issued before the shock trial can proceed.

11.7 MARINE PROTECTION, RESEARCH AND SANCTUARIES ACT

The Marine Protection, Research and Sanctuaries Act of 1972 (Ocean Dumping Act), as amended, makes it illegal for any person to transport material from the U.S. for the purpose of dumping it into ocean waters. The term "dumping" as defined under the Act does not include the intentional placement of any device in ocean waters for a purpose other than disposal. In the case of the proposed action, the explosive charge would be transported for the purposes of detonating the charge and conducting the shock trial. After each detonation, the test array would be recovered and floats and floating debris would be removed. Thus, the shock trial would not involve transporting material for the purpose of dumping it into ocean waters, and the proposed action would not require an ocean dumping permit.

The probability of a charge not detonating during a test is remote. Should a charge fail to explode, the Navy would attempt to identify the problem and detonate the charge with all marine mammal and sea turtle mitigation measures in place as described below. If these attempts failed, the Navy would recover the explosive and disarm it. Only in the case of an extreme emergency (e.g., charge could not be detonated or disarmed) or to safeguard human life would the Navy dispose of the charge at sea. The possibility of disposing the explosive charge at sea is very remote. However, if disposal at sea were necessary, the charge would be disposed in a manner that would not pose a hazard to the public.

11.8 COASTAL ZONE MANAGEMENT ACT

The Coastal Zone Management Act of 1972, as amended, provides for the effective management, beneficial use, protection, and development of the U.S. coastal zone. The Act enables individual states to develop and implement regulatory guidelines to ensure appropriate protection and compatibility of uses within their coastal zones. The shore-based operations and transit of ships and aircraft from shore support facilities to the test site would have no effects on coastal resources. Shore facility operations and ship and aircraft transits are of the same type routinely conducted by the Navy and would not involve any unusual or extraordinary activities. As the shock trial itself would occur well outside state waters and coastal zones, it would not directly or indirectly affect coastal resources of any state. Chemical byproducts of the detonations would be rapidly dispersed at the test site [Sections 4.1.5(b) and 4.1.5(c)] and therefore would not affect coastal water quality or air quality. Due to the small area affected and the short duration of the shock trial, the proposed action would not have significant impacts on commercial or sport fishery stocks, fishing activities, or the coastal fishing industry [Section 4.1.4(a)]. Existing and temporary facilities would provide all services in support of the shock trial, and no significant direct or indirect impacts on the local economy are expected (Section 4.2.2). The coastal tourist industry would not be affected by floating debris or dead fish; what little floating debris may result from the detonations would be removed, and any fish killed or injured by the explosions would not be expected to reach coastal waters (Section 4.2.2).

In conclusion, the shock trial would not have any impact on the resources or uses of the coastal zone. Therefore, no formal consistency determination under Section 307 of the Coastal Zone Management Act is required from any state.

11.9 MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act of 1918 (MBTA), as amended, regulates the taking, killing, and possession of migratory birds within U.S. territory. The MBTA applies to migratory birds as defined in the terms of conventions between the U.S. and Great Britain, Mexico, Japan, and the Union of Soviet Socialist Republics. Many of the seabird species that could occur at the test areas are migratory birds as defined in the act. No taking or killing of migratory birds would result from those portions of the proposed action taking place within U.S. territory at shore support facilities or during transit of ships and aircraft to the test site. While the MBTA does not apply, the Navy will make every effort to prevent and/or minimize harm to migratory seabirds that may be in the vicinity of the test site during detonation. The mitigation plan set out in Section 5.0 of the FEIS includes a provision for postponing detonations if flocks of birds are present within the safety range.

11.10 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT AND SUSTAINABLE FISHERIES ACT OF 1996

In September 1996, the U.S. Congress passed Public Law 104-297, the Sustainable Fisheries Act (SFA), which amended the Magnuson Fishery Conservation and Management Act (renamed the Magnuson-Stevens Fishery Conservation and Management Act, or the Magnuson-Stevens Act). With passage of the SFA, NMFS was charged with designating and conserving Essential Fish Habitat (EFH) for those species considered under federal Fishery Management Plans. Specifically, Section 303(a)(7) of the Magnuson-Stevens Act (16 U.S.C. § 1801 *et seq.*), as amended by the SFA, requires that EFH be properly described and identified.

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity"[16 U.S.C. § 1801(10)]. The EFH interim final rule summarizing EFH regulations (62 FR 66531-66559) outlines additional interpretation of the EFH definition. Waters, as defined previously, include "aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate." Substrate includes "sediment, hard bottom, structures underlying the waters, and associated biological communities." Necessary is defined as "the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem." Fish includes "finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds," whereas "spawning, breeding, feeding or growth to maturity" covers the complete life cycle of those species of interest.

These regulatory requirements and associated definitions are intended to minimize, to the extent practicable, any adverse effects on habitat caused by fishing or other non-fishing activities, and to identify other actions to encourage the conservation and enhancement of such habitat. According to the interim final rule (62 FR 66531-66559), a necessary initial step in identifying conservation and enhancement measures is to identify any adverse impacts that will require such measures to be implemented.

Federal agencies must consult with NMFS for any actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect EFH. An adverse effect is "any impact which reduces quality and/or quantity of EFH...[and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions." In response to the EFH consultation, NMFS is required to provide EFH conservation recommendations to the federal agency. After receiving these recommendations, the federal agency is to respond to NMFS describing the measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on such habitat. In the case where an agency disagrees with NMFS' recommendations, the agency must explain its reasons for not following the recommendations.

Further information on EFH is presented in **Appendix H**. For this EIS, the Navy reviewed information on managed species and their EFH near each of the three test areas. Based on an impact analysis, the Navy concluded that the proposed action would not adversely affect EFH at any of the test areas. Therefore, EFH consultation with the NMFS is not required. The Navy notified

the NMFS of this conclusion by letter accompanied by a copy of the DEIS. The NMFS response letter, included in Appendix H, concludes with the following statements: "*Since sensitive marine habitats have been avoided and the proposed action would be occurring in deep water, the NMFS anticipates that EFH and associated trust resources would not be significantly impacted by the proposed work. Because the DEIS adequately describes the proposed project and reasonably expected impacts to EFH and associated marine fishery resources, the NMFS has no comments or recommendation regarding site selection.*"

12.0 LIST OF PREPARERS

Name	Role	Education and Experience
DEPARTMENT OF THE NAVY		
William R. Sloger	Engineer-in-charge	M.S. Environmental Studies; M.E. Structural Engineering; B.S. Civil Engineering. 10 years relevant experience
Lyn B. Carroll	Environmental team manager	M.S. Engineering Management; B.S. Mechanical Engineering. 5 years relevant experience
Phil Barfield	Operational requirements (co-author, alternatives)	B.S. Mechanical Engineering. 15 years relevant experience
James C. Craig, Jr	Co-author, Appendix D	B.S. Physics. 30 years relevant experience
John E. Sigurdson	Co-author, Appendix E	Ph.D. Psychology; M.A. Experimental Psychology. 27 years relevant experience
Joel B. Gaspin	Co-author, Appendix E	B.A. Physics. 30 years relevant experience
David A. Helweg	Co-author, Appendix E	Ph.D. Psychology; M.A. Psychology; B.A. Neuroscience. 12 years relevant experience
CONTINENTAL SHELF ASSOCIATES, INC.		
Neal W. Phillips	EIS editor; co-author, all EIS chapters and Appendices B, C, and H	Ph.D. Ecology; M.S. Marine Studies; B.A. Biological Sciences. 16 years relevant experience
Luis M. Lagera, Jr.	Co-author, existing environment; analysis of aerial survey data for marine mammals and turtles; mapping and GIS support	Ph.D. Environmental Sciences (Ecology); M.S. Biological Sciences; B.S. Zoology. 11 years relevant experience
Stephen T. Viada	Aerial surveys for marine mammals and sea turtles; co-author, Appendix B	M.S. Biological Oceanography; B.S. Zoology. 18 years relevant experience
David B. Snyder	Co-author, existing environment (fish and fisheries) and Appendix H (essential fish habitat)	M.S. Marine Biology and Ichthyology; B.S. Zoology. 18 years relevant experience
Brian J. Balcom	Co-author, Appendix B	M.S. Marine Biology; B.S. Biology. 19 years relevant experience
Frederick B. Ayer, II	Project Director	B.S. Marine Biology. 26 years relevant experience
Melody B. Powell	Technical editor; DEIS document production coordinator	B.S. Zoology. 10 years relevant experience
Deborah V. Raffel	FEIS document production coordinator	12 years relevant experience
Karen I. Stokesbury	Public scoping hearings; Appendix A	10 years relevant experience

Name	Role	Education and Experience
BAE SYSTEMS		
William Paniszczyn	Shock trial program manager assistant; co-author, introduction, alternatives, mitigation and monitoring	B.S. Marine Engineering. 8 years shock trial planning and execution experience
Gregory Spring	Shock trial administration analyst	B.S. Industrial Design, 20 years Navy support experience, 4 years shock trial support experience
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION		
Janet Clarke	Mitigation team coordinator; co-author, mitigation and monitoring	M.A. Anthropology; B.S. Wildlife Management. 7 years relevant experience
TECHMATICS		
Greg Bryant	Co-author, mitigation and monitoring	B.S. Marine Engineering. 6 years relevant experience

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APPENDIX A

DISTRIBUTION LIST

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Mary Bell, Code 00TP
Department of Navy, Naval Sea Systems Command
2531 Jefferson Davis Highway
Arlington, Virginia 22242

CDMR Jim Becka
2403 Woodbridge Dr.
Manitowoc, Wisconsin 54220

Dr. Paul R. Bolduc
AAC/EMSP
501 DeLeon, Suite 101
Eglin AFB, Florida 32542-5133

Jesse Borthwick
Range Environmental Planning Office 46TW/XPE
101 West V Avenue Suite 222
Eglin Airforce Base, Florida 32542

Center for Naval Analysis
The Library
ATTN: Dale Jachlewski
4401 Ford Avenue
Alexandria, Virginia 22302

Norman Cherkia
NRL code 7420
555 Overlook Avenue, SW
Washington, DC 20375-5350

Lou Chiarella
EFH Coordinator
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
One Blackburn Drive
Gloucester, Massachusetts 01930

Larry Coar
Naval Air Warfare Center
Aircraft Division Detachment
Trumbo Point Annex
Pier D-1, B-28
Key West, Florida 33040-9013

Commander Naval Base
Public Affairs Office
Bldg N-26
Norfolk, Virginia 23511-6002

Commanding Officer
Ann Rosenberry
CODE 232.AR
Southwest Division
Naval Facilities Engineering Command
1220 Pacific Coast Highway
San Diego, California 92132-5178

Commanding Officer
Naval Station
Norfolk, Virginia 23511

Commanding Officer
Code N4
Naval Station Mayport
P.O. Box 280067
Mayport, Florida 32228

Commanding Officer
Naval Station Pascagoula
Building 10
Pascagoula, Mississippi 39595-0401

Commanding Officer
PCU WINSTON S. CHURCHILL (DDG 81)
590 Washington Street
Bath, Maine 04530
UIC 21955

COMNAVBASE Jacksonville
Attn: Regional Environmental Coordinator
Code N3 Box 102
Naval Air Station
Jacksonville, Florida 32212-0102

Andrea Costanzo, Code 662
Bldg. 19, Rm. A240
Commander, Carderock Division
Naval Surface Warfare Center
9500 MacArthur Blvd.
West Bethesda, Maryland 20817-5700

Council on Environmental Quality
722 Jackson Place NW
Washington, DC 20006

Jim Craig
Code 606
Naval Surface Warfare Center
Carderock Division
9500 MacArthur Boulevard
Building 19, Room A126
West Bethesda, Maryland 20817-5700

Congressman Ander Crenshaw
Fourth District, Florida
510 Cannon House Office Building
Washington, DC 20515-0904

Defense Technical Information Center
DTIC Customer Service Help Desk (DTIC-BLS)
8725 John J. Kingman Road, Suite 0944
Ft. Belvoir, Virginia 2060-6218

Department of Energy
Dave Harris\L-205
Lawrence Livermore National Lab
P.O. Box 808
Livermore, California 94551

Department of the Navy
Pacific Division
Naval Facilities Engineering Command
258 Makalapa Dr. Suite 100
Pearl Harbor, Hawaii 96860-3134
Attn: PLN 231 (Mr. Stanley Uehara)

Desiree Dimauro
Commandant G-ECZ-1
U.S. Coast Guard Headquarters
2100 2nd Street NW
Washington, DC 20593-0001

Barry S. Drucker
U.S. Department of the Interior
Minerals Management Service
Office of International Activities and Marine
Minerals (INTERMAR)
381 Elden Street, MS 4030
Herndon, Virginia 22070

Marguerite Duffy
Environmental Protection Agency
401 M Street SW, MC 2253
Washington, DC 20460

Conrad Erkelens
CINCPACFLT Natural and Cultural Resources
Manager
Code N46541 CINCPACFLT Environmental Division
250 Makalapa Drive
Pearl Harbor, Hawaii 96860-3131

FACSFAC Jacksonville
P.O. Box 40
Naval Air Station Jacksonville
Jacksonville, Florida 32212
Attn: LCDR Pat Powers, Operations Officer

Dagmar Fertl
U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Tom Fetherston, Code 551
Naval Undersea Warfare Center
Division Newport
1176 Howell Street
Newport, Rhode Island 02841

Roger Gentry
NOAA, NMFS
1315 East-West Hwy, Room 13602
Silver Spring, Maryland 20910

Tracy Gill
National Oceanic and Atmospheric Administration
1305 East-West Highway
Room 9205
Silver Spring, Maryland 20910

Dr. Robert Gisiner
Biological Science and Technology Program
Office of Naval Research, Code 341
800 N. Quincy Street
Arlington, Virginia 22217-5660

James Haluska
Code: 2032JH
Environmental Protection Specialist
Atlantic Division
Naval Facilities Engineering Command
1510 Gilbert Street
Norfolk, Virginia 23511-2699

Dana Hartley
NMFS-NEFSC
166 Water St.
Woods Hole, Massachusetts 02543

Maurice Hill
Minerals Management Service
770 Paseo Camarillo
Camarillo, California 93010

Sandra Herrell
Marine Environment Support Office
SPAWARSYSCEN D3621
53475 Strothe Road Rm. 258
San Diego, California 92152-6326

Ken Hollingshead
National Marine Fisheries Service
Office of Protected Resources
1335 East-West Highway
Silver Springs, Maryland 20910

Capt. F. Klein
NAVDEPNOAA
Room 6003 Hoover Building
14th & Constitution, NW
Washington, DC 20230

Jack Lewis
Minerals Management Service
381 Elden Street
Mail Stop 4360
Herndon, Virginia 20170-4817

Marine Mammal Commission
Attn: John R. Twiss, Jr., Executive Director
4340 East West Highway, Room 905
Bethesda, Maryland 20814

Marine Mammal Commission
Attn: Darel Jordan
4340 East West Highway Room 905
Bethesda, Maryland 20814

Selena R. Mellon
Ecological Risk Group
Environmental Sciences Division
Oak Ridge National Laboratory
Building 1501 MS 6036
P.O. Box 2008
Oak Ridge, Tennessee 37831-6036

Glenn Mitchell
Naval Underwater Warfare Center
1176 Howell Street
Building 11/CODE 551
New Port, Rhode Island 02841

Dr. Sue Moore
National Marine Fisheries Service
National Marine Mammal Laboratory
7600 Sandy Point Way, NE
Seattle, Washington 98115-0070

Keith D. Mullin
National Oceanic & Atmospheric Administration
(NOAA)
3209 Fredrick Street
Pascagoula, Mississippi 39567

National Marine Fisheries Service
Director, Office of Protected Resources
Marine Mammals Division
1315 East-West Highway
Silver Spring, Maryland 20910

National Marine Fisheries Service
Habitat Conservation Division
3500 Delwood Beach Road
Panama City, Florida 32408

Andreas Mager
EFH Coordinator
National Marine Fisheries Service
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702

Naval Air Warfare Center, Weapons Division
Attn Alex Stone code 529600E
521 Ninth Street
Point Magu, California 93042-5001

Naval Facilities Engineering Command
Commander (Environmental)
Attn: Craig W. Woods
Washington Navy Yard
1322 Patterson Avenue SE Suite1000
Washington, DC 20374-5065

Naval Staff
DERA Winfrith
Room 113, Building B21
Winfrith Newburgh
Dorchester
DORSET
UK
DT2 8XJ

Clyde Nishimura
Naval Research Laboratory
Code 7420
Washington, DC 20375

Officer in Charge
NAVUNSEAWARCEN DET HI/SOCAL
442 Everest St.
Waianae, Hawaii 96792-4309

Charles Oravetz
Deputy Regional Administrator for Protected Resources
National Marine Fisheries Service
Southeast Regional Office
9721 Executive Center Drive
St. Petersburg, Florida 33702-2432

Mark O. Pierson
Minerals Management Service
Pacific OCS Region
770 Paseo Camarillo
Camarillo, California 93010

Rodger Pugliese
South Atlantic Fishery Management Council
Southpark Bldg, Suite 306
One Southpark Circle
Charleston, South Carolina 29407-4699

Andrew Rich
Fort Matanzas National Monument
8635 A1A South
St. Augustine, Florida 32086

Sam H. Ridgway
Navy Marine Mammal Program, D3503 (PLBS)
49620 Beluga Rd
San Diego California 92152-6266

Tom Sarros
Naval Station Pascagoula
Code N75
Pascagoula, MS 39595

LCDR Jim Scafield
NFESC Code 553
Washington Naval Shipyard
Building 218
901 "M" Street SE
Washington, DC 20374

George Seabits
46 Test Wing/XTP
101 West D Avenue, Suite 222
Egland Air Force Base, Florida 32542-5307

John Sigurdson
Biosciences Division, Code D351
Space and Naval Warfare Systems Center
49620 Beluga Rd.
San Diego, California 92152

Dennis Smith
c/o National Marine Fisheries Service
Protected Resources Division
650 Capitol Mall Suite 6070
Sacramento, California 95814-4706

SPAWAR Systems Center San Diego
Code D711
53560 Hull Street
San Diego, California 92152-5001

Robert Stock
Program Executive Officer
Undersea Warfare
Code ASTO-2
2531 Jefferson Davis
Arlington, Virginia 22242-5169

Alex Stone
Project Manager
Naval Air Warfare Center
CODE 8320003
521 9TH Street
Point Mugu, California 93042-5001

Supervisor of Shipbuilding Conversion and Repair
Attn: CDR Dave Lewis Code 300
574 Washington Street
Bath, Maine 04530

Dr. Steve Swartz
NOAA Fisheries
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, Florida 33149

Wendy Teas
NMFS-SEFSC
75 Virginia Beach Drive
Miami, Florida 33149-1003
Attn: Sea Turtle Stranding Coordinator

Sal Testeverde
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
One Blackburn Drive
Gloucester, Massachusetts 01930

Marcia Thompson
NFESC Environmental Planning Team
ESC427
1100 23rd Ave
Port Hueneme, CA 93043-4370

U.S. Army CERL
Attn: Chawla/LLN
P.O. Box 9005
Champaign, Illinois 61826-9005

U.S. Army Corps of Engineers
Wilmington District
Environmental Resources Section
Attn: Frank Yelverton
P.O. Box 1890
Wilmington, North Carolina 28402-1890

U.S. Coast Guard
Office of Law Enforcement & Defense Ops
2100 2nd Street NW
Washington, DC 20241

U.S. Department of Commerce
Office of Ecology & Environmental Conservation
National Oceanic and Atmospheric Administration
Room 5813
Washington, DC 20230

U.S. Department of the Interior
Attn: James H. Lee
Office of Environmental Policy & Compliance
Richard B. Russell Federal Building
75 Spring Street, SW
Atlanta, Georgia 30303

Stan Uehara
Naval Facilities Engineering Command, Pacific Division
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

U.S. Department of Justice
General Litigation
10th & Pennsylvania Ave NW
Washington, DC 20350

U.S. Environmental Protection Agency
Director, Office of Federal Activities
401 M Street SW (2251)
Washington, DC 20460

U.S. Environmental Protection Agency
Administrator, Region III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

U.S. Environmental Protection Agency
Heinz J. Muller, Region IV
Atlanta Federal Center
61 Forsyth Street
Atlanta, Georgia 30303-8960

U.S. Fish & Wildlife Service
Environmental Coordination Branch
Department of the Interior
Washington, DC 20240

Deborah Verderame, Code 00TP
Department of Navy, Naval Sea Systems Command
2531 Jefferson Davis Highway
Arlington, Virginia 22242

LCDR Greg Wheelock
Director, NAVEODFLTLAU
2008 Stump Neck Road
Indian Head, Maryland 20640

Judy Wilson
Endangered Species Coordinator
381 Elden Street
MS4042
Herndon, Virginia 20170-4817

Mike Winnette
Code 661
Naval Surface Warfare Center
Carderock Division
9500 MacArthur Boulevard
Building 19, Room A244
West Bethesda, Maryland 20817-5700

Mike Zitko
Supship, Pascagoula
Supervisor of Shipbuilding, U.S. Navy
P.O. Box 7003
Pascagoula, Mississippi 39568-7003

STATE AGENCIES

Henry Ansley
Georgia Department of Natural Resources
Coastal Resources Division
One Conservation Way
Brunswick, Georgia 31523-8600

Commonwealth of Virginia
Marine Resources Commission
P.O. Box 736
2600 Washington Ave
Newport News, Virginia 23607-0756

Tom Felvey
Department of Environmental Quality
P.O. Box 10009
Richmond, Virginia 23240-0009

Ms. Lynn Griffin
DEP Office of Intergovernmental Programs
3900 Commonwealth Blvd., M.S. 47
Tallahassee, Florida 32399-3000

Duane Harris
Director
Department of Natural Resources
Coastal Resources Division
1200 Glynn Avenue
One Conservation Way
Brunswick, Georgia 31523-8600

Tom Hopkins
Office of the Secretary of Natural Resources
P.O. Box 1475
Richmond, Virginia 23212

John R. Marling
Director
Office of Environmental Impact Review
Division of Intergovernmental Coordination
Virginia Department of Environmental Quality
629 E. Main Street
Richmond, Virginia 23219

Ron Michaels
Georgia Department of Natural Resources
Coastal Resources Division
One Conservation Way
Brunswick, Georgia 31523-8600

Dr. Gerald Miller
Office of Environmental Assessment
61 Forsyth St. SW
Atlanta, Georgia 30303

Harold Rehels
Director
Environmental Protection Division
205 Butler Street
Suite 1152 East
Atlanta, Georgia 30334

Roger N. Schecter
Director
Department of Environment, Health, & Natural Resources
Division of Coastal Management
P.O. Box 27687
Raleigh, North Carolina 27611

Susan Shipman
Chief
Marine Fisheries Section
Georgia Department of Natural Resources
One Conservation Way
Brunswick, Georgia 31520-8687

State of Florida
Department of Community Affairs
Florida State Clearinghouse
2555 Shumard Oak Boulevard
Tallahassee, Florida 32399-2100

State of Florida
Department of Environmental Protection
Attn: David Struhs
Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Suzanne P. Tarr
Florida Department of Environmental Protection
Florida Marine Research Institute
100 8th Avenue SE
St. Petersburg, Florida 33701-5095

Virginia Dept of Environmental Quality
Office of Environmental Impact Review
Attn Silvia Gazzera
629 East Main Street, Sixth Floor
Richmond, Virginia 23219

Traycie West
Virginia Department of Environmental Quality
5636 Southern Boulevard
Virginia Beach, Virginia 23462

LOCAL AGENCIES

Mayor, City of Jacksonville
City Hall
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Jacksonville, Florida 32202

Mayor, City of Norfolk
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Norfolk, Virginia 23510

Mayor, City of Pascagoula
P.O. Drawer 908
Pascagoula, Mississippi 39568-0908

Mayor, City of Pensacola
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Pensacola, Florida 32501

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100 Herb Bauer Drive
St. Marys, Georgia 31558

OTHER INTERESTED PARTIES

Gary Aldridge
In Defense of Animals
P.O. Box 3087
Shepherdstown, West Virginia 25443

Peer Amble
1111 Chapala Street, Suite 100
Santa Barbara, California 93101

Applied Ordnance Technology
Patuxent River Office
Attn: Dana Hall
48015 Pinehill Run Road
Bldg. 2, Suite 17
Lexington Park, Maryland 20653

Marcian Ashby
133 Pine Street
Atlantic Beach, Florida 32233-4011

Nancy Azzam
American Cetacean Society
2300 Noble Avenue North
Golden Valley, Minnesota 55422

Robin W. Baird C-201
2747 South Kihei Road
Kihei, Hawaii 96753

Marianie Balolong
Jacksonville University
Marine Science Department
2457 Seymour Street
Jacksonville, Florida 32246

Susan Barco
Virginia Marine Science Museum
717 General Booth Boulevard
Virginia Beach, Virginia 23451

Michael Bean
Chairman, Wildlife Program
Environmental Defense Fund
1875 Connecticut Avenue NW
Washington, DC 20009

Elizabeth A. Becker
c/o TEC
1111 Chapala Street, Suite 100
Santa Barbara, California 93101

Stephanie Boyles
501 Front Street
Norfolk, Virginia 23513

Greg Bryant
Techmatics
Three Crystal Park
2231 Crystal Drive, Suite 1000
Arlington, Virginia 22201-3742

Vanessa Calamara
680 Alamona Blvd 1st Floor
Honolulu, Hawaii 96813

Linda Chamberlin, Ph.D.
Department of Biology
Valdosta State University
1500 North Patterson Street
Valdosta, Georgia 31698-0015

Ed Cherian
Tetra Tech Inc.
1593 Springhill Road, Suite 300
Vienna, Virginia 22182

David Clark
National Wildlife Federation
7205 Oakridge Avenue
Chevy Chase, Maryland 20815

Ms. Janet Clarke
SAIC
14620 268th Ave. E.
Buckley, Washington 98321

Cousteau Society
Attn: Clark Merriam
870 Greenbriar Circle #402
Chesapeake, Virginia 23320

Christopher Croft
Defenders of Wildlife
1101 14th Street NW
Washington, DC 20005

Mr. Daniel Cusick
c/o The Mobile Register
304 Government Street
Mobile, Alabama 36652

Mike D'Amico
Atlantic Biodiversity Center
P.O. Box 160
Nassau, Delaware 19969

Russell DeConti
Center for Coastal Studies
P.O. Box 1036
Provincetown, Massachusetts 02657

Robert Deegan
Sierra Club
340 Ramapo Road
Virginia Beach, Virginia 23462

Mike Delaney
7217 Kindler Rd.
Columbia, Maryland 21046

Cathi Delisle
Mystic Mammalife Aquarium
55 Coogan Boulevard
Mystic, Connecticut 06355

Kirstin Dobbs, Ph.D.
Senior Projects Officer, Species Conservation
Conservation, Biodiversity and World Heritage
Group
Great Barrier Reef Marine Park Authority
PO Box 1379
Townsville, Qld 4810
Australia

Sarah Dolman
WDCS Science Officer
Whale and Dolphin Conservation Society
James Street West
Bath BA1 2BT
United Kingdom

Muriel Ducloy
People for the Ethical Treatment of Animals
501 Front Street
Norfolk, Virginia 23510

Mary Duffy
Amelia Island Sea Turtle Watch, Inc.
P.O. Box 566
Fernandina Beach, Florida 32035

Margaret Dupree
1601 Kapiolani Street
Suite 1110
Honolulu, Hawaii 96814

Dynamic Systems
c/o Alex Stone
635 Slaters Lane
Suite 100
Alexandria, Virginia 22314

Dagmar Fertl
Geo-Marine
550 E. 15th Street
Plano, Texas 75074

Amanda Figuero
Law Offices Martinez Lorenzo
Union Plaza Building, Suite 1000
416 Ponce de Leon Avenue
Hatorey, Puerto Rico 00918-3424

Lilian Flank
Ecology and Environment, Inc.
15280 NW 79th Court, Suite 100
Miami Lakes, Florida 33016

Ari Friedlaender
Biological Sciences
University of NC at Wilmington
601 South College Road
Wilmington, North Carolina 28403

Kathryn S. Fuller
President
World Wildlife Fund
1250 24th Street NW
Washington, DC 20037

William W. Furr, Jr.
First Coast Fishing Club
14544 Plumosa Drive
Jacksonville Beach, Florida 32250

Dale Gauding
WVEC TV
613 Woodis Avenue
Norfolk, VA 23510

Joel Gaspin
28 Columbia Ave
Takoma Park, Maryland 20912

James Gesualdi, Esq.
58 Wingham Drive
Islip, Long Island, New York 11751-4112

Quent Gillard
EDAW
Suite 1
200 Sparkman Drive
Huntsville, Alabama 35805

Jeff Goodyear
1533 Gladstone Avenue
Victoria, B.C. Canada V8R1S4

John C. Goold
University of Wales Bangor
School of Ocean Sciences
Menai Bridge
Gwynedd LL59 5EY UK

Charles Greene
4512 Via Huerto
Santa Barbara, California 93110

Shane Guan
Grice Marine Biological Laboratory
University of Charleston
205 Fort Johnson Road
Charleston, South Carolina 29412

Frances R. Guarnieri
Flagler County Sea Turtle Patrols
9 Avalon Lane (Sea Colony)
Palm Coast, Florida 32137

Dr. Jay D. Hair
President
National Wildlife Federation
1400 Sixteenth Street NW
Washington, DC 20036-2266

Morton H. Hanson
Beaches Sea Turtle Patrol, Inc.
299-1 Atlantic Boulevard
Atlantic Beach, Florida 32233

Donna Hart
International Wildlife Coalition
P.O. Box 138
Elsberry, Missouri 63343

Jan Hartke
EarthKind USA
2100 L Street NW
Washington, DC 20037

Karen Hiu
615 Tiikoi Street, Suite 900
Honolulu, HI 96814-3141

Suzanne Iudicello
Vice President
Center for Marine Conservation
1725 DeSales Street
Suite 500
Washington, DC 20036

Bruce Jaildagian
Ocean Advocates
P.O. Box 384
New Smyrna Beach, Florida 32170

Missy James and Jack Nolen
89 Dewees Avenue
Atlantic Beach, Florida 32233-4011

E. Kalakauskis
Jacksonville Offshore Sport Fishing Club
1207 Aruba Court
Jacksonville, Florida 32226

Gary Kasaoka
1658 Liho Liho Street
Honolulu, Hawaii 96822

David Kastak
Long Marine Laboratory
100 Shaffer Road
Santa Cruz, California 95060

Dr. Darlene Ketten
Harvard Medical School
Dept of Otolaryngology
MEEI/Room 705C
243 Charles Street
Boston, Massachusetts 02114

Robert Krasko
Groundwater and Environmental Management
Services (GEMS)
1305 NOE Court
Neptune Beach, Florida 32266

Dr. Scott Kraus
New England Aquarium
Central Wharf
177 Milk Street
Boston, Massachusetts 02109

Lisa Lange
People for the Ethical Treatment of Animals
501 Front Street
Norfolk, Virginia 23510

Garry Leape
Greenpeace USA
1436 U Street NW
Washington, DC 20009

Jennifer Lewis
MSPCA
350 South Huntington Avenue
Boston, Massachusetts 02130

Beth E. Libert
Volusia County Turtle Patrol, Inc.
4738 South Peninsula Drive
Ponce Inlet, Florida 32127

Joanne Lowenstein-Whaley
Marineland, Inc.
9507 Ocean Shore Boulevard
Marineland, Florida 32086-9602

Klaus Lucke
Forschungs- und Technologiezentrum Westkueste
Hafentoern
25761 Buesum
Germany

Dr. Molly Lutcavage
New England Aquarium
Central Wharf
177 Milk Street
Boston, Massachusetts 02109

Kevin Lynch
Fernwood Street
Pacagoula, Mississippi 39567

Fiona Macnight
Center for Conservation Biology
Dept of Zoology and Entomology
University of Queensland
St Lucia QLD 4072
AUSTRALIA

Dr. Charles Malme
Engineering and Science Services
25 Rockwood Road
Hingham, Massachusetts 02043

David A. Mann
University of Maryland
Department of Zoology
1200 Zoology-Psychology Building
College Park, Maryland 20742-4415

Marye K. Marshall
Volusia Sea Turtle Society
P.O. Box 2524
New Smyrna Beach, Florida 32170

Dr. Marianne B. McEuen
3041 Doctors Lake Drive
Orange Park, Florida 32073

William McLellan
UNC Wilmington
Biological Sciences Dept.
601 S. College Drive
Wilmington, North Carolina 28403

Clark Lee Merriam
The Cousteau Society
870 Greenbriar Circle
Suite 402
Chesapeake, Virginia 23320

John Mitchell
2405 Mayport Road
Atlantic Beach, Florida 32233

William Carol Muffett
Defenders of Wildlife
1101 14th Street NW
Washington, D.C. 20005

Christina Myles – Tochko
Johns Hopkins University
Applied Physics Laboratory
11000 Johns Hopkins Road
Laurel, Maryland 20723

Natural Resources Defense Council
Office Administrator
1350 New York Avenue NW
Washington, DC 20005

Mike Nichols
12760 Cherokee Court
Grandbay, Alabama 36541

Ric O'Barry
Dolphin Project
P.O. Box 224
Coconut Grove, Florida 33233

Kata O'Connell
Humane Society International
35 Somerset Street
West Hartford, Connecticut 06110

Fred O'Regan
International Fund for Animal Welfare
411 Main Street
Yarmouth Port, Massachusetts 02675

Pell Marine Science Library
University of Rhode Island
Narragansett Bay Campus
Narragansett, Rhode Island 02882-1197

Kathy Penland
President, American Cetacean Society
3021 Lincoln Blvd., #A
Santa Monica, California 90405

Dennis Peters
630-C Anchor Street
Ft. Walton Beach, Florida 32548

Mike Phillips
c/o SRS Technologies
1401 Wilson Blvd. Suite 1200
Arlington, VA 22209

Susie Pike
University of California, San Diego
IGPP 0225
9500 Gilman Drive
La Jolla, California 92093-0225

Tracy Reiman
People for the Ethical Treatment of Animals
501 Front Street
Norfolk, Virginia 23510

W. John Richardson
LGL Limited
22 Fisher Street
P.O. Box 280
King City, Ontario
Canada L7B 1A6

Nathaniel Riggins
President, Titustown Civic League
1106 Matthew Henson Street
Norfolk, Virginia 23505

Jen Rinick
P.O. Box 3650
Washington, DC 20007

Sarah Robinson
8711 Perimeter Park Blvd. Suite 11
Jacksonville, Florida 32216

B.J. and Peggy Rogers
2106 Margie Moore Avenue
Pascagoula, Mississippi 39567-1735

Jim Rohr
1046 Novara Street
San Diego, California 92107

Dr. Naomi A. Rose
The Humane Society of the United States
2100 L Street, NW
Washington, DC 20037

William Rossiter
Cetacean Society International
P.O. Box 953
Georgetown, Connecticut 06829

C. Ruckdeschel
The Cumberland Island Museum
P.O. Box 796
St. Marys, Georgia 31558

Harry Rucker
104 Blue Heron Blvd.
Ocean Springs, Mississippi 39564

Jennifer Salerno
1725 Jefferson Davis Hwy
Suite 1203
Arlington, Virginia 22202

Dr. Theodor C. Sauer
Battelle Memorial Institute
397 Washington Street
Duxbury, Massachusetts 02332

Alice Scanlan
Virginia Marine Science Museum
717 General Booth Boulevard
Virginia Beach, Virginia 23451-4811

Allison Schaefers
Camden County Tribune
P.O. Box 470
St. Marys, Georgia 31558

Peter M. Scheifele
Director, Marine Education Programs/Bioacoustic Research
National Undersea Research Center
University of Connecticut
Avery Point Campus
1084 Shennecossett Road
Groton, Connecticut 06340-6097

Georgios Sekeriglou
TWD & Associates
1 Crystal Park
2011 Crystal Drive
Suite 209
Arlington, Virginia 22202

Marie L.M. Sheen
Amelia Island Turtle Watch
925 Tarpon Avenue #6
Fernandina Beach, Florida 32034

SIO Library Mono
Scripps Inst of Oceanography
9500 Gilman Dr 0175C
La Jolla, California 92093-0715

Chris Slay
173 Virginia Avenue
Athens, Georgia 30601

Judy Smith
Monograph Acquisition Service
Colorado State University Libraries
Fort Collins, Colorado 80523-1019

Virginia Smith
533 David Street
Neptune Beach, Florida 32266

Ms. Jennifer Smyers
ENSR
505 Loire Avenue, Suite K
Lafayette Louisiana 70507

Pamela Snyder
P. O. Box 158
Virginia Beach, Virginia 23451

Tracy Snyder
200 B 89th Street
Virginia Beach, Virginia 23451

Brandon L. Southall
C/o Schusterman Project
Long Marine Laboratory CSC
100 Shaffer Road
Santa Cruz, California 95062

Sandy Stan
Ponte Vedra Turtle Patrol
6344 Blue Heron Drive
Ponte Vedra Beach, Florida 32082

Evelyn D. Stauber
5155 Avenue B
St. Augustine, Florida 32095-6126

Tony Stokes
Great Barrier Reef
Marine Park Authority
2-68 Flinders Street
PO Box 1379
Townsville Old 4810
Australia

Robert P. Stoll
19 Little Bay Harbor
Ponte Vedra, FL 32082

Richard Stradling
Daily Press
7505 Warwick Blvd
Newport News, Virginia 23607

Richard Max Strahan
c/o Conservation Research Group
Boston College Law School
Newton, Massachusetts 02159

Kim Strate
Jacksonville Offshore Sport Fishing Club
350 Seminole Road
Atlantic Beach, Florida 32233

Wendy Swann
Society for Animal Protective Legislation
P.O. Box 3719
Georgetown Station
Washington, DC 20007

Betsy Swart
Friends of Animals
2000 P Street NW
Washington, DC 20036

Edward S. Syrjala
P.O. Box 149
Centerville, Massachusetts 02632

Tams Consultants, Inc.
Attn: Janet O'Neil
2101 Wilson Boulevard
Suite 300
Arlington, Virginia 22201

Ray Tarpley
Dept of Veterinary Anatomy & Public Health
College of Veterinary Medicine
Texas A&M
College Station, Texas 77843

Shirley Taylor
Chair, Sierra Club
National Marine Committee
1414 Hilltop Drive
Tallahassee, Florida 32308

The Beaches Leader
P.O. Box 50129
Jacksonville Beach, Florida 32250

The Florida Times Union
P.O. Box 2160
Jacksonville, Florida 32231

The Southeast Georgia Newspapers
Kings Bay Advertisor
P.O. Box 1429
11 South Lee Street
Kingsland, Georgia 31548

The Virginian Pilot & Ledger Star
P.O. Box 2160
Norfolk, Virginia 23510-2160

The Washington Post
1150 15th Street, N.W.
Washington, DC 20071

Dr. Peter Tyack
Biology Dept
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02534

David Underhill
WABB Radio
1551 Springhill. Ave.
Mobile, Alabama 36604

University of Southhampton
ATTN: Mrs. P. Simpson
Head of Information Services
National Oceanographic Library
Express Dock
Southhampton SO143ZH
United Kingdom

Claudia Utts-Smith
1713 Poplar Lane
Davis California 95616-1518

Roger and Paulette Walker
1416 Pinewood Road
Jacksonville Beach, Florida 32250

Alan Waltner
Environmental Law Offices
1736 Franklin Street, 8th Floor
Oakland, California 94612

Ronald R. Watson
Hanns Park
500 Wonderwood Drive
Jacksonville, Florida 32233

Raymond P. Weber
5505 Robin Hood Road, Suite I
Norfolk, Virginia 23513

Roger Weeder
WTLV - TV12
1070 East Adams
Jacksonville, Florida 32202

Debbie Weiner
ASPCA
1755 Massachusetts Avenue NW
Washington, DC 20036

Paul Wilbur
13140 Penndale
Fairfax, Virginia 22033

Lloyd Lee Wilson
536 Carnaby Court
Virginia Beach, Virginia 23454

Pamela A. Wilson
310 Prindle Drive East
Jacksonville, Florida 32225

Richard E. Wilson
U.S. Navy, Retired
Wavemasters Society
310 Prindle Drive East
Jacksonville, Florida 32225

Sharon Young
International Wildlife Coalition
22 Washburn Street
Bourne, Massachusetts 02532

George A. Young
Environmental Effects Consultants
3611 Janet Road
Wheaton, Maryland 20906-4353

APPENDIX B

MARINE MAMMALS, TURTLES, AND BIRDS

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APPENDIX B
MARINE MAMMALS, TURTLES, AND BIRDS

B.1 MARINE MAMMALS

B.1.1 Listed Species

Based on a review of historical sighting records, six species of endangered cetaceans may occur at the Mayport, Norfolk, or Pascagoula test areas. These include five baleen whales (blue whale, fin whale, humpback whale, northern right whale, and sei whale) and one toothed whale (sperm whale). In addition, one endangered species of sirenian (the Florida manatee) is occasionally found in coastal waters near Naval Station Mayport (though not present in or near any of the test areas). Finally, one endangered pinniped (the Caribbean monk seal) formerly occurred in the Gulf of Mexico but is believed to be extinct. All listed species are categorized by the National Marine Fisheries Service (NMFS) as "strategic stocks."

Blue Whale. Blue whales (*Balaenoptera musculus*) range from the Arctic to at least mid-latitudes including the waters of the Gulf of Mexico. This species is pelagic, primarily found feeding north of the Gulf of St. Lawrence during spring and summer. It is considered as a very occasional species in waters off the eastern U.S. (Winn, 1982). Limited migration has been documented south to subtropical waters during fall and winter. This species feeds on krill and copepods, the abundance of which most likely controls migration in and out of polar areas. Mating and calving occurs in late fall and winter. Gestation lasts 10 to 11 months. Calves are born every 2 to 3 years. Blue whales are usually seen solitary or in groups of two or three individuals. The minimum population for the western North Atlantic stock is 308 individuals (Waring et al., 1999).

Fin Whale. Fin whales (*Balaenoptera physalus*) range from the Arctic to the Greater Antilles, including the Gulf of Mexico. They are usually found inshore of the 2,000-m (6,562-ft) contour. This species occurs widely in the middle Atlantic throughout the year, with concentrations from Cape Cod north in summer and from Cape Cod south in winter. This species is frequently found along the New England coast from spring to fall in areas of fish concentration. It is thought that fin whales migrate north nearshore along the coast during spring and south offshore during winter. This species feeds on krill, planktonic crustaceans, and schooling fish such as herring and capelin. It is believed that fin whales breed in the middle Atlantic, with mating and calving occurring from November to March. Gestation lasts about 1 year and calves are suckled for 7 months. Fin whales off the eastern U.S. to Canada constitute a single stock (Donovan, 1991). The minimum population estimate for this species in the western North Atlantic is 1,803 individuals (Waring et al., 1999).

Humpback Whale. Humpback whales (*Megaptera novaeangliae*) range from the Arctic to the West Indies, including the Gulf of Mexico. They are found in middle Atlantic shallow coastal waters during spring and in waters around Cape Cod to Iceland during late spring to fall. During summer there are at least five geographically distinct feeding aggregations in the northern Atlantic. Generally, their distribution has been largely correlated to prey species and abundance. It is thought that migration south to the Caribbean occurs during fall. This species feeds largely on euphausiids and small fish such as herring, capelin, and sand lance. Calving and breeding occurs in

the Caribbean from January to March. Gestation lasts 10 months and calves are suckled for about 11 months. Critical habitats have been identified in the western Gulf of Maine and the Great South Channel (Massachusetts). Wiley et al. (1995) reported numerous strandings in Virginia and North Carolina and concluded that this region may be important as juvenile habitat. The minimum population estimate for the North Atlantic range of the humpback whale is 10,019 individuals (Waring et al., 1999).

Northern Right Whale. Northern right whales (*Eubalaena glacialis*) range from Iceland to eastern Florida, with occasional sightings in the Gulf of Mexico. This is the rarest of the world's baleen whales, with a minimum population estimate of 295 individuals (Knowlton et al., 1994; Waring et al., 1999). Coastal waters of the southeastern U.S. (off Georgia and northeast Florida) are important wintering and calving grounds for northern right whales, while the waters around Cape Cod and Great South Channel are used for feeding, nursery, and mating during summer (Kraus et al., 1988; Schaeff et al., 1993). From June to September, most animals are found feeding north of Cape Cod. Northern right whale mating probably occurs during late summer; gestation lasts 12 to 16 months, and calves are suckled for about 1 year (Knowlton and Kraus, 1989). Southward migration occurs offshore from mid-October to early January, although northern right whales may arrive off the Florida coast as early as November and may stay into late March (Kraus et al., 1993). Migration northward along the coast of Florida takes place between early January and late March. Coastal waters off the Carolinas may represent a migratory corridor for this species (Winn et al., 1986; Kraus et al., 1993). This species usually occurs shoreward of the 200-m (656-ft) contour line. Preferred water depths during recent surveys off the Florida coast range from 3 to 73 m (10 to 240 ft), with a mean of 12.6 m (41.3 ft) (Kraus et al., 1993).

Designated critical habitat for the northern right whale includes portions of Cape Cod Bay and Stellwagen Bank and the Great South Channel (off Massachusetts) and waters adjacent to the coasts of Georgia and northeast Florida (59 FR 28793, 3 June 1994). The southernmost critical habitat (**Figure B.1**) encompasses "waters between 31°15'N (i.e., near the mouth of Altamaha River, Georgia) and 30°15'N (i.e., near Jacksonville, Florida) from the shoreline out to 15 nautical miles offshore, and the waters between 30°15'N and 28°00'N (i.e., near Sebastian Inlet, Florida) from the shoreline out to 5 nautical miles."

Sei Whale. Sei whales (*Balaenoptera borealis*) range from south of the Arctic to northeast Venezuela, including the Gulf of Mexico. This species is considered to be pelagic and widely distributed from below polar seas to the Caribbean. It is believed that the following three main stocks occur: 1) Newfoundland/Labrador; 2) Nova Scotia; and 3) Caribbean/Gulf of Mexico. The Nova Scotia stock migrates along the coast, with occurrence south of Cape Cod in winter and from Cape Cod north to the Arctic in summer. This species feeds on copepods, krill, and small schooling fish such as anchovies, sauries, and mackerel. Peak pairing is reported to be from November to February in temperate waters. Gestation lasts 1 year and calves are born in February in warmer waters. Calves are suckled for 6 months. Large numbers concentrate in feeding grounds but usually travel in groups of 2 to 5 individuals. Existing data are insufficient for obtaining estimates of population size in the Atlantic (Waring et al., 1999).

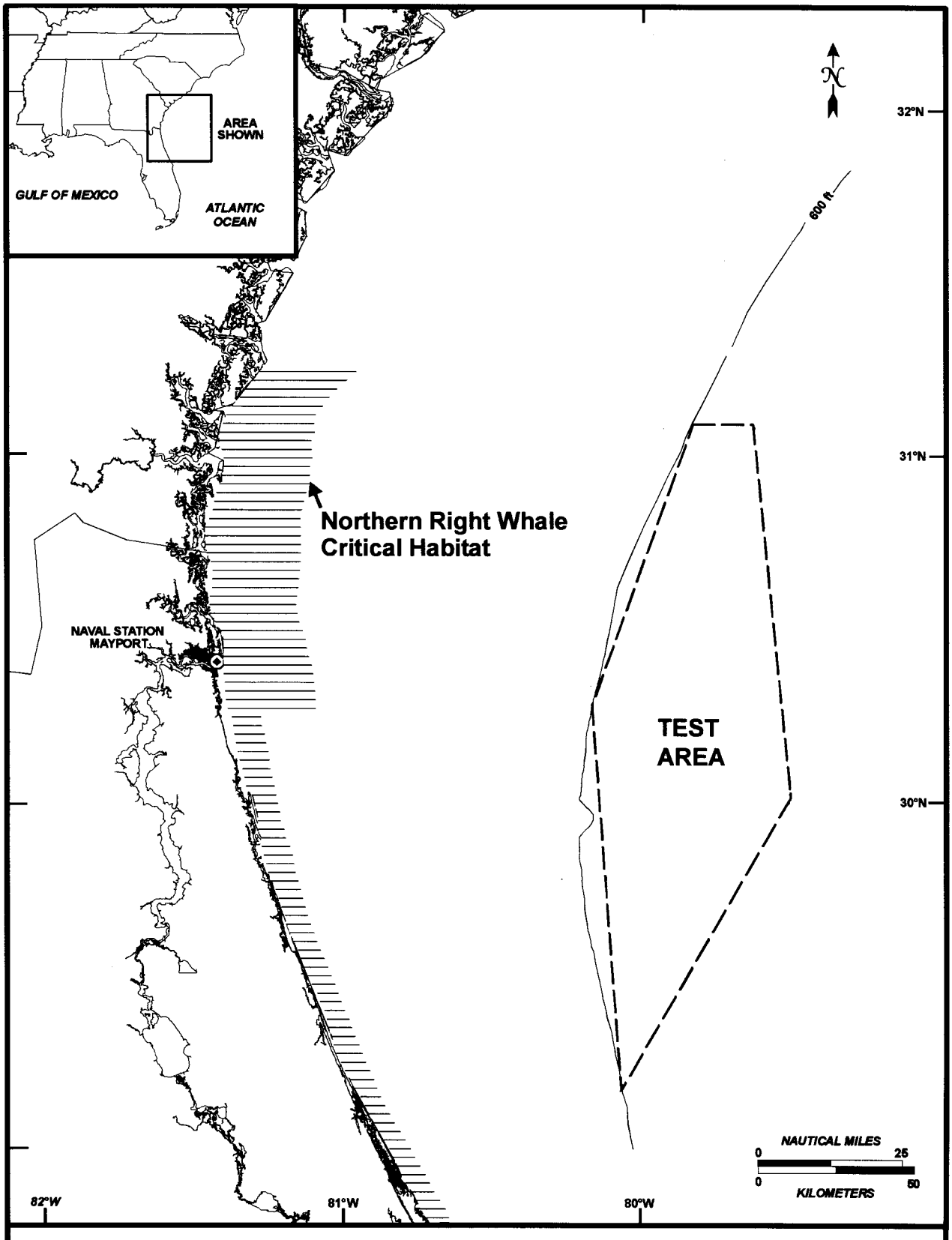

Figure B.1. Northern right whale critical habitat relative to the Mayport test area.

Sperm Whale. Sperm whales (*Physeter macrocephalus*) range from the Davis Straits to Venezuela, including the Gulf of Mexico. This species is pelagic, occurring along the continental shelf edge and slope, continuing into mid-ocean areas; it is occasionally found on the shelf. Sperm whales generally feed on mesopelagic (open ocean environment between 150 and 1,000 m [492 and 3,280 ft] depth) squid along the 1,000-m (3,280-ft) contour. North-south migratory routes observed through middle Atlantic areas are always inhabited. Females, calves, and juveniles remain south of 40°N to 42°N latitude throughout the year while mature males range to higher latitudes (68°N) during summer. This species is most abundant during spring. Mating season is prolonged, extending from late winter through early summer. Calves are born once every 3 to 6 years. Calving occurs between May and September in the northern hemisphere. Large, old males are solitary, while females, calves, and juveniles form "breeding schools" with 4 to 150 individuals. Young males form segregated bachelor groups, or "schools," of up to 50 individuals. The sperm whales which occur along the eastern U.S. represent only a fraction of the total stock. The nature of linkages of this habitat with others is unknown. The minimum population estimate for the North Atlantic stock is 1,617 individuals (Waring et al., 1999).

A resident population of sperm whales occurs in the northern Gulf, concentrated primarily just south of the the mouth of the Mississippi River (Würsig et al., 2000). This "focal point" is located about 200 km (110 nmi) west-southwest of the Pascagoula test area. The minimum population estimate for sperm whales in the northern Gulf of Mexico is 411 individuals (Blaylock et al., 1995).

Florida Manatee. The endangered Florida manatee (*Trichechus manatus latirostris*) occurs along the southeastern Atlantic and Gulf coasts. Because the manatee is a coastal species (U.S. Fish and Wildlife Service [USFWS], 1996), it is not expected to occur within or near any of the test areas. However, manatees occur in the entrance channel near Naval Station Mayport (USFWS, 1999) and during summer months are occasionally seen along the northeastern Gulf coast as far west as Louisiana and along the Atlantic coast as far north as Virginia.

In the southeastern U.S., manatees are limited primarily to Florida and Georgia. This group constitutes a separate subspecies called the Florida manatee that appears to be divided into at least two virtually separate populations -- one centered along the Atlantic coast and the other on the Gulf coast of Florida (USFWS, 1996). Despite concerted research, it has not been possible to develop a reliable estimate of manatee abundance in Florida. The highest single-day count of manatees from an aerial survey is 1,856 animals in January 1992 (Ackerman, 1995).

During the winter months, the manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia (USFWS, 1996). As water temperatures rise in spring, manatees disperse from winter aggregation areas. During summer months, they may migrate as far north as coastal Virginia on the east coast and the Louisiana coast on the Gulf of Mexico (USFWS, 1996). On the Florida west coast, sightings drop off sharply north of the Suwannee River (Marine Mammal Commission, 1986), although about 12 to 15 manatees are seen each summer in the Wakulla River at the base of the Florida panhandle. Louisiana is considered the western limit of the Florida manatee's range (Powell and Rathbun, 1984; Lefebvre et al., 1989).

Critical habitat for manatees has been designated by the USFWS. All of the critical habitat areas are in peninsular Florida, predominantly along the southwest and southeast coasts (USFWS, 1996).

Caribbean Monk Seal (presumed extinct). An endangered pinniped species formerly known from the Gulf of Mexico is the Caribbean monk seal (*Monachus tropicalis*), which is now believed to be extinct (Schmidly, 1981). The last reliable sighting of a Caribbean monk seal occurred in 1952, and many scientists believe that the species has been extinct since the early 1950s. Recently, Boyd and Stanfield (1998) reported circumstantial evidence for the presence of monk seals in the West Indies, suggesting that they may not be extinct. The conclusion was based on interviews with fishermen, some of whom chose monk seals when asked to select pictures of marine species known to them. Some fishermen also gave information about size and color that was consistent with many of these seals being monk seals. However, Early (1998) suggested that extralimital arctic seals may account for at least some of the sightings. Even if monk seals are found to be not extinct, they are assumed not to occur in the Gulf of Mexico based on the absence of sightings there in recent decades. Although the species is still listed as endangered, no recovery effort is being made due to its apparent extinction (NMFS, 1999).

B.1.2 Non-Listed Species

Non-listed cetaceans that may occur at the Mayport, Norfolk, or Pascagoula areas include both mysticetes (baleen whales) and odontocetes (toothed whales and dolphins). This includes two non-listed baleen whale species: minke whale and Bryde's whale. Both are rorquals (Family Balaenopteridae). The remaining non-listed species include beaked whales (Superfamily Ziphioidea), pygmy and dwarf sperm whales (Superfamily Physeteroidea), dolphins (Family Delphinidae) and porpoises (Family Phocoenidae). In addition, there is one non-listed pinniped species whose range includes the Norfolk area, and another non-listed pinniped represented by a few feral individuals in the Gulf of Mexico.

B.1.2.1 Mysticetes

Minke whales (*Balaenoptera acutorostrata*) have a widespread distribution in polar, temperate, and tropical waters. There are four recognized minke whale populations in the North Atlantic. Minke whales off the U.S. eastern seaboard are considered part of the Canadian East Coast population which covers the area from the eastern half of the Davis Strait out to 45°W and south to the Gulf of Mexico (Waring et al., 1999). The minimum population estimate is 2,145 individuals (Waring et al., 1999). The minke whale is considered extralimital in the Gulf of Mexico and would only be represented there by occasional strays (Jefferson and Schiro, 1997).

Along the U.S. east coast, the minke whale is the third most common large whale in the region (Winn, 1982). Blaylock et al. (1995) noted a strong seasonal component to minke whale distribution, with widespread and common occurrence of this species off the eastern coast of the U.S. in spring and summer. Minke whales are observed north of Cape Cod in summer, commonly in nearshore waters of the Gulf of Maine and Bay of Fundy. Migrations occur northward during spring and southward in fall. It is believed that this species spends winter offshore of south Florida and the Lesser Antilles. Mitchell (1991) suggested a possible winter distribution in the West Indies and the mid-ocean south and east of Bermuda. Lee (1985a) indicated that minke whales may

winter off the North Carolina coast, but are absent during other seasons. Manomet Bird Observatory (1989) recorded rare sightings of this species in summer, autumn, and winter (i.e., 2 to 5 individuals/100 transects) on the shelf north of Cape Hatteras. Sightings typically occur nearshore or within the 200-m (656-ft) contour. Like most other baleen whales, minke whales typically occupy the shelf proper, rather than the shelf edge (Waring et al., 1999). Preferred prey include herring, cod, salmon, capelin, squid, and shrimp (Leatherwood et al., 1976). Pairing is normally observed during October to March, coincident with calving. Gestation is about 10 to 11 months; nursing lasts for less than 6 months. It is believed that this species is more solitary, although large groups have been observed.

Bryde's whales (*Balaenoptera edeni*) range from off the southeastern U.S. including the Gulf of Mexico, to the southern Caribbean Sea and Brazil (Leatherwood and Reeves, 1983). This species is found primarily in tropical and subtropical waters, and seldom occurs above 40°N except in warm-water (above 20°C [68°F]) projections northward. It is the only mysticete commonly observed in the Gulf of Mexico (Jefferson and Schiro, 1997), where it tends to occur along the shelf edge (Mullin and Hoggard, 2000). Bryde's whales are not thought to undergo long migrations. Some northward movements during summer and southward movements during winter have been observed and suggest pursuit of prey. This species typically inhabits nearshore waters and feeds on schooling fish such as sardines, mackerel, anchovies, and herrings. Information from South African waters suggests they breed year-round. Stock size for the western north Atlantic population has not been estimated. The minimum population estimate for Bryde's whale in the northern Gulf of Mexico is 17 individuals (Blaylock et al., 1995).

B.1.2.2 Odontocetes

<u>Beaked Whales</u>. There are six species of beaked whales that may occur at one or more of the test areas (Leatherwood et al., 1976; Waring et al., 1999). They are Blainville's beaked whale (*Mesoplodon densirostris*), Cuvier's beaked whale (*Ziphius cavirostris*), Gervais' beaked whale (*M. europaeus*), Northern bottlenose whale (*Hyperoodon ampullatus*), Sowerby's beaked whale (*M. bidens*), and True's beaked whale (*M. mirus*). The members of the genus *Mesoplodon* are difficult to identify to the species level at sea. Therefore, much of the available characterization for these species is to genus level only. Similarly, the elusive nature of *Mesoplodon* spp. has, to date, prevented the acquisition of sufficient data to determine specific population trends (Waring et al., 1999). Beaked whales are a "strategic stock" under the Marine Mammal Protection Act (MMPA) (Waring et al., 1999). The minimum population estimate for beaked whales (including Cuvier's beaked whale and *Mesoplodon* spp.) in the western North Atlantic is 895 individuals (Waring et al., 1999). Stock sizes have not been estimated for beaked whales in the northern Gulf of Mexico except for Cuvier's beaked whale (minimum of 20 individuals) (NMFS, 1997).

Blainville's beaked whales (*Mesoplodon densirostris*) range from Nova Scotia to Florida and the Bahamas, including waters of the Gulf of Mexico. It could occur at any of the three test areas. This species is considered pelagic, inhabiting very deep waters. It is widely but sparsely distributed throughout tropical and warm temperate waters up to 45°N latitude in the western Atlantic due to the presence of the Gulf Stream (Leatherwood et al., 1976). Data suggest that Blainville's beaked whales feed on squid and live in family groups of three to six individuals. Little is known about the life history of this species.

Cuvier's beaked whales (*Ziphius cavirostris*) range from Massachusetts to the West Indies, including waters of the Gulf of Mexico. This species could occur at any of the three test areas. Stock structure in the northwestern Atlantic is unknown (Waring et al., 1999). As with other beaked whales, it is believed that this species inhabits pelagic waters and exhibits a wide distribution. Migration to higher latitudes during summer has been suggested. This species feeds primarily on squid and deep water fish, but is also known to eat crab and starfish. No marked breeding season is evident. It is believed that calving occurs year-round. Cuvier's beaked whales form family groups of about 15 individuals. Little is known about the life history of this species. Sightings from Cetacean and Turtle Assessment Program (CETAP) surveys (Winn, 1982) indicate the presence of Cuvier's beaked whales over the shelf break throughout the middle Atlantic region, with highest sightings recorded for late spring and summer.

Gervais' beaked whales (*Mesoplodon europaeus*) are considered pelagic, and strandings have been reported from the Middle Atlantic Bight to Florida into the Caribbean and the Gulf of Mexico (Leatherwood et al., 1976; Jefferson and Schiro, 1997). This species could occur at any of the three test areas. Data suggest that the preferred prey of this species is squid.

Northern bottlenose whales (*Hyperoodon ampullatus*) are found only in temperate to arctic waters of the North Atlantic. They could possibly be present at the Norfolk test area, but are not expected to occur at Mayport or Pascagoula. They follow a relatively well-defined migratory pattern, and are found at low latitudes only during winter (Leatherwood and Reeves, 1983). They are deep divers and appear to feed primarily on squid and fish (Leatherwood and Reeves, 1983; Jefferson et al., 1993). They are characterized as extremely uncommon or rare in the northern Atlantic, and current data are insufficient to determine population size (Waring et al., 1999).

Sowerby's beaked whales (*Mesoplodon bidens*) are known only from temperate to subarctic waters of the North Atlantic, and data suggest that they are more common in European than American waters (Leatherwood and Reeves, 1983). As with other *Mesoplodon* spp., little is known of their life history (Waring et al., 1999). Sowerby's beaked whale is considered extralimital in the Gulf of Mexico and would only be represented there by occasional strays (Jefferson and Schiro, 1997). It may occur at Norfolk but is considered unlikely to be present at Mayport.

True's beaked whales (*Mesoplodon mirus*) are a temperate water species that has been reported from Cape Breton Island, Nova Scotia to the Bahamas (Leatherwood et al., 1976). It is suggested that these whales are pelagic due to their infrequent stranding record. It is believed that True's beaked whales feed on squid as well as a variety of fish. As with other *Mesoplodon* spp., little is known about their life history. Although they may be present at Mayport or Norfolk, True's beaked whales are not expected to occur at Pascagoula.

Dwarf and Pygmy Sperm Whales. The pygmy sperm whale (*Kogia breviceps*) and the dwarf sperm whale (*Kogia simus*) appear to be distributed worldwide in temperate to tropical waters along the continental shelf edge and continental slope (Caldwell and Caldwell, 1989). Both species may occur at any of the three test areas. Pygmy sperm whales and dwarf sperm whales are difficult to distinguish and are typically categorized as *Kogia* spp. *Kogia* are rarely seen alive at sea because

they dive in response to survey vessels and aircraft (Würsig et al., 1996), but their presence is indicated by frequent strandings (Schmidly, 1981; Odell, 1996). There is no information on population size for the western Atlantic or northern Gulf of Mexico stocks (Waring et al., 1999). However, results cited by Hansen et al. (1994) from a 1992 survey in the South Atlantic indicated a *Kogia* spp. population of 420 individuals. Abundance estimates were derived from 1992 winter observations using line-transect techniques between Cape Hatteras, North Carolina and Miami, Florida. In the oceanic northern Gulf of Mexico, Mullin and Hoggard (2000) estimated a minimum of 273 individuals (lower confidence limit) based on ship surveys.

Dolphins and Porpoises. The family Delphinidae is taxonomically diverse and includes dolphins, killer whales, false killer whales, pygmy killer whales, Risso's dolphins (or grampus), pilot whales, and melon-headed whales. In addition, one member of the family Phocoenidae, the harbor porpoise, may be present in the Norfolk area.

Atlantic spotted dolphins (*Stenella frontalis*) range from New Jersey to Venezuela, including waters of the Gulf of Mexico. This species is found in warm temperate and tropical waters. The Atlantic spotted dolphin inhabits the continental shelf and slope, though southern populations occasionally come into shallow coastal waters. Favored prey include herrings, anchovies, and carangid fish. Mating has been observed in July, with calves born offshore. Atlantic spotted dolphins often occur in groups of up to 50 individuals. Stock structure in the western North Atlantic is unknown. The minimum population estimate for spotted dolphins (including both Atlantic spotted and pantropical spotted dolphins) is 1,617 individuals (Waring et al., 1999).

Atlantic white-sided dolphins (*Lagenorhynchus acutus*) are found in temperate and sub-polar waters of the North Atlantic, and appear to prefer deep waters of the outer continental shelf and slope. This species ranges from central West Greenland to Chesapeake Bay. Atlantic white-sided dolphins could occur at Norfolk but are not expected to occur at Mayport or Pascagoula (Schmidly, 1981; Jefferson and Schiro, 1997). The minimum population estimate for the western North Atlantic stock is 19,196 individuals (Waring et al., 1999). This is a "strategic stock" under the MMPA (Waring et al., 1999).

Bottlenose dolphins (*Tursiops truncatus*) in the western Atlantic range from Nova Scotia to Venezuela, as well as the waters of the Gulf of Mexico (Blaylock et al., 1995). This species is distributed worldwide in temperate and tropical inshore waters. Middle Atlantic populations are represented by a hematologically and morphologically distinct offshore stock and coastal stock (Duffield et al., 1983; Duffield, 1986; Hersh and Duffield, 1990). Aerial survey results reported by CETAP (Winn, 1982) and Kenney (1990) indicated the offshore stock extends along the entire shelf break from Georges Bank to Cape Hatteras during spring and summer. During fall, this distribution compressed towards the south, with fewer sightings in winter. According to Kenney (1990), the offshore stock is concentrated along the shelf break, extending beyond the shelf edge in lower concentrations. Recent research has indicated that there are a variety of stock structures possible within the coastal Atlantic bottlenose dolphin population both north and south of Cape Hatteras. Blaylock and Hoggard (1994), reporting results from the Southeast Cetacean Aerial Survey (SECAS) study (i.e., continental shelf waters; Cape Hatteras, North Carolina to mid-Florida; Gulf of Mexico waters), developed abundance estimates for the shallow, warm water Atlantic bottlenose dolphin

ecotype. The offshore distribution of coastal bottlenose dolphins south of Cape Hatteras has not been described. Blaylock and Hoggard (1994) noted, however, the possibility for coexistence of the coastal and offshore stocks inhabiting the edge of the outer continental shelf and slope waters south of Cape Hatteras. Bottlenose dolphins feed on shrimp and fish. Mating and calving occur from February to May in Florida waters. The calving interval is 2 to 3 years. They are found in groups of up to several hundred individuals with group sizes increasing with distance from shore. The minimum abundance estimate for the offshore stock in the western North Atlantic is 8,794 individuals (Waring et al., 1999). The minimum population estimate for the continental shelf edge and slope population of bottlenose dolphins in the northern Gulf of Mexico is 4,530 individuals (Blaylock et al., 1995).

Clymene dolphins (*Stenella clymene*) are widely distributed in subtropical and tropical waters of the Atlantic where they occur in the same geographic areas as *S. longirostris.* It is believed that this species lives over the deeper waters off the continental shelf (Blaylock et al., 1995). Little is known about its life history, and data on stock differentiation and population estimates in the Atlantic are not available (Blaylock et al., 1995). The minimum population estimate for clymene dolphins in the northern Gulf of Mexico is 4,120 individuals (Blaylock et al., 1995).

Common dolphins (*Delphinus delphis*) range from Newfoundland and Nova Scotia to northern South America. They are distributed in worldwide temperate, tropical, and subtropical offshore waters on the continental slope, shelf, and shelf edge (Blaylock et al., 1995). According to Kenney and Winn (1987), CETAP results indicated the temporal presence of common dolphins off the northeast U.S. coast in fall and winter, a trend which is the reverse of that exhibited by *Stenella* spp. and most other cetacean taxa, indicative of possible resource partitioning. The species is less common south of Cape Hatteras (Blaylock et al., 1995). Kenney and Winn (1987) also noted the possible co-occurrence of common dolphins with Atlantic spotted dolphins (*Stenella frontalis*). Common dolphins feed on epipelagic and mesopelagic fish, squid, and demersal fish (Kenney and Winn, 1987). Breeding is seasonal. Gestation lasts 10 to 11 months, with calves born in spring and fall. The minimum population estimate for the western North Atlantic stock is 16,060 individuals (Waring et al., 1999). This is a "strategic stock" under the MMPA (Waring et al., 1999). A recent review concludes that the common dolphin does not occur in the Gulf of Mexico (Jefferson and Schiro, 1997).

Fraser's dolphins (*Lagenodelphis hosei*) are distributed worldwide in tropical waters. This species appears to be largely oceanic, with preferred prey including shrimp, fish, and squid. Fraser's dolphins are found in groups of up to 500 individuals. Little is known about the life history of this species. There is no information on stock differentiation and population size in the Atlantic (Blaylock et al., 1995). Although this species could occur at any of the test areas, its presence is considered unlikely based on the low frequency of sightings.

False killer whales (*Pseudorca crassidens*) range from Maryland to Venezuela, including Gulf of Mexico waters. This species is distributed worldwide in tropical and temperate waters. False killer whales are generally considered to be oceanic but individuals have been observed in cool, nearshore waters. This species feeds on squid and fish. It is believed that mating occurs year-round, with a gestation period of about 15 months. False killer whales are found in large

groups composed of smaller family groups of four to six individuals. Stock definition and population estimates in the Atlantic are unknown (Blaylock et al., 1995). The minimum population estimate for the northern Gulf of Mexico is 236 individuals (Blaylock et al., 1995).

Killer whales (*Orcinus orca*) are characterized as uncommon or rare in waters of the western Atlantic. Although this species could occur at any of the test areas, its presence is considered unlikely based on the low frequency of sightings. They are distributed from the Arctic pack ice to the Lesser Antilles, including waters of the Gulf of Mexico. Migration is thought to occur in association with changes in food abundance. Killer whales feed on squid, fish, sea turtles, seabirds, and other marine mammals. It is believed that mating occurs throughout the year, with gestation requiring about 1 year. Killer whales are found in groups ranging from a few to 25 to 30 individuals, where social structure and territoriality may be important. Stock definition and population estimates in the Atlantic are unknown (Blaylock et al., 1995).

Melon-headed whales (*Peponocephala electra*) are distributed worldwide in tropical to subtropical waters (Blaylock et al., 1995). Melon-headed whales are highly social, and are known to occur in pods of 100 to 500 animals. They are often seen swimming with dolphin species and are known to feed on squid and small fish. There is some evidence to indicate a calving peak in July and August, but this evidence is inconclusive (Jefferson et al., 1993). The minimum population estimate is 2,888 individuals for the northern Gulf of Mexico and unknown for the western North Atlantic (Blaylock et al., 1995). Although this species could occur at any of the test areas, its presence is considered unlikely based on the low frequency of sightings.

Pygmy killer whales (*Feresa attenuata*) range from North Carolina to the Lesser Antilles, as well as Gulf of Mexico waters. This species is distributed worldwide in tropical and warm temperate waters. Preferred prey includes small fish. Nocturnal feeding has been noted for this species. It is believed that calving occurs in spring. This species is typically found in groups of 10 individuals. Little is known about the life history of this species. The minimum population estimate is 6 individuals for the western North Atlantic and 285 individuals for the northern Gulf of Mexico (Blaylock et al., 1995).

Short-finned pilot whales (*Globicephala macrorhynchus*) occur in the western Atlantic from New Jersey to Venezuela, as well as in waters of the Gulf of Mexico. This species is found worldwide in warm temperate and tropical waters. Sightings of pilot whales typically occur seaward of the continental shelf edge and within waters of the Gulf Stream (Winn, 1982). Little is known about migration. Preferred prey items include squid and fish. It is believed that this species has an extended breeding and calving season in warm waters. Short-finned pilot whales have been observed chasing and feeding on schools of tuna. There is no information on stock differentiation for the Atlantic population. The minimum population estimate is 457 individuals for the western North Atlantic stock (Waring et al., 1999) and 186 individuals for the northern Gulf of Mexico stock (Blaylock et al., 1995). Short-finned pilot whales are a "strategic stock" under the MMPA (Waring et al., 1999).

Long-finned pilot whales (*Globicephala melaena*) are distributed from Iceland to North Carolina. They are commonly found in both oceanic and certain coastal waters of the North Atlantic

(Jefferson et al., 1993). The stock structure of the North Atlantic population is currently unknown (Blaylock et al., 1995). The minimum population estimate for the western North Atlantic stock is 4,968 individuals (Waring et al., 1999). Long-finned pilot whales are a "strategic stock" under the MMPA (Waring et al., 1999). Long-finned pilot whales would not be expected to occur at Mayport or in the Gulf of Mexico (Schmidly, 1981; Jefferson and Schiro, 1997).

Pantropical spotted dolphins (*Stenella attenuata*) range from Massachusetts to the Lesser Antilles, including waters of the eastern Gulf of Mexico. They are distributed worldwide in subtropical and tropical oceans. They appear to prefer waters of the continental slope (Blaylock et al., 1995). It is believed that this species feeds on squid, fish, and shrimp. This species is often found in association with schools of tuna. Pantropical spotted dolphins occur in groups of 5 to 30 individuals. Little is known about the life history of this species and no information exists on stock differentiation for the Atlantic population (Waring et al., 1999). The minimum population estimate for spotted dolphins (including both Atlantic spotted and pantropical spotted dolphins) in the western North Atlantic is 1,617 individuals (Waring et al., 1999). For the northern Gulf of Mexico, the minimum population estimate for pantropical spotted dolphins is 26,510 individuals (Blaylock et al., 1995).

Risso's dolphins (*Grampus griseus*) range from eastern Newfoundland to the Lesser Antilles and Gulf of Mexico. This species is distributed worldwide in tropical to temperate waters. It is believed that Risso's dolphins undergo north-south, summer-winter migrations. Off the northeast U.S. coast, Risso's dolphins are distributed along the shelf edge from Cape Hatteras northward to Georges Bank during spring, summer, and fall (Winn, 1982; Payne et al., 1984). In winter, this species ranges further offshore (Blaylock et al., 1995). Typically, this species occupies the continental shelf edge year-round. This species feeds mainly on squid. Risso's dolphins are found in groups of 3 to 30 individuals, although groups of up to several hundred individuals have been reported. Current data are insufficient to determine stock differentiation and population trends in the Atlantic. The minimum population estimate is 11,140 individuals for the western North Atlantic stock (Waring et al., 1999) and 2,199 individuals for the northern Gulf of Mexico stock (Blaylock et al., 1995).

Rough-toothed dolphins (*Steno bredanensis*) are distributed worldwide in tropical to warm temperate waters (Blaylock et al., 1995). Within the western Atlantic they range from Virginia and North Carolina to northeastern South America, including eastern and northwestern Gulf of Mexico waters (Leatherwood and Reeves, 1983). This species is pelagic and usually found seaward of the continental slope edge. Little is known about the life history of this species and no information exists on stock differentiation and population levels in the Atlantic (Blaylock et al., 1995). The minimum population estimate for the northern Gulf of Mexico is 660 individuals (Blaylock et al., 1995).

Spinner dolphins (*Stenella longirostris*) range from North Carolina to southern Brazil, including Gulf of Mexico waters. Though presumably an offshore, deep-water species, they occur in both oceanic and coastal tropical waters (Blaylock et al., 1995). Two reproductive peaks in spring and fall have been suggested. Stock structure and population estimates of spinner dolphins in the western

North Atlantic are unknown (Blaylock et al., 1995). The minimum population estimate for the northern Gulf of Mexico is 4,465 individuals (Blaylock et al., 1995).

Striped dolphins (*Stenella coeruleoalba*) range from Nova Scotia to the Lesser Antilles, including the Gulf of Mexico. These dolphins are distributed worldwide in temperate and tropical waters. This species is considered to be found along the continental slope from the Gulf of Mexico to Georges Bank. Migratory patterns are uncertain. There is no information on stock differentiation in the Atlantic (Blaylock et al., 1995). The minimum population estimate is 18,220 individuals for the western North Atlantic and 3,409 individuals for the northern Gulf of Mexico (Waring et al., 1999).

Harbor porpoises (*Phocoena phocoena*) are found in cool temperate and subpolar waters of the Northern Hemisphere. They are typically found in shallow water, most often nearshore, although they occasionally travel over deeper offshore waters (Jefferson et al., 1993). During summer, harbor porpoises are concentrated in Canada and the northern Gulf of Maine. During fall and spring, they are widely distributed from Maine to North Carolina. The minimum population estimate for the Gulf of Maine/Bay of Fundy stock is 48,289 individuals (Waring et al., 1999). This is a "strategic stock" under the MMPA (Waring et al., 1999) and is a candidate species for listing as threatened under the Endangered Species Act (ESA). Candidate species do not receive substantive or procedural protection under the ESA. The candidate species list serves to notify the public that NMFS has concerns regarding these species that may warrant listing in the future. Harbor porpoises would not be expected to occur at Mayport or in the Gulf of Mexico.

B.1.2.3 Pinnipeds

Harbor seals (*Phoca vitulina*) are widely distributed from temperate to polar regions of the Northern Hemisphere. Along the eastern U.S. they are found from the Canadian Arctic to the mid-Atlantic (Jefferson et al., 1993). At sea, they are mainly found in coastal waters of the continental shelf and slope. Although the range of this species includes the Norfolk area, it is unlikely to be found so far offshore. The minimum population estimate for the western North Atlantic is 30,990 individuals (Waring et al., 1999).

One pinniped species, the California sea lion, is present in the northern Gulf but is unlikely to be found in the Pascagoula test area. These animals exist in the northern Gulf as feral individuals that probably escaped from or were released from marine parks (Schmidly, 1981). Another pinniped formerly known from the Gulf of Mexico (the Caribbean monk seal) is now believed to be extinct (Schmidly, 1981). This endangered species has been discussed previously in Section B.1.1.

B.1.3 Sources of Quantitative Data

For impact calculations in the EIS, it was necessary to develop density estimates for marine mammals in the proposed test areas. Sources of quantitative survey data were evaluated, as summarized in **Table B.1**. The following criteria were considered in selecting appropriate data sets:

- Data should come from relatively recent surveys (preferably, within the last 5 to 10 years)
- Coverage of the test area is preferred over nearby or regional coverage
- Data must have been collected and analyzed using standard line-transect methodology

Table B.1. Availability of marine mammal density data for potential test areas. The most useful sources are checked (✓).

Survey	Type	Advantages	Disadvantages	Conclusion
NEAR MAYPORT TEST AREA				
Fritts et al. (1983)	Aerial	* Includes appropriate water depth range	* Age of data (about 20 years) * Lack of overall density estimates * Lack of overlap with test area	Useful for species presence but not density estimates
Southeast Cetacean Aerial Surveys (SECAS) (Blaylock and Hoggard, 1994)	Aerial		* Winter only (Jan-Mar) * Inshore of test area (shelf only)	Not useful
SEAWOLF surveys (Dept. Navy, 1995, 1998b)	Aerial	* Includes part of test area * Close transect spacing and frequent coverage (monthly) during test period	* Focused on shelf edge, did not cover deeper portions of test area	✓Useful as secondary source
Navy right whale surveys (Dept. Navy, 1997)	Aerial	* Includes partial coverage of test area	* Winter only (Oct-Apr)	Not useful
Relentless cruise (Roden, 1998)	Shipboard	* Includes appropriate water depth range	* Only two transects near test area * One-time survey	Useful for species presence but not density estimates
New aerial surveys for this EIS (Dept. Navy, 1999)	Aerial	* Complete coverage of test area * Close transect spacing and 2 surveys (June, August) during test period	* None	✓PRIMARY SOURCE for Mayport area
NEAR NORFOLK TEST AREA				
Cetacean and Turtle Assessment Program (CETAP) (Winn, 1982)	Aerial	* Includes appropriate water depth range * Two survey blocks overlap test area	* Age of data (about 20 years)	✓Useful as secondary source
SEAWOLF surveys (Dept. Navy, 1995, 1998b)	Aerial	* Includes part of test area * Close transect spacing and frequent coverage (monthly) during test period	* Focused on shelf edge, did not cover deeper portions of test area	✓ PRIMARY SOURCE for Norfolk area
Unpublished data from NMFS shipboard surveys (1995)	Shipboard	* Includes appropriate water depth range in and near test area	* Most coverage is outside test area	✓Useful as secondary source
NEAR PASCAGOULA TEST AREA				
Scott et al. (1989)	Aerial	* Includes northeastern Gulf	* Shelf only, not continental slope	Not useful
Mullin et al. (1991, 1994)	Aerial	* Includes appropriate water depth range	* Limited observations near test area (study area mainly to the west)	✓Useful as secondary source
GulfCet (Hansen et al., 1996)	Aerial, shipboard	* Includes appropriate water depth range	* Limited observations near test are (study area is to the west)	✓Useful as secondary source
GulfCet II (Mullin and Hoggard, 2000)	Aerial, shipboard	* Includes test area and appropriate water depth range	* Coverage only during July-August (but two different years)	✓PRIMARY SOURCE for Pascagoula area

Mayport. Historical sources of marine mammal abundance data for the Mayport test area during summer months include aerial surveys by Fritts et al. (1983) and the Department of the Navy (1995, 1998b), as well as the *Relentless* cruise by the NMFS (Roden, 1998; Mullin, 1999). These sources are reviewed briefly below. Other programs such as SECAS (Blaylock and Hoggard, 1994) and the Navy right whale surveys off Mayport (Department of the Navy, 1997) were conducted only during winter months and are not applicable to the test period (May through September).

Fritts et al. (1983) conducted bimonthly aerial surveys offshore of Cape Canaveral during 1980 to 1981. Their Merritt Island, Florida (MIFL) survey block is shown in **Figure B.2**. Survey months applicable to the test period were June and August. Transects extended offshore to about the 1,000 m (3,280 ft) depth contour surveys and were flown at two altitudes -- 91 m (300 ft) and 228 m (750 ft) -- to maximize detection of animals of various sizes. Because the transects extended well offshore onto the continental slope, the survey data are useful in determining the species likely to be present in the Mayport test area. However, due to the age of the data (about 20 years), the lack of overall density calculations, and the location that does not overlap with the test area these data are not considered useful for estimating abundance within the Mayport test area.

In support of the SEAWOLF EIS, the Navy conducted monthly aerial surveys offshore of Mayport from April through September 1995 and May through September 1997 (Department of the Navy, 1995, 1998b). Parallel survey transects were 1.85 km (1 nmi) apart, with each transect extending 7.4 km (4 nmi) to the east and west of the 152 m (500 ft) depth contour (**Figure B.3**). The transects were centered on the shelf edge, but covered water depths ranging from <50 m (164 ft) inshore to >250 m (820 ft) at the outer ends of the transects. Methods were essentially the same on the two sets of surveys; however, the aircraft used in 1997 had bubble windows that eliminated a "blind spot" beneath the plane.

The close transect spacing and monthly frequency of the SEAWOLF surveys are advantageous. However, because the surveys focused on the shelf edge, they did not cover the deeper portions of the test area where cetacean abundances may differ. Therefore, they are not suitable as a primary source of abundance estimates for the Mayport test area. The data were originally analyzed using a strip transect methodology instead of line transect statistics (Department of the Navy, 1998a) and therefore previously reported density estimates are not directly comparable with estimates from other areas (e.g., GulfCet II data for the Pascagoula test area). For this EIS, the SEAWOLF data were reanalyzed using line transect statistics (Buckland et al., 1993) so that they could be compared directly with other available data sets.

A third source for the Mayport test area is the NMFS *Relentless* cruise (Roden, 1998; Mullin, 1999). This shipboard survey was conducted during July and August 1998 and consisted of a "double sawtooth" pattern of transects between Delaware Bay and Cape Canaveral (**Figure B.4**). The main disadvantage of the *Relentless* cruise for representing Mayport is wide transect spacing. Therefore, the *Relentless* data were not used for density estimates, though they were considered in developing the species list for the test area.

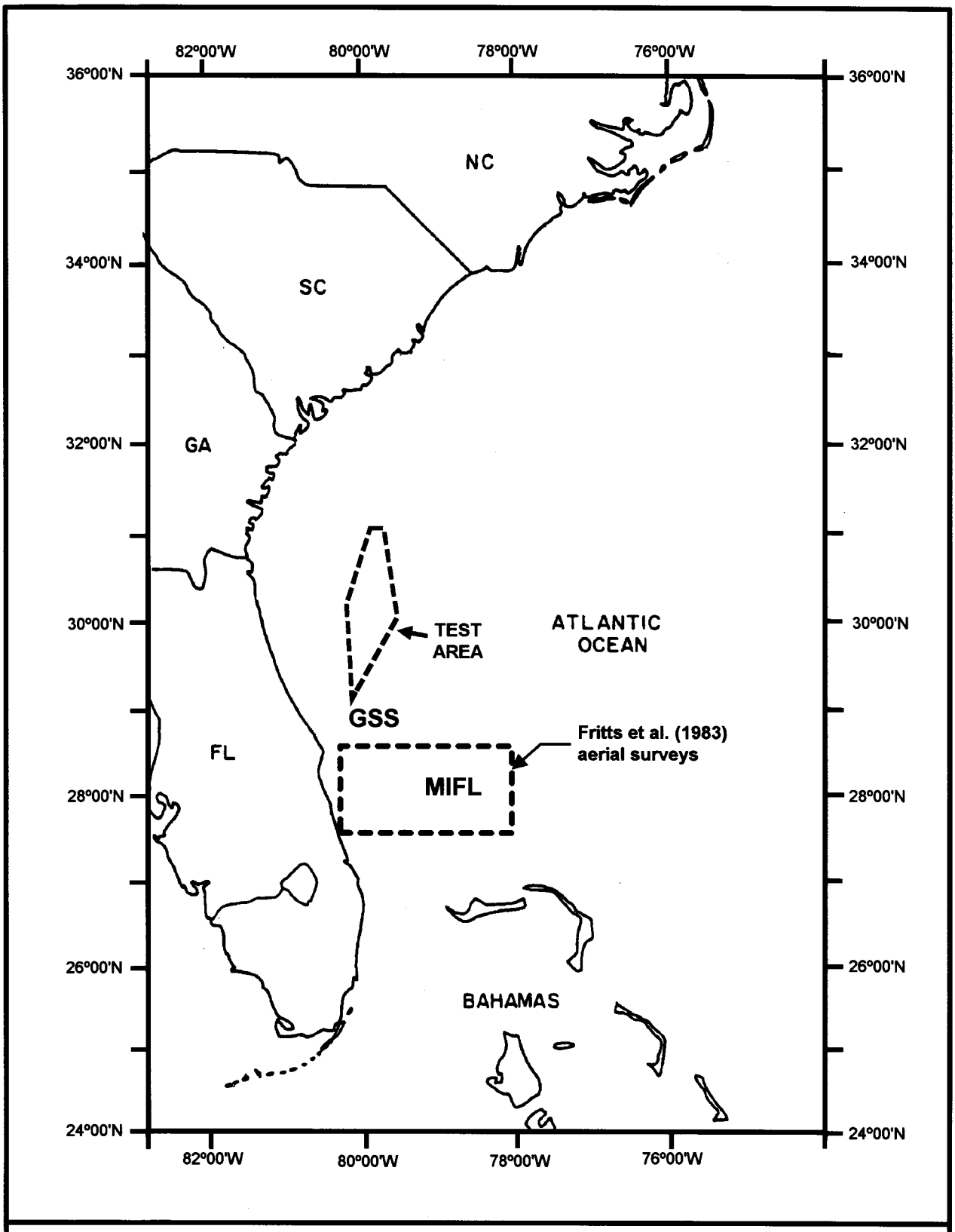

Figure B.2. The position of the MIFL survey subunit surveyed by Fritts et al. (1983) in relation to the coast of Florida.

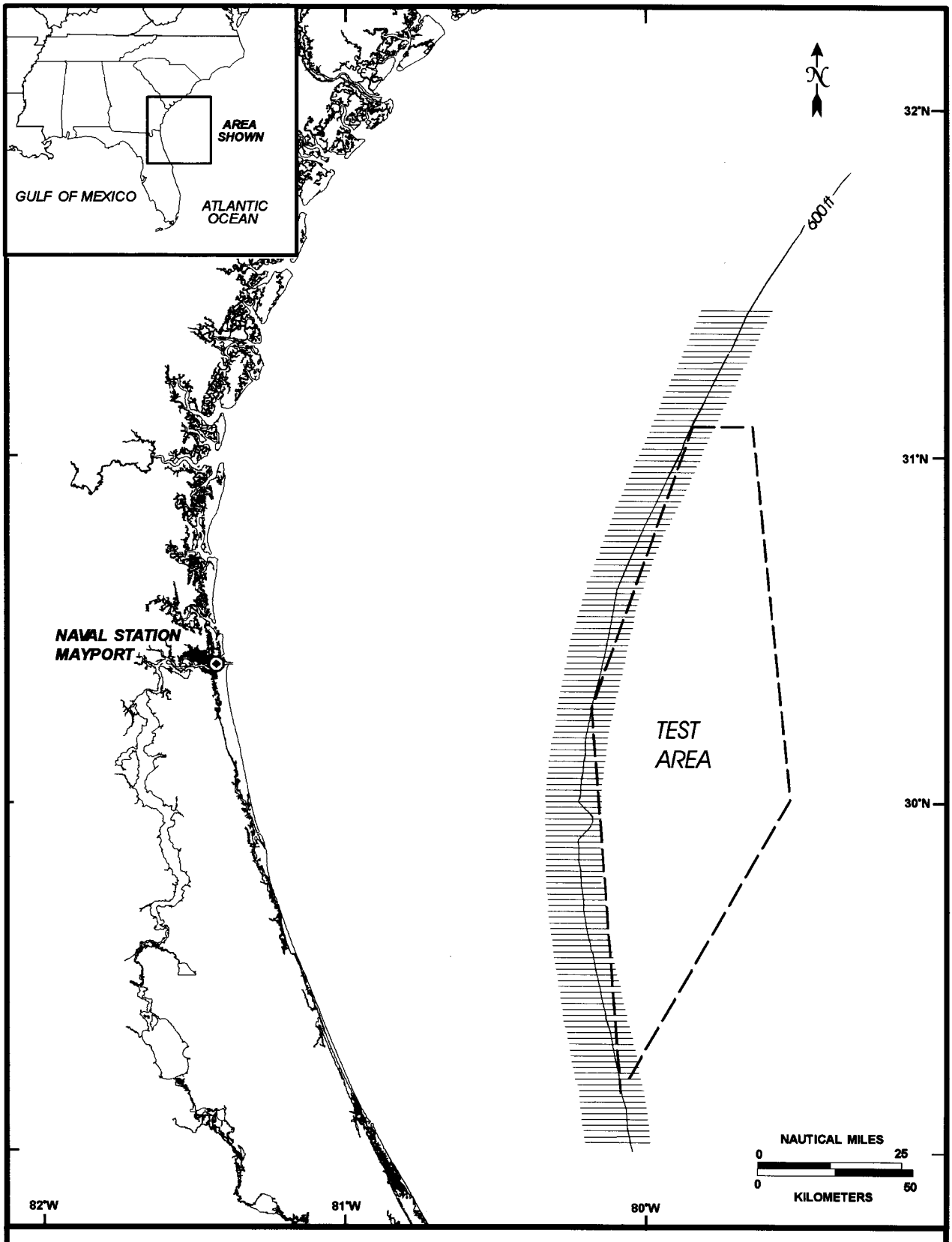

Figure B.3. Aerial transects surveyed by the Department of the Navy in 1995 and 1997 relative to the Mayport test area.

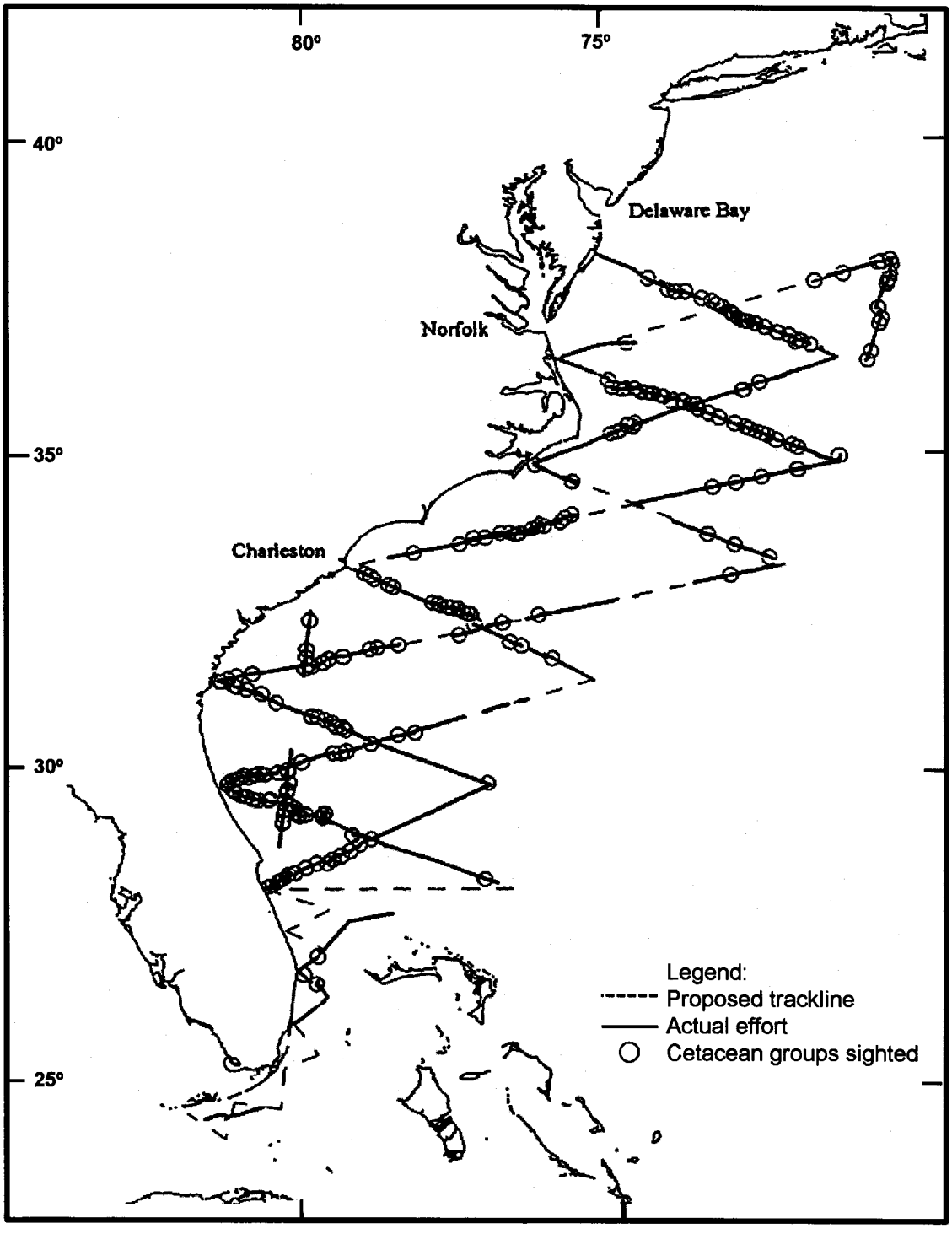

Figure B.4. Location of shipboard transects surveyed by the NMFS during July/August 1998 (From: Roden, 1998).

After reviewing these historical data sources and conferring with NMFS scientists, the Navy concluded that additional aerial surveys were needed to provide coverage of the Mayport test area during the appropriate season. Surveys were conducted during June and August 1999 using standard aerial survey methodology (Department of the Navy, 1999; see Section B.1.4.1). Transects are shown in **Figure B.5**. The reanalyzed SEAWOLF survey data were used as a secondary source (see Section B.1.4.2).

Norfolk. Historical sources of marine mammal abundance data for the Norfolk test area include aerial surveys by CETAP (Winn, 1982) and the Department of the Navy (1995, 1998b), as well as unpublished data from shipboard surveys by the NMFS. These sources are reviewed briefly below. The Manomet Bird Observatory (1989) also conducted aerial surveys between 1980 and 1987 from Nova Scotia to Cape Hatteras, but the study area was inshore of the 183 m (600 ft) depth contour.

CETAP (Winn, 1982) included aerial surveys of cetaceans from Nova Scotia to Cape Hatteras during 1978 to 1982. Transects were flown at an altitude of 229 m (750 ft) and there was coverage during all seasons. The study area was divided into various sampling blocks based on water depth and specific regions of interest (**Figure B.6**). Marine mammal densities for specific sub-blocks were reported separately by Kenney et al. (1985), with two of the blocks overlapping the Norfolk test area. The main drawback to using the CETAP data is their age (the observations are about 20 years old). The data remain useful for species occurrence and seasonality, but are of questionable use as the sole basis for current abundance estimates.

In support of the SEAWOLF EIS, the Navy conducted monthly aerial surveys offshore of Norfolk from April through September 1995 (Department of the Navy, 1995). Parallel survey transects were 1.85 km (1 nmi) apart, with each transect extending 7.4 km (4 nmi) to the east and west of the 152 m (500 ft) depth contour (**Figure B.7**). The transects were therefore centered on the shelf edge but extended onto the continental slope to a depth of about 1,000 to 1,200 m (3,280 to 3,937 ft). Advantages of these surveys include close transect spacing and the monthly frequency of the observations. However, because the surveys focused on the shelf edge, they did not cover the deeper portions of the test area where cetacean abundances may differ. The data were originally analyzed using a strip transect methodology instead of line transect statistics and therefore previously reported density estimates (Department of the Navy, 1998a) are not directly comparable with estimates from other areas (e.g., GulfCet II data for Pascagoula test area). For this EIS, the data were reanalyzed using line transect statistics (Buckland et al., 1993) so that they could be compared with other data sets (see Section B.1.4.2).

Discussions with NMFS scientists indicated that several cruises between 1990 and 1998 included quantitative marine mammal observations in and near the Norfolk test area during the May through September time period. Data from two 1995 cruises were readily available with perpendicular sighting distances (necessary for density calculations):

- R/V *Pelican* Cruise No. 95-01: Marine Mammal Abundance and Distribution Survey (9 July to 3 August 1995)
- R/V *Abel-J* Cruise No. 95-03: Marine Mammal Abundance and Distribution Survey (9 July to 2 August 1995)

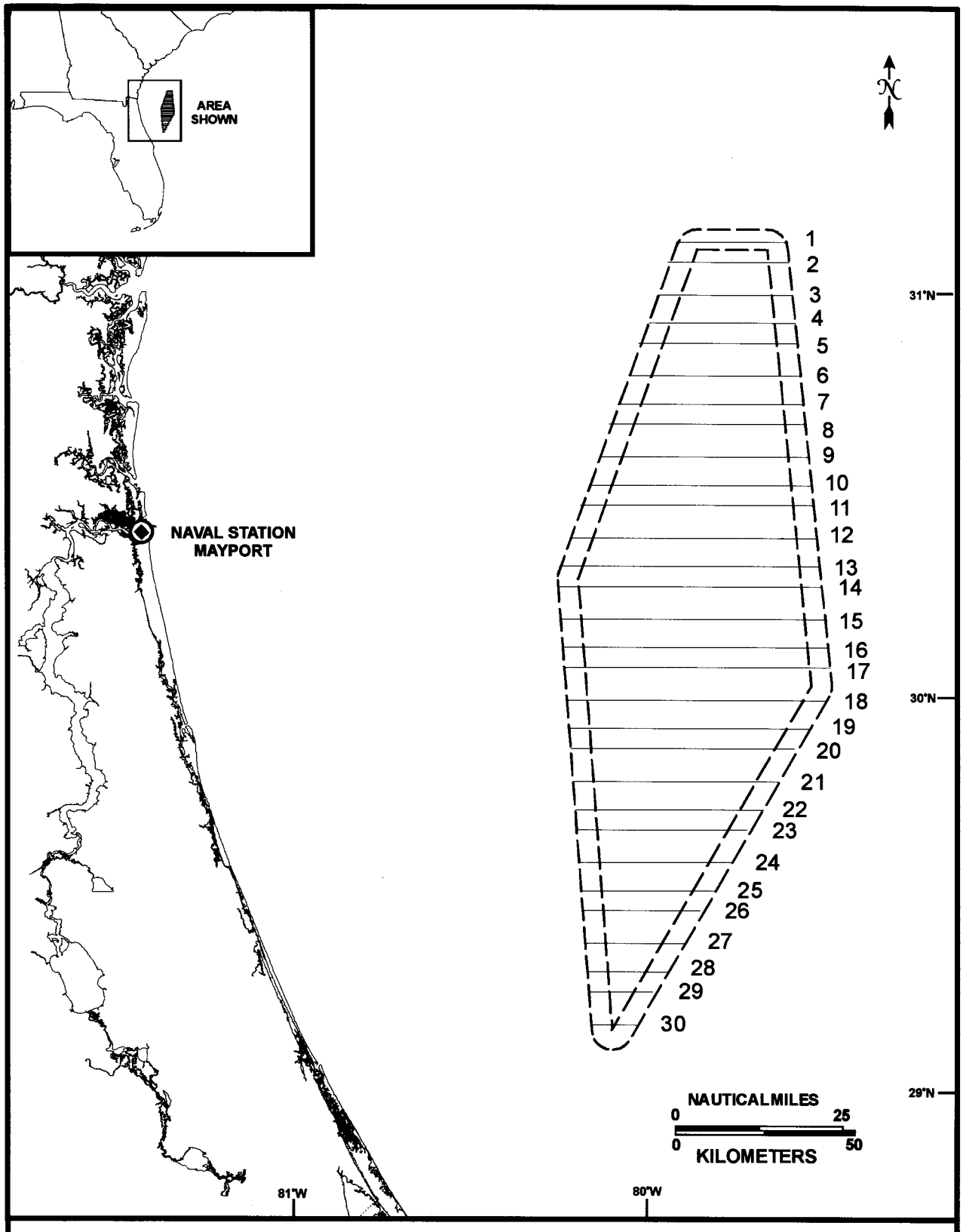

Figure B.5. Transect layout for June and August 1999 aerial surveys at Mayport test area. Beginning transects for each day's flight of 10 transects were randomized. Transects covered the test area plus a 3 nmi buffer.

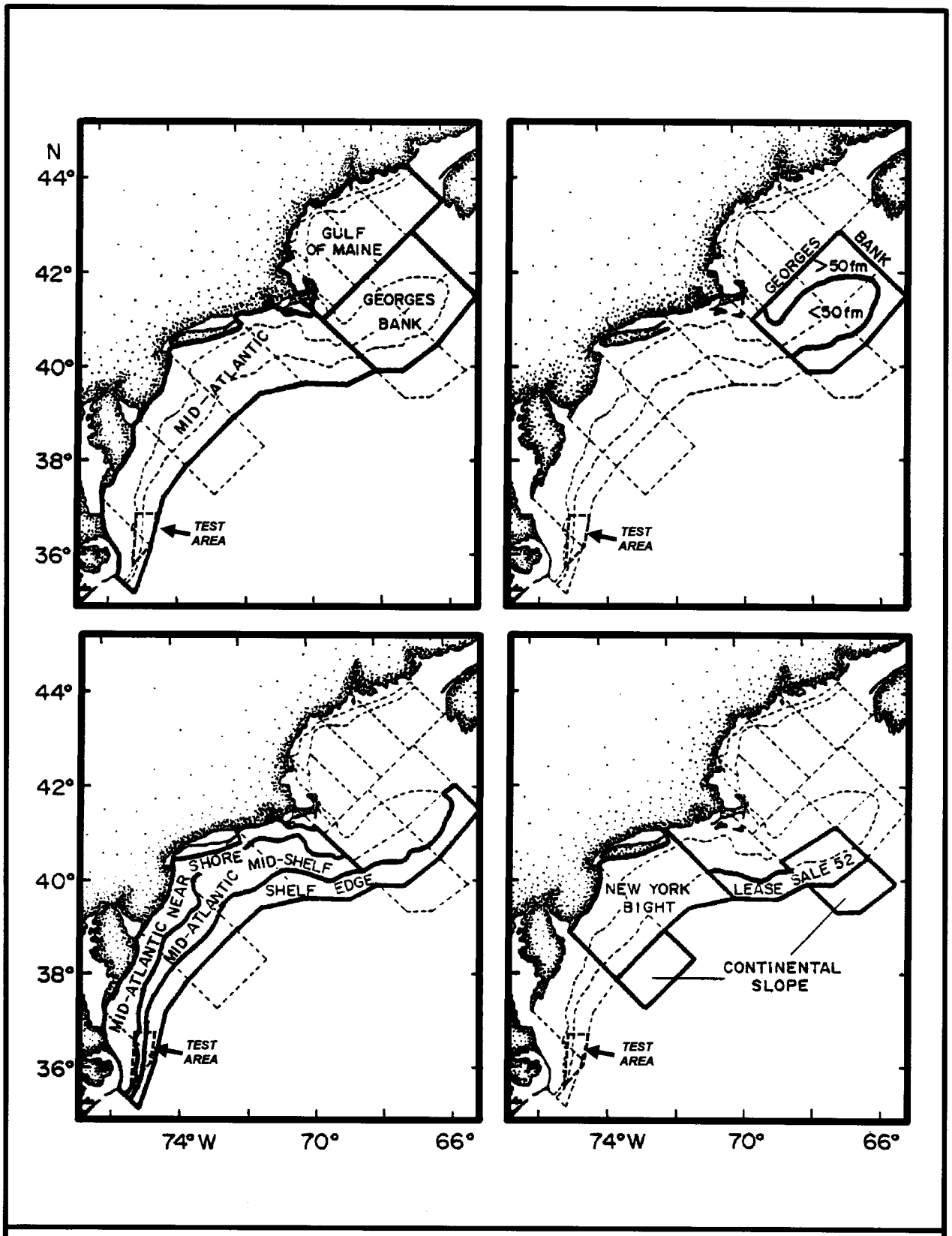

Figure B.6. Regions identified within the CETAP study area and used to calculate average seasonal cetacean and turtle densities and abundances (Adapted from: Winn, 1982). Dashed lines show the boundaries of the original aerial survey blocks and strata which were subsequently combined into these regions.

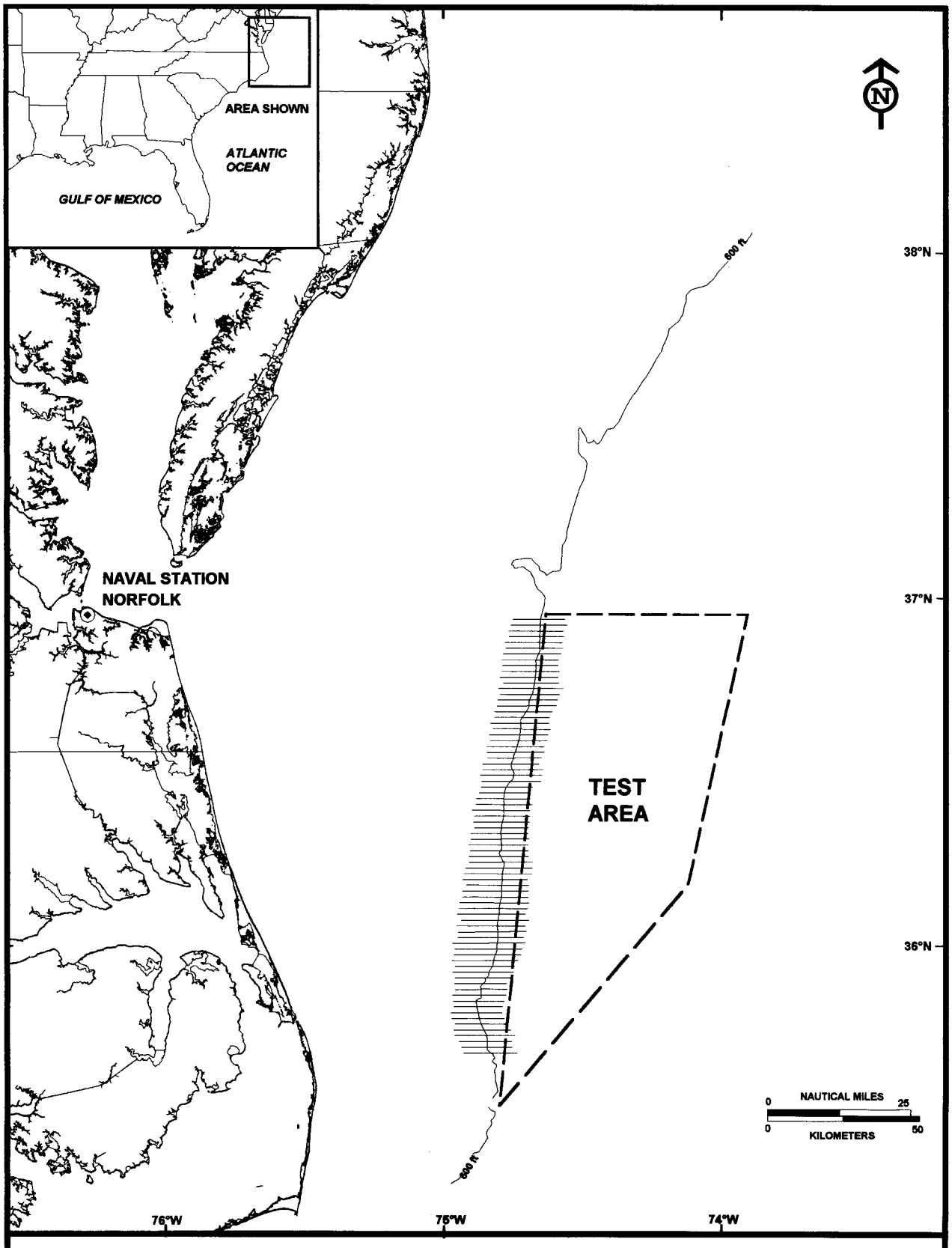

Figure B.7. Aerial transects surveyed by the Department of the Navy in 1995 relative to the Norfolk test area.

Transects covered during these surveys are shown in **Figure B.8**. Most of the coverage is north and northeast of the test area, although three transects are partly within it. Based on discussions with NMFS scientists, transects up to about 40°N were included. In conjunction with SEAWOLF and CETAP aerial surveys (see below), these were considered adequate to represent the test area.

To represent the Norfolk test area, the SEAWOLF aerial data set was chosen because it would be most comparable to the two other aerial data sets. Ship and aircraft surveys differ in the viewing time for a given length of transect, and therefore the correction for submerged animals differs substantially between aerial and ship surveys (see Appendix C). To avoid having this "submergence correction" heavily influence the impact calculations, it is preferable to use all aerial data (or all ship data) rather than comparing aerial vs. ship surveys.

The SEAWOLF data were reanalyzed using standard line transect methodology to produce abundance and density estimates for marine mammals (see Section B.1.4.2). These data were used as the primary source. The ship survey data were obtained from the NMFS and analyzed (see Section B.1.4.3) as a secondary source for context and comparison. The CETAP aerial survey data as reported by Kenney et al. (1985) were also used as a secondary source.

<u>Pascagoula</u>. Data are available from both aerial and shipboard observations during the GulfCet II program to estimate the abundance of marine mammals in and near the Pascagoula test area (Mullin and Hoggard, 2000). Aerial surveys conducted during two successive summers (1996 and 1997) provided the best coverage of the test area during the appropriate time period (**Figure B.9**). Standard aerial survey methods were used, which were nearly identical to those of the 1999 Mayport surveys and the 1997 SEAWOLF surveys. After reviewing these data and conferring with NMFS scientists, the Navy concluded that a subset of the GulfCet II aerial survey data would be appropriate to represent the Pascagoula test area. A copy of the data set was obtained from the NMFS, and a subset was constructed and reanalyzed for this EIS (see Section B.1.4.4). The subset consisted of 10 transects passing through or immediately adjacent to the test area (**Figure B.10**).

Other relevant sources of marine mammal data for the Gulf of Mexico include the GulfCet program (Davis and Fargion, 1996; Davis et al., 1998) and earlier observations along the continental slope by Mullin et al. (1991, 1994). These sources are useful for context and comparison. Scott et al. (1989) conducted extensive aerial surveys for marine mammals in the northern Gulf of Mexico, but the coverage focused on inshore and continental shelf areas.

<u>Conclusions</u>. **Table B.2** summarizes the review of historical data sources for marine mammal abundance at the Mayport, Norfolk, and Pascagoula test areas.

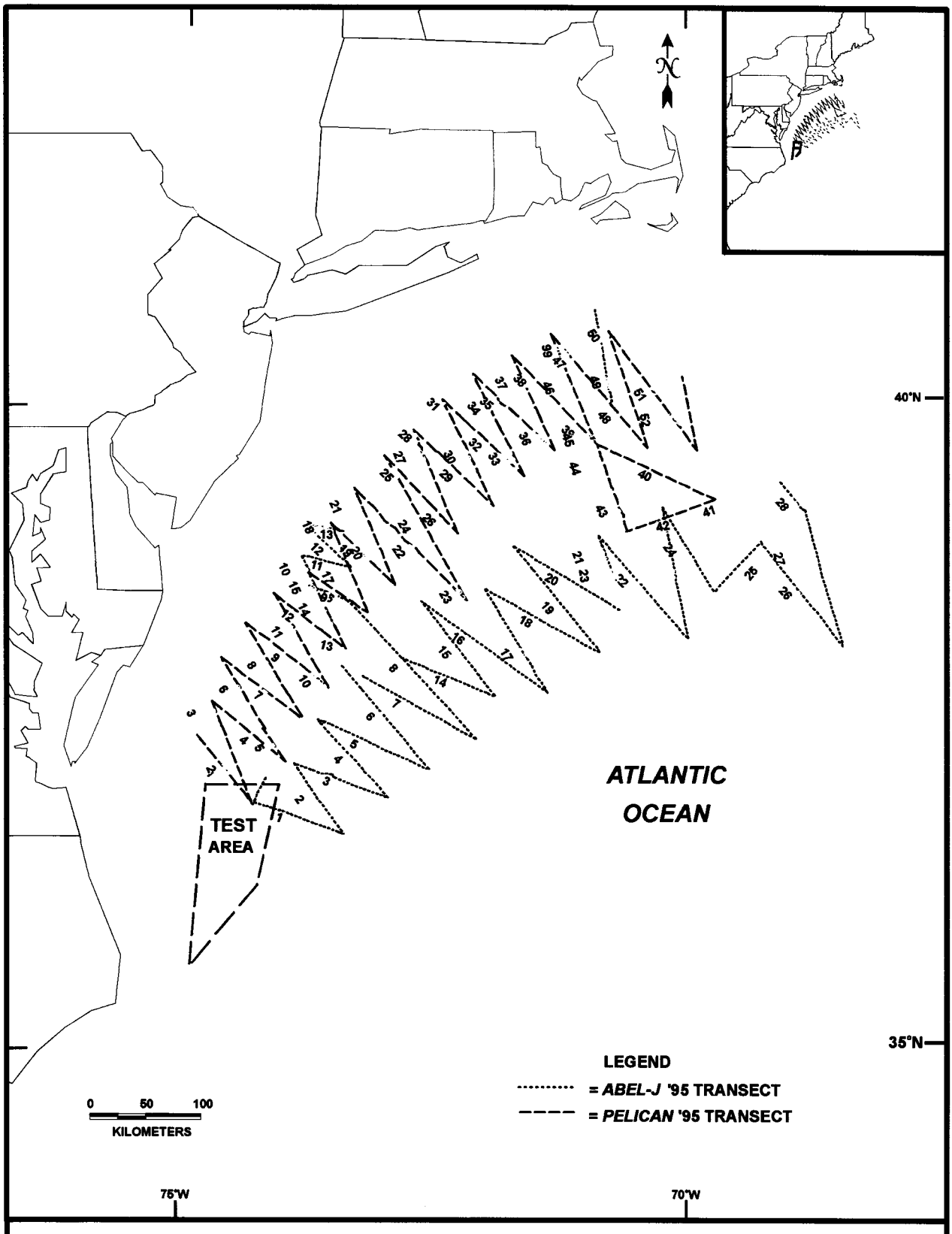

Figure B.8. Transects from 1995 *Abel-J* and *Pelican* surveys for marine mammals and sea turtles relative to the Norfolk test area. B.8.

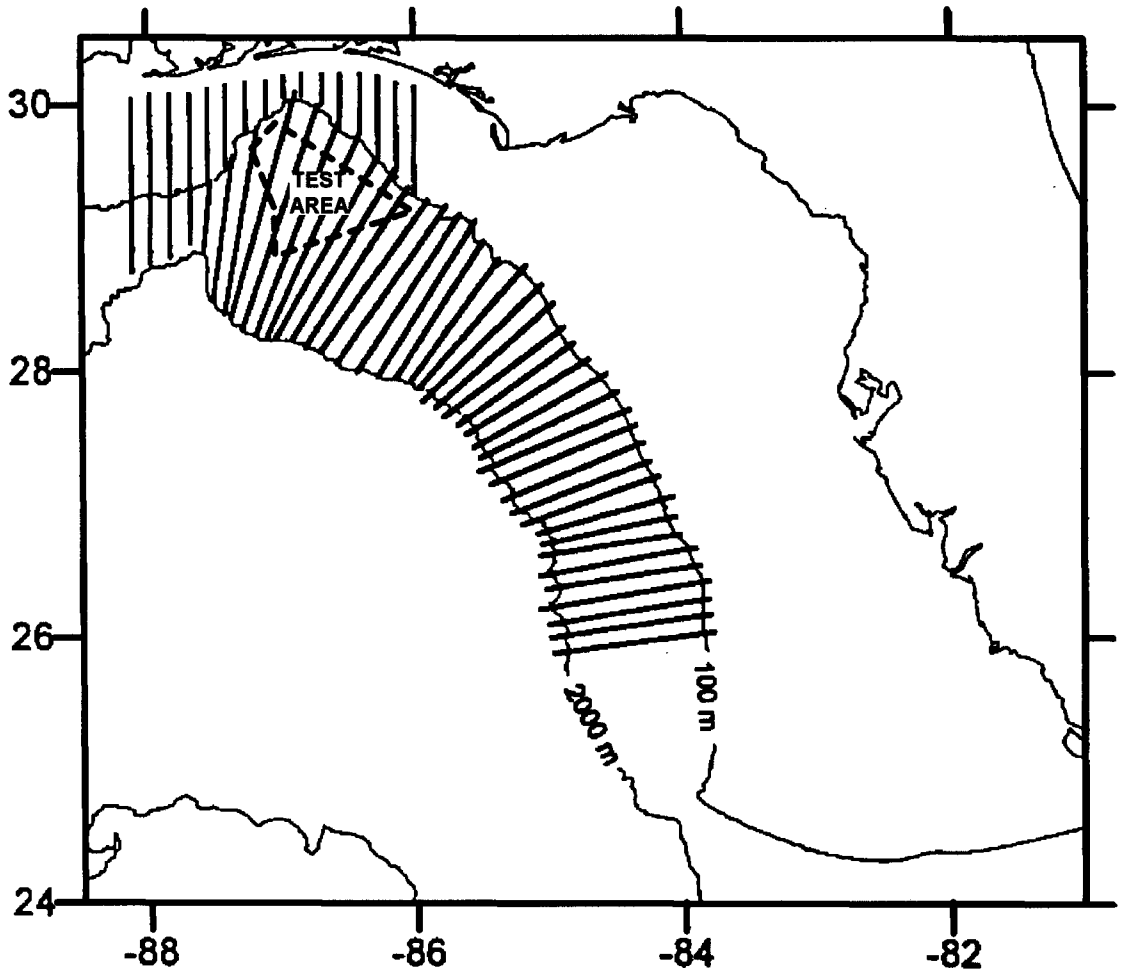

Figure B.9. GulfCet II aerial survey transect lines in the eastern Gulf of Mexico (From: Mullin and Hoggard, 1998).

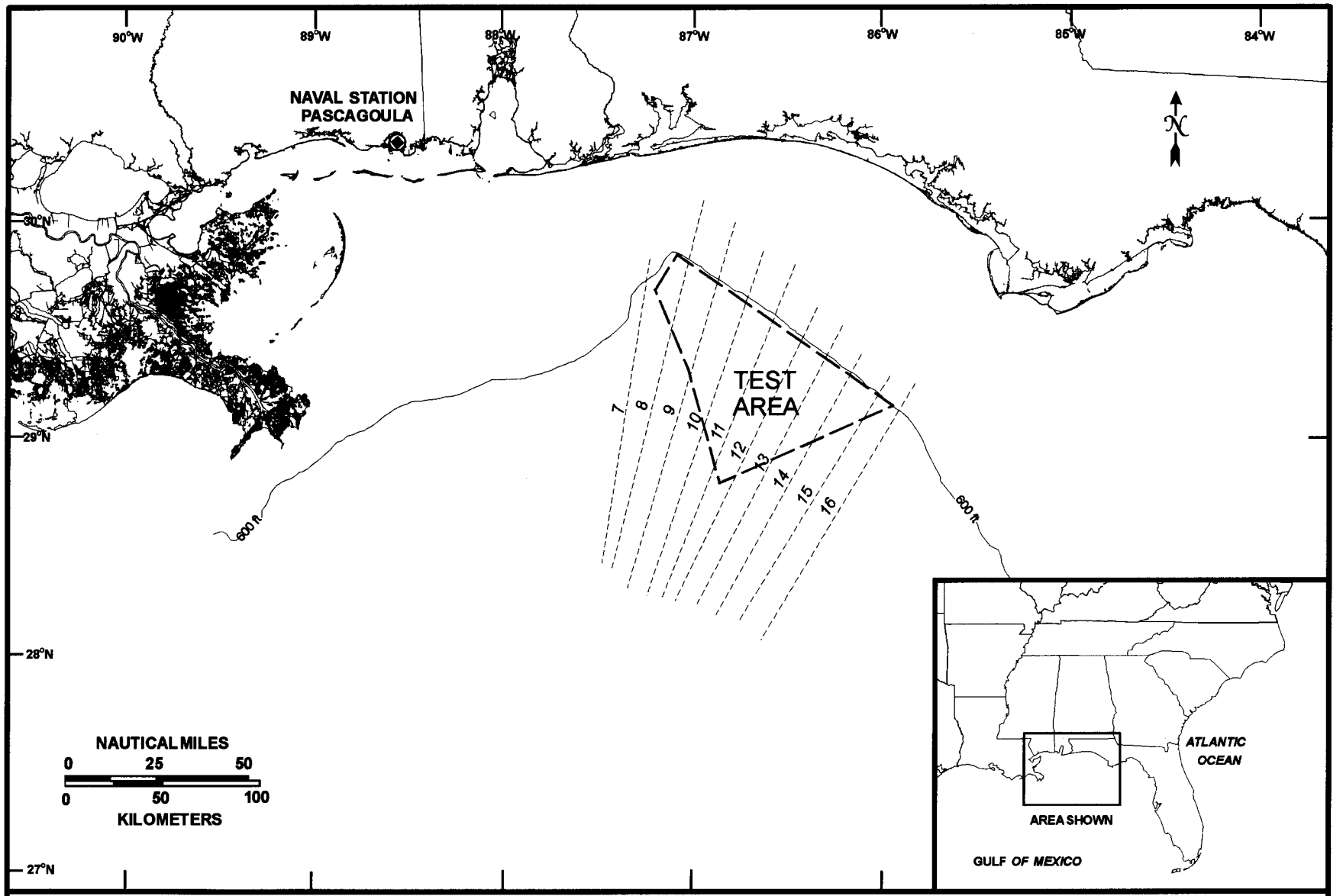

Figure B.10. GulfCet II aerial survey transects selected for DISTANCE analysis relative to the Pascagoula test area.

Table B.2. Data sources for marine mammal densities.

	Mayport	Norfolk	Pascagoula
Principal data source	• New aerial surveys (June and August 1999)	• SEAWOLF aerial surveys (Apr-Sept 1995)	• GulfCet II aerial surveys (July-August 1996 and 1997) (subset for Pascagoula)
Secondary source(s) (for comparison and context)	• SEAWOLF aerial surveys (Apr-Sept 1995 and May-Sept 1997)	• Unpublished data from two NMFS cruises (*Abel-J* and *Pelican*, July-August 1995) • CETAP aerial surveys (summer 1979-1981)	• Other GulfCet data for the region

B.1.4 Marine Mammal Density Estimates

B.1.4.1 New Aerial Surveys (Mayport)

New aerial surveys for marine mammals and turtles were conducted in June and August 1999 at the Mayport test area. Methods and results are summarized in the aerial survey report (Department of the Navy, 1999). An overview is presented here.

The aircraft was a Partenavia P 68C equipped with plexiglass bubble windows. Surveys were flown at an altitude of 229 m (750 ft) and a speed of 110 kts (204 kph). The survey design consisted of 30 transects arranged in an east-west direction (**Figure B.5**). For each survey (June or August), the 30 transects were surveyed during three days, with 10 randomly selected transects flown each day. Survey days were 3, 4, and 8 June and 16, 17, and 18 August. A team of two experienced observers monitored the sea surface for marine mammals and sea turtles. A Global Positioning System (GPS) was used for navigation. Sightings were entered on a laptop computer by the data recorder.

Data files from each survey day were assembled into a single database. The start and end positions of each transect flown were extracted and plotted in MapInfo (a geographic information system [GIS]) to calculate the actual transect length. Perpendicular sighting distance was calculated for each sighting by multiplying the altitude by the tangent of the perpendicular sighting angle.

The data were analyzed using the DISTANCE program (Laake et al., 1993), version 3.5. Analyses were run using transect data stratified by survey to produce overall estimates from the two surveys combined. For each species, the mean, coefficient of variation, and confidence limits were calculated for group density, individual density, and group size. A separate calculation was run for total marine mammals and total sea turtles.

Except for bottlenose dolphin and Risso's dolphin, the DISTANCE program initially returned warnings due to small numbers of observations which were insufficient to develop a sighting probability. Following the recommendations of the DISTANCE program manual, the problem was

addressed by using the sighting probability for a more common species belonging to the same sightability group. The bottlenose dolphin sighting probability was used for Atlantic spotted dolphin, bottlenose/Atlantic spotted dolphin, false killer whale, pilot whale, unidentified dolphin, and unidentified odontocete.

B.1.4.2 Reanalysis of SEAWOLF data (Mayport and Norfolk)

Aerial survey data collected by the Department of the Navy during April through September 1995 (Mayport and Norfolk) and May through September 1997 (Mayport only) were reanalyzed using standard line-transect methodology (Buckland et al., 1993).

The 1995 aerial surveys covered both Mayport and Norfolk SEAWOLF test areas. Six monthly surveys were flown from April to September. The survey aircraft was a Cessna 337G equipped with flat side windows. Surveys were flown at an altitude of 229 m (750 ft) and a speed of 110 kts (204 kph). Parallel survey transects were 1.85 km (1 nmi) apart, with each transect extending 7.4 km (4 nmi) to the east and west of the 152 m (500 ft) depth contour (**Figures B.3 and B.7**). At Mayport there were 145 transects and at Norfolk there were 76 transects. A set of about 25 transects was flown each survey day. A team of two experienced observers monitored the sea surface for marine mammals and sea turtles. Navigation and sighting positions were made using Loran C and GPS and saved on an onboard datalogger along with the survey number, block number, and transect number. Sightings data were entered onto data sheets by the data recorder.

In 1997, five monthly surveys (May through September) were flown at Mayport only. For the 1997 surveys, a Partenavia P 68C equipped with plexiglass bubble windows was used, eliminating a "blind spot" beneath the aircraft. Surveys were flown at an altitude of 229 m (750 ft) and a speed of 110 kts (204 kph). The survey design was the same as in 1995, with 145 east-west transects. About 30 transects were flown each survey day. A team of two experienced observers monitored the sea surface for marine mammals and sea turtles. A GPS was used for navigation. Survey data were entered on a laptop computer by the data recorder.

For this EIS, data from both 1995 and 1997 SEAWOLF surveys were reanalyzed using the DISTANCE program. Methods were the same as described previously for Mayport 1999 surveys.

In the 1995 Mayport data set, there were adequate sightings to develop sighting probabilities for bottlenose dolphin, pantropical spotted dolphin, and unidentified dolphin. The pantropical spotted dolphin sighting probability was used for spinner dolphins and *Stenella* spp., which had too few sightings to calculate this probability directly. In the 1997 Mayport data set, adequate sightings were available for bottlenose dolphin, bottlenose/Atlantic spotted dolphin, Risso's dolphin, and unidentified dolphin. The bottlenose dolphin sighting probability was used for the infrequently sighted Atlantic spotted dolphin, pilot whale, and rough-toothed dolphin. For pantropical spotted dolphin, spinner dolphin, and *Stenella* spp., there were insufficient sightings in the Mayport 1997 data set to calculate sighting probability. Pantropical sightings from the 1995 Mayport data could not be used because the earlier surveys used a different aircraft. The GulfCet II surveys used a similar aircraft and therefore, a sighting probability was derived based on all pantropical spotted dolphins sightings in the GulfCet II aerial transects on the continental slope.

A sperm whale sighting probability was derived from all GulfCet II aerial sightings of large whales on the continental slope (sperm whale, Bryde's whale, and unidentified large whale).

B.1.4.3 Analysis of NMFS Shipboard Data (Norfolk)

R/V *Abel-J* Cruise No. 95-03 was performed during 9 July to 2 August 1995 in the Gulf Stream and slope waters between Chesapeake Bay and southern New England. The cruise covered 2,607 km (1,408 nmi) of tracklines. The main objective was to conduct a line-transect population survey and to investigate if the distribution of cetaceans, especially 'strategic species' is continuous in Gulf Stream and slope water habitats. Biopsy samples, water column profiles, and photographic data were also collected.

R/V *Pelican* Cruise No. 95-01 was conducted from 9 July to 3 August 1995, beginning in Norfolk, VA and ending in Woods Hole, MA. The study covered approximately 3,155 km (1,704 nmi) of track lines in the continental slope waters from Chesapeake Bay, VA to Cape Cod, MA between 18.5 km (10 nmi) inshore of the 50 fathom contour and 18.5 km (10 nmi) offshore of the 1,000 fathom contour. The objectives of this leg of the survey were (1) to determine spatial distribution and estimate the abundance of marine mammals found in the study area; and (2) to determine if spatial distribution patterns are correlated with hydrographic features, such as, water depth, temperature or salinity, or with biological features such as zooplankton distribution.

Shipboard survey data from these two NMFS cruises were used to construct density estimates for the Norfolk test area. Data were obtained from the NMFS Northeast Region and were analyzed using the DISTANCE program, using the same methods described previously for Mayport 1999 surveys. Analyses were run using transect data stratified by survey to produce overall estimates from the two surveys combined. For each species, the mean, coefficient of variation, and confidence limits were calculated for group density, individual density, and group size. A separate calculation was run for total marine mammals.

Sightings were adequate to develop sighting probabilities for beaked whales, bottlenose dolphin, pilot whale, sperm whale, striped dolphin, unidentified dolphin, and unidentified large whale. The pilot whale sighting probability was used for the infrequently sighted false killer whale, dwarf/pygmy sperm whale, pygmy killer whale, Risso's dolphin, unidentified small whale, and unidentified odontocete. The sperm whale sighting probability was used for the infrequently sighted fin whale. The striped dolphin sighting probability was used for *Stenella* spp. The bottlenose dolphin sighting probability was used for Atlantic spotted dolphin and common (saddleback) dolphin.

B.1.4.4 Analysis of GulfCet II Data (subset for Pascagoula)

Aerial survey data from the GulfCet II program were obtained from the NMFS, and a subset was constructed to represent the Pascagoula test area. The subset consisted of 10 transects passing through and immediately adjacent to the test area. Data were available from two summer surveys (July-August 1996 and July-August 1997).

The survey aircraft was a DeHavilland DH-6 Twin Otter equipped with plexiglass bubble windows. Surveys were flown at an altitude of 229 m (750 ft) and a speed of 110 kts (204 kph). The overall design consisted of 58 transects arranged perpendicularly to isobaths (Transects 7 to 16 cover the Pascagoula test area). A team of four experienced observers rotating among observer and data recorder positions monitored the sea surface for marine mammals, sea turtles, fish, and floating debris. GPS was used for navigation and sighting positions were entered into a laptop computer by the data recorder.

Data were analyzed using the DISTANCE program, with the same methods described previously for Mayport 1999 data. Analyses were run using transect data stratified by year and a combined (mean) density and abundance estimate were calculated. There were adequate sightings of bottlenose dolphin, pygmy sperm whale, and leatherback turtle to calculate sighting probabilities. For clymene dolphin, pantropical spotted dolphin, spinner dolphin, and striped dolphin, a sighting probability was derived from all GulfCet II continental slope sightings of pantropical spotted dolphins during summer aerial surveys. A sighting probability for sperm whales was derived from all GulfCet II slope sightings of large whales (sperm whale, Bryde's whale, and unidentified large whale) during summer and winter aerial surveys.

B.1.4.5 Density Comparisons

Table B.3 summarizes density estimates for marine mammals for the Mayport, Norfolk, and Pascagoula test areas. Mean group densities (groups sighted/100 km^2) were 3.596 at Norfolk, 2.094 at Mayport, and 1.004 at Pascagoula. Individual densities (individuals/100 km^2) were 50.970 at Norfolk, 18.480 at Pascagoula, and 18.033 at Mayport. Although group densities at Pascagoula were only about half those at Mayport, the difference was offset by larger average group sizes, producing nearly identical individual density estimates.

Mayport. Eight cetacean taxa were sighted during the Navy's June and August 1999 surveys. These were Atlantic spotted dolphin, bottlenose dolphin, bottlenose/Atlantic spotted dolphin, false killer whale, pilot whale, Risso's dolphin, unidentified dolphin, and unidentified odontocete. Mean group and individual densities were 2.094 groups/100 km^2 and 18.033 individuals/100 km^2. The most frequently sighted (groups/100 km^2) were bottlenose dolphin (1.326) and Risso's dolphin (0.655). These two taxa accounted for 95% of the total group and individual densities. No mysticetes were seen.

During the 1995 and 1997 SEAWOLF surveys, the species list was similar, but mammal densities were generally lower. Total group densities during the 1995 and 1997 surveys were 0.592 and 1.300 groups/100 km^2, respectively. Total individual densities during 1995 and 1997 were 6.877 and 9.212 individuals/100 km^2. Identified taxa with the highest group densities (groups/100 km^2) during the 1995 surveys were bottlenose dolphin (0.105) and pantropical spotted dolphin (0.068). During the 1997 surveys, bottlenose dolphin (0.595) and Risso's dolphin (0.261) had the highest group densities and only a few pantropical spotted dolphins were seen. False killer whale was the only species seen during 1999 surveys that was not observed during either 1995 or 1997 SEAWOLF surveys. Species observed during SEAWOLF surveys but not seen during 1999 included sperm whale, pantropical spotted dolphin, rough-toothed dolphin, spinner dolphin, and

Table B.3. Marine mammal densities for the three test areas based on aerial and shipboard surveys.

	MAYPORT			PASCAGOULA			NORFOLK		
	Navy Aerial Surveys June and August 1999			GulfCet II Aerial Surveys (subset) July-August 1996 and 1997			SEAWOLF 1995 Aerial Surveys Monthly April-September 1995		
	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size
MYSTICETES									
Fin whale	--	--	--	--	--	--	0.304	0.101	3.00
Fin/sei whale	--	--	--	--	--	--	--	--	--
Humpback whale	--	--	--	--	--	--	0.009	0.009	1.00
Minke whale	--	--	--	--	--	--	0.051	0.051	1.00
Sei whale	--	--	--	--	--	--	0.098	0.049	2.00
Sei/Bryde's whale	--	--	--	--	--	--	0.035	0.035	1.00
Balaenoptera sp.	--	--	--	--	--	--	0.056	0.021	2.67
ODONTOCETES									
Atlantic spotted dolphin	0.095	0.016	6.00	0.263	0.022	12.00	9.534	0.672	14.19
Beaked whales*	--	--	--	--	--	--	--	--	--
Bottlenose dolphin	10.126	1.326	7.64	4.420	0.370	11.93	6.862	0.380	18.08
Bottlenose/Atl.spotted dolphin	0.160	0.018	8.67	0.344	0.031	11.00	0.343	0.043	8.00
Clymene dolphin	--	--	--	8.357	0.056	150.00	--	--	--
Common dolphin	--	--	--	--	--	--	0.360	0.002	155.00
Dwarf/pygmy sperm whale	--	--	--	0.524	0.384	1.36	--	--	--
False killer whale	0.047	0.006	8.00	--	--	--	--	--	--
Pantropical spotted dolphin	--	--	--	0.682	0.013	50.78	2.116	0.030	70.00
Pilot whale	0.420	0.034	12.33	--	--	--	16.173	1.552	10.42
Pygmy killer whale	--	--	--	--	--	--	--	--	--
Risso's dolphin	7.000	0.655	10.69	0.146	0.017	8.50	1.947	0.065	29.75
Rough-toothed dolphin	--	--	--	--	--	--	--	--	--
Sperm whale	--	--	--	0.034	0.024	1.40	0.040	0.030	1.33
Spinner dolphin	--	--	--	1.575	0.009	170.66	6.792	0.030	225.00
Striped dolphin	--	--	--	2.136	0.076	28.00	0.230	0.010	24.00
Stenella spp.**	--	--	--	--	--	--	1.424	0.063	22.50
Unidentified dolphin	0.179	0.033	5.40	--	--	--	4.581	0.436	10.52
Unidentified odontocete	0.005	0.005	1.00	--	--	--	--	--	--
Unidentified small whale	--	--	--	--	--	--	--	--	--
UNDETERMINED									
Unidentified large whale	--	--	--	--	--	--	0.017	0.017	1.00
TOTAL	**18.033**	**2.094**		**18.480**	**1.004**		**50.970**	**3.596**	

*includes *Mesoplodon* spp. and/or *Ziphius cavirostris*.

**includes clymene, spinner, and striped dolphins.

Table B.3. (Continued).

	MAYPORT (secondary) SEAWOLF 1997 Aerial Surveys Monthly May-September 1997			MAYPORT (secondary) SEAWOLF 1995 Aerial Surveys Monthly April-September 1995			NORFOLK (secondary) *Pelican* & *Abel-J* Cruises July-August 1995		
	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size
MYSTICETES									
Fin whale	--	--	--	--	--	--	--	--	--
Fin/sei whale	--	--	--	--	--	--	0.326	0.163	2.00
Humpback whale	--	--	--	--	--	--	--	--	--
Minke whale	--	--	--	--	--	--	--	--	--
Sei whale	--	--	--	--	--	--	--	--	--
Sei/Bryde's whale	--	--	--	--	--	--	--	--	--
Balaenoptera sp.	--	--	--	--	--	--	--	--	--
ODONTOCETES									
Atlantic spotted dolphin	0.240	0.022	11.14	1.049	0.059	17.82	0.263	0.006	42.40
Beaked whales*	--	--	--	--	--	--	0.648	0.278	2.33
Bottlenose dolphin	4.069	0.595	6.84	0.966	0.105	9.22	7.696	0.639	12.05
Bottlenose/Atl.spotted dolphin	1.378	0.205	6.73	0.377	0.065	5.80	--	--	--
Clymene dolphin	--	--	--	--	--	--	--	--	--
Common dolphin	--	--	--	--	--	--	0.027	0.001	42.00
Dwarf/pygmy sperm whale	--	--	--	--	--	--	0.026	0.013	2.00
False killer whale	--	--	--	--	--	--	--	--	--
Pantropical spotted dolphin	0.005	0.001	4.00	1.391	0.068	20.33	--	--	--
Pilot whale	0.228	0.011	20.00	--	--	--	3.324	0.319	10.43
Pygmy killer whale	--	--	--	--	--	--	0.015	0.008	2.00
Risso's dolphin	1.870	0.261	7.16	0.519	0.023	23.00	1.325	0.131	10.10
Rough-toothed dolphin	0.002	0.0004	6.50	--	--	--	--	--	--
Sperm whale	0.035	0.017	2.00	--	--	--	2.396	1.116	2.15
Spinner dolphin	0.030	0.003	9.00	0.737	0.015	50.00	--	--	--
Striped dolphin	--	--	--	--	--	--	28.780	0.510	56.39
Stenella spp.**	0.102	0.004	29.00	0.347	0.024	14.25	0.022	0.007	3.19
Unidentified dolphin	1.254	0.180	6.96	1.491	0.233	6.39	10.080	0.380	26.55
Unidentified odontocete	--	--	--	--	--	--	0.016	0.016	1.00
Unidentified small whale	--	--	--	--	--	--	0.180	0.091	1.98
UNDETERMINED									
Unidentified large whale	--	--	--	--	--	--	0.122	0.075	1.63
TOTAL	**9.212**	**1.300**		**6.877**	**0.592**		**55.247**	**3.751**	

*includes *Mesoplodon* spp. and/or *Ziphius cavirostris*.

**includes clymene, spinner, and striped dolphins.

clymene/spinner/striped dolphin [*Stenella* spp.]). The additional species sighted during the 1997 surveys may partly reflect the greater trackline mileage of the five combined SEAWOLF surveys.

No sperm whales were seen during the 1999 surveys, but single sightings of two individuals each were made during both the 1995 and 1997 SEAWOLF surveys. No sperm whales were seen near the Mayport test area during the *Relentless* cruise (Roden, 1998). These results indicate that sperm whales may occur in the area, but infrequently or at low densities. Due to this species' endangered status and its occurrence on the two SEAWOLF surveys, sperm whale densities from the SEAWOLF 1997 surveys (0.017 groups/100 km^2) will be used in the impact calculations in Appendix C.

<u>Norfolk</u>. Nineteen cetacean taxa were sighted during the Navy's April-September 1995 SEAWOLF surveys at the Norfolk test area. Mean group and individual densities were 3.596 groups/100 km^2 and 50.970 individuals/100 km^2. The most frequently sighted (groups/100 km^2) were pilot whales (1.552), Atlantic spotted dolphin (0.672), unidentified dolphin (0.436), and bottlenose dolphin (0.380). These four taxa accounted for 85% of groups sighted. The most abundant taxa (individuals/100 km^2) were pilot whales (16.173), Atlantic spotted dolphin (9.534), bottlenose dolphin (6.862), and spinner dolphin (6.792), which together accounted for 77% of the total. Large mean group sizes were observed for spinner dolphin (225), common dolphin (155), and pantropical spotted dolphin (70). Sperm whales and several species of mysticetes (fin, humpback, minke, sei, and possibly Bryde's whales) were seen. Fin whales were the most abundant of the large whales (0.101 groups/100 km^2).

Sixteen taxa were sighted during the 1995 *Abel-J* and *Pelican* cruises. Mean group and individual densities were 3.751 groups/100 km^2 and 55.247 individuals/100 km^2. The most frequently sighted (groups/100 km^2) identified taxa were sperm whale (1.116), bottlenose dolphin (0.639), striped dolphin (0.510), and pilot whale (0.319). These four taxa plus unidentified dolphins accounted for about 80% of the total group densities. Due to its large group sizes, striped dolphin had the highest individual density (28.780 individuals/100 km^2), accounting for about half of the total, followed by bottlenose dolphin (7.696 individuals/100 km^2).

Neither the *Abel-J* and *Pelican* cruises nor the SEAWOLF aerial surveys provided complete coverage of the test area, with the shipboard data derived mainly from transects to the north and east of the test area and the SEAWOLF data from the shallow, western edge of the test area. The shipboard observations are likely to be more representative for deepwater species due to the greater water depths covered, particularly during the *Pelican* cruise. For example, both sperm whales and striped dolphins were much more abundant in the shipboard data than in the SEAWOLF aerial surveys, which were limited to the shelf edge. Sperm whales were in fact the most frequently sighted species during both shipboard surveys (especially *Pelican*, which covered deeper waters). Numerous sperm whales were also sighted near the Norfolk test area during the NMFS *Relentless* cruise, which extended into deep, continental slope waters (Roden, 1998). For this reason, sperm whale densities from the ship surveys were used for impact analysis in Appendix C. All other species were represented by the SEAWOLF aerial data.

Marine mammal density data are also available from the two CETAP survey blocks overlapping the Norfolk test area (Kenney et al., 1985). Block H_z overlaps with the northern part of the test area

and Block I_z overlaps with the southern part. Total densities during the summer season were 111 individuals/100 km^2 in Block H_z and 102 individuals/100 km^2 in Block I_z. These densities are about twice those estimated from the SEAWOLF data or the *Abel-J* and *Pelican* cruises. However, relatively few taxa were seen. In Block H_z, the most abundant species (individuals/100 km^2) were "striped or spotted dolphin" (55.09), bottlenose dolphin (19.19), pilot whale (14.06), Risso's dolphin (11.14), and common dolphin (10.99). Sperm whales were also seen, with a density of 0.44 individuals/100 km^2. In Block I_z, the only taxa sighted were "unidentified dolphin" and "unidentified dolphin not Risso's dolphin."

Pascagoula. Ten cetacean taxa were sighted during the summer 1996 and 1997 GulfCet II surveys in the Pascagoula test area. Mean group and individual densities were 1.004 groups/100 km^2 and 18.480 individuals/100 km^2. The most frequently sighted (groups /100 km^2) were dwarf/pygmy sperm whale (0.384) and bottlenose dolphin (0.370). These two taxa accounted for 75% of all sightings. Sperm whales were the only large whales seen. The most abundant taxa were clymene dolphin, bottlenose dolphin, and striped dolphin, together accounting for 81% of individuals sighted. Spinner dolphin, clymene dolphin, and pantropical spotted dolphin had large average group sizes (171, 150, and 51 respectively).

In comparison, total marine mammal densities during the GulfCet II program as a whole (all continental slope transects, summer 1996 and 1997 combined) were 1.698 groups/100 km^2 and 50.080 individuals/100 km^2 (Mullin and Hoggard, 2000). The most frequently sighted species were bottlenose dolphin, pantropical spotted dolphin, and dwarf/pygmy sperm whale. In terms of numbers of individuals, pantropical spotted dolphins were the most abundant cetacean on the continental slope, followed by spinner dolphin and bottlenose dolphin. The Pascagoula test area, then, had lower than average group and individual densities, and the most abundant slope species in the northern Gulf (pantropical spotted dolphin) was infrequently sighted there.

The only large whale seen at the Pascagoula test area was the sperm whale. A resident population of sperm whales occurs in the northern Gulf, concentrated primarily just south of the the mouth of the Mississippi River (Würsig et al., 2000). This "focal point" is located about 200 km (110 nmi) west-southwest of the Pascagoula test area.

Bryde's whale is the only other large whale potentially occurring at Pascagoula, but it was not sighted during aerial surveys there. This is the only mysticete occurring regularly in the Gulf of Mexico, and there were two sightings of this whale during GulfCet ship surveys during spring months (Mullin and Hoggard, 2000). The mean density of Bryde's whale on the continental slope, based on the shipboard surveys, was 0.041 individuals/100 km^2.

B.2 SEA TURTLES

B.2.1 Species Descriptions

Five species of sea turtles may be found at the Mayport, Norfolk, or Pascagoula areas, based on historical sighting records. Endangered species are the hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), and leatherback sea turtles (*Dermochelys coriacea*). The loggerhead sea turtle (*Caretta caretta*) is a threatened species. The green sea turtle (*Chelonia mydas*) is listed as threatened, except for the Florida breeding population which is listed as endangered. Due to inability to distinguish between these two populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters (NMFS, 1996). Loggerhead and leatherback turtles are discussed first, as these are the species most likely to be found (as adults) at any of the test areas.

Loggerhead Sea Turtle. The loggerhead sea turtle (*Caretta caretta)* is found from South America to New England. This species generally occurs in subtropical waters. Juveniles are pelagic, often drifting in current gyres for several years. It is believed that subadults move to nearshore and into estuarine areas. Adult loggerheads concentrate within middle shelf to shelf edge waters (Schroeder and Thompson, 1987). Adults are found along the continental shelf of the Atlantic and Gulf of Mexico. Loggerheads feed primarily on benthic mollusks and crustaceans. Pelagic stages feed on coelenterates and cephalopods. Mating occurs in late March to early June. Nesting occurs from May to September. Most nesting of the western Atlantic population occurs on beaches of southeast Florida with other nesting areas located in northeast Florida, Georgia, South Carolina, and North Carolina, as well as the Gulf coast of Florida. Incubation lasts about 54 days in Florida and 63 days in Georgia. Hatchlings swim out to 22 to 28 km (12 to 15 nmi) offshore and begin a pelagic existence within *Sargassum* algae rafts. Murphy and Hopkins (1984) estimated that there were 14,150 nesting females utilizing southeast U.S. beaches in 1983, based on aerial and ground survey data. The NMFS and USFWS (1991b) estimated that there are approximately 58,000 nests deposited per year in the southeastern U.S. State agencies in Florida, Georgia, South Carolina, and North Carolina have estimated that approximately 50,000 to 70,000 nests are deposited annually in this region, according to the loggerhead turtle recovery plan prepared by the NMFS and USFWS (1991b).

Leatherback Sea Turtle. The leatherback sea turtle (*Dermochelys coriacea*) is a circumglobal species, currently divided into two subspecies (Thompson and Huang, 1993). The subspecies of interest here is *Dermochelys coriacea coriacea* which inhabits waters of the western Atlantic Ocean from Newfoundland to northern Argentina. It is believed that compared to other sea turtles, leatherbacks range the farthest north. This species may be found in shallow waters but is essentially open ocean, or pelagic (Marquez, 1990). Leatherback sea turtles are frequently observed in cool waters of higher latitudes, such as New England and the Canadian Maritime Provinces. Leatherback sea turtles are pelagic feeders (e.g., on coelenterates, particularly jellyfish). This species nests on high energy beaches (i.e., beaches exposed to strong wave action) in Florida as early as late February or March. Incubation lasts 65 days. Very little is known of the pelagic distribution of hatchling and/or juvenile leatherback turtles. Due to the endangered status of the leatherback turtle, all nesting areas are considered critical habitat.

Green Sea Turtle. The Atlantic green sea turtle (*Chelonia mydas*) occurs in U.S. Atlantic waters around the U.S. Virgin Islands, Puerto Rico, and continental waters from Texas to Massachusetts. This species may be found in convergence zones in deep water and in shallow, protected waters containing benthic (bottom) feeding grounds. Atlantic green sea turtles commonly feed upon seagrasses and algae, using reefs and rocky outcrops near grass beds for resting areas. Nesting areas are located on high energy beaches along the Atlantic coast of Florida. The NMFS and USFWS (1991a) identified several large and important nesting areas along the central and southeast coast of Florida, including Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties. Mating occurs in waters off nesting areas. Nesting occurs at night, with females producing clutches of eggs every 2 years. Hatchlings swim out to sea and enter a pelagic stage in convergence zones.

Hawksbill Sea Turtle. Hawksbill sea turtles (*Eretmochelys imbricata)* occur in tropical and subtropical seas of the Atlantic, Pacific, and Indian Oceans. In the western Atlantic, hawksbill turtles are generally found in clear tropical waters of the Caribbean, including the Florida Keys, the Bahamas, and the southwestern Gulf of Mexico. Hawksbill turtles are not frequently reported in the northern Gulf of Mexico or in Atlantic waters north of Cape Canaveral, Florida. Adults can be found in waters up to 100 m (328 ft) deep. This species feeds on encrusting organisms, particularly sponges. Juvenile hawksbill sea turtles are usually found near shallow coral reefs. Nesting areas for hawksbills in the Atlantic are found in the U.S. Virgin Islands, Puerto Rico, and south Florida. Hatchlings enter a pelagic phase, drifting with *Sargassum* rafts. Juveniles shift to a benthic foraging existence in shallow waters, progressively moving to deep waters as they grow and become capable of deeper dives for sponges. Due to this turtle's endangered status, all nesting areas are critical habitat. Within the continental U.S., nesting beaches are restricted to the southeast coast of Florida (i.e., Volusia through Dade Counties) and the Florida Keys (Monroe County), as noted by Meylan (1992) and the NMFS and USFWS (1993).

Kemp's Ridley Sea Turtle. The Kemp's ridley sea turtle (*Lepidochelys kempii*) is found from the Gulf of Mexico to New England, and occasionally as far north as Nova Scotia. Its distribution along the U.S. southeastern coast is mediated by the Gulf Stream. Adult turtles are usually found in the Gulf of Mexico. Juveniles may move northward along the U.S. Atlantic coast with the warm waters of the Gulf Stream. Individuals are reported to return southward when waters turn cold. It is believed that this species typically remains shoreward of the 50 m (164 ft) contour line. Kemp's ridley sea turtles forage in shallow water, feeding on crabs, shrimp, gastropods, and fish. Nesting occurs almost entirely in Rancho Nuevo beach, Tamaulipas, Mexico (NMFS and USFWS, 1992). Nesting occurs during the day in April, May, and June, with mature individuals returning on an annual basis (Prichard and Marquez, 1973). Due to the species' endangered status, all nesting areas are considered as critical habitat. According to the NMFS and USFWS (1992), juvenile and subadult Kemp's ridley sea turtles travel northward along the Atlantic seaboard in spring to feed in the productive, coastal waters between Georgia and New England; these migrants then move southward with the onset of cooler temperatures in late fall and winter. Henwood and Ogren (1987) and Schmid (1995) provided information on length frequency, seasonal occurrence, and long distance migratory patterns of Kemp's ridley sea turtles along the U.S. Atlantic coast.

B.2.2 Sources of Quantitative Data

Sources of quantitative survey data for sea turtles were reviewed for this EIS and are summarized in **Table B.4**. The following criteria were considered in selecting appropriate data sets:

- Data should come from relatively recent surveys (preferably, within the last 5 to 10 years)
- Coverage of the test area is preferred over nearby or regional coverage
- Data must have been collected and analyzed using standard line-transect methodology

Mayport. The Navy conducted new aerial surveys of the Mayport test area in June and August 1999 (see Section B.1.4.1). These surveys provide the most complete and site-specific coverage of the test area to estimate turtle abundances. Historical sources for comparison are discussed below, including aerial surveys by Fritts et al. (1983), the NMFS Southeast Turtle Surveys (SETS) (Thompson, 1984), and the Navy SEAWOLF surveys (Department of the Navy, 1995, 1998b). Most of the previous survey effort has concentrated in shallower waters on the shelf or along the shelf edge and is not directly representative of the test area.

Fritts et al. (1983) conducted bimonthly aerial surveys offshore of Cape Canaveral during 1980 to 1981. The surveys were flown at two altitudes: 91 m (300 ft) and 229 m (750 ft) to maximize detection of animals of various sizes. Their Merritt Island, Florida (MIFL) survey block (previously shown in **Figure B.2**) is south of the Mayport test area where other surveys have shown turtle abundances tend to be higher (Thompson, 1984; Thompson and Huang, 1993). Therefore, these data are probably not representative of turtle abundances in the Mayport test area. In addition, the data are about 20 years old. However, the surveys are of interest because transects extended well beyond the continental shelf to about the 1,000 m (3,280 ft) depth contour. The data show that sea turtles are most abundant on the continental shelf, inshore of the western wall of the Gulf Stream (Fritts et al., 1983).

The NMFS Southeast Turtle Surveys (SETS) covered waters offshore the southeastern U.S. from Cape Hatteras to Key West in 1982 and 1983 (Thompson, 1984; Thompson and Huang, 1993). The surveys focused exclusively on turtles and were flown at an altitude of 152 m (500 ft). These surveys were generally limited to the continental shelf, defined by the western edge of the Gulf Stream; however, some additional observations were made in deeper water (**Figure B.11**). SETS data clearly show that abundances of both loggerheads and leatherbacks are highest inshore of the Gulf Stream western wall, and therefore data from Blocks 6, 7, and 8 are likely to overestimate densities in the test area. Block GSS overlaps the test area and is more representative of the appropriate depth range, but the block extends well to the south of the test area where extremely high turtle densities are known to occur offshore of southeast Florida. Therefore, these data are not likely to be representative of the test area. In addition, the data are over 15 years old. For these reasons, the results are not considered suitable as the primary source for density estimates in the Mayport test area, but they are useful for comparison and context.

In support of the SEAWOLF EIS, the Navy conducted monthly aerial surveys offshore of Mayport from April through September 1995 (Department of the Navy, 1995) and May through September 1997 (Department of the Navy, 1998b). Methods have been described previously in Section B.1.4.2 and transect locations are shown in **Figure B.3**. These surveys were flown at an altitude of 229 m (750 ft), as compared with 152 m (500 ft) during the NMFS turtle surveys (Thompson, 1984).

Table B.4. Availability of sea turtle density data for potential test areas. The most useful sources are checked (✓).

Survey	Type	Advantages	Disadvantages	Conclusion
NEAR MAYPORT TEST AREA				
Fritts et al. (1983)	Aerial	* Includes appropriate water depth range	* Survey area off Merritt Island, Florida (MIFL) is south of test area offshore of a region of high turtle density	Possibly useful as secondary source
Southeast Turtle Surveys (SETS) (Thompson, 1984; Thompson and Huang, 1993)	Aerial	* Extensive coverage near test area	* Most survey blocks are on shelf, not slope * Deeper Gulf Stream South (GSS) block is south of test area near region of highest turtle density	✓Useful as secondary source
SEAWOLF surveys (Dept. Navy, 1995, 1998b)	Aerial	* Includes part of test area * Close transect spacing and frequent coverage (monthly) during test period	* Along shelf edge, did not cover deeper portions of test area where turtle densities may be lower in Gulf Stream	✓Useful as secondary source
Navy right whale surveys (Dept. Navy, 1997)	Aerial	* Includes some turtle observations in test area	* Winter only (Oct-Apr)	Not useful
New aerial surveys for this EIS (Dept. Navy, 1999)	Aerial	* Complete coverage of test area * Close transect spacing and two surveys (June, August) during test period	* None	✓PRIMARY SOURCE for Mayport test area
NEAR NORFOLK TEST AREA				
Cetacean and Turtle Assessment Program (CETAP) (Winn, 1982)	Aerial	* Includes appropriate water depth range near Norfolk test area	* Data are about 20 years old	✓Useful as secondary source
SEAWOLF surveys (Dept. Navy, 1995, 1998b)	Aerial	* Includes part of test area * Close transect spacing and frequent coverage (monthly) during test period	* Along shelf edge, did not cover deeper portions of test area (not as much of a problem at Norfolk because whole test area is inshore of Gulf Stream)	✓PRIMARY SOURCE for Norfolk test area
NEAR PASCAGOULA TEST AREA				
Lohoefener et al. (1990)	Aerial	* Includes some observations in northeastern Gulf near Pascagoula test area	* Mainly on shelf, not continental slope * No detailed presentation or analysis of deepwater sightings	Not useful
GulfCet (Hansen et al., 1994)	Aerial, shipboard	* Includes appropriate water depth range	* Limited observations near test area (study area is to the west)	✓Useful as secondary source
GulfCet II (Mullin and Hoggard, 2000)	Aerial, shipboard	* Includes test area and appropriate water depth range	* None	✓PRIMARY SOURCE for Pascagoula test area

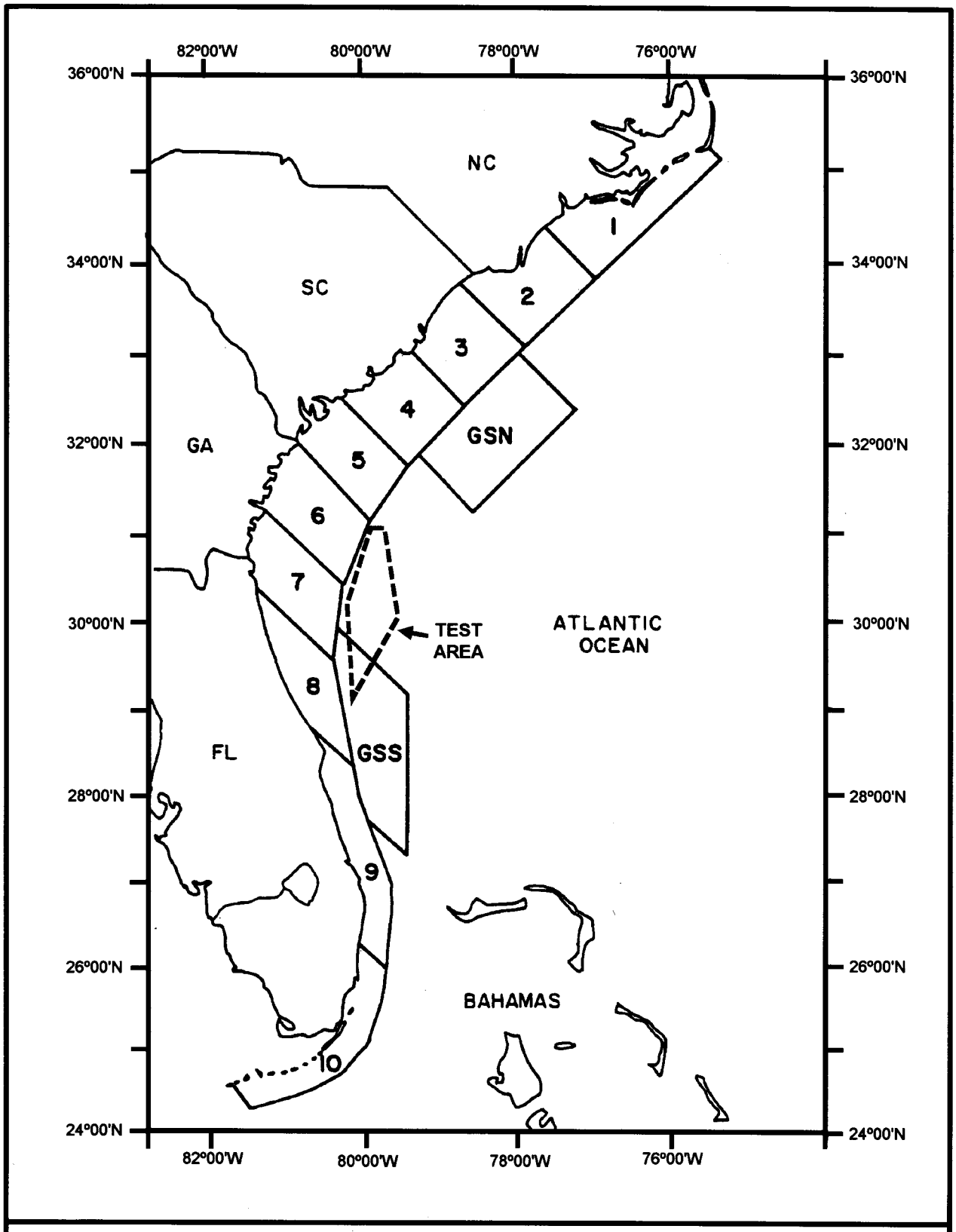

Figure B.11. Sampling blocks used in aerial surveys by Thompson (1994) and Thompson and Huang (1993) relative to the Mayport test area. GSN and GSS represent the northern and southern Gulf Stream blocks, respectively.

Because the surveys focused on the shelf edge, they did not cover the deeper portions of the test area beyond the western wall of the Gulf Stream and probably represent an overestimate of turtle densities in the test area, for reasons discussed previously. Also, the data were originally analyzed using a strip transect methodology instead of line transect statistics and therefore are not directly comparable with estimates from other areas (e.g., GulfCet II data for Pascagoula test area). For this EIS, the data were reanalyzed using line transect statistics (Buckland et al., 1993) so that they could be compared with the other turtle data sets.

Norfolk. The main sources of turtle abundance data for the Norfolk test area include the CETAP (Winn, 1982) and SEAWOLF aerial surveys (Department of the Navy, 1995). Both surveys included some coverage of the continental slope in this area. The NMFS southeast turtle surveys did not extend north of Cape Hatteras and focused on the continental shelf (Thompson, 1984; Thompson and Huang, 1993). Several other aerial surveys have been conducted off Virginia and/or North Carolina (Musick et al., 1994; Epperly et al., 1995; Keinath et al., 1996), but they focused on nearshore or shelf waters.

CETAP (Winn, 1982) included aerial surveys of marine turtles from Nova Scotia to Cape Hatteras (study area previously shown in **Figure B.6**). Data reported for the Mid-Atlantic shelf edge and continental slope provide the most relevant data for the Norfolk test area. The main drawback to the CETAP data is their age (about 20 years old). The data remain useful for species occurrence and seasonality, but are of questionable use as the sole basis for current abundance estimates.

In support of the SEAWOLF EIS, the Navy conducted monthly aerial surveys offshore of Norfolk from April through September 1995 (Department of the Navy, 1995). Methods have been described in Section B.1.4.2 and transect locations were previously shown in **Figure B.7**. The transects were centered on the shelf edge but extended onto the continental slope to a depth of about 1,000 to 1,200 m (3,280 to 3,937 ft). Although the SEAWOLF surveys covered only the shallow, western edge of the Norfolk test area, satellite imagery of sea surface temperate indicates that the Gulf Stream western wall is consistently seaward (east) of the entire Norfolk test area. Therefore, unlike the Mayport area, a sharp gradient in turtle distribution is not expected, and the SEAWOLF data are likely to be more representative of turtle densities in the Norfolk test area. For this EIS, the SEAWOLF data were reanalyzed using line transect statistics (Buckland et al., 1993) so that they could be compared with CETAP turtle densities for the continental slope.

Pascagoula. Aerial survey data are available from the GulfCet II program to estimate the abundance of sea turtles in and near the Pascagoula test area (Mullin and Hoggard, 2000). Aerial surveys conducted during two successive summers (1996 and 1997) provide the best coverage of the test area during the appropriate time period (**Figure B.9**). After reviewing these data and conferring with NMFS scientists, the Navy concluded that a subset of the GulfCet II aerial survey data would be appropriate to represent the Pascagoula test area. A copy of the data was obtained from the NMFS, and a subset was constructed and reanalyzed for this EIS (see Section B.2.3.4). Aerial survey data from the earlier GulfCeT program (Davis and Fargion, 1996) are also useful for context and comparison. Earlier studies of turtle associations with petroleum platforms focused mainly on the continental shelf and there was no detailed presentation or analysis of deepwater sightings (Lohoefener et al., 1990).

Conclusions. **Table B.5** summarizes the review of historical data sources for turtle abundance at the Mayport, Norfolk, and Pascagoula test areas.

Table B.5. Summary of data sources for sea turtle densities.

	Mayport	Norfolk	Pascagoula
Principal data source	• New Navy aerial surveys (June and August 1999)	• SEAWOLF aerial surveys (1995)	• GulfCet II aerial survey data from summer 1996/97 (subset reanalyzed for EIS)
Other sources (for context and comparison)	• SEAWOLF aerial surveys (1995 and 1997) • NMFS Southeast Turtle Surveys (SETS) (1982-83)	• CETAP aerial surveys (1979-81)	• other GulfCet II and GulfCet I data

B.2.3 Sea Turtle Density Estimates

Density estimates were developed using the DISTANCE program (Laake et al., 1993), which applies standard analytical methodology for line transect surveys (Buckland et al., 1993). Analyses were run to produce overall estimates for each data set. For each species, the mean, coefficient of variation, and confidence limits were calculated for group density, individual density, and group size. Since nearly all turtle sightings were solitary individuals, group size was usually 1.0 and individual densities were equal to group densities. A separate calculation was run for total total sea turtles (all species combined).

New aerial surveys for turtles and marine mammals were conducted in June and August 1999 at the Mayport test area. Methods have been summarized in Section B.1.4.1 and results are summarized in the aerial survey report (Department of the Navy, 1999). Only one turtle (a loggerhead) was seen on the June survey, and only six turtles (four leatherbacks, one loggerhead, and one unidentified turtle) were seen on the August survey. Due to the low numbers, the DISTANCE program could not reliably estimate sighting probabilities. Therefore, a sighting probability was derived from loggerhead turtles sightings during the 1997 Mayport SEAWOLF surveys.

SEAWOLF aerial survey data collected during April through September 1995 (Mayport and Norfolk) and May through September 1997 (Mayport only) were reanalyzed using the DISTANCE program. Survey methods have been described in Section B.1.4.2. A total of 141 turtles were seen "on effort" during the 1995 surveys, of which 129 (or 91%) were loggerheads. During the 1997 surveys, 238 turtles were seen "on effort," including 179 loggerheads, 39 leatherbacks, and 20 unidentified turtles. The 1997 data included sufficient numbers of sightings of all three categories to estimate sighting probabilities. For the 1995 analysis, the loggerhead sighting probability had to be used for the less frequently sighted leatherback and unidentified turtles.

Aerial survey data from the GulfCet II program were obtained from the NMFS, and a subset was constructed to represent the Pascagoula test area. Methods for the GulfCet II surveys have been described in Section B.1.4.4. The subset consisted of 10 transects (numbers 7 through 16) passing through and immediately adjacent to the test area. Data were available from two summer surveys (July-August 1996 and July-August 1997). Nine leatherbacks were sighted during the summer 1996 survey and four were sighted during the summer 1997 survey. One unidentified turtle was sighted during the 1996 survey; no loggerheads were seen. The data included sufficient numbers of leatherback turtles to estimate sighting probabilities. The leatherback sighting probability was also used for unidentified turtles.

Table B.6 summarizes density estimates for sea turtles for the Mayport, Norfolk, and Pascagoula test areas. Mean densities (turtles/100 km^2) were apparently highest at Norfolk (0.633) and about equal at Mayport (0.288) and Pascagoula (0.258).

Green, hawksbill, and Kemp's ridley turtles were not seen during aerial surveys of any test area. Although these species could be present, they are not likely to occur frequently at any of the test areas as adults. Juveniles may be present in association with *Sargassum* rafts. One hawksbill turtle was sighted during the *Abel-J* cruise north of the Norfolk test area, but no turtle density estimates were developed from shipboard sightings.

<u>Mayport</u>. Two turtle species, leatherback and loggerhead, were sighted during the June and August 1999 surveys. Unidentified turtles were also sighted. Leatherbacks and loggerheads accounted for 56% and 30%, respectively, of the total density of 0.288 turtles/100 km^2.

The 1999 Mayport densities were considerably lower than those estimated previously during 1995 and 1997 SEAWOLF surveys (0.830 and 1.780 turtles/100 km^2, respectively). However, the SEAWOLF surveys covered only the shallowest portion of the current test area and the higher densities may be related to the position of the Gulf Stream western wall. Previous observations by Fritts et al. (1983) and Thompson (1984) show that turtles are concentrated inshore of the western wall, with very low densities in the Gulf Stream itself. The position of the western wall varies but is generally inshore of the test area. Satellite imagery of sea surface temperature taken during both June and August 1999 surveys show the Gulf Stream flowing directly over the Mayport test area.

Loggerhead turtles were by far the most abundant in the Mayport SEAWOLF data, whereas leatherbacks were more abundant in the Mayport 1999 surveys (although one loggerhead and no leatherbacks were seen in June). Higher abundance of leatherbacks offshore is consistent with the more "pelagic" nature of leatherback distribution and is also observed in the GulfCet II data where loggerheads dominate on the continental shelf while leatherbacks dominate on the slope.

Much higher densities were observed during the Southeast Turtle Surveys (SETS) conducted in 1982 and 1983 (Thompson, 1984; Thompson and Huang, 1993). However, these surveys were generally limited to the continental shelf as defined by the western edge of the Gulf Stream (study area previously shown in **Figure B.11**). Over 80% of the turtles sighted were loggerheads, with highest densities during spring and summer coinciding generally with the nesting season (Thompson and Shoop, 1983; Thompson, 1984). During summer, average loggerhead densities in

Table B.6. Sea turtle densities for the three test areas based on aerial surveys.

	MAYPORT			PASCAGOULA			NORFOLK		
	Navy Aerial Surveys June & August 1999			GulfCet II Aerial Surveys July-August 1996 and 1997			SEAWOLF Aerial Surveys Monthly April-September 1995		
	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size
Leatherback turtle	0.162	0.162	1	0.203	0.203	1	0.006	0.006	1.00
Loggerhead turtle	0.086	0.086	1	--	--	--	0.608	0.594	1.02
Unidentified turtle	0.040	0.040	1	0.055	0.055	1	0.018	0.018	1.00
TOTAL	**0.288**	**0.288**		**0.258**	**0.258**		**0.633**	**0.618**	

	MAYPORT (secondary)			MAYPORT (secondary)		
	SEAWOLF 1997 Aerial Surveys Monthly May-September 1997			SEAWOLF 1995 Aerial Surveys Monthly April-September 1995		
	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size
Leatherback turtle	0.423	0.423	1	0.023	0.023	1
Loggerhead turtle	1.208	1.208	1	0.783	0.771	1.02
Unidentified turtle	0.149	0.149	1	0.023	0.023	1
TOTAL	**1.780**	**1.780**		**0.830**	**0.818**	

Blocks 6 and 7 (inshore of the Mayport test area) were estimated to be 5.31 and 6.59 turtles/100 km^2, respectively. Leatherbacks were seen throughout the area but in much lower densities than loggerheads (Thompson and Huang, 1993). During summer, average leatherback densities in Blocks 6 and 7 were estimated to be 0.058 and 0.437 turtles/100 km^2, respectively. The highest densities of both loggerheads and leatherbacks were recorded during summer in Block 8, south of the Mayport test area; for leatherbacks, this phenomenon was attributed to abundant food supplies rather than nesting activity (Thompson and Huang, 1993).

SETS included summer observations in deeper waters of the Gulf Stream south of the Mayport test area (Block GSS on **Figure B.11**). Loggerhead densities there averaged 11.8 turtles/100 km^2 and leatherback densities averaged 0.233 turtles/100 km^2. These densities are not representative of the test area because the GSS block was directly offshore of southeast Florida nesting beaches where the highest turtle abundances were observed in Blocks 8 and 9. Both loggerhead and leatherback densities in the GSS block were much lower than those observed inshore during the same season.

Although the 1999 aerial surveys showed low turtle densities in the Mayport test area, the SEAWOLF and SETS data show that much higher turtle densities can be encountered nearby. These data indicate that to avoid high turtle densities at Mayport, it is important to select a test site in deep waters seaward of the Gulf Stream western wall (i.e., within or east of the Gulf Stream). The site selection process described in Section 5.0 of the FEIS includes both aerial surveys and a review of satellite imagery to aid in selecting a test site with low turtle densities.

Norfolk. Loggerhead, leatherback, and unidentified turtles were sighted during the April through September 1995 SEAWOLF surveys at Norfolk. Loggerhead turtles accounted for 96% of the total density of 0.633 turtles/100 km^2.

Mean turtle densities reported from CETAP for the mid-Atlantic continental slope were 1.12 turtles/100 km^2 for loggerheads and 0.14 turtles/100 km^2 for leatherbacks (Winn, 1982). These are higher than the Norfolk SEAWOLF numbers and considerably higher than mean turtle densities calculated for the Mayport and Pascagoula test areas. However, they are comparable to higher turtle densities seen at Mayport during 1995 and 1997 SEAWOLF surveys.

Unlike the situation at Mayport, the Gulf Stream is usually to the east of the entire Norfolk test area. Therefore, there is no reason to expect that turtle densities in the Norfolk test area would be lower than those observed along its western edge during the SEAWOLF surveys. The higher turtle densities observed during CETAP, which included deeper waters, confirm this conclusion.

Pascagoula. Leatherback and unidentified turtles were sighted during the July-August 1996 and 1997 GulfCet II surveys in the Pascagoula test area. Leatherbacks had the higher density, accounting for 79% of the total of 0.258 turtles /100 km^2.

Mean densities from GulfCet II summer surveys over the eastern Gulf of Mexico continental slope were 0.327 turtles/100 km^2 for leatherbacks, 0.034 turtles/100 km^2 for loggerheads, and 0.048 turtles/100 km^2 for unidentified turtles (Mullin and Hoggard, 2000). Therefore, total turtle densities in the Pascagoula test area are somewhat lower than the overall GulfCet II average.

B.3 SEABIRDS

The following range, habitat, general life history information, and expected presence for open ocean seabirds that may occur offshore of Mayport, Norfolk, or Pascagoula, has been adapted from Rowlett (1980), Clapp et al. (1982a,b, 1983), Powers (1983), Lee (1984, 1985b, 1986), Lee and Horner (1989), Hoopes et al. (1994), Peake (1996), and Ribic et al. (1997).

B.3.1 Procellariiformes

The Order Procellariiformes includes seabirds such as albatrosses, petrels, shearwaters, and storm petrels.

Northern Fulmars (*Fulmarus glacialis*) are found in the Arctic Ocean south to Newfoundland. They winter at sea south of New Jersey and feed in the open ocean on squid, shrimp, and fish. Northern Fulmars nest in rocky cliffs. They are common to abundant in waters off North Carolina in spring and fall. There are no records of this species south of the Carolinas, and it is presumed not to occur at either the Mayport or Pascagoula test area.

Bermuda (Cahow) Petrels (*Pterodroma cahow*) are subtropical. Their distribution at sea is unknown. They are a very rare species which feed on squid, shrimp, and small fish in the open sea. They breed in burrows in Bermuda, and are considered rare visitors to waters off North Carolina, with sightings noted in April and December. No sightings for this species have been made in waters off Florida's Atlantic coast, and it is presumed not to occur at the Mayport or Pascagoula test areas.

Black-capped Petrels (*Pterodroma hasitata*) are tropical to subtropical in distribution. Nesting occurs within burrows located on steep forested cliffs of Caribbean islands. They are common visitors to waters off North Carolina year-round, most commonly in May, October, and December. The majority of sightings have been over deep water (914 to 1,829+ m [3,000 to 6,000+ ft]), though less common between 183 to 914 m (600 to 3,000 ft). Black-capped Petrels are thought to be casual vagrants to shelf waters of the northern Chesapeake Bight. They apparently migrate to Gulf Stream waters. Only a few historic sightings of this species have been made in waters off Florida's Atlantic coast. They are presumed not to occur at the Pascagoula test area.

Cory's Shearwaters (*Puffinus diomedea*) occur on the east coast of North America during summer and fall. They feed in the open ocean and typically follow ships. Cory's Shearwaters nest in rock crevices or on open ground. They are common to abundant off North Carolina in spring, summer, and fall and a fairly common, widely dispersed summer visitor in shelf waters of the northern Chesapeake Bight. Cory's Shearwaters are the most abundant shearwater in waters off Florida's Atlantic coast from May to December. Peak numbers are seen from September to November. This species has also been sighted occasionally in the northern Gulf of Mexico.

Greater Shearwaters (*Puffinus gravis*) breed in large colonies on small islands in the southern Atlantic but migrate to the North Atlantic during summer. They feed in the open ocean on small fish and squid. Greater Shearwaters are common in waters off North Carolina in spring and summer, though most abundant in waters of the Gulf Stream and along the edge of the continental slope. They are uncommon during late spring, summer, and fall as a visitor to shelf waters of the

northern Chesapeake Bight. They are locally abundant during June and early July and, occasionally fairly common from late October to early November. Greater Shearwaters are relatively uncommon in waters off Florida's Atlantic coast but have been seen in all months except March and April. They have also been sighted in the northern Gulf of Mexico, particularly during July through September.

Sooty Shearwaters (*Puffinus griseus*) are abundant to common visitors in waters off North Carolina in May and June, although present year-round. They are uncommon spring and early summer transients over the entire shelf of the northern Chesapeake Bight. Sooty Shearwaters are relatively rare in waters off Florida's Atlantic coast. There, it is suggested that their peak abundance is in May and June, although data are limited. This species has also been sighted occasionally in the northern Gulf of Mexico.

Manx Shearwaters (*Puffinus puffinus*) are occasional visitors in the western Atlantic. They are mostly seen at sea from Newfoundland to Cape Hatteras. Manx Shearwaters undergo very long migrations. They breed in colonies on islands in the eastern Atlantic. They are rare visitors to waters off North Carolina in winter and spring. They are rare transients in spring and fall over shelf waters of the northern Chesapeake Bight and have been recorded only rarely in waters off Florida's Atlantic coast, with most observations during fall and winter. Manx Shearwaters are very unlikely to occur in the northern Gulf of Mexico.

Audubon's Shearwaters (*Puffinus lherminieri*) are found in tropical waters but may occur as far north as New York during summer. They nest in colonies on islands. They are common to abundant off North Carolina in spring, summer, and fall. Audubon's Shearwaters are rare summer and early fall visitors to shelf waters of the northern Chesapeake Bight. They are the second most abundant shearwater in waters off Florida's Atlantic coast, with peak numbers from July to early November (although they may be present year-round). This species has been frequently sighted in the northern Gulf of Mexico.

Wilson's Storm-petrels (*Oceanites oceanicus*) occur on the western Atlantic during summer. They generally feed in the open ocean but sometimes enter bays and estuaries. They breed in rocky cliffs and on offshore islands in the Antarctic and subantarctic seas and are common to abundant off North Carolina in spring, summer, and fall. Wilson's Storm-petrels are summer visitors to shelf waters of the northern Chesapeake Bight and are locally abundant beyond 50 km (27 nmi) offshore. They are the most abundant storm-petrel in waters off Florida's Atlantic coast; presence has been noted from April to November with peak numbers seen in May and June. This species has been frequently sighted in the northern Gulf of Mexico.

White-faced Storm-petrels (*Pelagodroma marina*) are rare visitors to waters off North Carolina in fall. They are probably casual late summer and fall vagrants to shelf waters of the northern Chesapeake Bight. Strays may rarely be encountered south of Cape Hatteras. No records for this species are known from Florida's Atlantic coast or the northern Gulf of Mexico.

Leach's Storm-petrels (*Oceanodroma leucorhoa*) are found in Labrador south to Maine. They breed in colonies on rocky islands and coasts in the eastern Atlantic and winter in the open ocean. They are common off North Carolina in spring and late summer, although also present in fall. Leach's

Storm-petrels are rare and widely dispersed from April to November in shelf waters of the northern Chesapeake Bight, although probably present in fall and winter. They are considered rare visitors to waters off Florida's Atlantic coast and the northern Gulf of Mexico.

Band-rumped (Harcourt's) Storm-petrels (*Oceanodroma castro*) are inhabitants of tropical and subtropical seas. They occur in the western North Atlantic from late May through mid-August, although peak abundance is in mid-July. They are highly pelagic and generally solitary. They are common visitors to deep waters off North Carolina in summer. They rarely occur off Florida's Atlantic coast and in the northern Gulf of Mexico except accidentally (e.g., following hurricanes).

B.3.2 Pelecaniformes

The Order Pelecaniformes includes seabirds such as tropicbirds, boobies and gannets, pelicans, cormorants, and frigatebirds.

White-tailed Tropicbirds (*Phaethon lepturus*) are uncommon visitors to waters off North Carolina in summer. They are probably casual late summer and early fall vagrants over warm slope waters and eddies of the Gulf Stream (along the edge of the continental shelf) of the northern Chesapeake Bight. They are frequently sighted in waters off Florida's Atlantic coast but are only occasionally seen in the northern Gulf of Mexico.

Red-billed Tropicbirds (*Phaethon aethereus*) are uncommon visitors to waters off North Carolina in spring and summer. Similarly, they are uncommon in waters off Florida's Atlantic coast and the northern Gulf of Mexico. Red-billed Tropicbirds are more uncommon in the southeastern U.S. than their congeners, the White-tailed Tropicbirds.

Masked Boobies (*Sula dactylatra*) are associated with tropical waters around the Bahamas and West Indies. They are occasionally found in Florida, Louisiana, and Texas. They feed in the open sea on fish, particularly flyingfish, and breed in colonies on open ground. They are presumed not to occur at the Norfolk test area, as there is but a single suspect record for occurrence in North Carolina. They are rare visitors to the central and southern Florida Atlantic coast, with most records from August to September. They have frequently been sighted in the northern Gulf of Mexico.

Brown Boobies (*Sula leucogaster*) are found in tropical waters in the Gulf of Mexico. They feed on flying fish and breed on coastal islands. They are very unlikely to be present at the Norfolk test area. Brown Boobies are considered to be rare in waters off Florida's Atlantic coast, although occurrence is possible year-round. They have been sighted in the northern Gulf of Mexico.

Northern Gannets (*Morus bassanus*) are common to abundant visitors to waters off North Carolina in winter and spring, although present year-round. They are also abundant in waters off Florida's Atlantic coast and present from October to April, with peak abundances seen from November to February. They also are seen in the northern Gulf of Mexico.

American White Pelicans (*Pelecanus erythrorhychos*) breed in Canada and the western U.S. and winter along the Atlantic and Gulf coasts, with some individuals remaining for the summer. They are only occasional visitors to North Carolina and are therefore considered unlikely to occur at the Norfolk

test area. They occur along the Florida and Alabama coasts throughout the year but are only abundant during winter and migrations.

Brown Pelicans (*Pelecanus occidentalis*) breed in the southeastern U.S. as well as the Caribbean, Central America, and South America, and they winter over much of this same range. They nest in colonies, typically on small coastal islands. In North Carolina and the northern Gulf of Mexico, Brown Pelicans occur regularly, but in small numbers. They are abundant year-round on the Atlantic coast of Florida. The Brown Pelican is an endangered species, but this designation does not apply to populations inshore of the proposed test areas (e.g., in Alabama, Florida, or anywhere along the U.S. Atlantic coast). Missippippi, Louisiana, and Caribbean populations are still classified as endangered.

Double-crested Cormorants (*Phalacrocorax auritus*) breed in Canada and along the U.S. Atlantic and Pacific coasts and inland. They winter along the U.S. Atlantic, Pacific, and Gulf coasts as well as in Mexico and Central America. Non-breeding residents occur along the Georgia coast throughout the year but are least abundant during summer. Florida is the only southeastern coastal state where there are significant numbers of breeding Double-crested Cormorants; the year-round population there is augmented by wintering birds from the north. Although present along the Mid-Atlantic and Gulf coasts during winter and migrations, Double-crested Cormorants are considered unlikely to occur at either the Norfolk or Pascagoula test area during the May through September time period.

Magnificent Frigatebirds (*Fregata magnificens*) are uncommon visitors to waters off North Carolina in spring and summer and casual vagrants during spring, summer, and fall over shelf waters of the northern Chesapeake Bight. They occur year-round in waters off Florida's Atlantic coast and in the northern Gulf of Mexico, though they are more common during summer.

B.3.3 Charadriiformes

The Order Charadriiformes includes seabirds such as phalaropes, jaegers and skuas, gulls, and terns.

Red-necked Phalaropes (*Phalaropus lobatus*) are common to abundant visitors to waters off North Carolina in spring and fall. They are abundant as transients in waters off Florida's Atlantic coast and are most abundant in April and May and September and October. They are occasionally seen in the northern Gulf of Mexico as fall migrants.

Red Phalaropes (*Phalaropus fulicaria*) are common to abundant visitors to waters off North Carolina in fall, winter, and spring. They are fairly common spring and fall transients to shelf waters of the northern Chesapeake Bight, though uncommon and irregular in winter. They are found usually beyond 70 km (38 nmi) from shore. Red Phalaropes are common to abundant in waters off Florida's Atlantic coast as a winter migrant. They are occasionally seen in the northern Gulf of Mexico.

Pomarine Jaegers (*Stercorarius pomarinus*) are common visitors to waters off North Carolina in spring and fall. They are primarily transients over shelf waters of the northern Chesapeake Bight.

Pomarine Jaegers may be present year-round in North Carolina but are uncommon in spring and fairly common in fall. They have been sighted off Florida's Atlantic coast and in the northern Gulf of Mexico as migrants.

Parasitic Jaegers (*Stercorarius parasiticus*) are common visitors to waters off North Carolina in fall, although uncommon in spring. Similarly, they are uncommon spring and fall transients to shelf waters of the northern Chesapeake Bight, with few sightings noted in summer. They have been sighted off Florida's Atlantic coast and in the northern Gulf of Mexico as migrants.

Long-tailed Jaegers (*Stercorarius longicaudus*) are the smallest and probably least common of the jaegers that could occur at the test areas. They are uncommon visitors to waters off North Carolina year-round and rare spring and fall transients to shelf waters of the northern Chesapeake Bight. They have occasionally been sighted off Florida's Atlantic coast and in the northern Gulf of Mexico as migrants.

Laughing Gulls (*Larus atricilla*) are common year-round inhabitants along the Atlantic and Gulf coasts. Major breeding colonies are scattered within the Gulf of Mexico and in the Carolinas. They have been sighted frequently during aerial surveys along the coast of the southeastern U.S. and the northern Gulf of Mexico and could occur at any of the test areas.

Caspian Terns (*Sterna caspia*) breed along the southeastern U.S. coast from Virginia to Florida and along the Gulf coast (primarily Louisiana and Texas). They also winter along the southeastern Atlantic and Gulf coasts and could be present year-round inshore of any of the test areas.

Royal Terns (*Sterna maxima*) breed primarily along the southeastern Atlantic coast from Maryland south to central Florida, as well as in the Caribbean. They also winter along the southeastern Atlantic and Gulf coasts and are likely to be common year-round residents inshore of any of the test areas.

Sandwich Terns (*Sterna sandvicensis*) breed regularly along the Mid-Atlantic coast from Virginia through South Carolina, and may have extended their range north to Maryland. There is some nesting in northeastern Florida and along the northern Gulf coast. Sandwich Terns winter in Argentina, Brazil, and Mexico.

Roseate Terns (*Sterna dougallii*) breed mainly along the northern Atlantic coast. Sporadic nesting occurs along the Mid-Atlantic coast including North Carolina, and regular breeding colonies are present in the Florida Keys. Wintering grounds are in Trinidad and off both coasts of South America. Roseate Terns could be present at Norfolk or Mayport as transients during fall migrations, but they are not expected to be present in the northern Gulf of Mexico. The Roseate Tern is endangered in the northeastern and Mid-Atlantic states including Virginia, and threatened in North and South Carolina, Georgia, and Florida.

Common Terns (*Sterna hirundo*) breed primarily in prairie marshes of north-central and northeastern North America, as well as Eurasia and Africa. Along the U.S. east coast, breeding areas are located from Maine south to North Carolina. Common Terns are present in North Carolina during summer

months but are more abundant during spring and fall migrations to and from wintering areas in the Caribbean and Central and South America. They are occasionally seen along Florida's Atlantic coast, primarily during fall migrations. They occur along the Alabama coast throughout the year but are most abundant during spring and fall migrations.

Arctic Terns (*Sterna paradisaea*) breed mainly in Alaska and Canada, with some breeding on the U.S. Atlantic coast in Maine and Massachusetts. They winter circumpolarly in antarctic and subantarctic waters and are not likely to be present at any of the test areas except as occasional spring or fall migrants transiting the Norfolk area.

Forster's Terns (*Sterna forsteri*) breed in the prairie marshes of north-central North America, in the Gulf of Mexico (especially Louisiana and Texas), and sporadically along the Atlantic coast including Virginia and North Carolina. Most of the world population winters in and near the Gulf of Mexico. They could be present at any of the test areas, primarily as migrants.

Least Terns (*Sterna antillarum*) breed commonly along the southeastern Atlantic and northern Gulf coasts and are most abundant from April through September. They winter along the northeastern coast of South America. Although the interior population of the Least Tern is listed as endangered, this designation does not apply to populations along the coast.

Bridled Terns (*Sterna anaethetus*) are found in the non-breeding season in offshore waters from the Carolinas to Florida. They breed in colonies in tropical waters of the Atlantic on rocky or sandy islands. They are abundant to common in waters off North Carolina in summer and fall. Similarly, they are casual late summer visitors (i.e., when surface temperatures reach a maximum) to shelf waters of the northern Chesapeake Bight. Bridled Terns occur regularly in some numbers in waters off Florida's Atlantic coast in summer and fall, with peak numbers in late April and May, and again in August and September. They are commonly observed offshore in the northern Gulf of Mexico.

Sooty Terns (*Sterna fuscata*) breed primarily in Florida, at Bush Key in the Dry Tortugas. They also breed in small numbers on the Chandeleur Islands in Louisiana and on islands along the Texas coast. Sooty Terns are uncommon visitors to waters off North Carolina in summer and early fall, and are most frequently observed following tropical storms and hurricanes. Sooty Terns occur frequently in waters off Florida's Atlantic coast from late summer through early fall. They are rarely seen in the northern Gulf except near the aforementioned breeding areas.

Black Terns (*Chlidonias niger*) are arctic birds that nest in freshwater marshes in the interior of North America. They could be present near the test areas during spring and fall migrations to wintering areas in South America. Some (non-breeding) individuals may also be present in coastal areas during summer months.

Black Skimmers (*Rynchops niger*) breed along the Atlantic coast from Massachusetts to east-central Florida as well as along the northern Gulf coast. They winter from southern North Carolina to Florida and in the Gulf of Mexico. Therefore, they could be present near any of the test areas during any season.

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APPENDIX C

IMPACT CALCULATIONS FOR MARINE MAMMALS AND TURTLES

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APPENDIX C
IMPACT CALCULATIONS FOR MARINE MAMMALS AND TURTLES

C.1 INTRODUCTION AND OBJECTIVES

The objective of this appendix is to provide a quantitative basis for comparing alternative test areas (Mayport, Norfolk, and Pascagoula) in the Final Environmental Impact Statement (FEIS). Minimizing the risk of killing or injuring a marine mammal or sea turtle is a major environmental consideration in choosing an acceptable test area. This risk is quantified in terms of probabilities of mammals and turtles occurring in the Safety Range (radius of 3.7 km or 2 nmi). Also, the appendix estimates numbers of marine mammals and turtles that may be killed or injured or experience temporary disruption of hearing-based behaviors as a result of the shock trial. In addition to providing a basis for comparing alternatives in the FEIS, the marine mammal numbers were used for the "incidental take request" submitted to the National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act (MMPA). There is no "incidental take request" required for turtles, but similar estimates were developed to treat the two groups consistently.

Impact calculations in this appendix are based on mammal and turtle densities derived from aerial and/or ship surveys described in Appendix B. Such surveys do not detect all of the population, because some animals are submerged and cannot be seen from aircraft or ships. For impact calculations, these density estimates have been adjusted to account for submerged individuals. Similarly, estimates of the likelihood of detecting mammals or turtles during pre-detonation monitoring take submergence into account.

The following discussion frequently refers to groups of marine mammals. Groups are the fundamental unit of marine mammal sightings during aerial and ship surveys. The density of groups (rather than individuals) is the appropriate basis for calculating risk because many cetacean species occur in herds. For example, consider two hypothetical test areas, one with 50 groups of 2 animals and the other with 2 groups of 50 animals. Assume that within each large test area, a small Safety Range (3.7 km [2 nmi] radius) will be selected. The risk of at least one group occurring within the Safety Range would be much greater in the first case because there are many more groups to encounter. Also, in the second case, a group occurring in the Safety Range would be easily detected, since large herds are highly visible. If only individual densities were compared, the two test areas would be considered equivalent, which is clearly not the case. The density of groups, along with mean group size, provides the appropriate basis for calculating risk, and ultimately, estimating numbers of individuals potentially affected by the proposed action.

C.2 APPROACH

Ultimately, four quantities are of interest:

1. The probability of zero marine mammal or turtle groups being present in the Safety Range. This is termed "**probability of clear range**" since it means the detonation could occur with no mammals or turtles present in the Safety Range. Presence refers to both detectable and non-detectable (submerged, silent) groups.

2. The probability of one or more groups being present in the Safety Range, and one or more groups being detected. This is termed "**probability of delay**" since detection of one or more groups would postpone detonation.
3. The probability of one or more groups being present in the Safety Range, but none detected. This is termed "**probability of take**" since it means a detonation could occur with mammals or turtles in the Safety Range.
4. The expected number of mammals (and turtles) within various radii of the detonation point (e.g., maximum horizontal ranges for mortality, injury, and disruption of hearing-based behaviors). This quantity is referred to as "**incidental take.**"

The probability of "clear range" is calculated from densities estimated during aerial and/or shipboard surveys. These numbers are adjusted to account for submerged individuals that would not have been detected. Resulting densities are multiplied by the area of the Safety Range to predict expected numbers of groups. With some assumptions about the spatial distribution of groups, probabilities of zero groups (or one or more groups) within the Safety Range can be calculated.

The probabilities of "take" and "delay" require additional information about the probability of detecting mammal and turtle groups during pre-detonation monitoring. This information comes from the design of the monitoring program (numbers and spacing of transects), as well as published data on sighting probabilities by aerial and shipboard observers. Information about submergence intervals of mammals and turtles is also needed to estimate the proportion of the population that is on the surface and therefore available for visual detection. The probability of "delay" is calculated by multiplying detection probabilities by the probability of one or more groups being present. The probability of "take" is calculated by subtraction, since the probabilities of "clear range," "delay" and "take" must sum to 1.0.

The following sections develop the basis for calculating the quantities of interest:

- <u>Impact Criteria, Thresholds and Ranges</u>. Criteria, thresholds, and ranges for mortality, injury, and disruption of hearing-based behaviors are summarized based on Appendices D and E. Impact areas are calculated using maximum ranges as radii.
- <u>Densities</u>. Density estimates for marine mammals and turtles in the three test areas are presented based on aerial and shipboard surveys. Densities are later adjusted to account for submerged (undetectable) individuals.
- <u>Mitigation Effectiveness</u>. Mitigation effectiveness is estimated for aerial, shipboard, and passive acoustic monitoring. Detection probabilities are calculated for each species of marine mammal and turtle.
- <u>Probability Analysis</u>. Based on adjusted densities, expected numbers of mammals and turtles in the Safety Range are calculated. These numbers are used to estimate the probability of zero mammal and turtles in the Safety Range (i.e., probability of "clear range"). Probabilities of presence and detection are then combined to calculate probability of mammals or turtles being present in Safety Range but undetected ("take") or present and detected ("delay").

- Incidental Take. Expected numbers of mammals and turtles within impact radii for mortality, injury, and disruption of hearing-based behaviors are calculated. These are multiplied by the maximum number of detonations (4) to estimate incidental take "without mitigation." Detection probabilities from the monitoring program are then factored in to estimate incidental take "with mitigation."

In the FEIS, marine mammal and turtle densities are listed to three decimal places, following the example of the GulfCet II report (Mullin and Hoggard, 2000). Due to the number of variables involved in the impact calculations and the inherent variability in estimating them, probabilities and incidental take estimates are calculated to three decimal places but rounded to two decimal places in the final calculation. Ultimately, numbers of marine mammals and turtles affected are rounded up to whole numbers of individuals.

C.3 IMPACT CRITERIA, THRESHOLDS, AND RANGES

This section summarizes the marine mammal and sea turtle impact criteria used for subsequent calculations. Mortality and injury criteria are discussed in detail in Appendix D, and auditory impact criteria are discussed in Appendix E. The following terminology is used in this Appendix:

- Criterion = specific impact that could be used to represent a broad type of impacts (mortality, injury, disruption of hearing-based behaviors). For example, onset of extensive lung hemorrhage is used in the FEIS as a criterion for mortality.
- Threshold = the specific level of sound pressure, impulse, or energy needed to cause the specific impact stated in a criterion. For example, the impulse associated with the predicted onset of extensive lung hemorrhage is 52.8 psi-msec (364 Pa-sec).
- Range = the maximum horizontal distance from the detonation point where the threshold level is predicted to occur. For example, the predicted range for onset of extensive lung hemorrhage under DDG 81 shock trial conditions is 4,434 ft (1,351 m).

Criteria, thresholds, and ranges for mortality, injury, and disruption of hearing-based behaviors are summarized in **Table C.1** and ranges are illustrated in **Figure C.1**.

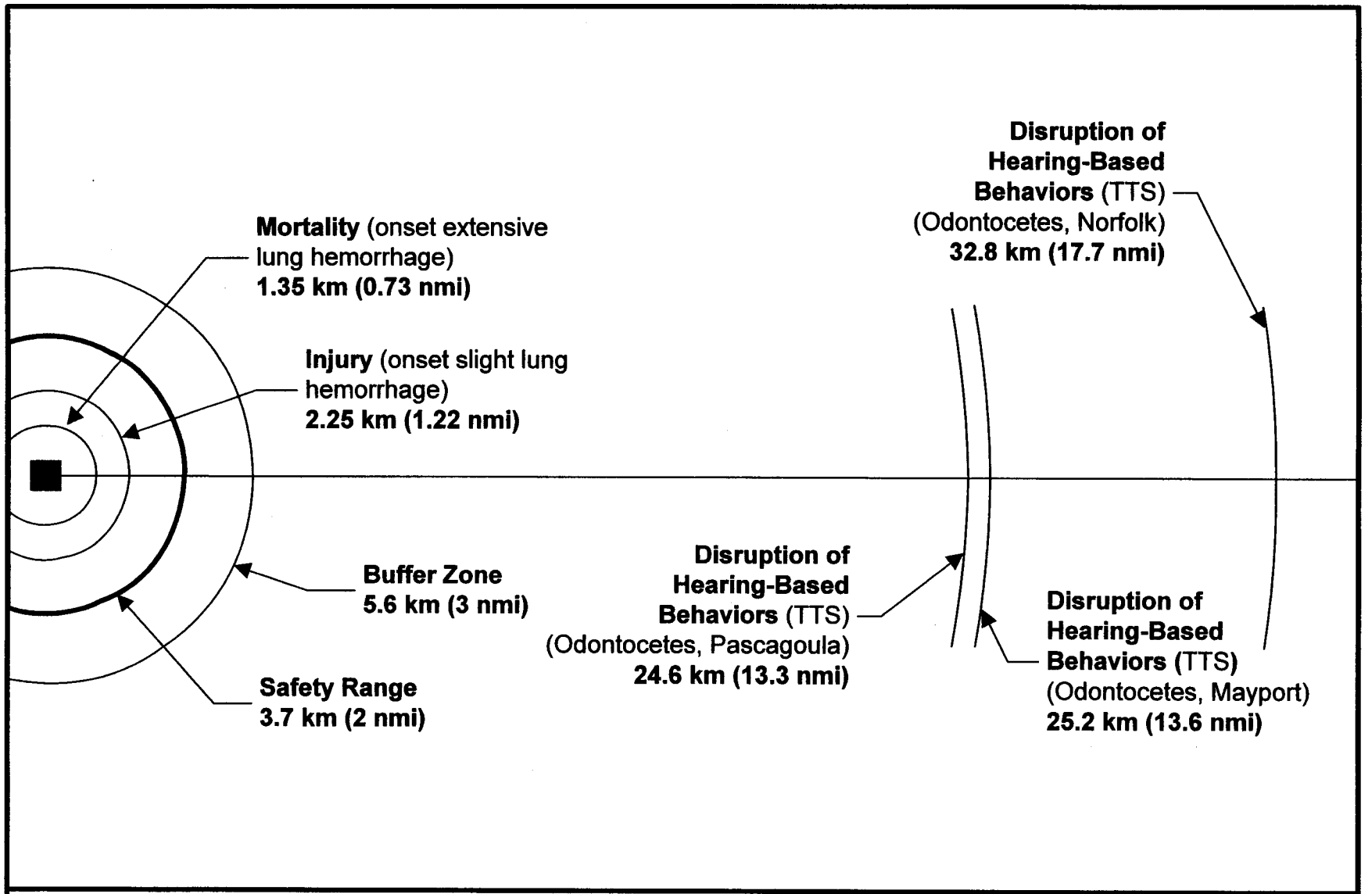

Figure C.1. Illustration of predicted ranges for various criteria in relation to the detonation point. Odontocete TTS rangesshown are the maximum for each test area regardless of water depth. TTS ranges for mysticetes are not shown (see Table C.1 for ranges).

Table C.1. FEIS impact criteria, thresholds, and ranges.

Impact Category	Criterion	Threshold	Range	
			Odontocetes and Sea Turtles	Mysticetes
Mortality	Onset of extensive lung hemorrhage	Impulse: 52.8 psi-msec (364 Pa-sec)	4,434 ft (1,351 m) (0.73 nmi)	
Injury	Onset of slight lung hemorrhage	Impulse: 25.3 psi-msec (175 Pa-sec)	7,383 ft (2,250 m) (1.22 nmi)	
Disruption of hearing-based behaviors	Temporary threshold shift (TTS)	182 dB energy in any 1/3 octave band or 12 psi peak pressure [a]	Mayport: [b] 13.3 to 25.2 km (7.2 to 13.6 nmi) Norfolk: [b] 16.7 to 32.8 km (9.0 to 17.7 nmi) Pascagoula: [b] 15.9 to 24.6 km (8.6 to 13.3 nmi)	Mayport: [b] 24.1 to 27.8 km (13.0 to 15.0 nmi) Norfolk: [b] 25.9 to 42.6 km (14.0 to 23.0 nmi) Pascagoula: [b] 22.8 to 29.6 km (12.3 to 16.0 nmi)

[a] Both energy and pressure were estimated in each case, with the more conservative of the two being used. In most cases, the 182 dB energy criterion was the determining factor.

[b] Separate onset TTS ranges were calculated using the 182 dB energy criterion for mysticetes vs. odontocetes and sea turtles. The odontocete/sea turtle ranges are based on frequencies ≥100 Hz and the mysticetes ranges are based on frequencies ≥10 Hz. Onset TTS ranges were calculated at three different water depths for each test area; the maximum and minimum ranges are given. Onset TTS range generally increased with water depth (but the maximum was not always at the greatest depth; see Appendix E).

C.4 MARINE MAMMAL AND TURTLE DENSITIES

Table C.2 summarizes data sources for calculating marine mammal and turtle densities. Additional information on the surveys and the basis for their selection is provided in Appendix B. Actual numbers of marine mammals and turtles occurring at a specific test site cannot be known in advance. The recent historical data used to represent the densities within the three test areas are considered the best available scientific data.

Table C.2. Data sources for marine mammal and turtle densities.

	Mayport	Norfolk	Pascagoula
Principal data source	• Mammals and turtles: New aerial surveys (June and August 1999)	• Mammals and turtles: SEAWOLF aerial surveys (Apr-Sept 1995)	• Mammals and turtles: GulfCet II aerial surveys, July-Aug 1996 and 1997 (subset for Pascagoula)
Secondary source(s) (for comparison)	• Mammals and turtles: SEAWOLF aerial surveys (Apr-Sept 1995 and May-Sept 1997)	• Mammals: NMFS *Abel-J* and *Pelican* cruises (July-August 1995) and CETAP aerial surveys (summer 1979-1981) • Turtles: CETAP aerial surveys (summer 1979-1981)	• Mammals and turtles: Other GulfCet data for the region

Aerial survey data were available for both the Mayport test area (new surveys were conducted in June and August 1999) and the Pascagoula test area (a subset of the GulfCet II data was obtained). For Norfolk, both aerial data (from 1995 SEAWOLF surveys) and shipboard data (from 1995 *Abel-J* and *Pelican* cruises) were considered for marine mammals (only the aerial data were available for turtles). Overall cetacean densities from the aerial and ship surveys were similar. The aerial data set was chosen for the impact analysis because it would be most comparable to the two other aerial data sets. Ship and aircraft surveys differ in the viewing time for a given length of transect, and therefore the correction for submerged animals differs substantially between aerial and ship surveys. To avoid having this "submergence correction" heavily influence the impact calculations, it is preferable to use all aerial data (or all ship data) rather than comparing aerial vs. ship surveys. An exception was made for sperm whale densities, which were much higher in the ship data. Because the ship surveys covered deeper water than the SEAWOLF aerial surveys (which were limited to the western edge of the test area), the high sperm whale densities are considered more representative of the test area. The high sperm whale densities in deep waters near the Norfolk test area are also confirmed by 1998 *Relentless* cruise results. Therefore, sperm whale densities from the ship surveys were used to represent the Norfolk test area. All other mammal and turtle species at Norfolk were represented by the SEAWOLF aerial data.

C.4.1 Density Comparisons: Marine Mammals

Table C.3 summarizes density estimates for marine mammals for the Mayport, Norfolk, and Pascagoula test areas. Mean group densities (groups sighted/100 km^2) were 3.596 at Norfolk, 2.094 at Mayport, and 1.004 at Pascagoula. Individual densities (individuals/100 km^2) were 50.970 at Norfolk, 18.480 at Pascagoula, and 18.033 at Mayport. Although group densities at Pascagoula were only about half those at Mayport, the difference was offset by larger average group sizes, producing nearly identical individual density estimates.

<u>Mayport</u>. Eight cetacean taxa were sighted during the Navy's June and August 1999 surveys. These were Atlantic spotted dolphin, bottlenose dolphin, bottlenose/Atlantic spotted dolphin, false killer whale, pilot whale, Risso's dolphin, unidentified dolphin, and unidentified odontocete. Mean group and individual densities were 2.094 groups/100 km^2 and 18.033 individuals/100 km^2. The most frequently sighted (groups/100 km^2) were bottlenose dolphin (1.326) and Risso's dolphin (0.655). These two taxa accounted for 95% of the total group and individual densities. No mysticetes were seen.

No sperm whales were seen during the 1999 surveys, but single sightings of two individuals each were made during both the 1995 and 1997 SEAWOLF surveys. No sperm whales were seen near the Mayport test area during the *Relentless* cruise (Roden, 1998). These results indicate that sperm whales may occur in the area, but infrequently or at low densities. Due to this species' endangered status and its occurrence on the two SEAWOLF surveys, sperm whale densities from the SEAWOLF 1997 surveys (0.017 groups/100 km^2) were used in the subsequent impact calculations. Otherwise, the 1999 survey data were used.

<u>Norfolk</u>. Nineteen cetacean taxa were sighted during the Navy's April-September 1995 SEAWOLF surveys at the Norfolk test area. Mean group and individual densities were 3.596 groups/100 km^2

Table C.3. Marine mammal densities for the three test areas based on aerial and shipboard surveys (page 1 of 2).

	MAYPORT			PASCAGOULA			NORFOLK		
	Navy Aerial Surveys June and August 1999			GulfCet II Aerial Surveys (subset) July-August 1996 and 1997			SEAWOLF 1995 Aerial Surveys Monthly April-September 1995		
	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size
MYSTICETES									
Fin whale	–	–	–	–	–	–	0.304	0.101	3.00
Fin/sei whale	–	–	–	–	–	–	–	–	–
Humpback whale	–	–	–	–	–	–	0.009	0.009	1.00
Minke whale	–	–	–	–	–	–	0.051	0.051	1.00
Sei whale	–	–	–	–	–	–	0.098	0.049	2.00
Sei/Bryde's whale	–	–	–	–	–	–	0.035	0.035	1.00
Balaenoptera sp.	–	–	–	–	–	–	0.056	0.021	2.67
ODONTOCETES									
Atlantic spotted dolphin	0.095	0.016	6.00	0.263	0.022	12.00	9.534	0.672	14.19
Beaked whales*	–	–	–	–	–	–	–	–	–
Bottlenose dolphin	10.126	1.326	7.64	4.420	0.370	11.93	6.862	0.380	18.08
Bottlenose/Atl.spotted dolphin	0.160	0.018	8.67	0.344	0.031	11.00	0.343	0.043	8.00
Clymene dolphin	–	–	–	8.357	0.056	150.00	–	–	–
Common dolphin	–	–	–	–	–	–	0.360	0.002	155.00
Dwarf/pygmy sperm whale	–	–	–	0.524	0.384	1.36	–	–	–
False killer whale	0.047	0.006	8.00	–	–	–	–	–	–
Pantropical spotted dolphin	–	–	–	0.682	0.013	50.78	2.116	0.030	70.00
Pilot whale	0.420	0.034	12.33	–	–	–	16.173	1.552	10.42
Pygmy killer whale	–	–	–	–	–	–	–	–	–
Risso's dolphin	7.000	0.655	10.69	0.146	0.017	8.50	1.947	0.065	29.75
Rough-toothed dolphin	–	–	–	–	–	–	–	–	–
Sperm whale	–	–	–	0.034	0.024	1.40	0.040	0.030	1.33
Spinner dolphin	–	–	–	1.575	0.009	170.66	6.792	0.030	225.00
Striped dolphin	–	–	–	2.136	0.076	28.00	0.230	0.010	24.00
Stenella spp.**	–	–	–	–	–	–	1.424	0.063	22.50
Unidentified dolphin	0.179	0.033	5.40	–	–	–	4.581	0.436	10.52
Unidentified odontocete	0.005	0.005	1.00	–	–	–	–	–	–
Unidentified small whale	–	–	–	–	–	–	–	–	–
UNDETERMINED									
Unidentified large whale	–	–	–	–	–	–	0.017	0.017	1.00
TOTAL	**18.033**	**2.094**		**18.480**	**1.004**		**50.970**	**3.596**	

*includes *Mesoplodon* spp. and/or *Ziphius cavirostris*

**includes clymene, spinner, and striped dolphins

Table C.3. Marine mammal densities for the three test areas based on aerial and shipboard surveys (page 2 of 2).

	MAYPORT (secondary) SEAWOLF 1997 Aerial Surveys Monthly May-September 1997			MAYPORT (secondary) SEAWOLF 1995 Aerial Surveys Monthly April-September 1995			NORFOLK (secondary) Pelican & Able-J Cruises July-August 1995		
	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size	Individuals/ 100 km^2	Groups/ 100 km^2	Avg Group Size
MYSTICETES									
Fin whale	–	–	–	–	–	–	–	–	–
Fin/sei whale	–	–	–	–	–	–	0.326	0.163	2.00
Humpback whale	–	–	–	–	–	–	–	–	–
Minke whale	–	–	–	–	–	–	–	–	–
Sei whale	–	–	–	–	–	–	–	–	–
Sei/Bryde's whale	–	–	–	–	–	–	–	–	–
Balaenoptera sp.	–	–	–	–	–	–	–	–	–
ODONTOCETES									
Atlantic spotted dolphin	0.240	0.022	11.14	1.049	0.059	17.82	0.263	0.006	42.40
Beaked whales*	–	–	–	–	–	–	0.648	0.278	2.33
Bottlenose dolphin	4.069	0.595	6.84	0.966	0.105	9.22	7.696	0.639	12.05
Bottlenose/Atl.spotted dolphin	1.378	0.205	6.73	0.377	0.065	5.80	–	–	–
Clymene dolphin	–	–	–	–	–	–	–	–	–
Common dolphin	–	–	–	–	–	–	0.027	0.001	42.00
Dwarf/pygmy sperm whale	–	–	–	–	–	–	0.026	0.013	2.00
False killer whale	–	–	–	–	–	–	–	–	–
Pantropical spotted dolphin	0.005	0.001	4.00	1.391	0.068	20.33	–	–	–
Pilot whale	0.228	0.011	20.00	–	–	–	3.324	0.319	10.43
Pygmy killer whale	–	–	–	–	–	–	0.015	0.008	2.00
Risso's dolphin	1.870	0.261	7.16	0.519	0.023	23.00	1.325	0.131	10.10
Rough-toothed dolphin	0.002	0.0004	6.50	–	–	–	–	–	–
Sperm whale	0.035	0.017	2.00	–	–	–	2.396	1.116	2.15
Spinner dolphin	0.030	0.003	9.00	0.737	0.015	50.00	–	–	–
Striped dolphin	–	–	–	–	–	–	28.780	0.510	56.39
Stenella spp.**	0.102	0.004	29.00	0.347	0.024	14.25	0.022	0.007	3.19
Unidentified dolphin	1.254	0.180	6.96	1.491	0.233	6.39	10.080	0.380	26.55
Unidentified odontocete	–	–	–	–	–	–	0.016	0.016	1.00
Unidentified small whale	–	–	–	–	–	–	0.180	0.091	1.98
UNDETERMINED									
Unidentified large whale	–	–	–	–	–	–	0.122	0.075	1.63
TOTAL	**9.212**	**1.300**		**6.877**	**0.592**		**55.247**	**3.751**	

*includes *Mesoplodon* spp. and/or *Ziphius cavirostris*

**includes clymene, spinner, and striped dolphins

and 50.970 individuals/100 km^2. The most frequently sighted (groups/100 km^2) were pilot whales (1.552), Atlantic spotted dolphin (0.672), unidentified dolphin (0.436), and bottlenose dolphin (0.380). These four taxa accounted for 85% of groups sighted. The most abundant taxa (individuals/100 km^2) were pilot whales (16.173), Atlantic spotted dolphin (9.534), bottlenose dolphin (6.862), and spinner dolphin (6.792), which together accounted for 77% of the total. Large mean group sizes were observed for spinner dolphin (225), common dolphin (155), and pantropical spotted dolphin (70). Sperm whales and several species of mysticetes (fin, humpback, minke, sei, and possibly Bryde's whales) were seen. Fin whales were the most abundant of the large whales (0.101 groups/100 km^2).

Sixteen taxa were sighted during the 1995 *Abel-J* and *Pelican* cruises. Mean group and individual densities were 3.751 groups/100 km^2 and 55.247 individuals/100 km^2. The most frequently sighted (groups/100 km^2) identified taxa were sperm whale (1.116), bottlenose dolphin (0.639), striped dolphin (0.510), and pilot whale (0.319). These four taxa plus unidentified dolphins accounted for about 80% of the total group densities. Due to its large group sizes, striped dolphin had the highest individual density (28.780 individuals/100 km^2), accounting for about half of the total, followed by bottlenose dolphin (7.696 individuals/100 km^2).

As noted previously, the SEAWOLF aerial data were used for impact calculations in order to provide the best comparison with the aerial data sets for the other two test areas. However, the high sperm whale densities observed during the *Abel-J* and *Pelican* cruises were considered more representative of the test area, and therefore sperm whale densities from the ship surveys were used for impact analysis. All other species were represented by the SEAWOLF aerial data.

<u>Pascagoula</u>. Ten cetacean taxa were sighted during the summer 1996 and 1997 GulfCet II surveys in the Pascagoula test area. Mean group and individual densities were 1.004 groups/100 km^2 and 18.480 individuals/100 km^2. The most frequently sighted (groups /100 km^2) were dwarf/pygmy sperm whale (0.384) and bottlenose dolphin (0.370). These two taxa accounted for 75% of all sightings. Sperm whales were the only large whales seen. The most abundant taxa were clymene dolphin, bottlenose dolphin, and striped dolphin, together accounting for 81% of individuals sighted. Spinner dolphin, clymene dolphin, and pantropical spotted dolphin had large average group sizes (171, 150, and 51, respectively).

The only large whale seen at the Pascagoula test area was the sperm whale. Bryde's whale is the only other large whale likely to occur there. This is the only mysticete seen regularly in the Gulf of Mexico, and there were two sightings in spring near the Pascagoula test area during GulfCet II ship surveys (Mullin and Hoggard, 2000). The mean density of Bryde's whale on the continental slope, based on shipboard surveys during spring 1996-1997, was 0.041 individuals/100 km^2 (Mullin and Hoggard, 2000). This value was used for subsequent impact analysis. For all other species, the aerial survey data were used.

Species with No Density Estimates. The following species are considered likely to occur at the respective test areas (from FEIS Table 3.1) but were not seen during the surveys used to develop density estimates. The absence of these species may reflect submergence (including aircraft avoidance), low density, and/or patchy distribution and abundance. Species not seen during aerial surveys are taken into account in the incidental take calculations by assuming that 1 individual of each species would experience disruption of hearing-based behaviors. The exceptions are sperm whale at Mayport (for which SEAWOLF 1997 density estimates were used) and Bryde's whale at Pascagoula (for which a density estimate from GulfCet II ship surveys was used).

Species for which no density estimate was developed:

Mayport (12 species)	Norfolk (9 species)	Pascagoula (7 species)
• dwarf sperm whale • pygmy sperm whale • Blainville's beaked whale • Cuvier's beaked whale • Gervais' beaked whale • True's beaked whale • clymene dolphin • pantropical spotted dolphin • pygmy killer whale • rough-toothed dolphin • spinner dolphin • striped dolphin	• dwarf sperm whale • pygmy sperm whale • Blainville's beaked whale • Cuvier's beaked whale • Gervais' beaked whale • True's beaked whale • false killer whale • pygmy killer whale • rough-toothed dolphin	• Blainville's beaked whale • Cuvier's beaked whale • Gervais' beaked whale • false killer whale • pygmy killer whale • pilot whale • rough-toothed dolphin

C.4.2 Density Comparisons: Sea Turtles

Table C.4 summarizes density estimates for sea turtles for the Mayport, Norfolk, and Pascagoula test areas. Nearly all turtle sightings are solitary animals and therefore individual (rather than group) densities are appropriate for comparison. Mean densities (turtles/100 km^2) were highest at Norfolk (0.633) and about equal at Mayport (0.288) and Pascagoula (0.258).

Mayport. Two turtle species, leatherback and loggerhead, were sighted during the June and August 1999 surveys. Unidentified turtles were also sighted. Leatherbacks and loggerheads accounted for 56% and 30%, respectively, of the total density of 0.288 turtles/100 km^2.

Norfolk. Loggerhead, leatherback, and unidentified turtles were sighted during the April through September 1995 SEAWOLF surveys at Norfolk. Loggerhead turtles accounted for 96% of the total density of 0.633 turtles/100 km^2.

Pascagoula. Leatherback and unidentified turtles were sighted during the July-August 1996 and 1997 GulfCet II surveys in the Pascagoula test area. Leatherbacks had the higher density, accounting for 79% of the total of 0.258 turtles /100 km^2.

Species with No Density Estimates. Green, hawksbill, and Kemp's ridley turtles were not seen during aerial surveys of any test area. One hawksbill turtle was sighted during the *Abel-J* cruise north of the Norfolk test area, but no turtle density estimates were developed from shipboard

Table C.4. Sea turtle densities for the three test areas based on aerial surveys.

	MAYPORT			PASCAGOULA			NORFOLK		
	Navy Aerial Surveys June & August 1999			GulfCet II Aerial Surveys July-August 1996 and 1997			SEAWOLF Aerial Surveys Monthly April-September 1995		
	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size
Leatherback turtle	0.162	0.162	1	0.203	0.203	1	0.006	0.006	1.00
Loggerhead turtle	0.086	0.086	1	--	--	--	0.608	0.594	1.02
Unidentified turtle	0.040	0.040	1	0.055	0.055	1	0.018	0.018	1.00
TOTAL	**0.288**	**0.288**		**0.258**	**0.258**		**0.633**	**0.618**	

	MAYPORT (secondary)			MAYPORT (secondary)		
	SEAWOLF 1997 Aerial Surveys Monthly May-September 1997			SEAWOLF 1995 Aerial Surveys Monthly April-September 1995		
	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size	Mean Individuals/ 100 km^2	Mean Groups/ 100 km^2	Mean Group Size
Leatherback turtle	0.423	0.423	1	0.023	0.023	1
Loggerhead turtle	1.208	1.208	1	0.783	0.771	1.02
Unidentified turtle	0.149	0.149	1	0.023	0.023	1
TOTAL	**1.780**	**1.780**		**0.830**	**0.818**	

sightings. These species are not likely to be present at any of the test areas as adults, although juveniles may be present in association with *Sargassum* rafts. Species not seen during aerial surveys were taken into account in the impact calculations by assuming that 1 individual of each species would experience disruption of hearing-based behaviors.

C.5 MITIGATION EFFECTIVENESS

The pre-detonation monitoring program for mammals and sea turtles has three main components: aerial, shipboard, and passive acoustic monitoring. Effectiveness of each monitoring component is defined as the proportion of marine mammal (or turtle) groups present that are expected to be detected. Visual monitoring (aerial and shipboard) is subject to the limitation that it can only detect animals at or near the surface. Passive acoustic monitoring is designed to detect submerged sperm whales and mysticetes, but only if they are making sounds. Together, these monitoring techniques offer the possibility of detecting most marine mammals at the test areas. Most adult sea turtles will not be detected because they spend most of their time submerged and are silent.

Pre-detonation aerial monitoring includes two parts (see FEIS Section 5.0). First is the monitoring of the 10 x 15 nmi test cell, consisting of 16 transects, each 18.5 km (10 nmi) long, at a line spacing of 1.85 km (1 nmi). After this is complete, the aircraft would return to the starting point and maintain its position 2.8 km (1.5 nmi) ahead of the WINSTON S. CHURCHILL by flying 11.1 km (6 nmi) transects perpendicular to the ship's course at a line spacing of 0.9 km (0.5 nmi). Just before detonation, the aircraft would return to fly over the ship. Shipboard monitoring consists of observers onboard the WINSTON S. CHURCHILL, which by definition would be near the detonation point (center of the Safety Range) at all times.

C.5.1 Effective Strip Width

To estimate the probability of detecting animals on the surface, an Effective Strip Width (ESW) was estimated for both aerial and shipboard monitoring. ESW is a quantity derived from analysis of aerial survey data (Buckland et al., 1993). During marine mammal and turtle surveys, sighting probability varies with perpendicular distance from the aircraft or ship. A sighting probability function is developed to describe this variation. Densities of sightings are estimated using f(0), which is the sighting probability function evaluated at zero perpendicular distance. The half-strip width (μ) is the reciprocal of f(0), and it is the width such that, if all groups were detected out to this distance to either side of the aircraft or ship and none were detected beyond it, then the expected number of groups would be the same as for the actual survey. This provides a strip width that can be used to estimate the area effectively monitored. For aerial monitoring, the half-strip width was multiplied by two since observers can detect to either side of the airplane (i.e., ESW = 2μ). For shipboard monitoring, the original half-strip width (μ) = ESW/2 was used since, rather than defining a strip to either side of the ship's course, the value was used to define a radius around the ship.

Data to estimate ESW are available from aerial and shipboard surveys that provided the density data for the test areas. However, since individual surveys often have only a few sightings of each species, it is preferable to estimate ESW from a larger data set (Buckland et al., 1993). Estimates produced during the GulfCet II program (Mullin and Hoggard, 2000) were used as described below.

Table C.5 presents ESW estimates from the GulfCet II aerial surveys. GulfCet used a Twin Otter aircraft with bubble windows, and a similar aircraft would be used for the shock trial and flown at the same altitude. Therefore, the GulfCet sighting probabilities are assumed to be reasonable for estimating strip widths during pre-detonation monitoring. The GulfCet II values are also assumed to be reasonable for the 1999 Mayport aerial surveys and the 1997 SEAWOLF aerial surveys. Both of those surveys used a Partenavia aircraft with bubble windows (similar to the Twin Otter) and were flown at the same altitude and air speed as the GulfCet II surveys. The 1995 SEAWOLF surveys at Norfolk used a different aircraft (Cessna) that did not have bubble windows, creating a "blind spot" beneath the plane. The possible differences in ESW for the 1995 SEAWOLF surveys do not have any significant effect in the calculations in this appendix.

For shipboard monitoring, the ESW values for shipboard GulfCet II surveys were used, as summarized in **Table C.6**. A shipboard ESW was not estimated for turtles, and a value of zero was assumed for purposes of calculation even though some turtles may be detected by shipboard observers. The half-strip width (μ=ESW/2) values were used to define a radius of 100% detection around the ship. Note that the GulfCet numbers were estimated using two observers, whereas the shipboard monitoring team would include four observers (two with Bigeye binoculars and two with handheld binoculars), which could improve detection. Bridge height may also differ between the GulfCet survey vessel and the WINSTON S. CHURCHILL.

Table C.5. Effective strip width (ESW) for detection of marine mammals and turtles based on GulfCet II aerial surveys (From: Mullin and Hoggard, 2000).

Group	Species Included	ESW (km)
Large whales	Sperm whale Bryde's whale Unidentified large whale	1.224
Cryptic whales	Dwarf/pygmy sperm whale Beaked whales Unidentified small whale Unidentified odontocete Unidentified dolphin	0.697
Small whales/large dolphins	False killer whale Pygmy killer whale Pilot whale Atlantic spotted dolphin Bottlenose dolphin Risso's dolphin Rough-toothed dolphin	0.775
Small dolphins	Pantropical spotted dolphin Clymene dolphin Spinner dolphin Striped dolphin	0.797
Sea turtles	Leatherback turtle Loggerhead turtle	0.559

Table C.6. Effective half-strip width (μ) for detection of marine mammals based on GulfCet II shipboard surveys (From: Mullin and Hoggard, 2000).

Group	Species Included	μ=ESW/2 (km)
Large whales	Sperm whale Bryde's whale Unidentified large whale	2.141
Cryptic whales	Dwarf/pygmy sperm whale Beaked whales Unidentified small whale Unidentified odontocete Unidentified dolphin	1.235
Small whales/large dolphins	False killer whale Pygmy killer whale Pilot whale Atlantic spotted dolphin Bottlenose dolphin Risso's dolphin Rough-toothed dolphin	1.799
Small dolphins	Pantropical spotted dolphin Clymene dolphin Spinner dolphin Striped dolphin	1.672
Unidentified dolphin	Unidentified dolphin	2.222

C.5.2 Submergence (Availability Bias)

The ESW values refer only to detection of animals present on the surface, i.e., those that are potentially detectable by observers. A certain proportion of the population is submerged and is therefore unavailable for visual detection. This is referred to as "availability bias" (Marsh and Sinclair, 1989).

To correct for availability bias, the probability of detecting a marine mammal on the surface must be multiplied by the probability of the species being present on the surface. Similarly, observed densities can be corrected for availability bias by dividing them by the proportion of time the species is present on the surface within the viewing range. For example, if a species is on the surface 10% of the time, the observed density would be divided by 0.1 (i.e., multiplied by 10). For species with long dive times, the simplest estimate is the mean proportion of time the animal spends at the surface. However, for species with short dive times and surface intervals, the time within the range of the aerial (or shipboard) observer becomes a significant factor. The probability of being on surface during this time interval (t) is given by Eberhardt et al. (1979) and Barlow et al. (1988) as follows:

$$S_t = (s + t)/(s + d) \qquad \textit{[Equation 1]}$$

where S_t = probability of being on surface within the viewing interval (t); s = mean surface time; and d = mean dive time. The equation can also be expressed as:

$$S_t = [s/(s + d)] + [t/(s+d)] \qquad \textit{[Equation 2]}$$

$$\text{i.e., } S_t = (\text{proportion of time on surface}) + [\, t / (s+d) \,]$$

The viewing interval (t) can be estimated based on the ESW values and ship or aircraft speed. For aerial surveys, assuming that an observer can effectively sight animals one-half ESW in front of and behind the aircraft, a given point would be in view for about the time it takes to cover one ESW. Aerial surveys are conducted at a speed of 110 kts, or 204 km/hour. The ESW for large whales would be covered in about 22 seconds. The ESW for small whales/large dolphins, small dolphins, and cryptic whales would be covered in about 12 to 14 seconds. The ESW for turtles would be covered in about 10 seconds.

For shipboard monitoring, a speed of 7.5 kts (13.9 km/hour) is assumed. This is the maximum speed that the WINSTON S. CHURCHILL will be moving during pre-detonation monitoring and is slightly less than the typical speed during shipboard marine mammal surveys. The ESW for large whales would be covered in about 18.5 minutes. The ESW for cryptic whales would be covered in about 11 minutes. The ESW for small whales/large dolphins and small dolphins would be covered in about 14 to 15 minutes.

Sperm Whales. For sperm whales, according to Barlow and Sexton (1996), "the proportion of time spent during surfacing series is relatively constant at 17%" despite a wide range of dive times. This is based on Caldwell et al. [1966, as cited in Leatherwood et al. (1982)]. Median dive time (d) and surface time (s) are assumed to be about 20 minutes and 4 minutes, respectively (Barlow and Sexton, 1996). Based on an aerial viewing interval (t) of 0.36 minutes, *Equation 1* predicts the probability of being on surface during an aerial survey is about 0.20. For shipboard detection, the viewing interval is 18.5 minutes and *Equation 1* predicts the probability of being on surface during the viewing interval would be 0.95. Because sperm whales can sometimes have significantly longer dive times than used for this calculation, a conservative value of 0.75 is used.

Other Large Whales. Mysticetes (the only other large whales other than sperm whales) are estimated to be on the surface about 10% to 40% of the time (Leatherwood et al., 1982; Winn, 1982; Calambokidis et al., 1989; Stern, 1992; Kopelman and Sadove, 1995). Using 20% as a starting point and assuming a typical surface plus dive time of 10 minutes or less, the probability of being on the surface during the aerial viewing interval (0.36 minutes) would be 0.20 or less, based on Equation 2. With a shipboard viewing interval of 18.5 minutes and surface plus dive times typically of 10 minutes or less, the probability of being on surface at least once during the shipboard viewing interval should be close to 1.0, based on Equation 2. A conservative estimate of 0.75 is used.

Cryptic Whales. Based on dive interval studies by Barlow et al. (1997), beaked whales and dwarf/pygmy sperm whales are expected to be on the surface about 10% of the time. With an aerial viewing interval of about 12 seconds and combined dive plus surface times of 20 to 30 minutes, the probability of being on surface during the aerial viewing interval is assumed to be about the same as the proportion of time on surface, or 0.10. With a shipboard viewing interval of about 11 minutes and surface plus dive times assumed to be 20 to 30 minutes, the probability of being on surface at least once during the shipboard viewing interval is estimated to be 0.50.

Small Whales, Large Dolphins, and Small Dolphins. Small odontocetes typically have short dive intervals (a few seconds to a few minutes) and are on the surface 30% to 80% of the time (Evans, 1974; Barlow et al., 1988; Mate et al., 1994). The aerial viewing interval is 12 to 14 seconds. A reasonable estimate for the probability of being on surface during the aerial viewing interval is 0.50. The shipboard viewing interval is 14 to 15 minutes, making the probability of being on the surface at least once during this interval essentially 1.0. Some of the species in this category form large groups in which individual dive times are not synchronized, increasing the likelihood of at least one individual being on the surface at a given time (thereby allowing detection of the rest of the group). A conservative value of 0.90 is used.

Sea Turtles. Keinath et al. (1996) tagged loggerhead sea turtles off the North Carolina coast and found that they spent 10.6% of their time on the surface. A similar value of 0.10 (i.e., 10%) was used in the SEAWOLF EIS based on personal communication with a sea turtle expert (Thompson, 1996). For leatherbacks, Keinath and Musick (1993) reported that tagged animals at St. Croix, U.S. Virgin Islands, spent about 13% of their time on the surface. Other authors have reported higher values of 33% (Eckert et al., 1989), 40%-48% (Eckert et al., 1986), and 23%-64% (Standora et al., 1984). There is some difficulty in applying these values to aerial detection, because telemetric data may only indicate that a turtle is "near" the surface -- i.e., it might not be visible from an aircraft.
A conservative value of 0.10 (i.e., 10%) was used for all sea turtles. Since dive times can be long and the aerial viewing interval would be about 10 seconds, the probability of being available for aerial detection was assumed equal to the proportion of time on surface, or 0.10. Shipboard detection was assumed to be zero, even though some turtles may be sighted by shipboard observers.

C.5.3 Effectiveness Calculations

Table C.7 summarizes mitigation effectiveness calculations for various categories of marine mammals and sea turtles. Effectiveness of individual components (aerial monitoring of the test cell, aerial monitoring of the Safety Range, shipboard monitoring, passive acoustic monitoring) are discussed below.

Aerial Monitoring, 1 nmi Spacing. To estimate the probability of detecting animals on the surface, the line length of the monitoring transects during each pre-detonation effort was summed and then multiplied by the ESW for each species group. The initial monitoring of the 10 x 15 nmi test cell consists of 16 transects at 1.85 km (1 nmi) spacing, each transect being 18.5 km (10 nmi) long (excluding turns, which are outside the test cell), for a total length of 296.3 km (160 nmi). Using the "small whale/large dolphin" category as an example, the ESW value of 0.775 km would yield a total coverage of 229.6 km^2. The total area of the 10 x 15 nmi test cell is 514.4 km^2. Therefore, the proportion of the test cell covered would be 229.6/514.4, or 0.446. This value was multiplied by the proportion of the population estimated to be available for aerial detection (previously estimated to be 0.50). Therefore, the proportion of small whale/large dolphin groups detected by this component of the aerial monitoring is 0.223. In other words, it is expected that 22.3% of "small whale/large dolphin" groups would be detected by aerial monitoring of the test cell using 1 nmi line spacing.

Table C.7. Estimated mitigation effectiveness of pre-detonation monitoring in detecting marine mammals and turtles (page 1 of 4).

	AERIAL MITIGATION IN 10 x 15 nm TEST CELL (1 nmi spacing)						
	Effective Strip Width (km)	Mit. Transect Length (km) in 10x15 cell	Mit. Coverage (Length x strip width) (km2)	Total Area of 10x15 cell (km2)	Proportion of 10x15 cell Covered	Proportion Available for Detection	Proportion Expected to Be Detected
Sperm whale	1.224	296.3	362.67	514.4	0.705	0.20	**0.141**
Other large whales	1.224	296.3	362.67	514.4	0.705	0.20	**0.141**
Cryptic whales [a]	0.697	296.3	206.52	514.4	0.401	0.10	**0.040**
Small whale/large dolphin [b]	0.775	296.3	229.63	514.4	0.446	0.50	**0.223**
Small dolphin [c]	0.797	296.3	236.15	514.4	0.459	0.50	**0.230**
Unidentified dolphin	0.697	296.3	206.52	514.4	0.401	0.50	**0.201**
Sea turtles	0.559	296.3	165.63	514.4	0.322	0.10	**0.032**
[a] includes beaked whales, dwarf/pygmy sperm whale [b] includes Atlantic spotted, bottlenose, Risso's, and rough-toothed dolphins and pilot whales [c] includes clymene, spinner striped, pantropical spotted dolphins	From GulfCet II data set					See text for explanation	**(A)**

Table C.7. Estimated mitigation effectiveness of pre-detonation monitoring in detecting marine mammals and turtles (page 2 of 4).

	AERIAL MITIGATION IN SAFETY RANGE (0.5 nmi spacing)						
	Effective Strip Width (km)	Mit. Transect Length (km) in Safety Range	Mit. Coverage (Length x strip width) (km2)	Total Area SafetyRange (km2)	Proportion of Safety Range Covered	Proportion Available for Detection	Proportion Expected to Be Detected
Sperm whale	1.224	39.39	48.21	43.10	1.119	0.20	**0.224**
Other large whales	1.224	39.39	48.21	43.10	1.119	0.20	**0.224**
Cryptic whales [a]	0.697	39.39	27.45	43.10	0.637	0.10	**0.064**
Small whale/large dolphin [b]	0.775	39.39	30.53	43.10	0.708	0.50	**0.354**
Small dolphin [c]	0.797	39.39	31.39	43.10	0.728	0.50	**0.364**
Unidentified dolphin	0.697	39.39	27.45	43.10	0.637	0.50	**0.319**
Sea turtles	0.559	39.39	22.02	43.10	0.511	0.10	**0.051**
[a] includes beaked whales, dwarf/pygmy sperm whale	From GulfCet II data set				Values >1.0 indicate overlapping coverage	See text for explanation	**(B)**
[b] includes Atlantic spotted, bottlenose, Risso's, and rough-toothed dolphins and pilot whales							
[c] includes clymene, spinner striped, pantropical spotted dolphins							

Table C.7. Estimated mitigation effectiveness of pre-detonation monitoring in detecting marine mammals and turtles (page 3 of 4).

	SHIPBOARD MONITORING					
	Effective Strip Width (km)	Mit. Coverage (km2) with strip width as radius	Total Area SafetyRange (km2)	Proportion of Safety Range Covered	Proportion Available for Detection	Proportion Expected to Be Detected
Sperm whale	2.141	14.40	43.10	0.334	0.75	**0.251**
Other large whales	2.141	14.40	43.10	0.334	0.75	**0.251**
Cryptic whales [a]	1.235	4.79	43.10	0.111	0.50	**0.056**
Small whale/large dolphin [b]	1.799	10.17	43.10	0.236	0.90	**0.212**
Small dolphin [c]	1.672	8.78	43.10	0.204	0.90	**0.183**
Unidentified dolphin	2.222	15.51	43.10	0.360	0.90	**0.324**
Sea turtles	0	0.00	43.10	0.000	0.10	**0.000**
[a] includes beaked whales, dwarf/pygmy sperm whale	From GulfCet II data set				See text for explanation	**(C)**

[b] includes Atlantic spotted, bottlenose, Risso's, and rough-toothed dolphins and pilot whales

[c] includes clymene, spinner striped, pantropical spotted dolphins

Table C.7. Estimated mitigation effectiveness of pre-detonation monitoring in detecting marine mammals and turtles (page 4 of 4).

	Combined Aerial Detection Probability	Combined Aerial+Ship Detection Probability	Proportion Detected by Passive Acoustic Monitoring	OVERALL PROPORTION DETECTED (aerial, ship & acoustic)
Sperm whale	0.333	0.500	0.75	0.88
Other large whales	0.333	0.500	0.25	0.63
Cryptic whales [a]	0.101	0.151	0	0.15
Small whale/large dolphin [b]	0.498	0.605	0	0.60
Small dolphin [c]	0.510	0.600	0	0.60
Unidentified dolphin	0.455	0.632	0	0.63
Sea turtles	0.082	0.082	0	0.08
	(D) Equals A+(B(1-A))	(E) Equals D+(C(1-D))	(F)	(G) Equals E+(F*(1-E)) (rounded to two decimals)

[a] includes beaked whales, dwarf/pygmy sperm whale

[b] includes Atlantic spotted, bottlenose, Risso's, and rough-toothed dolphins and pilot whales

[c] includes clymene, spinner striped, pantropical spotted dolphins

Aerial Monitoring, 0.5 nmi Spacing (Safety Range). The same logic was applied to the Safety Range monitoring, which consists of transects at 0.5 nmi spacing. The aircraft would remain three lines ahead of the DDG 81, but just prior to detonation would return to fly a transect over the ship, which would continue moving forward. Therefore at the moment of detonation, it would have covered two transects ahead of the ship, or a total of six transects passing through the Safety Range (as defined by the 2 nmi radius around the charge at that moment) (**Figure C.2**). Total transect length is 39.39 km. Again using "small whales/large dolphins" as an example, the ESW of 0.775 km would yield a total coverage of 30.53 km^2, which is 0.708 of the total area within the Safety Range (43.10 km^2). This value was multiplied by the proportion of the population estimated to be available for aerial detection (previously estimated to be 0.50). Therefore, the proportion of small whale/large dolphin groups detected by this component of the aerial monitoring is 0.354. In other words, it is expected that 35.4% of "small whale/large dolphin" groups within the Safety Range would be detected by aerial monitoring using the 0.5 nmi line spacing.

Shipboard Monitoring. For shipboard monitoring, the ESW values for shipboard GulfCet II surveys were used, as summarized in **Table C.6**. A shipboard ESW was not estimated for turtles, and a value of zero was assumed for purposes of calculation even though some turtles may be detected by shipboard observers. The half-strip width (μ=ESW/2) values were used to define a radius of 100% detection around the ship. For example, for the "small whale/large dolphin" category, using the μ value of 1.799 km as radius would define an area of 10.17 km^2, which is 0.236 times the Safety Range area of 43.10 km^2. This value was multiplied by the proportion of the population estimated to be available for shipboard detection (previously estimated to be 0.90). Therefore, the proportion of small whale/large dolphin groups detected by this component of the aerial monitoring is 0.212. In other words, it is expected that 21.2% of "small whale/large dolphin" groups within the Safety Range would be detected by shipboard monitoring.

Aerial and Shipboard Combined. The combined probability of aerial and shipboard detection can be calculated if the individual probabilities are assumed to be independent. Independence of aerial and shipboard monitoring is a reasonable assumption since these are independent platforms. For the two aerial monitoring components, independence is also a reasonable assumption due to water and animal movement between successive passes over the same geographic area. For the "small whale/large dolphin" category, 22.3% of groups would be detected during test cell monitoring using 1 nmi line spacing; 35.4% of the remaining groups would be detected during Safety Range monitoring using the 0.5 nmi line spacing. The combined probability of aerial detection is:

$$0.223 + (0.354 \times (1-0.223)) = 0.498, \text{ or } 49.8\%$$

Shipboard monitoring would detect 21.2% of the remaining groups on the surface, and therefore the combined probability of aerial and shipboard detection is:

$$0.498 + (0.212 \times (1-0.498) = 0.605, \text{ or } 60.5\%$$

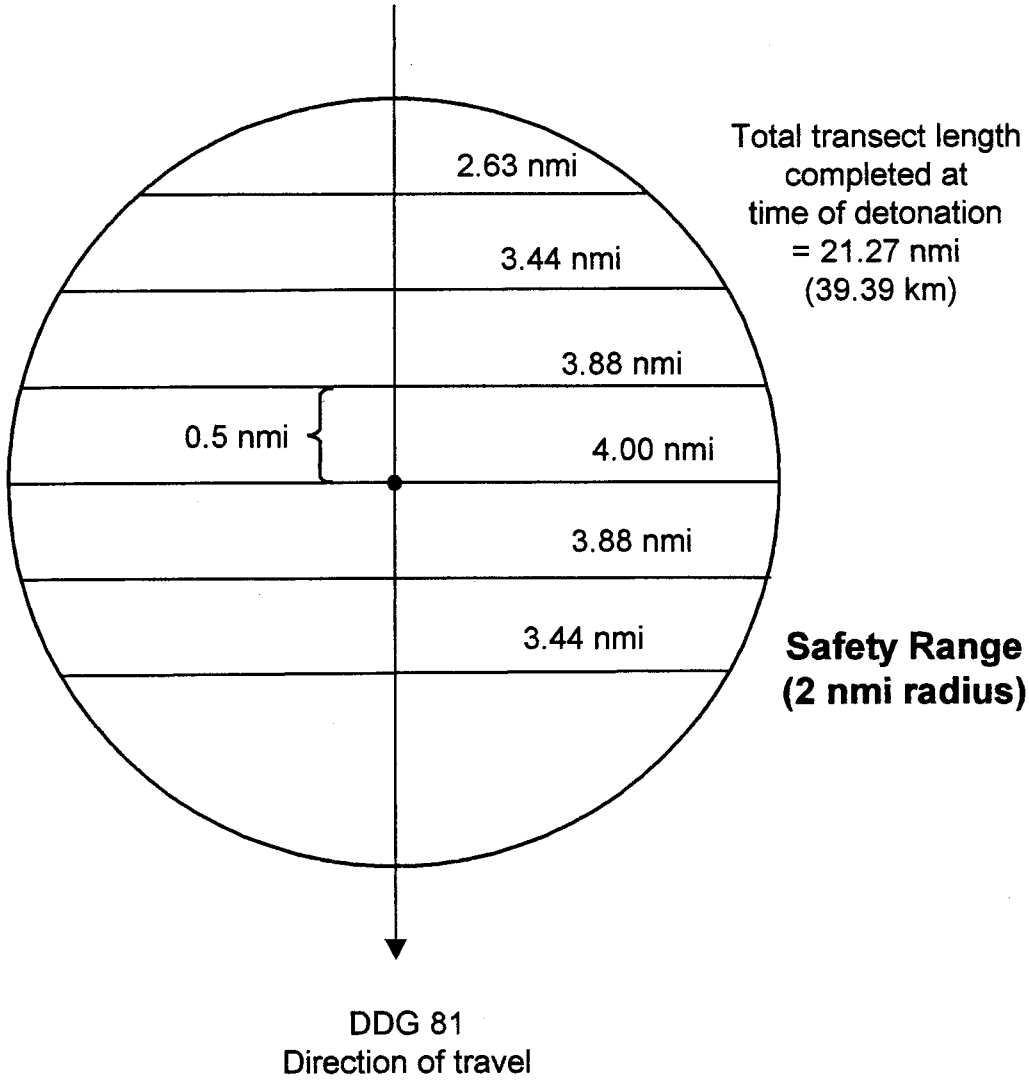

Figure C.2. Lengths of aerial transects at 0.5 nmi spacing completed within the Safety Range at the time of detonation.

Passive Acoustic Monitoring. Passive acoustic monitoring system (see Section 5.0) is capable of detecting marine mammal sounds within the Safety Range. The following values were estimated for acoustic detection probability based on values used in the SEAWOLF EIS (Department of the Navy, 1998):

- Sperm whales 0.75
- Baleen whales: 0.25

These estimates are based on the tendency of the animals to make detectable sounds. Sperm whales produce distinctive clicked vocalizations, or "codas" (Jefferson et al., 1993) and are considered very likely to be detected acoustically if present in the area. Acoustic detection studies of sperm whales in the northern Gulf of Mexico during GulfCet II have shown a high degree of agreement with concurrent ship surveys (Norris et al., 2000), indicating that sperm whales are highly detectable.

Overall Mitigation Effectiveness. Estimated mitigation effectiveness for each category of marine mammals and turtles is summarized in the last column of **Table C.7**. The final values have been rounded to two decimal places. Including all types of monitoring (aerial, shipboard, and passive acoustic), the overall proportion detected is estimated to be 0.88 for sperm whales, 0.63 for other large whales, 0.15 for cryptic whales, 0.60 for small whales and large dolphins, 0.60 for small dolphins, 0.63 for unidentified dolphins, and 0.08 for sea turtles. These numbers are used in subsequent sections to calculated probabilities and incidental take numbers.

C.6 PROBABILITY ANALYSIS

This section calculates the three probabilities cited at the beginning of the Appendix:

1. The probability of zero marine mammal or turtle groups being present in the Safety Range. This is termed "**probability of clear range**" since it means the detonation could occur with no mammals or turtles present in the Safety Range. Presence refers to both detectable and non-detectable (submerged, silent) groups.

2. The probability of one or more groups being present in the Safety Range, and one or more groups being detected. This is termed "**probability of delay**" since detection of one or more groups would postpone detonation.

3. The probability of one or more groups being present in the Safety Range, but none detected. This outcome is termed "**probability of take**" since it means a detonation could occur with mammals or turtles in the Safety Range.

These probabilities can be calculated based on the densities and mitigation effectiveness estimates discussed previously. Calculations for Mayport, Norfolk, and Pascagoula are presented in **Tables C.8**, **C.9**, and **C.10**, respectively.

The Mayport calculations (**Table C.8**) will be discussed in detail as an example. The first column lists mean group densities of mammal and turtles (groups/100 km^2) from **Tables C.3** and **C.4**. Note

Table C.8. Probability analysis of marine mammals and turtles for the Mayport test area.

	A	B	C	D	E	F	G	H	I	J
						"CLEAR RANGE"			"DELAY"	"TAKE"
	Mean Groups/ 100 km^2	Proportion of Total Population Detected	Adjusted Mean Groups/ 100 km^2	Area of Safety Range (km^2)	Expected # Groups in Safety Range	Poisson Probability of Zero in Safety Range (Pzero)	Probability of One or More Groups in Safety Range	Proportion Detected by Pre-Detonation Monitoring	Probability of One or more Present and Detected	Probability of One or More Present and Not Detected
MARINE MAMMALS										
Sperm whale*	0.017	0.20	0.086	43.096	0.037	0.963	0.037	0.875	0.032	0.005
Atlantic spotted dolphin	0.016	0.50	0.032	43.096	0.014	0.986	0.014	0.605	0.008	0.005
Bottlenose dolphin	1.326	0.50	2.652	43.096	1.143	0.319	0.681	0.605	0.412	0.269
Bottlenose/Atl.spotted dolphir	0.018	0.50	0.037	43.096	0.016	0.984	0.016	0.605	0.010	0.006
False killer whale	0.006	0.50	0.012	43.096	0.005	0.995	0.005	0.605	0.003	0.002
Pilot whale	0.034	0.50	0.068	43.096	0.029	0.971	0.029	0.605	0.018	0.011
Risso's dolphin	0.655	0.50	1.310	43.096	0.565	0.569	0.431	0.605	0.261	0.170
Unidentified dolphin	0.033	0.50	0.066	43.096	0.029	0.972	0.028	0.632	0.018	0.010
Unidentified odontocete	0.005	0.10	0.055	43.096	0.024	0.977	0.023	0.151	0.004	0.020
Any marine mammal	**2.111**		**4.318**	43.096	**1.861**	**0.16**	**0.844**	**0.605**	**0.51**	**0.33**
SEA TURTLES										
Leatherback turtle	0.162	0.10	1.618	43.096	0.697	0.498	0.502	0.082	0.041	0.461
Loggerhead turtle	0.086	0.10	0.863	43.096	0.372	0.689	0.311	0.082	0.025	0.285
Unidentified turtle	0.040	0.10	0.400	43.096	0.172	0.842	0.158	0.082	0.013	0.145
Any sea turtle	**0.288**		**2.881**	43.096	**1.242**	**0.29**	**0.711**	**0.082**	**0.06**	**0.65**
*Sperm whale not seen during 1999 aerial surveys but seen during both 1995 and 1997 SEAWOLF surveys (used 1997 data)	From aerial surveys in June and August 1999	Based on submergence intervals	Equals observed density divided by proportion detected		Equals density times area of Safety Range	Probability of zero given expected no. of (E)	Equals 1-F	From Table C.7 Average is weighted by group density	Equals G*H	Equals G*(1-H)

Table C.9. Probability analysis of marine mammals and turtles for the Norfolk test area.

	A	B	C	D	E	F	G	H	I	J
						"CLEAR RANGE"			"DELAY"	"TAKE"
	Mean Groups/ 100 km^2	Proportion of Total Population Detected	Adjusted Mean Groups/ 100 km^2	Area of Safety Range (km^2)	Expected # Groups in Safety Range	Poisson Probability of Zero in Safety Range (Pzero)	Probability of One or More Groups in Safety Range	Proportion Detected by Pre-Detonation Monitoring	Probability of One or more Present and Detected	Probability of One or More Present and Not Detected
MARINE MAMMALS										
Fin whale	0.101	0.20	0.506	43.096	0.218	0.804	0.196	0.625	0.122	0.073
Humpback whale	0.009	0.20	0.044	43.096	0.019	0.981	0.019	0.625	0.012	0.007
Minke whale	0.051	0.20	0.256	43.096	0.111	0.895	0.105	0.625	0.065	0.039
Sei whale	0.049	0.20	0.244	43.096	0.105	0.900	0.100	0.625	0.062	0.037
Sei/Bryde's whale	0.035	0.20	0.173	43.096	0.074	0.928	0.072	0.625	0.045	0.027
Balaenoptera sp.	0.021	0.20	0.106	43.096	0.046	0.955	0.045	0.625	0.028	0.017
Sperm whale*	1.116	0.75	1.488	43.096	0.641	0.527	0.473	0.875	0.414	0.059
Atlantic spotted dolphin	0.672	0.50	1.344	43.096	0.579	0.560	0.440	0.605	0.266	0.174
Bottlenose dolphin	0.380	0.50	0.759	43.096	0.327	0.721	0.279	0.605	0.169	0.110
Bottlenose/Atl.spotted dolphir	0.043	0.50	0.086	43.096	0.037	0.964	0.036	0.605	0.022	0.014
Common dolphin	0.002	0.50	0.005	43.096	0.002	0.998	0.002	0.605	0.001	0.001
Pantropical spotted dolphin	0.030	0.50	0.060	43.096	0.026	0.974	0.026	0.600	0.015	0.010
Pilot whale	1.552	0.50	3.104	43.096	1.338	0.262	0.738	0.605	0.446	0.291
Risso's dolphin	0.065	0.50	0.131	43.096	0.056	0.945	0.055	0.605	0.033	0.022
Spinner dolphin	0.030	0.50	0.060	43.096	0.026	0.974	0.026	0.600	0.015	0.010
Striped dolphin	0.010	0.50	0.019	43.096	0.008	0.992	0.008	0.600	0.005	0.003
Stenella spp.	0.063	0.50	0.127	43.096	0.055	0.947	0.053	0.600	0.032	0.021
Unidentified dolphin	0.436	0.50	0.871	43.096	0.375	0.687	0.313	0.632	0.198	0.115
Unidentified large whale	0.017	0.20	0.086	43.096	0.037	0.963	0.037	0.625	0.023	0.014
Any marine mammal	**4.682**		**9.469**	43.096	**4.081**	**0.02**	0.983	0.653	**0.64**	**0.34**
SEA TURTLES										
Leatherback turtle	0.006	0.10	0.061	43.096	0.026	0.974	0.026	0.082	0.002	0.024
Loggerhead turtle	0.608	0.10	6.084	43.096	2.622	0.073	0.927	0.082	0.076	0.852
Unidentified turtle	0.018	0.10	0.184	43.096	0.079	0.924	0.076	0.082	0.006	0.070
Any sea turtle	**0.633**		**6.329**	43.096	**2.728**	**0.07**	**0.935**	**0.082**	**0.08**	**0.86**
*Sperm whale density from 1995 ship surveys (Abel-J and Pelican)	From 1995 aerial survey data (SEAWOLF)	Proportion available for aerial detection (see text)	Observed density/ proportion detected		Equals density times area of Safety Range	Probability of zero given expected no. of (E)	Equals 1-F	From Table C.7 Average is weighted by group density	Equals G*H	Equals G*(1-H)

Table C.10. Probability analysis of marine mammals and turtles for the Pascagoula test area.

					"CLEAR RANGE"				"DELAY"	"TAKE"
	A	B	C	D	E	F	G	H	I	J
	Mean Groups/ 100 km^2	Proportion of Total Population Detected	Adjusted Mean Groups/ 100 km^2	Area of Safety Range (km^2)	Expected # Groups in Safety Range	Poisson Probability of Zero in Safety Range (Pzero)	Probability of One or More Groups in Safety Range	Proportion Detected by Pre-Detonation Monitoring	Probability of One or more Present and Detected	Probability of One or More Present and Not Detected
MARINE MAMMALS										
Bryde's whale*	0.041	0.75	0.055	43.096	0.024	0.977	0.023	0.625	0.015	0.009
Sperm whale	0.024	0.20	0.120	43.096	0.052	0.950	0.050	0.875	0.044	0.006
Atlantic spotted dolphin	0.022	0.50	0.044	43.096	0.019	0.981	0.019	0.605	0.011	0.007
Bottlenose dolphin	0.370	0.50	0.741	43.096	0.319	0.727	0.273	0.605	0.165	0.108
Bottlenose/Atl.spotted dolphir	0.031	0.50	0.063	43.096	0.027	0.973	0.027	0.605	0.016	0.011
Clymene dolphin	0.056	0.50	0.111	43.096	0.048	0.953	0.047	0.600	0.028	0.019
Dwarf/pygmy sperm whale	0.384	0.10	3.840	43.096	1.655	0.191	0.809	0.151	0.122	0.687
Pantropical spotted dolphin	0.013	0.50	0.027	43.096	0.012	0.988	0.012	0.600	0.007	0.005
Risso's dolphin	0.017	0.50	0.034	43.096	0.015	0.985	0.015	0.605	0.009	0.006
Spinner dolphin	0.009	0.50	0.018	43.096	0.008	0.992	0.008	0.600	0.005	0.003
Striped dolphin	0.076	0.50	0.153	43.096	0.066	0.936	0.064	0.600	0.038	0.025
Any marine mammal	**1.045**		**5.206**	43.096	**2.244**	**0.11**	**0.894**	**0.276**	**0.25**	**0.65**
SEA TURTLES										
Leatherback turtle	0.203	0.10	2.028	43.096	0.874	0.417	0.583	0.082	0.048	0.535
Loggerhead turtle	–	0.10	–	43.096	–	–	–	0.082	–	–
Unidentified turtle	0.055	0.10	0.549	43.096	0.237	0.789	0.211	0.082	0.017	0.194
Any sea turtle	**0.258**		**2.577**	43.096	**1.110**	**0.33**	**0.671**	**0.082**	**0.05**	**0.62**
*Bryde's whale not seen on aerial transects in Pascagoula test area but seen on ship surveys (used density estimate from Mullin and Hoggard, 1999)	From GulfCet aerial surveys in July-August 1996 & 1997	Proportion available for aerial detection (see text)	Equals observed density divided by proportion detected		Equals density times area of Safety Range	Probability of zero given expected no. of (E)	Equals 1-F	From Table C.7 Average is weighted by group density	Equals G*H	Equals G*(1-H)

that since turtle group sizes are 1.0, turtle "groups" are actually individual animals. The next column (B) presents the proportion of the population believed to have been detected by aerial surveys, based on proportion of time the animals spend submerged. For example, turtles are submerged about 90% of the time, so only 10% of the population is believed to have been detected on the aerial surveys. In the next column (C), adjusted mean densities are calculated as the original densities divided by the proportion available for detection. Using turtles again as an example, the original densities have been divided by 0.1 (multiplied by 10) to account for submerged individuals. The adjusted mean densities are then divided by 100 and multiplied by the area of the Safety Range (column D) to calculate the expected number of groups in the Safety Range (column E).

Next, the probability of zero groups in the Safety Range ("**clear range**") is calculated in column F. To calculate this probability, it is assumed that groups are approximately random in their spatial distribution. Therefore, the probability of zero can be calculated from the Poisson distribution:

$$P\text{ (observed = 0 given mean x)} = \frac{e^{-x}\,(\mu)^0}{0!} = e^{-x}$$

The assumption of an approximately random distribution is reasonable for individual turtles and for mammal groups (obviously not for individuals, which are highly aggregated). To the extent that groups are distributed non-randomly, i.e., aggregated, the probability of zero will be underestimated by the Poisson distribution. In other words, if groups are themselves clustered together, then the probability of encountering zero groups in a given Safety Range-sized area will be higher than predicted by a random model. There is considerable evidence that marine mammal groups and sea turtles are <u>not</u> randomly distributed but are associated with certain oceanographic features. For example, cetacean densities are higher inside cold core rings and in the confluence zones between warm and cold core rings (Davis et al., 2000); sea turtles have temperature preferences (Coles, 1999) and are concentrated inshore of the Gulf Stream western wall [Fritts et al., 1983). However, as discussed in Section 5.0, test site selection would use satellite imagery and aerial surveys to avoid areas where marine mammals and turtles are highly concentrated. Therefore, the assumption of random distribution is reasonable, especially for comparing among test areas since the same assumption is applied to all three test areas.

The probability of zero in the Safety Range is high for individual species of marine mammals and turtles, but substantially lower for "any marine mammal" or "any sea turtle." The probability of one or more groups in the Safety Range is calculated by subtraction (1 minus the probability of zero groups in the Safety Range, or G = 1 minus column F).

Next, in order to calculate probabilities of "delay" and "take," it is necessary to consider the probability of detecting a mammal or turtle group. This information has been calculated for general categories of mammals and turtles in **Table C.7** and is entered here for each species in column H of **Table C.8**. The probability of "delay" is the product of "one or more groups present" (column G) and "proportion detected" (column H). The probability of "take" is the product of "one or more groups present" (column G) and "proportion not detected" (1 minus column H).

Probability of Clear Range. The probability of zero marine mammal groups in the Safety Range is 0.16 at Mayport, 0.11 at Pascagoula, and 0.02 at Norfolk. The probability of zero turtles in the Safety Range is 0.33 at Pascagoula, 0.29 at Mayport, and 0.07 at Norfolk. For turtles, this order reflects the mean group densities at the three test areas, with higher densities corresponding to low probabilities of "clear range." For mammals, although Pascagoula had the lowest density, it did not have the lowest probability of clear range, due to the submergence correction for dwarf/pygmy sperm whales which were the most frequently sighted species there (i.e., observed densities were multiplied by 10 to correct for animals not seen).

Probability of Delay. The probability of one or more marine mammal groups occurring in the Safety Range and being detected (thereby causing a delay) is 0.64 at Norfolk, 0.51 at Mayport, and 0.25 at Pascagoula. The high probability of delay at Norfolk reflects, in part, the high group density of sperm whales, which are highly likely to be detected if present. The low probability at Pascagoula partly reflects the relative abundance of dwarf/pygmy sperm whales, which have a low probability of detection.

The probability of "delay" for sea turtles is low at 0.08 at Norfolk, 0.06 at Mayport, and 0.05 at Pascagoula. Since most turtles are submerged, they are not expected to be detected and therefore the probability of a turtle-related delay is low at all three test areas.

Probability of Take. The probability of one or more marine mammal groups occurring in the Safety Range and not being detected (potentially resulting in mortality or injury) is 0.65 at Pascagoula, 0.34 at Norfolk, and 0.33 at Mayport.

The probability of "take" for sea turtles is 0.86 for Norfolk, 0.65 for Mayport, and 0.62 for Pascagoula. The relatively high probability of "take" (as compared with the marine mammal numbers) reflects the low detectability of turtles due to most of the population being submerged.

C.7 INCIDENTAL TAKE CALCULATIONS

Incidental take calculations for Mayport, Norfolk, and Pascagoula are presented in **Tables C.11**, **C.12**, and **C.13**, respectively.

Calculations for Mayport (**Table C.11**) will be explained as an example. Mean mammal and turtle densities are first adjusted for submergence as explained previously, producing adjusted mean densities. Ranges for mortality, injury, and disruption of hearing-based behaviors are used as the radii for concentric circles around the detonation point. The expected number of groups of a given species within the respective ranges is calculated as the adjusted mean density multiplied by the area of each circle. The results represent the numbers of mammal groups (or individual turtles) that would be affected if a detonation occurred at a randomly selected point in the test area, with no mitigation. The numbers are multiplied by the maximum number of detonations (4) to calculate potential incidental take, again neglecting mitigation. Then, the proportion of the population of each species expected to be detected by combined aerial, shipboard, and passive acoustic monitoring is introduced (from **Table C.7**). The numbers of groups for "four detonations, no mitigation" are multiplied by (1 minus proportion detected) to account for the effectiveness of

Table C.11. Incidental take calculations for marine mammals and turtles at the Mayport test area (page 1 of 3).

	Observed Mean Groups/ 100 km^2	Proportion of Population Assumed to be Detected	Adjusted Mean Groups/ 100 km^2	IMPACT RANGE			AREA WITHIN IMPACT RANGE		
				Mortality (km)	Injury (km)	Harassment (km)	Mortality (km^2)	Injury (km^2)	Harassment (km^2)
MARINE MAMMALS									
Sperm whale*	0.017	0.20	0.086	1.351	2.250	25.2	5.734	10.170	1979.133
Atlantic spotted dolphin	0.016	0.50	0.032	1.351	2.250	25.2	5.734	10.170	1979.133
Bottlenose dolphin	1.326	0.50	2.652	1.351	2.250	25.2	5.734	10.170	1979.133
Bottlenose/Atl.spotted dolphin	0.018	0.50	0.037	1.351	2.250	25.2	5.734	10.170	1979.133
False killer whale	0.006	0.50	0.012	1.351	2.250	25.2	5.734	10.170	1979.133
Pilot whale	0.034	0.50	0.068	1.351	2.250	25.2	5.734	10.170	1979.133
Risso's dolphin	0.655	0.50	1.310	1.351	2.250	25.2	5.734	10.170	1979.133
Unidentified dolphin	0.033	0.50	0.066	1.351	2.250	25.2	5.734	10.170	1979.133
Unidentified odontocete	0.005	0.10	0.055	1.351	2.250	25.2	5.734	10.170	1979.133
Any marine mammal	**2.111**		**4.318**	1.351	2.250	25.2	**5.734**	**10.170**	**1979.133**
SEA TURTLES									
Leatherback turtle	0.162	0.10	1.618	1.351	2.250	25.2	5.734	10.170	1979.133
Loggerhead turtles	0.086	0.10	0.863	1.351	2.250	25.2	5.734	10.170	1979.133
Unidentified turtle	0.040	0.10	0.400	1.351	2.250	25.2	5.734	10.170	1979.133
Any sea turtle	**0.288**		**2.881**	1.351	2.250	25.2	**5.734**	**10.170**	**1979.133**
*Sperm whale not seen during 1999 aerial surveys but seen during both 1995 and 1997 SEAWOLF surveys (used 1997 data)	From aerial surveys of Mayport test area	Proportion available for aerial detection (see text)	Observed density divided by proportion detected	From Appendix D	From Appendix D	From Appendix E		*Area within injury radius minus area within mortality radius	**Area within harassment radius minus area within injury radius

Table C.11. Incidental take calculations for marine mammals and turtles at the Mayport test area (page 2 of 3).

	Expected No. of Groups (Single detonation, no mitigation)			Expected No. of Groups (Four detonations, no mitigation)			Proportion of Population Detected by Monitoring	Expected No. of Groups (Four detonations, with mitigation)		
	Mortality	Injury	Harassment	Mortality	Injury	Harassment		Mortality	Injury	Harassment
MARINE MAMMALS										
Sperm whale*	0.005	0.009	1.712	0.020	0.035	6.847	0.88	0.002	0.004	6.847
Atlantic spotted dolphin	0.002	0.003	0.629	0.007	0.013	2.516	0.60	0.003	0.005	2.516
Bottlenose dolphin	0.152	0.270	52.487	0.608	1.079	209.946	0.60	0.240	0.426	209.946
Bottlenose/Atl.spotted dolphin	0.002	0.004	0.730	0.008	0.015	2.921	0.60	0.003	0.006	2.921
False killer whale	0.001	0.001	0.234	0.003	0.005	0.935	0.60	0.001	0.002	0.935
Pilot whale	0.004	0.007	1.349	0.016	0.028	5.395	0.60	0.006	0.011	5.395
Risso's dolphin	0.075	0.133	25.927	0.300	0.533	103.708	0.60	0.119	0.211	103.708
Unidentified dolphin	0.004	0.007	1.310	0.015	0.027	5.239	0.63	0.006	0.010	5.239
Unidentified odontocete	0.003	0.006	1.080	0.013	0.022	4.321	0.15	0.011	0.019	4.321
Any marine mammal	**0.248**	**0.439**	**85.458**	**0.990**	**1.757**	**341.830**		**0.391**	**0.694**	**341.830**
SEA TURTLES										
Leatherback turtle	0.093	0.165	32.016	0.371	0.658	128.066	0.08	0.341	0.604	128.066
Loggerhead turtles	0.049	0.088	17.084	0.198	0.351	68.335	0.08	0.182	0.322	68.335
Unidentified turtle	0.023	0.041	7.917	0.092	0.163	31.666	0.08	0.084	0.149	31.666
Any sea turtle	**0.165**	**0.293**	**57.017**	**0.661**	**1.172**	**228.067**		**0.607**	**1.076**	**228.067**

*Sperm whale not seen during 1999 aerial surveys but seen during both 1995 and 1997 SEAWOLF surveys (used 1997 data)

Expected number of groups equals mean density times area of specified impact range

Values for single detonation were multiplied by four

From Table C.7

Mitigation reduces mortality and injury, but not harassment since most of harassment range is outside Safety Range

Table C.11. Incidental take calculations for marine mammals and turtles at the Mayport test area (page 3 of 3).

	Expected Group Size				Number of Individuals (Four detonations, with mitigation)			
	Mortality	Injury	Harassment		Mortality	Injury	Harassment	
MARINE MAMMALS								
Sperm whale*	2	2	2		0.005	0.009	13.695	
Atlantic spotted dolphin	6	6	6		0.017	0.031	15.099	
Bottlenose dolphin	7.64	7.64	7.64		1.835	3.256	1603.256	
Bottlenose/Atl.spotted dolphin	8.67	8.67	8.67		0.029	0.051	25.314	
False killer whale	8	8	8		0.009	0.015	7.483	
Pilot whale	10	10	12.33		0.062	0.110	66.540	
Risso's dolphin	10	10	10.69		1.187	2.106	1108.378	
Unidentified dolphin	5.40	5.40	5.40		0.030	0.054	28.292	
Unidentified odontocete	1	1	1		0.011	0.019	4.321	
Any marine mammal					**3.19**	**5.65**	**2872.38**	
				Rounded:	**4**	**6**	**2885**	<--added 12
SEA TURTLES								
Leatherback turtle	1	1	1		0.341	0.604	128.066	
Loggerhead turtles	1	1	1		0.182	0.322	68.335	
Unidentified turtle	1	1	1		0.084	0.149	31.666	
Any sea turtle					**0.61**	**1.08**	**228.07**	
				Rounded:	**1**	**2**	**232**	<--added 3

*Sperm whale not seen during 1999 aerial surveys but seen during both 1995 and 1997 SEAWOLF surveys (used 1997 data)

For mortality and injury, used 10 or average group size, whichever was less. Assumed groups large than 10 would be detected.

For harassment, used average group size from surveys

Final values rounded up to nearest whole number

Added 12 mammals and 3 turtles to harassment (1 individual for each species not seen) and rounded up

Table C.12. Incidental take calculations for marine mammals and turtles at the Norfolk test area (page 1 of 3).

	Observed Mean Groups/ 100 km²	Proportion of Population Assumed to be Detected	Adjusted Mean Groups/ 100 km²	IMPACT RANGE			AREA WITHIN IMPACT RANGE		
				Mortality (km)	Injury (km)	Harassment (km)	Mortality (km²)	Injury (km²)	Harassment (km²)
MARINE MAMMALS									
Fin whale	0.101	0.20	0.506	1.351	2.250	42.6	5.734	10.170	5685.332
Humpback whale	0.009	0.20	0.044	1.351	2.250	42.6	5.734	10.170	5685.332
Minke whale	0.051	0.20	0.256	1.351	2.250	42.6	5.734	10.170	5685.332
Sei whale	0.049	0.20	0.244	1.351	2.250	42.6	5.734	10.170	5685.332
Sei/Bryde's whale	0.035	0.20	0.173	1.351	2.250	42.6	5.734	10.170	5685.332
Balaenoptera sp.	0.021	0.20	0.106	1.351	2.250	42.6	5.734	10.170	5685.332
Atlantic spotted dolphin	0.672	0.50	1.344	1.351	2.250	32.8	5.734	10.170	3363.947
Bottlenose dolphin	0.380	0.50	0.759	1.351	2.250	32.8	5.734	10.170	3363.947
Bottlenose/Atl.spotted dolphin	0.043	0.50	0.086	1.351	2.250	32.8	5.734	10.170	3363.947
Common dolphin	0.002	0.50	0.005	1.351	2.250	32.8	5.734	10.170	3363.947
Pantropical spotted dolphin	0.030	0.50	0.060	1.351	2.250	32.8	5.734	10.170	3363.947
Pilot whale	1.552	0.50	3.104	1.351	2.250	32.8	5.734	10.170	3363.947
Risso's dolphin	0.065	0.50	0.131	1.351	2.250	32.8	5.734	10.170	3363.947
Sperm whale	1.116	0.75	1.488	1.351	2.250	32.8	5.734	10.170	3363.947
Spinner dolphin	0.030	0.50	0.060	1.351	2.250	32.8	5.734	10.170	3363.947
Striped dolphin	0.010	0.50	0.019	1.351	2.250	32.8	5.734	10.170	3363.947
Stenella spp.	0.063	0.50	0.127	1.351	2.250	32.8	5.734	10.170	3363.947
Unidentified dolphin	0.436	0.50	0.871	1.351	2.250	32.8	5.734	10.170	3363.947
Unidentified large whale	0.017	0.20	0.086	1.351	2.250	42.6	5.734	10.170	5685.332
Any marine mammal	**4.682**		**9.469**	1.351	2.250	32.8	**5.734**	**10.170**	
SEA TURTLES									
Leatherback turtle	0.006	0.10	0.06	1.351	2.250	32.8	5.734	10.170	3363.947
Loggerhead turtles	0.608	0.10	6.08	1.351	2.250	32.8	5.734	10.170	3363.947
Unidentified turtle	0.018	0.10	0.18	1.351	2.250	32.8	5.734	10.170	3363.947
Any sea turtle	**0.633**		**6.329**	1.351	2.250	32.8	**5.734**	**10.170**	**3363.947**
*Sperm whale density from 1995 ship surveys (Abel-J and Pelican)	From 1995 aerial surveys near test area (SEAWOLF)	Proportion available for aerial detection (see text)	Observed density divided by proportion detected	From Appendix D	From Appendix D	From Appendix E		*Area within injury radius minus area within mortality radius	**Area within harassment radius minus area within injury radius

Table C.12. Incidental take calculations for marine mammals and turtles at the Norfolk test area (page 2 of 3).

	Expected No. of Groups (Single detonation, no mitigation)			Expected No. of Groups (Four detonations, no mitigation)			Proportion of Population Detected by Monitoring	Expected No. of Groups (Four detonations, with mitigation)		
	Mortality	Injury	Harassment	Mortality	Injury	Harassment		Mortality	Injury	Harassment
MARINE MAMMALS										
Fin whale	0.029	0.051	28.762	0.116	0.206	115.048	0.63	0.043	0.077	115.048
Humpback whale	0.003	0.004	2.486	0.010	0.018	9.946	0.63	0.004	0.007	9.946
Minke whale	0.015	0.026	14.582	0.059	0.104	58.327	0.63	0.022	0.039	58.327
Sei whale	0.014	0.025	13.859	0.056	0.099	55.434	0.63	0.021	0.037	55.434
Sei/Bryde's whale	0.010	0.018	9.815	0.040	0.070	39.259	0.63	0.015	0.026	39.259
Balaenoptera sp.	0.006	0.011	6.015	0.024	0.043	24.061	0.63	0.009	0.016	24.061
Atlantic spotted dolphin	0.077	0.137	45.218	0.308	0.547	180.873	0.60	0.122	0.216	180.873
Bottlenose dolphin	0.044	0.077	25.533	0.174	0.309	102.132	0.60	0.069	0.122	102.132
Bottlenose/Atl.spotted dolphin	0.005	0.009	2.887	0.020	0.035	11.549	0.60	0.008	0.014	11.549
Common dolphin	0.000	0.000	0.156	0.001	0.002	0.624	0.60	0.000	0.001	0.624
Pantropical spotted dolphin	0.003	0.006	2.034	0.014	0.025	8.134	0.60	0.006	0.010	8.134
Pilot whale	0.178	0.316	104.424	0.712	1.263	417.695	0.60	0.281	0.499	417.695
Risso's dolphin	0.008	0.013	4.402	0.030	0.053	17.608	0.60	0.012	0.021	17.608
Sperm whale	0.085	0.151	50.042	0.341	0.605	200.168	0.88	0.043	0.076	200.168
Spinner dolphin	0.003	0.006	2.031	0.014	0.025	8.124	0.60	0.006	0.010	8.124
Striped dolphin	0.001	0.002	0.645	0.004	0.008	2.580	0.60	0.002	0.003	2.580
Stenella spp.	0.007	0.013	4.258	0.029	0.051	17.032	0.60	0.012	0.021	17.032
Unidentified dolphin	0.050	0.089	29.305	0.200	0.354	117.221	0.63	0.074	0.131	117.221
Unidentified large whale	0.005	0.009	4.908	0.020	0.035	19.630	0.63	0.007	0.013	19.630
Any marine mammal	**0.543**	**0.963**	**351.362**	**2.172**	**3.852**	**1405.446**		**0.754**	**1.338**	**1405.446**
SEA TURTLES										
Leatherback turtle	0.004	0.006	2.064	0.014	0.025	8.255	0.08	0.013	0.023	8.255
Loggerhead turtles	0.349	0.619	204.652	1.395	2.475	818.610	0.08	1.281	2.273	818.610
Unidentified turtle	0.011	0.019	6.191	0.042	0.075	24.765	0.08	0.039	0.069	24.765
Any sea turtle	**0.363**	**0.644**	**212.908**	**1.452**	**2.575**	**851.630**		**1.333**	**2.365**	**851.630**

*Sperm whale density from 1995 ship surveys (Abel-J and Pelican)

Expected number of groups equals mean density times area of specified impact range

Values for single detonation were multiplied by four

From Table C.7

Mitigation reduces mortality and injury, but not harassment since most of harassment range is outside Safety Range

Table C.12. Incidental take calculations for marine mammals and turtles at the Norfolk test area (page 3 of 3).

	Expected Group Size				Number of Individuals (Four detonations, with mitigation)			
	Mortality	Injury	Harassment		Mortality	Injury	Harassment	
MARINE MAMMALS								
Fin whale	3	3	3		0.130	0.231	345.157	
Humpback whale	1	1	1		0.004	0.007	9.946	
Minke whale	1	1	1		0.022	0.039	58.327	
Sei whale	2	2	2		0.042	0.074	110.869	
Sei/Bryde's whale	1	1	1		0.015	0.026	39.259	
Balaenoptera sp.	2.67	2.67	2.67		0.024	0.043	64.165	
Atlantic spotted dolphin	10	10	14.19		1.218	2.161	2565.696	
Bottlenose dolphin	10	10	18.08		0.688	1.220	1846.538	
Bottlenose/Atl.spotted dolphin	8	8	8		0.062	0.110	92.390	
Common dolphin	10	10	155		0.004	0.007	96.796	
Pantropical spotted dolphin	10	10	70		0.055	0.098	569.395	
Pilot whale	10	10	10.42		2.813	4.990	4352.409	
Risso's dolphin	10	10	29.75		0.119	0.210	523.861	
Sperm whale	2.15	2.15	2.15		0.092	0.162	429.850	
Spinner dolphin	10	10	225		0.055	0.098	1827.942	
Striped dolphin	10	10	24		0.018	0.031	61.910	
Stenella spp.	10	10	22.5		0.116	0.206	383.194	
Unidentified dolphin	10	10	10.52		0.736	1.305	1232.846	
Unidentified large whale	1	1	1		0.007	0.013	19.630	
Any marine mammal					**6.22**	**11.03**	**14630.18**	
				Rounded:	**7**	**12**	**14640**	<--added 9
SEA TURTLES								
Leatherback turtle	1	1	1		0.013	0.023	8.255	
Loggerhead turtles	1	1	1		1.281	2.273	818.610	
Unidentified turtle	1	1	1		0.039	0.069	24.765	
Any sea turtle					**1.33**	**2.36**	**851.63**	
				Rounded:	**2**	**3**	**855**	<--added 3

*Sperm whale density from 1995 ship surveys (Abel-J and Pelican)

For mortality and injury, used 10 or average group size, whichever was less. Assumed groups larger than 10 would be detected

For harassment, used average group size from surveys

Final values rounded up to nearest whole number

Added 9 mammals and 3 turtles to harassment (1 individual for each species not seen) and rounded up

Table C.13. Incidental take calculations for marine mammals and turtles at the Pascagoula test area (page 1 of 3).

	Observed Mean Groups/ 100 km^2	Proportion of Population Assumed to be Detected	Adjusted Mean Groups/ 100 km^2	IMPACT RANGE			AREA WITHIN IMPACT RANGE		
				Mortality (km)	Injury (km)	Harassment (km)	Mortality (km^2)	Injury (km^2)	Harassment (km^2)
MARINE MAMMALS									
Sperm whale	0.024	0.20	0.12	1.351	2.250	24.6	5.734	10.170	1885.262
Bryde's whale*	0.041	0.75	0.05	1.351	2.250	29.6	5.734	10.170	2736.634
Atlantic spotted dolphin	0.022	0.50	0.04	1.351	2.250	24.6	5.734	10.170	1885.262
Bottlenose dolphin	0.370	0.50	0.74	1.351	2.250	24.6	5.734	10.170	1885.262
Bottlenose/Atl.spotted dolphir	0.031	0.50	0.06	1.351	2.250	24.6	5.734	10.170	1885.262
Clymene dolphin	0.056	0.50	0.11	1.351	2.250	24.6	5.734	10.170	1885.262
Dwarf/pygmy sperm whale	0.384	0.10	3.84	1.351	2.250	24.6	5.734	10.170	1885.262
Pantropical spotted dolphin	0.013	0.50	0.03	1.351	2.250	24.6	5.734	10.170	1885.262
Risso's dolphin	0.017	0.50	0.03	1.351	2.250	24.6	5.734	10.170	1885.262
Spinner dolphin	0.009	0.50	0.02	1.351	2.250	24.6	5.734	10.170	1885.262
Striped dolphin	0.076	0.50	0.15	1.351	2.250	24.6	5.734	10.170	1885.262
Any marine mammal	**1.045**		**5.21**	1.351	2.250	24.6	**5.734**	**10.170**	**1885.262**
SEA TURTLES									
Leatherback turtle	0.203	0.10	2.03	1.351	2.250	24.6	5.734	10.170	1885.262
Loggerhead turtles	--	0.10	--	1.351	2.250	24.6	5.734	10.170	1885.262
Unidentified turtle	0.055	0.10	0.55	1.351	2.250	24.6	5.734	10.170	1885.262
Any sea turtle	**0.258**		**2.577**	1.351	2.250	24.6	**5.734**	**10.170**	**1885.262**
*Bryde's whale not seen on aerial transects in Pascagoula test area but seen on ship surveys (used density estimate from Mullin and Hoggard, 1999)	From aerial surveys of Pascagoula test area (GulfCet II)	Proportion available for aerial detection (see text)	Equals observed density divided by proportion detected	From Appendix D	From Appendix D	From Appendix E		*Area within injury radius minus area within mortality radius	**Area within harassment radius minus area within injury radius

Table C.13. Incidental take calculations for marine mammals and turtles at the Pascagoula test area (page 2 of 3).

	Expected No. of Groups (Single detonation, no mitigation)			Expected No. of Groups (Four detonations, no mitigation)			Proportion of Population Detected by Monitoring	Expected No. of Groups (Four detonations, with mitigation)		
	Mortality	Injury	Harassment	Mortality	Injury	Harassment		Mortality	Injury	Harassment
MARINE MAMMALS										
Sperm whale	0.007	0.012	2.265	0.028	0.049	9.060	0.88	0.003	0.006	9.060
Bryde's whale*	0.003	0.006	1.496	0.013	0.022	5.984	0.63	0.005	0.008	5.984
Atlantic spotted dolphin	0.003	0.004	0.827	0.010	0.018	3.308	0.60	0.004	0.007	3.308
Bottlenose dolphin	0.042	0.075	13.969	0.170	0.301	55.878	0.60	0.067	0.119	55.878
Bottlenose/Atl.spotted dolphir	0.004	0.006	1.181	0.014	0.025	4.723	0.60	0.006	0.010	4.723
Clymene dolphin	0.006	0.011	2.101	0.026	0.045	8.402	0.60	0.010	0.018	8.402
Dwarf/pygmy sperm whale	0.220	0.391	72.400	0.881	1.562	289.599	0.15	0.748	1.326	289.599
Pantropical spotted dolphin	0.002	0.003	0.506	0.006	0.011	2.025	0.60	0.002	0.004	2.025
Risso's dolphin	0.002	0.003	0.648	0.008	0.014	2.593	0.60	0.003	0.006	2.593
Spinner dolphin	0.001	0.002	0.348	0.004	0.008	1.392	0.60	0.002	0.003	1.392
Striped dolphin	0.009	0.016	2.876	0.035	0.062	11.503	0.60	0.014	0.025	11.503
Any marine mammal	**0.299**	**0.529**	**98.617**	**1.194**	**2.118**	**394.467**		**0.864**	**1.532**	**394.467**
SEA TURTLES										
Leatherback turtle	0.116	0.206	38.224	0.465	0.825	152.895	0.08	0.427	0.757	152.895
Loggerhead turtles	–	–	–	–	–	–	–	–	–	–
Unidentified turtle	0.031	0.056	10.353	0.126	0.223	41.410	0.08	0.116	0.205	41.410
Any sea turtle	**0.148**	**0.262**	**48.576**	**0.591**	**1.048**	**194.305**		**0.543**	**0.963**	**194.305**

*Bryde's whale not seen on aerial transects in Pascagoula test area but seen on ship surveys (used density estimate from Mullin and Hoggard, 1999)

Expected number of groups equals mean density times area of specified impact range

Values for single detonation were multiplied by four

From Table C.7

Mitigation reduces mortality and injury, but not harassment since most of harassment range is outside Safety Range

Table C.13. Incidental take calculations for marine mammals and turtles at the Pascagoula test area (page 3 of 3).

	Expected Group Size				Number of Individuals (Four detonations, with mitigation)			
	Mortality	Injury	Harassment		Mortality	Injury	Harassment	
MARINE MAMMALS								
Sperm whale	1.4	1.4	1.4		0.005	0.009	12.684	
Bryde's whale*	2.3	2.3	2.3		0.011	0.019	13.763	
Atlantic spotted dolphin	10	10	12		0.040	0.071	39.695	
Bottlenose dolphin	10	10	11.93		0.672	1.191	666.553	
Bottlenose/Atl.spotted dolphir	10	10	11		0.057	0.101	51.950	
Clymene dolphin	10	10	150		0.102	0.181	1260.365	
Dwarf/pygmy sperm whale	1.36	1.36	1.36		1.019	1.808	394.902	
Pantropical spotted dolphin	10	10	50.78		0.025	0.044	102.845	
Risso's dolphin	8.5	8.5	8.5		0.026	0.047	22.039	
Spinner dolphin	10	10	170.66		0.017	0.030	237.573	
Striped dolphin	10	10	28		0.140	0.248	322.093	
Any marine mammal					**2.11**	**3.75**	**3124.46**	
				Rounded:	**3**	**4**	**3132**	<--added 7
SEA TURTLES								
Leatherback turtle	1	1	1		0.427	0.757	152.895	
Loggerhead turtles	–	–	–		–	–	1.000	
Unidentified turtle	1	1	1		0.116	0.205	41.410	
Any sea turtle					**0.54**	**0.96**	**195.30**	
				Rounded:	**1**	**1**	**199**	<--added 3

*Bryde's whale not seen on aerial transects in Pascagoula test area but seen on ship surveys (used density estimate from Mullin and Hoggard, 1999)

For mortality and injury, used 10 or average group size, whichever was less. Assumed groups larger than 10 would be detected

For harassment, used average group size from surveys

Final values rounded up to nearest whole number

Added 7 mammals and 3 turtles to harassment (1 individual for each species not seen) and rounded up

pre-detonation monitoring. The result is the number of groups expected to be "taken" as a result of four detonations with mitigation.

The final step is accounting for group size, since all previous calculations pertain to the number of groups affected. For turtles, the group size is one (1) and the number of groups is the same as the number of individuals. For marine mammals, the mean group size from aerial or shipboard surveys was used for estimating disruption of hearing-based behaviors. For each species, the number of groups expected to be affected was multiplied by mean group size to predict number of individuals affected. For marine mammal mortality and injury, the group size for each species was assumed to be no larger than 10 individuals, since larger groups would almost certainly be detected in the Safety Range. Therefore, the minimum of (a) the mean group size or (b) 10 individuals was used. For each species, the number of groups expected to be killed or injured was multiplied by mean group size to predict number of individuals killed or injured. The fractions for individual species were summed and then rounded up to the nearest whole number. Finally, it was assumed that 1 individual of each species that was not included in the density and take calculations (species potentially present but not seen during the surveys used to develop density estimates; see Section C.4.1) would experience disruption of hearing-based behaviors.

Marine mammal calculations predict the highest mortalities and injuries for Norfolk (7 and 12 individuals, respectively), followed by Mayport (4 killed, 6 injured) and Pascagoula (3 killed, 4 injured). Behavioral disruption numbers are about five times higher at Norfolk (14,640) than at either Mayport (2,885) or Pascagoula (3,132). The larger difference reflects the fact that onset TTS range increases with water depth and Norfolk is the deepest test area.

For sea turtles, the calculations predict 2 mortalities at Norfolk and 1 mortality at Mayport or Pascagoula. Similarly, 3 injuries are predicted at Norfolk, 2 at Mayport, and 1 at Pascagoula. Behavioral disruption numbers are several times higher at Norfolk (855) than at Mayport (232) or Pascagoula (199), again reflecting both turtle densities and the greater water depth of the Norfolk test area.

C.8 INCIDENTAL TAKE IN RELATION TO STOCK SIZES

Table C.14 compares mortality and injury estimates with marine mammal population sizes. For each test area, the table includes only those cetacean species that had a "take" probability greater than 0.01 (from **Table C.8**, **C.9**, or **C.10**). Minimum population sizes were obtained from the latest available stock estimates prepared by the NMFS (Blaylock et al., 1995; Waring et al., 1999, 2000). Mortality and injury estimates for each species were summed, rounded up to the nearest whole number, and divided by the minimum population size. Because minimum population sizes stated by NMFS are reported to three or four digits, proportions of the population affected are calculated to three decimal places.

The calculations show that the numbers of marine mammals potentially killed or injured during the shock trial would represent a small fraction of the total population. The proportion of the minimum population affected is 0.001 or less for almost every species, and the highest value is only 0.011 (dwarf/pygmy sperm whale at Pascagoula).

Table C.14. Comparison of predicted mortality and injury with stock size for cetacean species with greater than 1% probability of take. Probability of take and estimated numbers killed and injured are from Tables C.8 through C.13. Minimum population, total annual mortality from all human sources, and the loss the population can sustain (potential biological removal, PBR) are from Waring et al. (1999, 2000) except where indicated otherwise. Strategic stocks are indicated (i.e., those for which total annual mortality exceeds PBR; endangered, threatened, and depleted species are automatically designated as strategic stocks even if annual mortality does not exceed PBR).

	Probability of "Take"	Estimated Number of Individuals		Minimum Population Estimate	Proportion of Population Affected [a]	Total Annual Mortality from All Human Sources (individuals)	Potential Biological Removal (PBR) (individuals)	Strategic Stock?
		Killed	Injured					
MAYPORT								
Bottlenose dolphin	0.269	1.835	3.256	20,642	<0.001	5.3	206	No
Pilot whale	0.011	0.062	0.110	8,148	<0.001	146	78	Yes
Risso's dolphin	0.170	1.187	2.106	22,540	<0.001	13	216	No
NORFOLK								
Fin whale	0.073	0.130	0.231	1,803	0.001	0.5	3.6	Yes
Minke whale	0.039	0.022	0.039	3,097	<0.001	2.7	31	No
Sei whale	0.037	0.057 [b]	0.100 [b]	870 [c]	0.001	0.0	N/A	Yes
Atlantic spotted dolphin	0.174	1.218	2.161	23,699	<0.001	7.8	236	No
Bottlenose dolphin	0.110	0.688	1.220	20,642	<0.001	5.3	206	No
Pilot whale	0.291	2.813	4.990	8,148	<0.001	146	78	Yes
Risso's dolphin	0.022	0.119	0.210	22,540	<0.001	13	216	No
Sperm whale	0.059	0.092	0.162	3,400	<0.001	0.0	6.8	Yes
PASCAGOULA								
Bottlenose dolphin	0.108	0.672	1.191	4,530 [d]	<0.001	2.8 [d]	45 [d]	No
Clymene dolphin	0.019	0.102	0.181	4,120 [d]	<0.001	0.0 [d]	41 [d]	No
Dwarf/pygmy sperm whale	0.687	1.019	1.808	273 [e]	0.011	0.0	N/A	No
Striped dolphin	0.025	0.140	0.248	3,409 [d]	<0.001	0.0 [d]	34 [d]	No

[a] Mortality and injury estimates were summed and rounded up to the nearest whole number, then divided by the minimum population estimate.
[b] Includes animals identified as sei/Bryde's whale.
[c] Minimum population not estimated by Waring et al. (1999, 2000). Used minimum population estimate by Mitchell and Chapman (1977).
[d] From Blaylock et al. (1995).
[e] Minimum population not estimated by Waring et al. (1999, 2000) or Blaylock et al. (1995). Used lower confidence limit of abundance estimate for the oceanic northern Gulf of Mexico population by Mullin and Hoggard (1999).

Even small numbers killed or injured can be significant for species designated by the NMFS as "strategic stocks" because their total annual mortality from human activities exceeds the annual loss that the population can sustain (potential biological removal, or PBR). Endangered and threatened marine mammals are automatically strategic stocks even if annual mortality does not exceed PBR.

The only strategic stocks likely to be present at Mayport are sperm whale, pilot whales, and beaked whales. Of these, only pilot whales are included in the table because their take probability slightly exceeds 0.01. Calculations predict 0.062 killed and 0.110 injured. Summing these and rounding up yields a total of 1 pilot whale potentially killed or injured. This would represent <0.001 of the minimum population estimate of 8,148 pilot whales. Given the low probability of take for pilot whales at Mayport, it is highly unlikely that any deaths or injuries of a strategic stock would occur there.

Strategic stocks likely to be present at Norfolk are fin whale, humpback whale, sei whale, sperm whale, beaked whales, common dolphin, and pilot whales. Of these, only the fin whale, sei whale, sperm whale, and pilot whales have take probabilities exceeding 0.01. Proportions of the minimum population affected would be 0.001 or less for each of these strategic stocks.

Strategic stocks likely to be present at Pascagoula are sperm whale, beaked whales, and pilot whales. None of these have a take probability greater than 0.01. It is highly unlikely that any deaths or injuries of a strategic stock would occur at Pascagoula.

Unlike marine mammals, sea turtles do not have regular stock estimates. However, leatherback and loggerhead populations are estimated to number in the hundreds of thousands (Magnuson et al., 1990; Marine Turtle Expert Working Group, 1996). In this context, death or injury of one or two individuals would represent a tiny fraction of the population and would be small in comparison to existing natural and anthropogenic sources of mortality.

C.9 DISCUSSION AND CONCLUSIONS

Table C.15 summarizes marine mammal and turtle densities, probabilities of "clear range," "delay," and "take," and incidental take estimates for each test area.

C.9.1 Marine Mammals

Marine mammal densities are higher at Norfolk than at Mayport or Pascagoula. Accordingly, the mean probability of "clear range" for marine mammals is higher at Mayport (0.16) and Pascagoula (0.11) than at Norfolk (0.02). Mayport may offer much higher clear range probabilities at times (e.g., the probability would be 0.37 based on the June 1999 survey data alone). At all three test areas, the low "clear range" probabilities indicate that delays and/or takes are likely.

Table C.15. Summary of probabilities and incidental take calculations.

	Mayport	Norfolk	Pascagoula
MARINE MAMMALS			
Mean Density (groups/100 km^2)	2.094	3.596	1.004
Mean Density (individuals/100 km^2)	18.033	50.970	18.480
Probability of "Clear Range"	0.16	0.02	0.11
Probability of "Delay"	0.51	0.64	0.25
Probability of "Take"	0.33	0.34	0.65
Incidental Take (individuals)			
Mortality	4	7	3
Injury	6	12	4
Behavioral disruption (due to TTS)	2885	14640	3132
TURTLES			
Mean Density (individuals/100 km^2)	0.29	0.63	0.26
Probability of "Clear Range"	0.29	0.07	0.33
Probability of "Delay"	0.06	0.08	0.05
Probability of "Take	0.65	0.86	0.62
Incidental Take (individuals)			
Mortality	1	2	1
Injury	2	3	1
Behavioral disruption (due to TTS)	232	855	199

The Norfolk test area has the highest probability of delay (0.64). This reflects the high mammal densities overall, and in particular, the high group density of sperm whales, which are highly likely to be detected if present. The low delay probability at Pascagoula (0.25) reflects both low abundance overall and the fact that one of the most abundant species, dwarf/pygmy sperm whales, has a low probability of detection. Mayport is in the middle (0.51), having low densities and lacking high relative abundances of either sperm whales or cryptic whales.

The probability of "take" is highest at Pascagoula (0.65) and lower and about equal at Norfolk (0.34) and Mayport (0.33). The relatively high probability of "take" at Pascagoula reflects the relative abundance of dwarf/pygmy sperm whales, which have a low probability of being detected if present. However, in terms of numbers of individuals affected, incidental take calculations predict that Norfolk would have the highest incidental take (7 killed, 12 injured), followed by Mayport (4 killed, 6 injured) and Pascagoula (3 killed, 4 injured).

Large numbers of marine mammals could experience disruption of hearing-based behaviors due to detonations at any of the test areas. Estimated mammal numbers are highest at Norfolk (14,640) and lower and about equal at Pascagoula (3,132) and Mayport (2,885). Norfolk has not only the highest marine mammal densities, but also the largest onset TTS ranges. It is the deepest test area, and onset TTS range tends to increase with increasing water depth (see Appendix E). Also, onset TTS range is greater for mysticetes than for odontocetes, and Norfolk is the test area where mysticetes are most likely to be present during the test period.

C.9.2 Sea Turtles

Sea turtle densities are also higher at Norfolk than at Mayport or Pascagoula. Accordingly, the probability of "clear range" for turtles is low at Norfolk (0.07) and higher and about equal at Pascagoula (0.33) and Mayport (0.29). A critical point not evident in these comparisons is that turtle densities just inshore of the Mayport test area can be much higher than those estimated for any of the three test areas. The tendency of turtles to remain inshore of the Gulf Stream western wall is well documented and presumably explains the very low turtle densities observed during June and August 1999 Mayport surveys. If Mayport is selected as the test area, satellite imagery would be reviewed prior to each detonation to ensure that any specific test site selected is within the Gulf Stream (i.e, seaward of the western wall) (see Section 5.0).

The probability of "delay" for sea turtles is low: 0.08 at Norfolk, 0.06 at Mayport, and 0.05 at Pascagoula. Since most turtles are submerged, they are not expected to be detected and therefore the probability of a turtle-related delay is low at all three test areas. Accordingly, the probability of "take" for sea turtles is relatively high as compared with the marine mammal numbers. The probability of take is highest at Norfolk (0.86) and lower and about equal at Mayport (0.65) and Pascagoula (0.62). Since the two species of turtles most likely to be present as adults (leatherbacks and loggerheads) are about equally detectable, the difference among test areas with respect to "delay" and "take" probabilities mainly reflects the density differences rather than species composition.

For turtles, the calculations indicate that if Mayport or Pascagoula is selected, 1 turtle is likely to be killed and either 1 (Pascagoula) or 2 (Mayport) injured. At Norfolk, it is predicted that 2 would be killed and 3 injured. Numbers of turtles potentially experiencing disruption of hearing-based behaviors are about an order of magnitude lower than the mammal numbers and are highest at Norfolk, which had the highest turtle densities and greatest onset TTS range.

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APPENDIX D

PHYSICAL IMPACTS OF EXPLOSIONS ON MARINE MAMMALS AND TURTLES

James C. Craig, Jr.

Naval Surface Warfare Center
Carderock Division
Bethesda, MD

This appendix summarizes information on the potential physical effects of underwater explosions on marine mammals and turtles. A review of mechanisms for injury from underwater explosions is included. Results from experiments conducted mainly with terrestrial mammals are used to develop conservative criteria and ranges for lethal and non-lethal injury. Limited data for sea turtles are also reviewed. These data are used in the Environmental Consequences section of the FEIS to estimate numbers of marine mammals and turtles that could be killed or injured, and to evaluate the established Safety Range.

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APPENDIX D
PHYSICAL IMPACTS OF EXPLOSIONS ON MARINE MAMMALS AND TURTLES

D.1 INTRODUCTION

The effects of an underwater explosion on a marine mammal or turtle are dependent upon many factors, including the size, type, and depth of both the animal and the explosive, the depth of the water column, and the standoff distance from the charge to the animal. Potential impacts can range from brief acoustic effects, tactile perception, and physical discomfort to both non-lethal and lethal injuries. Annoyance of and discomfort to marine mammals and turtles could occur as a result of non-injurious physiological responses to both the acoustic signature and the shock wave from the underwater explosion. Non-lethal injury includes slight injury to internal organs and the auditory system; however, delayed lethality can be a result of complications from individual or cumulative sub-lethal injuries. Short term or immediate lethal injury would be a result of massive combined trauma to internal organs as a direct result of proximity to the point of detonation. It is very unlikely that injury would occur from exposure to the chemical by-products released into surface waters [Young, 1984; Naval Surface Warfare Center (NSWC), 1992; also see Section 4 of this FEIS].

The appendix discusses several criteria for potential physical impacts to marine mammals and turtles. Specific mortality and injury criteria developed in this appendix are used in Appendix C of the FEIS to estimate numbers of marine mammals and turtles that could be killed or injured, as follows:

- Lethality assessments can be made on the basis of the predicted cavitation region of an explosion (Section D.7), lethal peak shock wave pressures (Section D.4.2.2), or model predictions of lethal injury to internal organs based on partial impulse (pressure integrated over a specified time interval) (Section D.4.2.1). The most conservative of the mortality criteria discussed here is the predicted **onset of extensive lung hemorrhage** (predicted onset of mortality) for a small mammal representing a calf dolphin. The impulse associated with the predicted onset of extensive lung hemorrhage is 52.8 psi-msec (364 Pa-sec). The calculated maximum range for this criterion under DDG 81 shock trial conditions is 4,434 ft (1,351 m) or about 0.73 nmi.

- Potential slight injury criteria discussed include the onset of slight lung injury (Section D.4.1) and 50% tympanic membrane (TM) rupture (Section D.4.3). A criterion of **onset of slight lung hemorrhage** to a 12.2 kg (27 lb) mammal representing a calf dolphin is used in the FEIS to calculate numbers of animals potentially injured since this criterion has a slightly greater maximum calculated range. Slight lung injury is not necessarily a serious or life-threatening injury. The impulse associated with onset of slight lung injury to a calf dolphin is 25.3 psi-msec (175 Pa-sec). The maximum range for this criterion under DDG 81 shock trial conditions is estimated to be 7,383 ft (2,250 m) or about 1.20 nmi.

A non-injurious physical effect, tactile perception (such as a brief "sting"), is also discussed in Section D.6. Tactile perception would be unlikely at ranges that exceed 5 to 11 nmi (9 to 20 km). Strong "stings" would be highly probable at ranges less than about 0.4 to 0.7 nmi (0.7 to 1.3 km). Between these ranges, tactile perception (including moderate "stings") is possible.

Information presented in this appendix has been updated from the SEAWOLF FEIS (Department of the Navy, 1998) to reflect the change in charge depth (200 ft [61 m] vice 100 ft [30.5 m]) and the deeper water in the test areas under consideration (600 to 8,000 ft [183 to 2,438 m] vice 500 ft (152 m)]. The greater charge depth increases the duration of the direct portion of the shock wave and the deeper water combined with the greater charge depth increase the duration of the bottom-reflected pressure wave. The net result for the DDG 81 shock trial, as compared to the SEAWOLF shock test, is an increase in the predicted ranges for all criteria that are impulse or energy-dependent. Ranges for criteria based on maximum shock wave pressure levels are generally unchanged at upper to mid water column depths. At the lower levels of the water column in water depths similar to that for the SEAWOLF FEIS, ranges for pressure-dependent criteria are larger since the deeper charge is closer to the bottom – enhancing the bottom-reflected pressure wave.

This appendix includes numerous supporting tables and figures. To avoid interrupting the flow of the discussion, they are presented at the end of the appendix.

D.2 MARINE MAMMAL ANATOMY IN RELATION TO EFFECTS OF UNDERWATER EXPLOSIONS

The actual vulnerability of marine mammals to underwater explosions is largely unknown (Ketten, 1995). Results of very small explosives charge ("seal bomb") tests on dolphin carcasses as reported by Myrick et al. (1990) are discussed in Section D.4.2.2. Blast injuries from large explosive charges to humpback whales near a Canadian construction site as reported by Ketten (1995) and Todd et al. (1996) are discussed in Section D.4.3.1. Injuries to marine mammals from an extremely large (2,750,000 lb [1,250,000 kg]) conventional underwater blast and several underground nuclear blasts reported in Richardson et al. (1995) are beyond the scope of this appendix.

Ketten (1994, 1995, 1998) has reviewed the functional anatomy of marine mammal ears, the latter two papers focusing on blast injury and acoustic trauma. Cetaceans, derived from terrestrial mammals, have retained an air-filled middle ear which makes them susceptible to all ranges of compressive-rarefactive/blast injury (Ketten, 1994, 1998). Ketten (1995) concludes that, "[W]hale middle and inner ears are most heavily modified structurally from those of terrestrial mammals in ways that accommodate rapid pressure changes. The end product is an acoustically sensitive ear that is simultaneously adapted to sustain moderately rapid and extreme pressure changes.... It is possible that these special adaptations coincidentally may provide protective mechanisms that lessen the risk of injury from high intensity noise, but no behavioural or psychometric studies are available which directly address this issue." Richardson et al. (1995) note that although marine mammals are presumably better adapted to pressure changes and other aspects of the aquatic medium, their auditory systems are also better adapted to transmit rapid pressure fluctuations in

the water to the inner ear. Thus, it is unclear whether marine mammals are less, equally, or more vulnerable to blast injury than are terrestrial mammals (Richardson et al., 1995).

The ranges at which different species and sizes of marine mammals may be injured are estimates based largely on experiments with terrestrial mammals. Effects on marine mammals may differ due to anatomical and physiological characteristics that have been shaped by their aquatic existence. Some characteristics, such as highly reinforced lung tissues, may or may not tend to decrease the risk of lung injury. Other characteristics, such as light, oil-filled bones and near loss of certain skeletal structures, have no direct effect in the lung injury model used. The higher lung volume to body mass ratio of marine mammals (Kooyman, 1973) has been taken into account in the model. A reduction in lung volume with hydrostatic pressure is taken into account; partial or total lung collapse at depth (as occurs in some marine mammals) could further reduce the risk of lung injury. However, because of the uncertainties in extrapolating from terrestrial to marine mammals, effect ranges in this appendix have been calculated using conservative assumptions that should deliberately overestimate the risk of injury.

D.3 PRIMARY BLAST INJURY DESCRIPTION

"*Blast injury* is a general term that refers to the biophysical and pathophysiological events and the clinical syndromes that occur when a living body is exposed to blast of any origin. Blast wave physical properties, the complexity of the waveform, and the number of blast repetitions determine the potential for *primary blast injury* (PBI).... PBI occurs when the blast wave strikes and compresses the body. Energy is transferred directly from the transmitting medium (air or water) to the body surface. Damage is almost totally limited to the auditory system and the gas-containing structures of the respiratory and gastrointestinal tract.... The classic case of pure PBI is usually seen in a casualty who has been exposed to an underwater detonation" (Office of the Surgeon General, 1991).

The following subsections offer detailed descriptions of PBI to human subjects exposed to air and underwater blasts from both wartime and terrorist actions. These descriptions cover the spectrum of injuries ranging from trivial to lethal. The more severe injuries to the respiratory and gastrointestinal tract would require immediate medical intervention to preclude mortality. The Office of the Surgeon General (1991) reports on four specific wartime incidents of underwater blast exposure with mortality rates ranging from 15% to 85% even with medical intervention. Medical intervention for marine mammals obviously is not possible and moderate to severe injuries could be expected to cause relatively high mortality rates for injured marine mammals. Specific injury severity descriptions and criteria as applied to potential impacts to marine mammals are briefly mentioned in Section D.4.

D.3.1 Primary Blast Injury to the Respiratory System

"The lungs are the vital organs that are most vulnerable to PBI. Damage to the lungs may include (a) pulmonary contusions, with or without lacerations, (b) pneumothorax, (c) traumatic lung cysts, (d) interstitial emphysema, (e) pneumomediastinum, or (f) subcutaneus emphysema. ...Pulmonary contusions impair gas exchange at the alveolar level. The degree of respiratory insufficiency will

depend on the degree of hemorrhage. These contusions develop, stabilize, and resolve relatively rapidly.... In humans...these contusions may resolve in about 1 week...The blood in a pulmonary contusion usually stays within the lung, but if the contusion is complicated by parenchymal laceration, bleeding may occur not only within the parenchyma but also in the pleural space, creating a hemothorax. ...Pneumothorax, the most serious form of intrathoracic barotrauma, is the presence of air in the pleural cavity. ...A blast casualty may have a hemopneumothorax if both blood and air are in the pleural space, and might experience not only the respiratory-distress symptoms of pneumothorax, but also hemotopsis and cardiovascular collapse. ...Air may be forced from the alveoli and airways into the interstitium of the lung either as traumatic lung cysts or as interstitial emphysema. ...Interstitial emphysema occurs when air dissects from the airway along bronchial walls. ...Pneumoediastinum and subcutaneous emphysema can occur when interstitial emphysema decompresses into the medastinum or the subcutaneous tissue space. ...Neither pneumomediastinum nor subcutaneous emphysema by themselves pose a significant threat" (Office of the Surgeon General, 1991).

D.3.2 Air Embolism in Primary Blast Injury

"Air emboli may be liberated from the lacerated lung into the arterial circulation, where they may cause occlusions – often with disastrous results. Any organ may be affected by a local vascular obstruction, but the casualty may suffer (a) a cerebrovascular accident when cerebral vessels are occluded, or (b) a myocardial infarction when coronary vessels are occluded. Air emboli cause most of those deaths that occur within an hour of the blast incident" (Office of the Surgeon General, 1991).

D.3.3 Primary Blast Injury to the Gastrointestinal Tract

"Casualties who have pure PBI to the gastrointestinal tract are most likely to have been injured in an underwater blast. ...An injury to the gastrointestinal tract is often overshadowed by the more immediately life-threatening pulmonary contusions and lacerations, as well as by the air emboli that result from them. ...Like injuries to the lungs, the most common primary blast lesions of the gastrointestinal tract are found in the air-containing organs. These lesions commonly include (a) hematomas and perforations of the bowel, (b) hematomas and tears of the mesentery, and (c) ruptures of the hollow abdominal viscera. ...Retroperitoneal hemorrhage and damage to the solid abdominal organs are much less common... Subcapsular hemorrhage in the liver, spleen or kidneys is the most common of these injuries; very rarely, the force of the blast will fracture one of these solid organs" (Office of the Surgeon General, 1991).

D.3.4 Primary Blast Injury to the Auditory System

"The ear is the organ that is most frequently damaged by blast waves, and, at low blast doses (those below the level at which minimal respiratory lesions appear), may be the only anatomical site of detectable PBI. As is the case in other body systems that are vulnerable to PBI, the ear is damaged when the blast wave strikes and causes tissue distortion, tissue stress, and ultimately tissue failure. ...Aural injuries from blast may range from a trivial insult to a major disruption of

the middle- and inner-ear structures. ...The most common injury will be hearing loss, with or without tympanic-membrane rupture. The hearing loss may be (a) conductive, (b) sensorneural, or (c) a combination of the two. Waves with sufficient peak pressures may overload the auditory system and cause damage to any of the component parts, including (a) ruptures of the tympanic membrane, (b) dislocations or fractures of the ossicular chain, and (c) damage to the organ of Corti within the cochlea" (Office of the Surgeon General, 1991). Auditory system injuries considered in this appendix will be statistically significant injuries involving (TM) ruptures and permanent hearing loss expected to occur to a large percentage of those animals located at ranges relatively close to the point of detonation [nominally within a 1.2 nmi (2.2 km) radius]. Appendix E discusses temporary and permanent auditory threshold shifts and the maximum ranges expected for temporary threshold shift.

D.4 MARINE MAMMAL INJURY FROM UNDERWATER EXPLOSIONS

Based on a parametric evaluation of the effects of charge weight and depth using the Goertner (1982) model, Young (1991) concluded that a conservative safe range for non-injury to a small mammal (representative of a calf dolphin) was approximated by $R=578w^{0.28}$ (*R* is in feet and *w* is in pounds of explosive). For the DDG 81 shock trial, this equation yields a nominal "safe" standoff range of 7,620 ft (2,223 m) or 1.25 nmi (2.2 km). Young points out that a project-specific safety range should be evaluated by conducting a detailed impact analysis. The detailed impact analysis for the DDG 81 shock trial is described below. Possible marine mammal responses to underwater explosions will be discussed and the maximum ranges for the most significant of these potential responses will be selected as specific criteria for the estimation of numbers of animals potentially affected by the DDG 81 shock trial (see Appendix C).

Figure D.1 shows regression analyses of terrestrial mammal test data from Yelverton (1981), as reported by Richardson et al. (1995). The curves shown in **Figure D.1** reportedly represent the best fit from test data for "No Injury," "1% Mortality," and "50% Mortality" based on injury to internal organs. Auditory system injuries are not included in these equations. These regression curves can be described by

$$\ln I = 1.969 + 0.386 \ln M \quad \text{(No Injury)}$$
$$\ln I = 2.588 + 0.386 \ln M \quad \text{(1\% Mortality)}$$
$$\ln I = 3.019 + 0.386 \ln M \quad \text{(50\% Mortality)}$$

where I is impulse in psi-msec and M is body mass in kg. These equations cannot be used to directly calculate the effects of a large charge explosion on a marine mammal, but are useful in providing shallow depth impulse limits for various injury severity levels required to develop and validate the injury prediction model. Injuries to the auditory system are not described by the above equations.

D.4.1 Onset of Slight Injury

Using data from tests with small terrestrial mammals from the Yelverton et al. (1973) and Richmond et al. (1973) reports, Goertner (1982) developed a conservative model for calculating the ranges for occurrence of two types of internal organ injury to marine mammals exposed to underwater explosion shock waves. The two injury mechanisms considered are (1) slight lung hemorrhage, and (2) contusions and hemorrhage of the gastrointestinal (G.I.) tract. (Although very likely to occur concurrently with internal organ injury, auditory system injury is covered separately in Section D.4.3.) For lung hemorrhage, the Goertner model considers lung volume as a function of animal weight and depth and considers shock wave duration and impulse tolerance as a function of animal weight and depth. Goertner indicated that slight injury to the G.I. tract could be related to the magnitude of the peak shock wave pressure over the hydrostatic pressure and would be independent of mammal size and weight. Slight contusions to the G.I. tract occurred during small charge tests (Richmond et al., 1973) when the peak shock wave pressure was 104 psi (717 kPa) above hydrostatic pressure. Onset of G.I. tract contusion and onset of slight lung hemorrhage are injuries from which a mammal would be expected to recover on its own and would not be debilitating. For small mammals, significant G.I. tract injury (G.I. tract hemorrhage) would be expected to occur at ranges significantly closer to the explosion than the maximum calculated ranges for the onset of slight lung injury. Standard explosive similitude equations are used to calculate the shock wave impulse. Injury ranges determined on the basis of the Goertner model are most appropriate for use in regions close to the explosive charge.

Table D.1 presents a comparison between small charge injury data (Richmond et al., 1973) and predicted values based on the Goertner model. The reference values used in this application of the Goertner model are the lowest impulse and body mass for which slight lung injury was reported by Richmond et al. (1973): 22.8 psi-msec (157.3 Pa-sec) impulse and 93 lb (42 kg) body weight. After correcting for the atmospheric and hydrostatic pressures for the data, the minimum impulse (I) for predicting onset of slight lung hemorrhage in a small mammal is

$$I = 19.7\ (M/42)^{1/3} \text{ psi-msec, or}$$
$$I = 136\ (M/42)^{1/3} \text{ Pa-sec,}$$

and M is the body mass (in kg) of the subject animal. Impulse values from the above equation provide a shallow depth "starting point" for determining the maximum range and the corresponding at-depth impulse level for the specific charge weight and marine mammal size. A maximum range cannot be calculated using only the above impulse/body mass relationship and the total impulse similitude equation for a specific explosive.

The test data indicate the ranges, peak shock wave pressures, and impulses for which slight lung hemorrhage actually occurred to the test subject. The model predictions are ranges, peak pressures, and impulses describing conditions sufficient for the onset of slight lung hemorrhage. Regression curve values (**Figure D.1**, Yelverton, 1981) indicate that for the range of body weights (masses) of 13 to 93 lb (6 to 42 kg), the "No Injury" impulses would be expected to range from 14.3 to 30.3 psi-msec (98.7 to 209.1 Pa-sec). Predictions for onset of slight lung injury based on actual test conditions using the Goertner model indexed to 19.7 psi-msec (136 Pa-sec) for a 93 lb (42 kg)

mammal range from 10.1 to 22.2 psi-msec (69.7 to 153.2 Pa-sec). **Figure D.2** presents a body mass versus impulse comparison among the Yelverton (1981) "No Injury" regression from **Figure D.1** and calculated data points representing both actual test conditions for occurrence of slight lung hemorrhage and predictions for onset of slight lung hemorrhage using the DDG 81 injury model for the specified test conditions. In order for the onset of slight lung injury model to be conservative, the predicted impulse values must be no greater than either the test values or regression curve predictions and the predicted ranges must be no less than the test values. As can be seen in **Table D.1** and **Figure D.2**, these conditions are met by the onset of slight lung injury model. Note that the Yelverton "No Injury" criterion is changed to "Onset of Slight Injury" for the DDG 81 injury model since predictions are indexed to conditions that did produce slight lung injury to a small terrestrial mammal.

The maximum calculated horizontal range for slight contusions to the G.I. tract is 2,306 ft (703 m). The calculated peak shock wave pressure at this range is 106 psi (731 kPa). *For a small mammal (27 lb or 12.2 kg, representing a calf dolphin), the impulse associated with the predicted onset of slight lung hemorrhage is 25.3 psi-msec (175 Pa-sec), the maximum horizontal range is 7,383 ft (2,250 m).* This range greatly exceeds the 492 to 2,953 ft (150 to 900 m) "transitional lethal zone" described by Ketten (1995) as a zone where "serious sublethal injury predominates." The calculated peak pressure at the 7,383 ft (2,250 m) maximum range is 28 psi (193 kPa), significantly below the calculated pressure levels of 681 to 87 psi (4,695 and 87 kPa) at the 492 and 2,953 ft (150 and 900 m) ranges, respectively. [Using the "index mammal mass" of 42 kg (93 lb) yields an onset of slight lung injury range of 6,224 ft (1,897 m) with a 200 ft (61 m) charge depth. The modified Goertner model is very sensitive to mammal weight. By assuming the smaller mammal weight for the DDG 81 impact analysis, the onset of slight injury range is maximized for conservatism.]

D.4.2 Lethal Injury

D.4.2.1 Lethality from Injury to Internal Organs

Extensive lung hemorrhage is a debilitating injury that all animals would not be expected to survive. Based on pathology reports (Richmond et al., 1973), G.I. tract injuries associated with the onset of extensive lung hemorrhage would include contusions with no ulcerations. As the severity of extensive lung hemorrhage increases beyond the onset level, G.I. tract injuries would generally be expected to increase significantly to include contusions with ulcerations throughout the entire G.I. tract and ultimately to include ruptures of the G.I. tract. The expected mortality level associated with these combined severe injuries would be quite high.

Richmond et al. (1973) reported that the lowest impulse level to inflict extensive lung injury was 44.4 psi-msec (306 kPa-sec) for a 75 lb (34 kg) mammal. After correcting for atmospheric and hydrostatic pressures, and based on the cube root scaling of body mass as used in the Goertner lung injury model, the minimum impulse for predicting onset of extensive lung hemorrhage is

$$I_M = 42.9\ (M/34)^{1/3} \text{ psi-msec, or}$$
$$I_M = 296\ (M/34)^{1/3} \text{ Pa-sec,}$$

where M is the body mass (in kg) of the subject animal and I_M is the minimum impulse for onset of mortality. Impulse values from the above equation provide a shallow depth "starting point" for determining the maximum range and the corresponding at-depth impulse level for the specific charge weight and marine mammal size. A maximum range cannot be calculated using only the above impulse/body mass relationship and the total impulse similitude equation for a specific explosive. Although the Goertner model was not originally developed for mortality calculations, it lends itself to this use because of the ability to specify reference impulse and body mass values.

Table D.2 provides a comparison between actual injury data (Richmond et al., 1973) and predicted values based on the Goertner model as used in this document. The test data indicate ranges, peak shock wave pressures, and impulses for which extensive lung hemorrhage actually occurred to the test subjects. The model predictions are ranges, peak pressures, and impulses describing conditions sufficient for the onset of extensive lung hemorrhage when using the modified Goertner model.

Regression curve values (Yelverton, 1981) indicate that for the range of body weights (masses) of 75 to 110 lb (34 to 50 kg) the "1% Mortality" impulses would be expected to range from 51.9 to 60.2 psi-msec (354 to 410 Pa-sec). Predictions for onset of extensive lung hemorrhage based on actual test conditions using the Goertner model indexed to 42.9 psi-msec (296 Pa-sec) for a 75 lb (34 kg) mammal range from 43.5 to 48.2 psi-msec (296 to 328 Pa-sec).

Figure D.3 presents a body mass versus impulse comparison among the Yelverton (1981) "1% Mortality" regression from **Figure D.1** and calculated data points representing both actual test conditions for occurrence of extensive lung hemorrhage and predictions for onset of extensive lung hemorrhage using the DDG 81 injury model for the specified test conditions. In order for the onset of extensive lung injury model to be conservative, the predicted impulse values must be no greater than either the test values or the regression curve values, and the predicted ranges must be no less than the test values.

As can be seen in **Table D.2** and **Figure D.3**, these conditions are met by the onset of extensive lung injury model. Therefore, the predicted onset of extensive lung hemorrhage will be used as a conservative index for onset of mortality. (Because of the possible extreme combinations of very small charges and large to extremely large mammals, the onset of extensive lung injury model would not always apply. The extreme short ranges and resultant high peak shock wave pressures become indicative of significant external tissue damage and associated severe internal injuries. The onset of extensive lung injury model is therefore limited to ranges and impulses where the peak shock wave pressure is less than 1,400 psi [9.7 MPa]. See Section D.4.2.2, below, for lethal injuries from high peak pressure.)

For a small mammal (27 lb or 12.2 kg), the impulse associated with the predicted onset of mortality is 52.8 psi-msec (364 Pa-sec), the maximum calculated horizontal range is 4,434 ft (1,351 m). This range exceeds the 984 ft (300 m) maximum "mixed lethal to PTS" range from Ketten (1995). The calculated pressures at the 4,434 ft (1,351 m) and 984 ft (300 m) ranges are 50 and 307 psi (345 and 2,117 kPa), respectively.

Based on the Yelverton (1981) 50% Mortality regression curve, impulses sufficient for 50% mortality range from 79.9 to 92.7 psi-msec (551 to 640 Pa-sec) for the range of body weights (masses) of 75 to 110 lb (34 to 50 kg). Referring to **Table D.2** it can be seen that the first six rows of test data have values near or within the Yelverton 50% Mortality requirements. **Table D.3** presents a comparison of test data (Richmond et al., 1973) and Goertner model predictions. For occurrence of extensive lung hemorrhage, the Goertner model was indexed to 84.9 psi-msec (586 kPa-sec) for a 93 lb (42 kg) mammal

$$I_{50\%} = 84.9\ (M/42)^{1/3} \text{ psi-msec, or}$$
$$I_{50\%} = 586\ (M/42)^{1/3} \text{ Pa-sec,}$$

where M is the body mass (in kg) of the subject animal and $I_{50\%}$ is impulse for 50% mortality. Impulse values from the above equation provide a shallow depth "starting point" for determining the maximum range and the corresponding at-depth impulse level for the specific charge weight and marine mammal size. A maximum range cannot be calculated using only the above impulse/body mass relationship and the total impulse similitude equation for a specific explosive.

Figure D.4 presents a body mass versus impulse comparison among the Yelverton (1981) "50% Mortality" regression from **Figure D.1** and calculated data points representing both actual test conditions for occurrence of extensive lung hemorrhage and predictions for occurrence of extensive lung hemorrhage using the DDG 81 injury model for the specified test conditions. The extensive lung hemorrhage calculations are in good agreement with the test data and the Yelverton 50% Mortality regression curve. The predicted impulse values are less than the regression curve values and the predicted ranges are slightly greater than the test values. The range and impulse values predicted for the occurrence of extensive lung hemorrhage and its attendant severe to extensive G.I. tract injuries can be used as an index for 50% mortality. As with the onset of extensive lung injury model, the extensive lung injury model is limited to ranges and impulses where the peak shock wave pressure is less than 1,400 psi (9.7 Mpa).

For a small mammal (27 lb or 12.2 kg), the impulse associated with 50% mortality is 90 psi-msec (621 Pa-sec), the maximum calculated horizontal range is 3,034 ft (925 m). This 50% mortality range is nominally equivalent to the 2,953 ft (900 m) range from Ketten (1995) that is the maximum expected range for serious sublethal injury.

D.4.2.2 Lethal Injury from Shock Waves with High Peak Pressure

Ketten (1995) describes the zone from 230 to 492 ft (70 to 150 m) as 100% lethal. Ketten (1995) indicates that at ranges of 230 to 328 ft (70 to 100 m) "death would likely be immediate or follow within days as a result of concussive brain damage, cranial fractures, hemorrhage, etc. for the majority of animals. For the remainder, permanent, profound deafness from massive inner ear trauma would seriously impair the animal's ability to survive...." Based on Ketten (1995), calculated peak pressures are 1,635 and 681 psi (11.3 to 4.7 MPa) at the 230 and 492 ft (70 and 150 m) ranges, respectively.

Myrick et al. (1990) reported on the effects to dolphin carcasses from underwater explosion tests using a 0.15 oz (5.76 g) "seal bomb." No damage was noted at a detonation distance of 2.3 ft (0.7 m). When the "seal bomb" was detonated 2 ft (0.6 m) away, "... a 5 x 7-cm jagged wound 4-cm deep was incurred above the right shoulder.... Subsequent examination of the carcass disclosed that the right shoulder blade had been shattered, the diaphysis of the humerus fractured, and the subscapular and intercostal musculature pulverized, but no penetration was made into the pulmonary cavity. Examination of the cranial bones revealed fractures to hamular processes of both pterygoids and a fractured left temporal bone. No internal damage was found, except possible evidence of compression on the right lung by the first right rib, thought perhaps to have been associated with the shoulder-blast damage. Participants in the examination of the specimen could not attribute cause of the cranial damage to test explosions partly because the temporal fracture was on the side opposite the shoulder damage. Further, there was no certainty that the cranial damage was not incurred elsewhere since postmortem history of the specimen was unknown" (Myrick et al., 1990).

Assuming the "seal bomb" to have a 90% TNT equivalence, the calculated peak shock wave pressures are 1,451 psi (10.0 MPa) at a distance of 2.3 ft (0.7 m), and 1,711 psi (11.8 MPa) at a distance of 2 ft (0.6 m). Animals exposed to shock wave pressures of these magnitudes, regardless of the charge size or animal body weight, will be subjected to extremely high impulse levels. Depending upon the size of the animal, these impulse levels may or may not be lethally injurious to the animals' internal organs; however, overall system shock and significant external tissue damage as well as severe localized damage to the skeletal system would be expected. Animals suffering these types of injuries also would probably be at increased risk of disease and predation. For a 10,000 lb (4,536 kg) charge, the nominal calculated range for a peak shock wave pressure of 1,400 psi (9.7 MPa) is 243 ft (74 m). This range is consistent with the 230 ft (70 m) minimum "killing ground" range predicted by Ketten (1995, 1998).

All internal organ injury models used in this document use the 681 psi (4.7 MPa) pressure based on Ketten (1995) as a limiting value. All animals exposed to a peak shock wave pressure of this magnitude or greater would be considered lethally injured (100% mortality).

D.4.3 Auditory System Injury

"In general, the most sensitive organ to the primary effects of a blast wave is the ear" (Office of the Surgeon General, 1991). Tympanic membrane rupture, while not necessarily a serious or life-threatening injury, is a statistically useful index of injury that correlates to permanent hearing loss (Ketten, 1995, 1998). "As frequency of rupture increases so does the incidence of permanent hearing loss. In zones where >50% tympanic membrane rupture occurred, 30% of the victims had permanent hearing loss" (Ketten, 1998). The permanent loss may be either asymptotic threshold shift (ATS) or permanent threshold shift (PTS) as described by Ketten (1995, 1998). Beyond the range required to cause 50% TM rupture, "the relative incidence of PTS to TTS will largely depend on individual susceptibility.... (T)he variables that will determine TTS vs. PTS are highly species dependent and the animals are sufficiently mobile that no global, permanent division of these intermediate zones will be correct" (Ketten, 1995).

In this section, criteria will be developed to conservatively estimate the range for occurrence of 50% TM rupture (30% PTS). Significant occurrence of TM rupture would be expected at "near field" ranges significantly closer to the charge than the ranges for temporary threshold shift (TTS) and onset of PTS. These "far field" effects are described in Appendix E.

For the DDG 81 injury model, TM rupture criteria can be developed based on a limited number of small charge underwater explosion tests conducted with small terrestrial mammals as reported by both Yelverton et al. (1973) and Richmond et al. (1973). TM rupture-specific tests were conducted with dogs (nominal 55 lb [25 kg] body mass) using 1 lb (0.45 kg) TNT charges. Additional TM rupture data from general injury tests conducted with sheep (nominal 88 lb [40 kg] body mass) using 0.5 lb and 1 lb (0.23 kg and 0.45 kg) pentolite charges are also included. The test conditions and results from Richmond et al. (1973) are provided in **Table D.4**. Seven of the 11 test groups were conducted with only three subjects; two with six subjects; and two with 12 subjects. In some instances, eardrums were not accessible or readable following a test. For conservatism, these cases are counted as TM ruptures. To simplify the analysis, only eardrums directly facing the blast in the TM rupture-specific tests are used. Eardrums facing away from the blast potentially were subjected to significantly different shock wave loading than those directly facing the blast. Additionally, eardrums facing away from the blast may have been damaged by later-occurring intra-cranial pressures and/or cranial trauma rather than by directly measurable or readily calculable shock wave parameters. Handling and submergence tests conducted with control animals not subjected to explosions reportedly did not cause any TM ruptures.

Ketten (1998) states that "peak pressures of ~150 psi ... are consistent with 50% incidence of eardrum rupture (30% hearing loss) in larger animals ...". Based on Ketten (1995), the calculated free-field range for 150-psi (1035-kPa) shock wave peak pressure from a 10,000 lb (4,536 kg) HBX-1 charge is 1,833 ft (559 m). This range is roughly the mid-point of the 984 to 2,789 ft (300 to 850 m) region identified in Figure 5 of Ketten (1995) as a zone in which ">50% animals have some permanent hearing loss (all ranges of acoustic trauma)." Based on Ketten (1995), peak pressures at the 984 and 2,789 ft (300 and 850 m) limits of this acoustic trauma zone are 307 and 93 psi (2,118 and 642 kPa), respectively. The limited data from **Table D.4** indicate that the 150 psi (1,035 kPa) criterion for 50% TM rupture appears to be a conservative predictor for the small terrestrial animals exposed to detonations of small explosive charges. The 150 psi (1,035 kPa) criterion does not include a duration component and, therefore, does not provide a convenient means to estimate the potential contributory effects on injury (TM rupture) from the bottom-reflected pressure wave.

Damage to terrestrial mammal internal organs typically has been referenced to total shock wave *impulse* (pressure integrated over time) (Richmond et al., 1973; Yelverton et al., 1973). Yelverton et al. (1973) state that eardrum ruptures would occur at sub-lethal impulses of 20 to 40 psi-msec (138 to 276 Pa-sec) and that an impulse of 10 psi-msec (69 Pa-sec) or less would not cause eardrum ruptures. **Figure D.5** shows the maximum percentage of eardrum ruptures as a function of calculated total shock wave impulse from **Table D.4**. (Note that all zero eardrum rupture values are shown as "1%" because of the log-log plot.)

It is not clear from the limited data from very small charges and an extremely limited sample size presented in **Table D.4** and shown in **Figure D.5** that impulse is the appropriate metric for

predicting TM rupture for all charge sizes and ranges. Although an impulse criterion does include a duration component and does permit consideration of the effects of bottom-reflected pressure waves, there is considerable difficulty in applying an impulse-only criterion based on small charge tests to a 10,000 lb (4,536 kg) charge test. Compare data set 6 in **Table D.4** with the calculated shock wave parameters for an identical 22.2 psi-msec (153 Pa-sec) impulse level from a 10,000 lb (4,536 kg) charge detonated at a 200 ft (61 m) depth. The shock wave parameters for the small/large charge include 232/18 psi (1601/124 kPa) peak pressure, 0.653/0.060 in-lb/in^2 (11.44/1.05 milli-Joules/cm^2) energy, and 0.07/1.43 msec duration. For a given impulse level, values for pressure and energy can differ by an order of magnitude when comparing very small charges to a 10,000 lb (4,536 kg) charge. Within narrow ranges of charge weights and test geometries, shock wave impulse can be at least an indicator, if not a predictor, for the occurrence of TM rupture. It may not be appropriate to expect comparable injury severity from equal impulses from shock waves that are characterized by radically different pressures, energies, and durations.

Appendix E indicates that acoustic *energy* (proportional to the *square* of pressure integrated over time) may be one of the appropriate parameters for evaluation of the response of the mammalian ear to the intensities of underwater noise at least sufficient to cause TTS. **Figure D.6** is percent TM rupture as a function of calculated total shock wave energy flux density using the calculated values from **Table D.4**. The *upper bound* (e.g., highest percentage of TM rupture observed for a specific energy level) for percentages of eardrums ruptured and the computed shock wave energy flux density values from data sets 1, 2, 5, 9, and 11 fall reasonably into place along an exponential curve. (Note that all zero rupture values are shown as "1%" because of the log-log plot. The occurrence of the numerous zero values for TM rupture within a set of explosion tests may be indicative of the variability inherent in TM rupture.) The shock wave energy flux density appears to be at least as good an indicator/predictor of auditory system injury (TM rupture) as impulse and, for the DDG 81 shock trial conditions, provides a means to include the potential effects of the bottom-reflected pressure wave.

Table D.5 provides the calculated shock wave energy flux densities for TM rupture percentages ranging from ~8% to 100%. Logarithmic interpolation between the values for data sets 2 and 5 (42% and 67% TM rupture, respectively) indicates that the calculated energy flux density required for the occurrence of 50% TM rupture (~30% PTS) is 1.17 in-lb/in^2 (20.44 milli-Joules/cm^2). The small sample sizes for the tests reported in **Table D.4** in combination with the inherent variability in the occurrence of TM rupture at levels less than ~50% preclude realistic predictions of low percentages of occurrence of TM rupture.

For a 10,000 lb (4,536 kg) charge detonated 328 ft (100 m) below the sea surface in a water depth of at least 6,560 ft (2,000 m) as considered by Ketten (1995), at a 328 ft (100 m) depth the calculated range for 150 psi (1,035 kPa) is 1,710 ft (521 m). The calculated ranges for a shock wave energy flux density of 1.17 in-lb/in^2 (20.44 milli-Joules/cm^2) are 4,181 and 4,077 ft (1,274 and 1,243 m) with and without inclusion of the bottom-reflected wave, respectively. Both energy-based ranges exceed the 2,789 ft (850 m) maximum range for >50% PTS from Ketten (1995) and fall within a region identified by Ketten as a zone in which "the majority of animals have a temporary hearing loss but some permanent auditory damage will be found (transitional trauma)." Using energy flux density as the 50% TM rupture criterion predicts a pressure level, range, and injury

severity consistent with the pressure level, range, and injury predictions of Ketten when applied to the conditions described by Ketten (1995). The energy flux density criterion is therefore considered to be reasonable and conservative.

The Yelverton/Richmond TM rupture data used to develop the criterion can be further evaluated by comparing with other mammalian TM rupture data. Table 1 of Ketten (1995) lists overpressures (in air) needed to induce 50% TM rupture in sheep, pigs, dogs, monkeys, humans, rabbits, and guinea pigs. According to Ketten (1995), sheep and pigs have ears closest anatomically to those of whales; Ketten (personal communication) has also indicated that rabbits and guinea pigs are least similar to marine mammals and should not be used for comparison. Excluding only rabbits and guinea pigs from consideration, overpressures ranging from 57 to 345 kPa are needed to cause 50% TM rupture. The overpressures convert to in-water pressures of 491 to 2,973 psi (3.4 to 20.5 MPa), and calculated ranges for the 10,000 lb (4,536 kg) charge are 2,139 to 443 ft (652 to 135 m). These comparisons show that using the shock wave energy flux density as the 50% TM rupture criterion based on the Yelverton/Richmond data set is reasonable and more conservative than would be derived using peak shock wave pressure and other mammalian TM rupture data.

Ranges for 150 psi (1,035 kPa) and 1.17 in-lb/in^2 (20.44 milli-Joules/cm^2) are calculated and the greater of the two ranges is used as a conservative range for the predicted occurrence of 50% TM rupture (30% PTS). For the DDG 81 shock trial conditions, the shock wave energy flux density criterion produces significantly larger ranges than the peak pressure criterion. For all water depths in the test areas under consideration (600 to 8,000 ft [183 to 2,438 m]), the maximum calculated range for 50% TM rupture (30% PTS) is 7,095 ft (2,163 m) for an animal at the bottom in 1,100 ft (335 m) deep water. The calculated peak shock wave pressure at this maximum range is 51 psi (352 kPa).

Based on shock wave energy criteria, **Figure D.7** presents an overlay of the calculated animal and water depth dependent injury ranges for 50% incidence of TM rupture for the water depths under consideration. (The "tail" extending to the right for each of the presented curves is the result of the bottom-reflected pressure wave that causes an increase in the impact range in the vicinity of the bottom for each of the water depths at the sites considered.) Also shown for reference are the calculated ranges for 150 psi (1,035 kPa). The calculated ranges for 50% TM rupture vary from ~0.5 to 0.8 nmi (0.9 to 1.5 km) in the upper to middle water column depths out to a maximum range of ~1.2 nmi (2.2 km) in 1,100-ft (335-m) deep water. The *maximum* ranges for 150 psi (1,035 kPa) and 50% incidence of TM rupture from **Figure D.7** are shown in **Figure D.8** as a function of *maximum* water depth. **Table D.6** provides the predicted ranges and shock wave peak pressures at selected depths in 1,100 ft (335 m) water for 50% incidence of TM rupture for the 10,000 lb (4,536 kg) charge using the energy flux density criteria.

D.4.3.1 Lethality as a Result of Auditory System Injury

As noted above, TM rupture is not necessarily a serious or life-threatening injury. However, auditory damage has been reported to affect the mortality rate of whales in at least one case. Todd et al. (1996), reporting on the observed impacts of construction project blasting operations on seasonally resident humpback whales, noted that, "humpback whales showed little behavioral

reaction to the detonations in terms of decreased residency, overall movements, or general behavior. However, it appears that the increased entrapment rate [in fishing gear] may have been influenced by the long term effects of exposure to deleterious levels of sound... ". Lien et al. (1993) initially reported on the humpback whale behavioral responses; Ketten et al. (1993) and Ketten (1995) provided a detailed pathological description of the eardrum injuries.

The construction project differs significantly from the DDG 81 shock trial described in this document in several important respects:

- The whales at the construction site were seasonal residents, whereas marine mammals in the proposed test areas are expected to be transients and would probably not be exposed to high sound pressure levels from multiple detonations.
- The construction project used a 1 nmi (1.9 km) safety range for all charge weights, from less than 2,200 lb (1,000 kg) to 12,125 lb (5,500 kg). The shock trial will use a much greater safety range of 2 nmi (3.7 km) with a charge of 10,000 lb (4,536 kg).
- The blasting site for the construction project was a narrow, shallow fjord with rock walls and a hard reflective bottom. The highly reflective bottom and walls would likely have increased the intensity of the pressure levels to which the animals were exposed. In contrast, the proposed test areas for the shock trial are in open ocean waters away from highly reflective side and bottom surfaces.

In addition, because the sound exposure levels are unknown, this event does not provide any information that could be used to evaluate the predicted injury ranges developed in this appendix.

D.5 CALCULATED INJURY RANGES FOR MARINE MAMMALS

Figure D.9 provides a summary of injury severity levels as a function of range and pressure from Ketten (1995, 1998) for a 10,000 lb (4,536 kg) charge detonated at a depth of 328 ft (100 m) in a minimum of 6,560 ft (2,000 m) of water. Also shown in the figure are points indicating specific injury severity levels for a small mammal (representative of a calf dolphin) *at a depth of 328 ft (100 m)* using the DDG 81 injury model criteria as applied to the deep water and deep charge conditions used by Ketten (1995). The DDG 81 model predictions for injury levels were determined on the basis of impulse, energy, or pressure as appropriate to the specific injury criterion as discussed in the preceding sections of this appendix. For comparative purposes these injury severity criteria are shown as a function of range and the calculated peak shock wave pressure at that specific range. As can be seen in the figure, under identical assumed conditions the DDG 81 injury model predictions are consistent with those of Ketten. Significant auditory system injury (50% TM rupture) is predicted in the Ketten "PTS/TTS Transition" region. Predicted onset of slight lung injury, onset of mortality, and 50% mortality follow in order – all occurring in the Ketten "Serious Sublethal Injury" range which includes injury categories of ">50% PTS" and "Mixed lethal to PTS." One hundred percent mortality occurs at the near charge limit of the Ketten "100% Lethal" region. Under identical assumed conditions, the DDG 81 injury model predictions of injury severity are consistent with those of Ketten (1995, 1998).

Figure D.10 repeats the Ketten (1995, 1998) injury severity, pressure, and range information from the preceding figure. Also shown in the figure are points indicating specific injury severity levels for a small mammal (representative of a calf dolphin) at the *maximum* calculated injury ranges using the DDG 81 injury model criteria as applied to the DDG 81 shock trial conditions in 1,100 ft (335 m) water depth. The DDG 81 model predictions for injury levels were determined on the basis of impulse, energy, or pressure as appropriate to the specific injury criterion as discussed in the preceding sections of this appendix. For comparative purposes, these injury severity criteria are shown as a function of range and the calculated peak shock wave pressure at that specific range. As compared to the ranges and pressures in **Figure D.9**, the points representing the maximum ranges for internal organ injury for the DDG 81 shock trial occur at greater ranges and, therefore, lower pressures. This effect is a result of the Goertner model assumption of a marine mammal being more vulnerable to injury at shallow depth as a result of larger lung volume (uncompressed lungs) at shallow depth. Auditory system injury (50% TM rupture) also occurs at a greater range than in **Figure D.9**. The shallower water depth for the DDG 81 shock trial causes a significant bottom-reflected pressure wave influence in the determination of the range for 50% TM rupture. The maximum range for 50% TM rupture occurs at the bottom where the pressure and energy are higher at a given distance than in the middle to upper water column region.

Figures D.11 through **D.14** provide calculated range contours for 50% TM rupture, onset of slight injury, onset of mortality (onset of extensive lung hemorrhage), and 50% mortality (extensive lung hemorrhage) for the 10,000 lb (4,536 kg) charge at a 200 ft (61 m) detonation depth. For reference, the calculated ranges for a peak shock wave pressure of 100 psi (690 kPa) are also shown. This is the nominal calculated pressure that correlates to the maximum "killing ground" range of 800 m (2,625 ft) (Ketten, 1995). Separate figures are provided for animals representative of cetaceans ranging from 3.3-ft-long/27 lb (1 m/12.2 kg) calf and 8 ft long/384 lb (2.4 m/174 kg) adult dolphins to 20 ft long/ 3,110 lb (6.1 m/1,410 kg) and 55 ft long/64,800 lb (16.8 m/29,400 kg) whales. Lung-volume- to-body-mass ratios of 3.9% have been presumed (Kooyman, 1973). These cetacean sizes were used by Goertner (1982), O'Keeffe and Young (1984), and the Department of the Navy (1998) in previous assessments of the potential effects of underwater explosions on marine mammals and are included in this appendix for continuity with prior explosives effects documentation. All injury and mortality impact predictions in Appendix C are based on the maximum calculated ranges for a small mammal since the model was developed on the basis of tests conducted with small mammals. There are no data to support the direct extrapolation to either marine mammals or to larger mammals.

D.6 MARINE MAMMAL TACTILE PERCEPTION

Occurrence of tactile perception to cetaceans from the shock wave is inferred from data on voluntary human subjects exposed to the shock wave from a 1 lb (0.45 kg) pentolite charge and a 300 lb (136 kg) TNT charge (Christian and Gaspin, 1974). "This inference seems plausible given studies on dolphin skin sensitivity where the authors concluded that the most sensitive areas of the dolphin skin (mouth, eyes, snout, melon, and blowhole) are about as sensitive as the skin of the human lips and fingers (Ridgway and Carder, 1990, 1993). Overall skin sensitivity of dolphins equals that of humans (Ridgway and Carder, 1993). Skin sensitivity for... large whales has not been tested." (Moore, 1993).

Exposed to the shock wave from the 1 lb (0.45 kg) charge, human subjects reported feeling no stings or pressure at a 120 ft (36.6 m) range (3.0 psi-msec [20.4 Pa-sec] impulse and 96 psi [654 kPa] peak pressure); feeling moderate stings at a 115 ft (35.1 m) range (3.3 psi-msec [22.5 Pa-sec] impulse and 98 psi [668 kPa] peak pressure); and feeling strong stings at a 100 ft (30.5 m) range (4.2 psi-msec [28.6 Pa-sec] impulse and 115 psi [784 kPa] peak pressure). Shock wave durations were 0.033, 0.035, and 0.040 msec; and calculated energy flux densities were 0.06, 0.06, and 0.08 in-lb/in^2 (1.1, 1.1, and 1.4 milli-Joules/cm^2), respectively. Exposed to the shock wave from the 300 lb (136 kg) TNT charge at a 4,050 ft (1,235 m) range, human subjects heard "a muffled 'thud'or rumbling.... No sensation of pressure on the body was experienced by any of the four divers..." (Christian and Gaspin, 1974). Nominal calculated shock wave parameters for the 300 lb (136 kg) test include a total impulse of 4 psi-msec (28 Pa-sec), total shock wave energy flux density of 0.01 in-lb/in^2 (0.18 milli-Joules/cm^2) and a 15 psi (104 kPa) peak shock wave pressure. The calculated total shock wave duration for the direct and bottom reflected shock waves is 0.3 msec.

Based on the above limited descriptions, partial impulse, energy flux density and peak shock wave pressure are used for criteria that describe a reasonable hierarchy for the potential occurrence of tactile perception resulting from shock waves from larger charges. Tactile perception is believed unlikely when the peak shock wave pressure is less than 15 psi (104 kPa) *and* the energy flux density is less than 0.01 in-lb/in^2 (0.18 milli-Joules/cm^2). Moderate stings are possible when the peak shock wave pressure exceeds 15 psi (104 kPa) *and* the shock wave energy flux density exceeds 0.06 in-lb/in^2 (1.1 milli-Joules/cm^2). Strong stings are probable when the partial impulse exceeds 3.3 psi-msec (22.8 Pa-sec) within 0.035 msec.

Depth-dependent horizontal ranges for tactile perception as well as the shock wave peak pressures at these ranges for the 10,000 lb (4,536 kg) charge are presented in **Table D.7**. Depending upon water and animal depths, tactile perception would be unlikely at ranges that exceed 5 to 11 nmi (9.3 to 20.4 km). As the range to the charge decreases, tactile perception would be expected to increase in magnitude to include moderate stings and ultimately to strong stings. Moderate stings are probable at ranges of 1.2 to 3.5 nmi (2.2 to 6.5 km). Strong stings would be highly probable at ranges less than about 0.4 to 0.7 nmi (0.7 to 1.3 km).

For the water depths under consideration, **Figure D.15** presents an overlay of the calculated animal and water depth-dependent range contours for tactile perception for the 10,000 lb (4,536 kg) charge at a 200 ft (61 m) detonation depth. (The "tail" extending to the right for each of the presented curves is the result of the bottom-reflected pressure wave that causes an increase in the impact range in the vicinity of the bottom for the specific maximum water depth at each of the sites considered.) The *maximum* range values from **Figure D.15** are shown as a function of *maximum* water depth in **Figure D.16**.

Marine mammals could experience tactile perception of the detonation at ranges well beyond those for 50% TM rupture or lung injury. The tactile perception likely would be of such brevity that it would be expected to cause at most a momentary startle response. Based on previously calculated injury ranges for small mammals, the stronger tactile responses (moderate to strong

stings) likely would occur in combination with significant injuries to the auditory system and other internal organs.

D.7 EFFECTS OF CAVITATION ON MARINE MAMMALS

"Cavitation occurs when compression waves, which are generated by the underwater detonation of an explosive charge, propagate to the surface and are reflected back into the water as rarefaction waves. These rarefaction waves cause a state of tension to occur within a large region of water. Since water cannot ordinarily sustain a significant amount of tension, it cavitates and the surrounding pressure rises to the vapor pressure of water. The region in which this occurs is known as the cavitation region, and it includes all water which cavitates at any time after the detonation of the explosive charge. The upper and lower boundaries, which show the maximum extent of the cavitated region, form what is referred to as the cavitation envelope. ...The time of cavitation closure is defined as the time at which the lower boundary displacement equals the surface layer displacement. It is at this time that the accreting surface layer and the accreting lower boundary collide and generate the water hammer pressure pulse" (Costanzo and Gordon, 1989).

The direct effects of cavitation on marine mammals are unknown. The presence of a marine mammal within the cavitation region created by the detonation of small charges could annoy, injure, or increase the severity of the injuries caused by the shock wave. The area of cavitation from a 10,000 lb (4,536 kg) charge would be expected to be an area of near total physical trauma. Presence within the negative pressure cavitation region could injure the auditory system or lungs. A mammal located at (or in the immediate vicinity of) the cavitation closure depth would be subjected to a water hammer pressure pulse. Using the methods of Costanzo and Gordon (1989), the maximum lateral extent of this cavitation area is 2,240 ft (683 m) for the 10,000 lb (4,536 kg) charge. At this maximum lateral range, direct shock wave effects alone would be expected to cause 50% or greater mortality to mammals weighing less than 100 lb (45 kg). It is not expected that any fish or smaller animals would survive the combined effects of the relatively high shock wave impulses and the violent cavitation. (Refer to **Figure D.17** for delineation of the cavitation region.)

D.8 EFFECTS ON SEA TURTLES

There are few reports on injuries and virtually no quantitative data concerning the direct effects of underwater explosions on sea turtles. Information on impacts to turtles from explosions are reported by the National Research Council (1996), Klima et al. (1988), and O'Keeffe and Young (1984). (The O'Keeffe and Young and Klima et al. data are summarized in **Table D.8**.)

The National Research Council (1996) reports that "Two immature green turtles (100 to 150 feet away) were killed when 20 pounds of plastic explosives (C-4) were detonated in open water... Necropsies revealed extensive internal damage, particularly the lungs...." Water, charge and turtle depths are unknown. Turtle body mass is also unknown, but is assumed to be small for an "immature" turtle. In open water, 20 lb (9.1 kg) of C-4 would be expected to generate nominal peak pressures of 244 and 347 psi (1,684 and 2,394 kPa) at 150 and 100 ft (45.7 and 30.5 m)

ranges, respectively. Using the modified Goertner model for small mammals and conservative charge and turtle depths (10 ft [3 m]), 150 ft (45.7 m) is the calculated 50% mortality range (extensive lung hemorrhage) for an 8 lb (4 kg) mammal. The 100 ft (30.5 m) range corresponds to the 50% mortality range for a 57 lb (26 kg) mammal. Smaller animals are believed to be at even greater risk of mortality. Model predictions do not contradict the anecdotal turtle mortality information.

Klima et al. (1988) conducted an experiment in which Kemp's ridley and loggerhead turtles were placed in cages at four distances from a oil platform to be removed with explosives. The cages were submerged to a depth of 15 ft (4.5 m) over the 30 ft (9 m) sea bottom just prior to the simultaneous explosion of four 50.75 lb (23 kg) charges of nitromethane placed inside the platform pilings at a depth of 16 ft (5 m) below the mudline. Loggerhead and Kemp's ridley turtles at 750 ft (213 m) and 1,200 ft (366 m), as well as one loggerhead at 3,000 ft (915 m) were rendered unconscious. The Kemp's ridley turtle closest to the explosion (range of 750 ft or 229 m) was slightly injured, with an everted cloacal lining; ridleys at ranges of 1,200 ft (366 m), 1,800 ft (549 m) and 3,000 ft (915 m) were apparently unharmed. All loggerheads displayed abnormal pink coloration caused by dilated blood vessels at the base of the throat and flippers, a condition that persisted for about 3 weeks.

The Klima et al. (1988) data set with the buried 203 lb (93 kg) total charge weight presents interesting low-level, non-injury response data. However, the lack of pressure measurements and the use of buried charges in shallow water present very nearly a total analysis conundrum. Peak shock wave pressures for buried charges can be as low as 10% of the expected free-field values for non-buried charges (Connor, 1990). The estimated/calculated peak pressures presented by the researchers are of such low magnitude that injury would not be expected. Based on the ranges and estimated pressures for this data set, standard similitude equations and weak shock theory (Gaspin, 1983) were used to calculate an equivalent "non-buried" charge weight. A 2 lb (0.92 kg) TNT charge detonated free-field would produce the shock wave pressures at the ranges shown in **Table D.8.** However, since the water depth was extremely shallow, multiple shock wave pulses and bulk cavitation resulting from bottom and surface-reflected shock waves could have impacted the turtles.

A major problem with the Klima et al. (1988) experiment was the lack of published pressure measurements to estimate the magnitude and duration of the shock wave received by the turtles. As a follow-up, Connor (1988) states that "several turtles were to have been tethered near the site of ongoing platform/leg piling severance operations in the Gulf of Mexico... Strong ecological objections were raised, and these tests have been canceled for the foreseeable future." Although pressure measurements were subsequently made during a platform removal (Connor, 1990), further sea turtle experiments were never conducted (Connor, 1996). Gitschlag and Herczeg (1994) subsequently reported that only two turtles were impacted by explosive platform removals during 1986-1992. The authors did not present any data on the specific effects or turtle distance from the explosions.

The O'Keeffe and Young (1984) data are from three underwater shock tests carried out off Panama City, Florida in 1981. During each test, a charge equivalent of 1,200 lb (544 kg) of TNT was

detonated at mid-depth in water about 120 ft (37 m) deep. At least three turtles were noted in the area following the detonations. One turtle at a range of 500 to 700 ft (152 to 213 m) was killed. A second turtle at a range of 1,200 ft (366 m) received minor injuries. A third turtle at 2,000 ft (610 m) was apparently unaffected. At a depth of 60 ft (18 m), calculated shock wave pressures are 239, 161, 85, and 47 psi (35, 23, 12, and 7 kPa) at ranges of 500, 700, 1,200, and 2,000 ft (152, 213, 366, and 610 m), respectively.

Although anecdotal, the observations presented by O'Keeffe and Young (1984) are the best and most useful data. In the absence of any model for shock wave effects on turtles, the Goertner (1982) model was run for the test conditions for onset of lung hemorrhage, onset of extensive lung hemorrhage, and extensive lung hemorrhage. **Figures D.18** and **D.19** present the results. Because turtle depths at the time of detonation are unknown (but presumably well below the surface), the post-detonation ranges are indicated with a vertical line from water surface to the bottom in both figures.

As can be seen from **Figure D.18**, the 400 lb (181 kg) turtle located 500 to 700 ft (152 to 213 m) from the detonation and at depths of 10 ft (3 m) or greater would have been in a zone of onset of mortality to greater than 50% mortality. The mortal injury suffered by this turtle is fully consistent with the model predictions.

Figure D.19 presents the predicted onset of slight injury, onset of mortality, and 50% mortality curves for the two 200 to 300 lb (91 to 136 kg) turtles. To be conservative, the lower end of this weight range (200 lb or 91 kg) was used for calculations. The turtle at a range of 2,000 ft (610 m) would be expected to be uninjured if located in the upper half of the water column. The turtle at a range of 1,200 ft (366 m) would be expected to suffer minor to severe injuries depending on its depth. Again, the actual responses of the turtles are reasonably consistent with model predictions; the turtle at 2,000 ft (610 m) was uninjured and the turtle at 1,200 ft (366 m) suffered minor injuries.

Figure D.20 presents the calculated bulk cavitation region and closure depth for the 1,200 lb (544 kg) charge. The predictions for deep water may not accurately represent the shallow water cavitation region. Again, turtle ranges are indicated by a vertical line drawn from the water surface to the seafloor. Only the mortally injured 400 lb (181 kg) turtle was within the bulk cavitation region.

On the basis of the first data set in **Table D.8**, O'Keeffe and Young (1984) proposed that a safe range for turtles from an underwater explosion could be expressed by $R = 200\ w^{1/3}$, where R is the safe range in feet and w is the charge weight in pounds. This equation was subsequently modified by Young (1991) based on safe ranges established by the National Marine Fisheries Service for platform removal operations using explosives. The revised equation is $R = 560\ w^{1/3}$. Applied to the Klima et al. (1988) observations, this equation predicts a safe range of 3,291 ft (1,003 m), which exceeds the greatest distance at which an effect was observed (turtle unconscious at 3,000 ft or 915 m). Applied to the O'Keeffe and Young (1984) report, this equation predicts a safe range of 5,951 ft (1,814 m) – nearly triple the range from the charge of the uninjured turtle. For the DDG 81 shock trial conditions, this equation would predict a safe range of 12,065 ft (3,677 m) – the same as

the 2 nmi (3.7 km) safety range established for the shock trial. At this range, the modified Goertner model predicts the onset of slight lung injury only for those animals weighing less than ~0.2 kg (0.5 lb).

Lung injury criteria for marine mammals developed in this appendix vary with animal size, with smaller animals being more vulnerable. Mortality calculations in the FEIS are conservatively based on the values for a small mammal representative of a calf dolphin (27 lb or 12.2 kg). Because adult sea turtles can weigh several hundred pounds, the mortality range should be less for them (i.e., they would have to be much closer to the detonation to be killed). Therefore, using the small mammal mortality range for sea turtles should overestimate turtle impacts. Juvenile and hatchling turtles have a small body mass, but they are typically associated with floating *Sargassum* in near-surface waters. As shown in **Figure D.11**, ranges for both onset of mortality (onset of extensive lung hemorrhage) and injury (onset of slight lung injury) are generally much less near the surface (i.e., the animals would have to be closer to the detonation to be affected). This is also true for cavitation (**Figure D.20**). Although the Goertner model as used does not consider the effects of anatomical differences between mammals and turtles, using the small mammal mortality and injury criteria for juvenile and hatchling sea turtles is believed to be reasonable and conservative.

In conclusion, the very limited data available for mortality and injury of sea turtles from underwater explosions are not inconsistent with the lung injury predictions for small mammals developed in this appendix. Therefore, use of the same lung injury and mortality criteria for sea turtles and small mammals is reasonable. The lack of reported data precludes any assumptions or predictions concerning potential auditory system injury to sea turtles.

D.9 CONCLUSIONS

A variety of physical impacts to marine mammals and turtles have been discussed in this appendix. Criteria and estimated ranges are summarized in **Table D.9**. For the DDG 81 shock trial conditions, **Figure D.21** summarizes the maximum calculated ranges for 50% incidence of TM rupture; G.I. tract contusion; the onset of slight lung injury; onset of mortality; 50% mortality; and, 100% mortality as a function of mammal body mass. The maximum slight injury range for the smallest animal (27 lb or 12.2 kg) is for onset of slight lung injury. For animals above 37 lb (17 kg), the maximum range for slight injury is determined by 50% TM rupture.

All injury range criteria are based on the maximum calculated slight injury range for a small mammal since the model was developed on the basis of tests conducted with small mammals. There are no data to support the direct extrapolation from small to moderate size terrestrial mammals to either marine mammals or to larger mammals. The mortality and injury criteria adopted for calculations in the Environmental Consequences section of the FEIS are as follows:

- Mortality. The mortality criteria is the predicted onset of extensive lung hemorrhage for a 27 lb (12.2 kg) mammal representative of a calf dolphin based on the modified Goertner (1982) model. The calculated maximum range for this criterion under DDG 81 shock trial conditions is 4,434 ft (1,351 m) at a depth of 66 ft (20 m). The impulse associated with the predicted maximum range for onset of extensive lung hemorrhage is 52.8 psi-msec (364 Pa-sec).

- Injury. The injury criterion is determined by the maximum calculated range for slight, but significant injury to a small marine mammal. The two injury categories considered are onset of slight lung injury and 50% TM rupture. The maximum range for the slight injury criterion under DDG 81 shock trial conditions is calculated to be 7,383 ft (2,250 m) or about 1.2 nautical miles at a depth of 91 ft (27.7 m) for onset of slight lung injury. The impulse associated with this criterion is 25.3 psi-msec (175 Pa-sec). Onset of slight lung injury is not necessarily a serious or life-threatening injury, but is a useful index of possible injury. Given the approximate nature of the methodologies used and the numerous conservative assumptions made, the 4% difference between the maximum range for onset of slight lung injury to a small mammal (7,383 ft or 2,250 m) and the maximum range for 50% TM rupture (7,095 ft or 2,163 m) is a direct result of the small mammal size chosen and the specific shock trial conditions. This minor difference in maximum ranges is not considered significant. A shallower charge depth as was the case for the SEAWOLF FEIS (Department of the Navy, 1998), would result in the maximum range for 50% TM rupture exceeding the maximum range for onset of slight lung injury by about 4%. Again, an almost insignificant difference would exist between the two maximum calculated ranges for slight injury to a small mammal.

- Safe Range. The modified Goertner model predicts onset of slight lung injury only to animals weighing less than 0.5 lb (0.2 kg) at the 2 nmi (3.7 km) safety range. The 2 nmi (3.7 km) Safety Range for the DDG 81 shock trial exceeds the Young (1991) 1.25 nmi (2.2 km) "safe" range for a calf dolphin and equals the Young (1991) 2 nmi (3.7 km) "safe" range for turtles. On the basis of conservative assumptions and the best available information, it is believed that the use of a 2 nmi (3.7 km) Safety Range will prevent significant injury to marine mammals and turtles.

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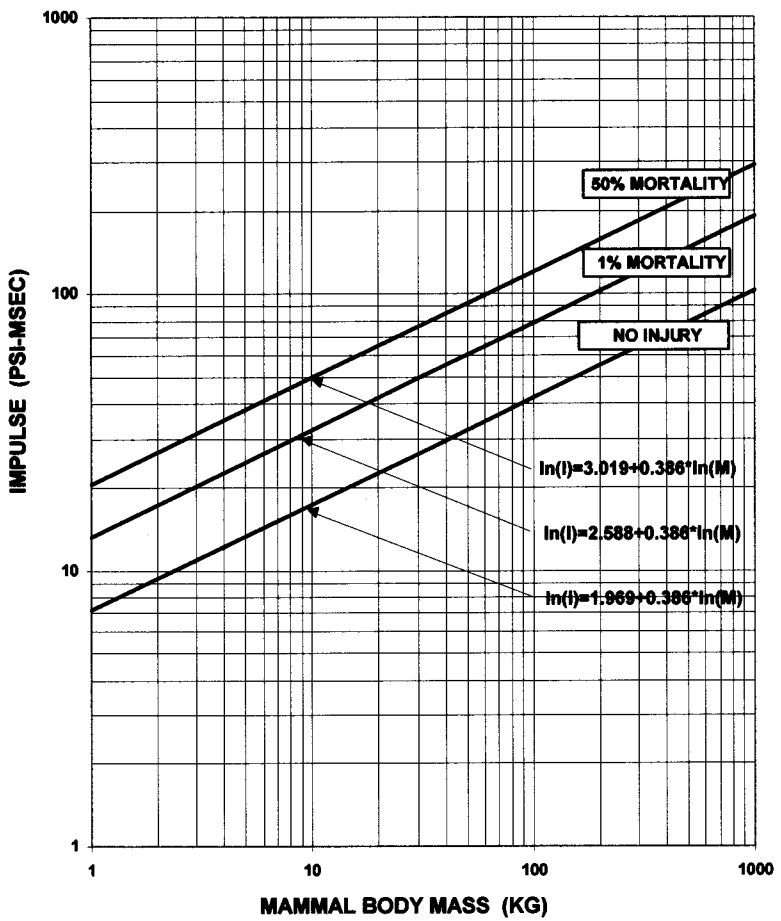


Figure D.1. Regression curves for blast damage to mammals as a function of mammal mass (Source: Yelverton, 1981).

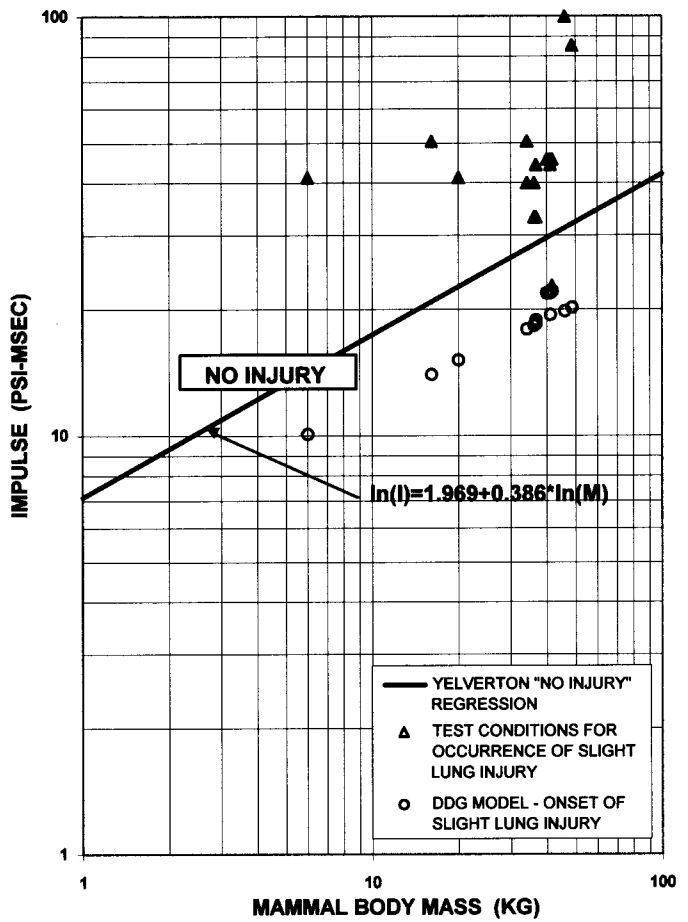


Figure D.2. Comparison of impulses for test conditions, "no injury" regression, and calculated "onset of slight lung hemorrhage."

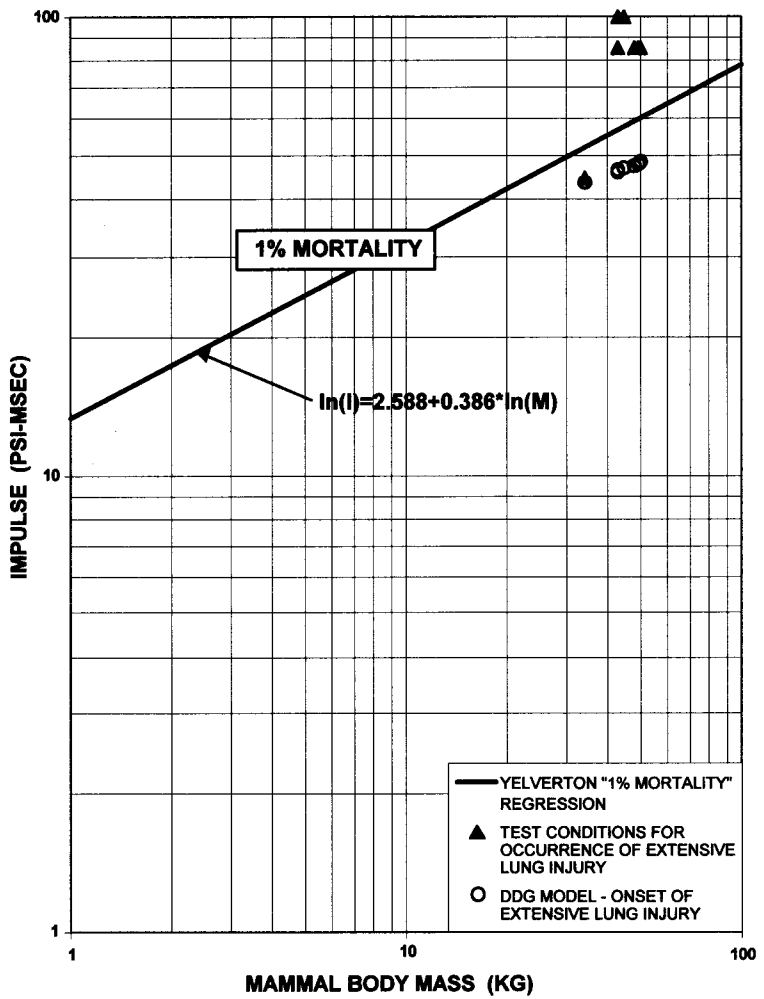


Figure D.3. Comparison of impulses for test conditions, "1% mortality" regression, and calculated "onset of extensive lung hemorrhage."

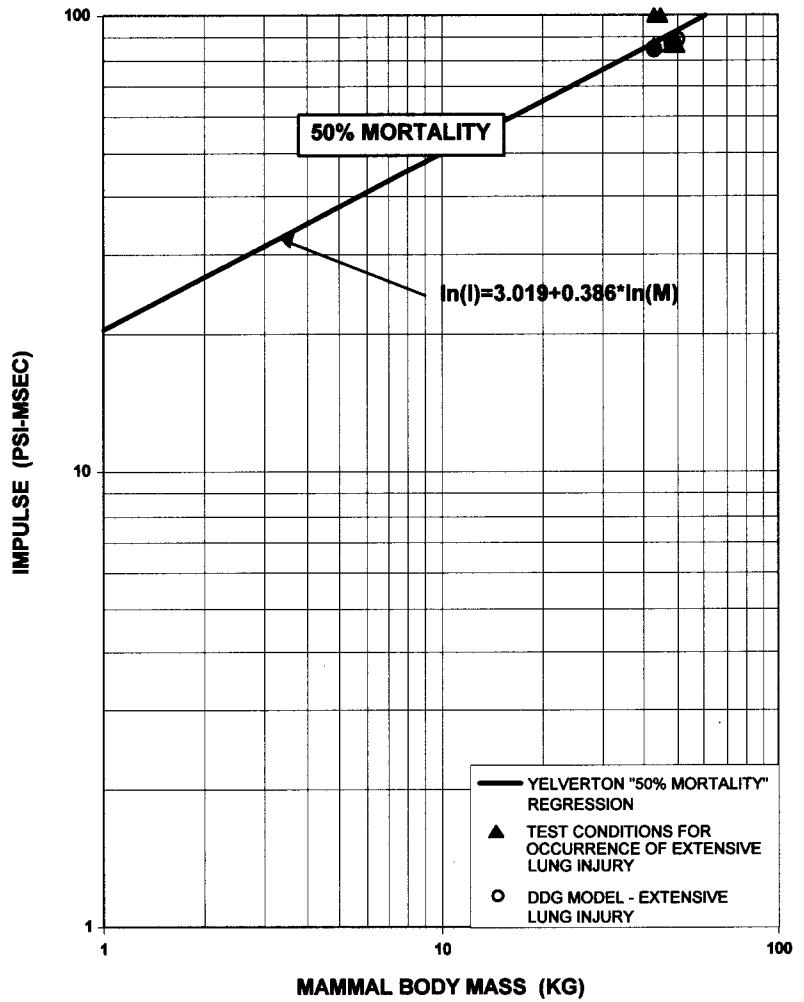


Figure D.4. Comparison of impulses for test conditions, "50% mortality" regression, and calculated "extensive lung hemorrhage."

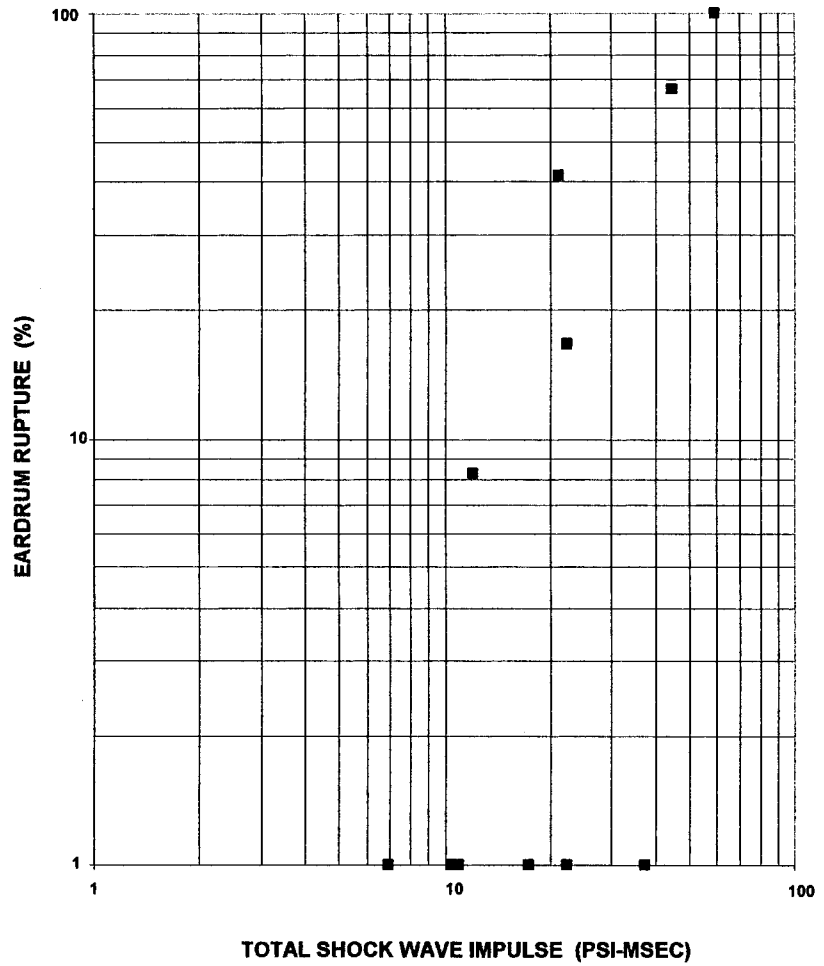


Figure D.5. Eardrum rupture as a function of calculated total shock wave impulse.

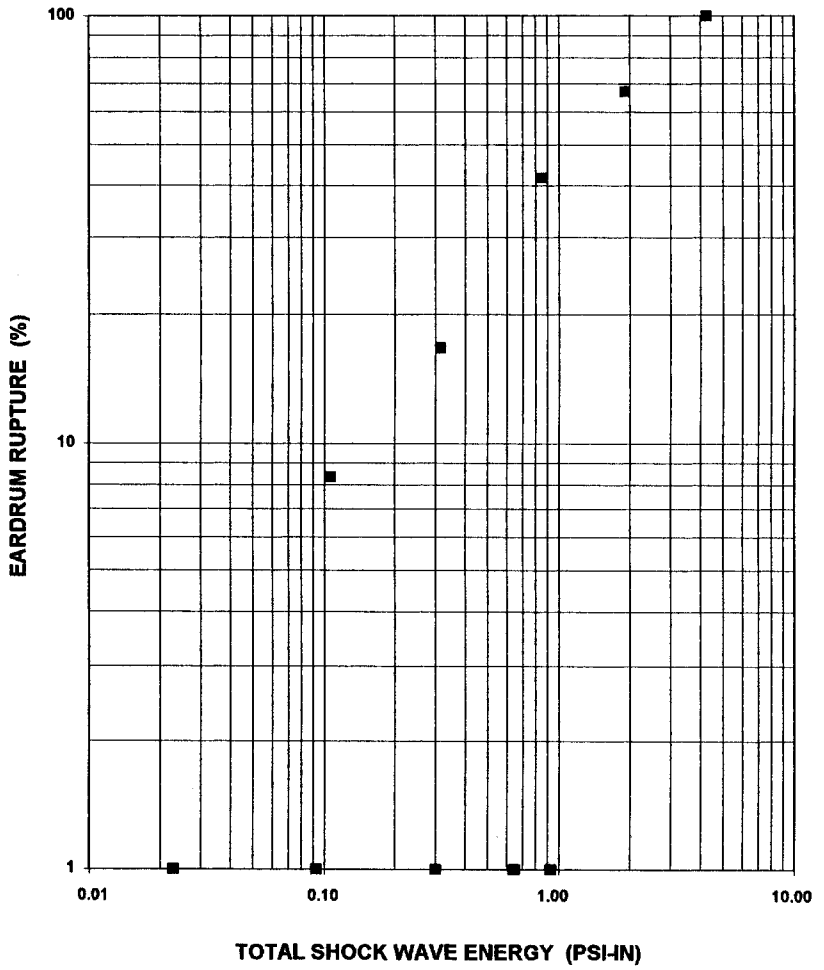


Figure D.6. Eardrum rupture as a function of calculated total shock wave energy.

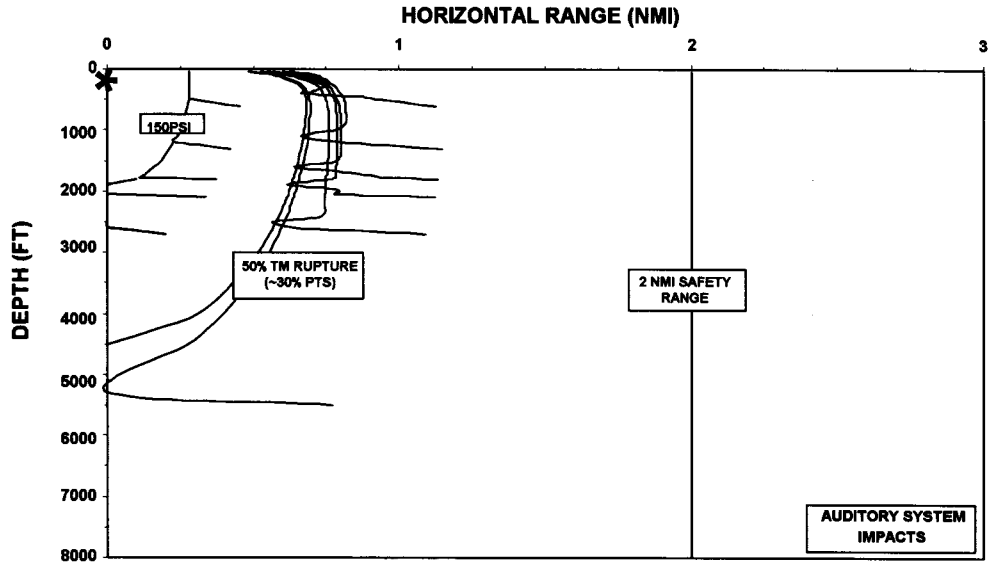


Figure D.7. Eardrum rupture as a function of range and depth for selected water depths. The "tail" extending to the right for each curve is the result of the bottom-reflected pressure wave that causes an increase in the impact range near the bottom for each water depth considered.

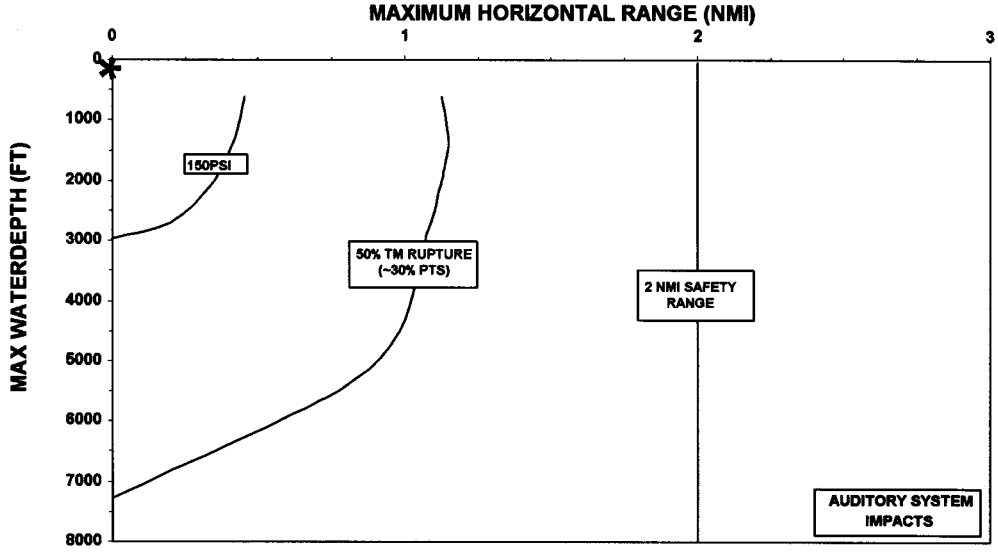
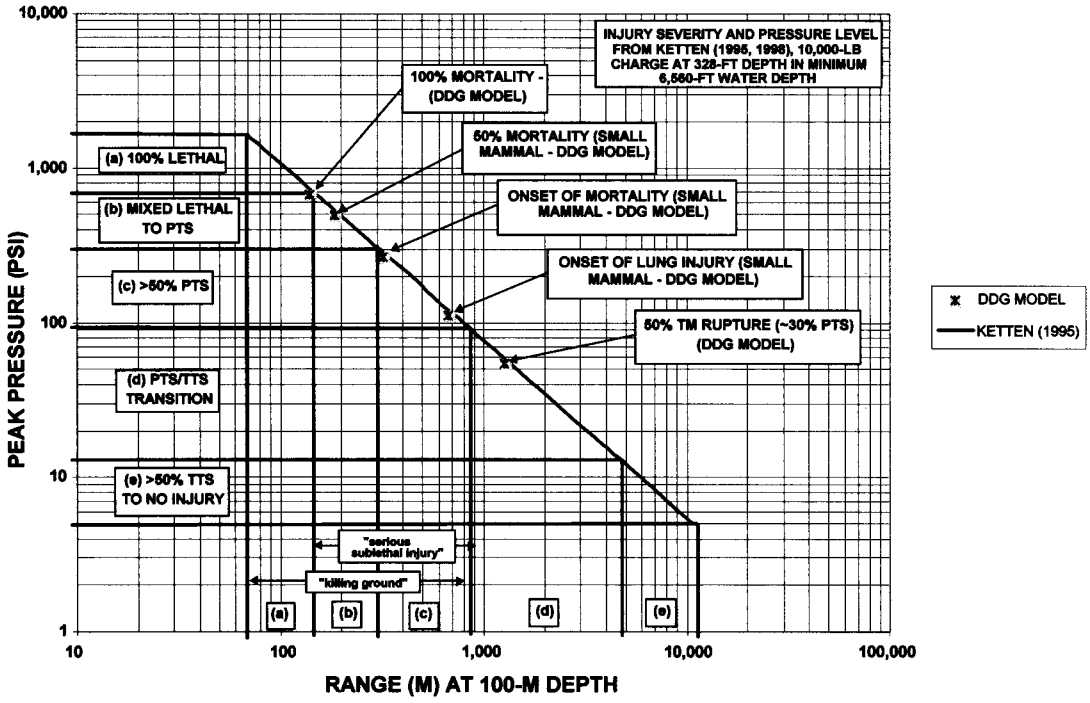
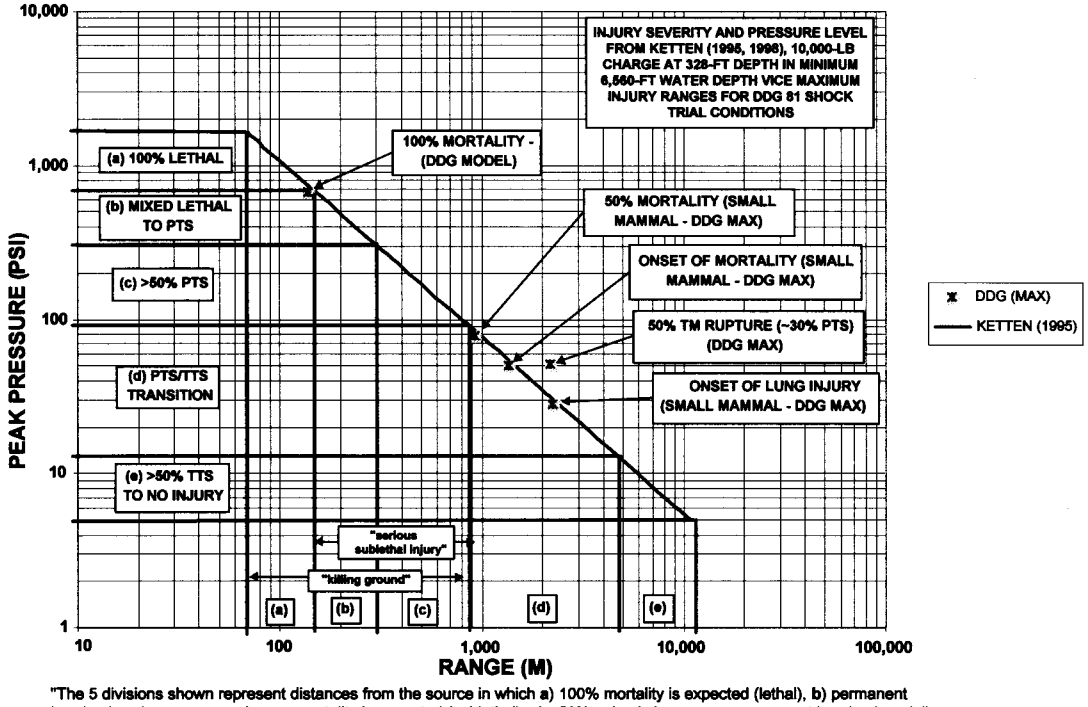


Figure D.8. Maximum ranges for eardrum rupture as a function of maximum water depth.



"The 5 divisions shown represent distances from the source in which **a**) 100% mortality is expected (lethal), **b**) permanent hearing loss is common and some mortality is expected (sublethal), **c**) >50% animals have some permanent hearing loss (all ranges of acoustic trauma), **d**) the majority of animals have temporary hearing loss but some permanent auditory damage will be found (transitional trauma), and **e**) little or no clinically detectable auditory damage (low impact) (Figure 5, Ketten,1995)"

Figure D.9. Predicted injury severity as a function of range and pressure for a 10,000 lb (4,536 kg) HBX-1 charge detonated at a depth of 328 ft (100 m) in 6,560 ft (2,000 m) water depth.



"The 5 divisions shown represent distances from the source in which **a**) 100% mortality is expected (lethal), **b**) permanent hearing loss is common and some mortality is expected (sublethal), **c**) >50% animals have some permanent hearing loss (all ranges of acoustic trauma), **d**) the majority of animals have temporary hearing loss but some permanent auditory damage will be found (transitional trauma), and **e**) little or no clinically detectable auditory damage (low impact) (Figure 5, Ketten,1995)"

Figure D.10. Comparison of injury severity as a function of range and pressure for a 10,000 lb (4,536 kg) HBX-1 charge.

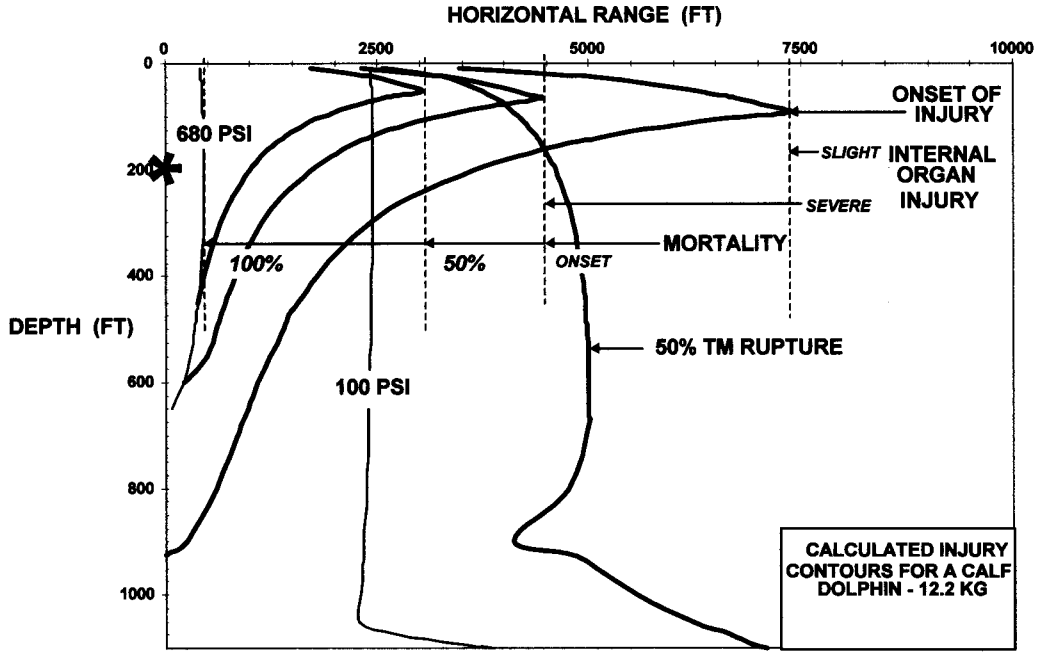


Figure D.11. Calculated injury contours for a calf dolphin (27 lb or 12.2 kg) for a 10,000 lb (4,536 kg) HBX-1 charge detonated at a depth of 200 ft (61 m).

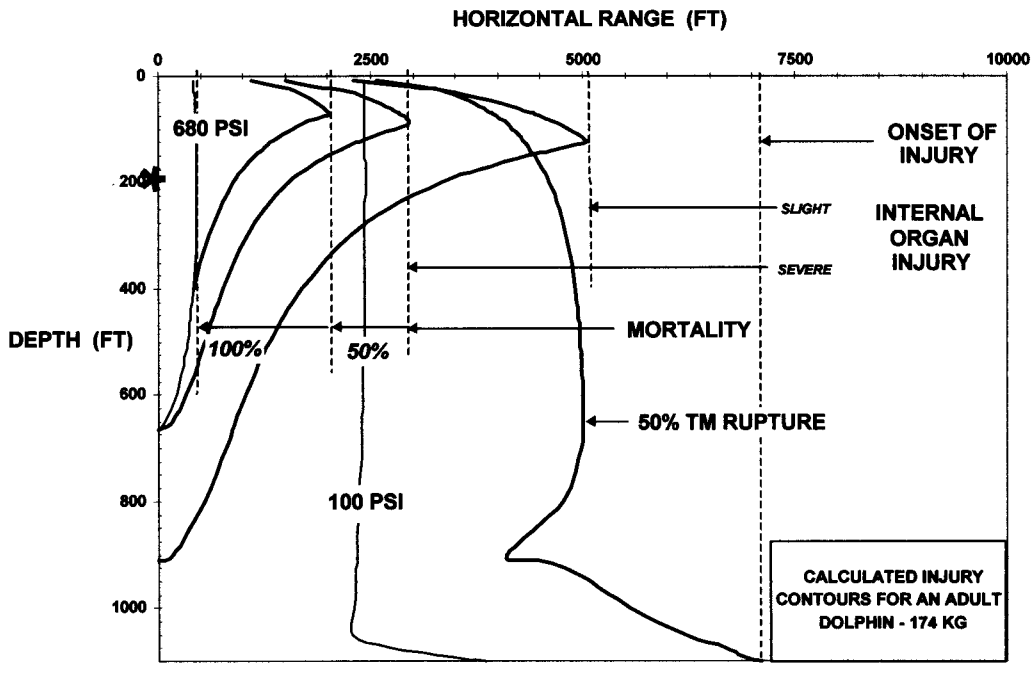


Figure D.12. Calculated injury contours for an adult dolphin (384 lb or 174 kg) for a 10,000 lb (4,536 kg) HBX-1 charge detonated at a depth of 200 ft (61 m).

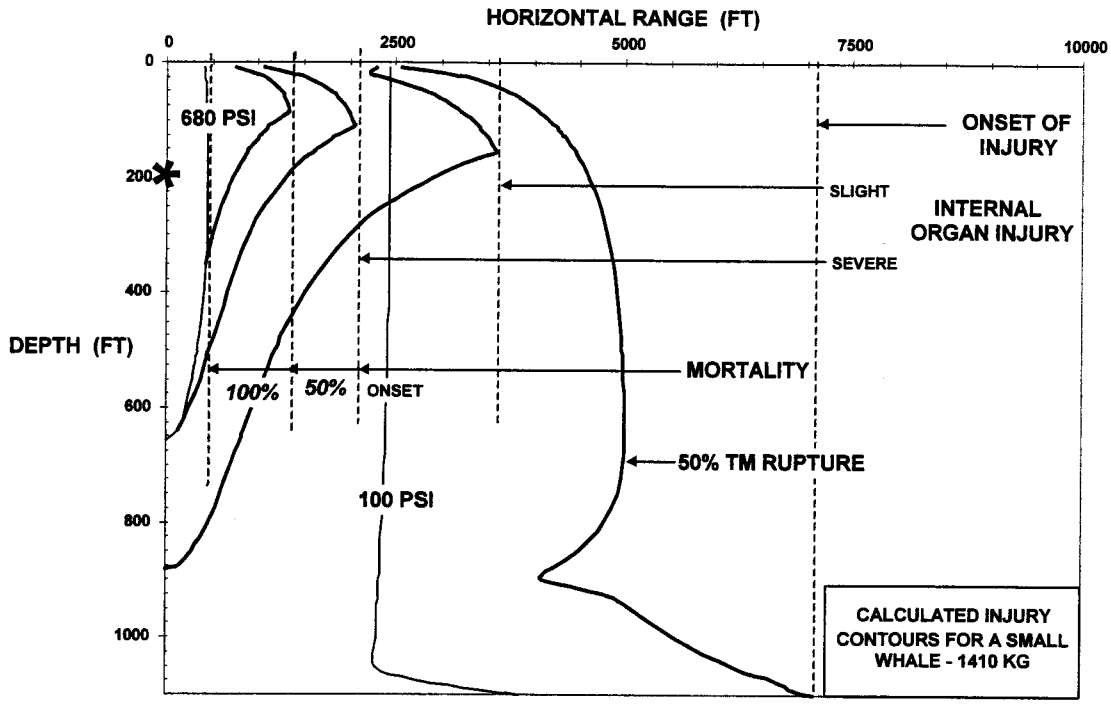


Figure D.13. Calculated injury contours for a small whale (3,110 lb or 1,410 kg) for a 10,000 lb (4,536 kg) HBX-1 charge detonated at a depth of 200 ft (61 m).

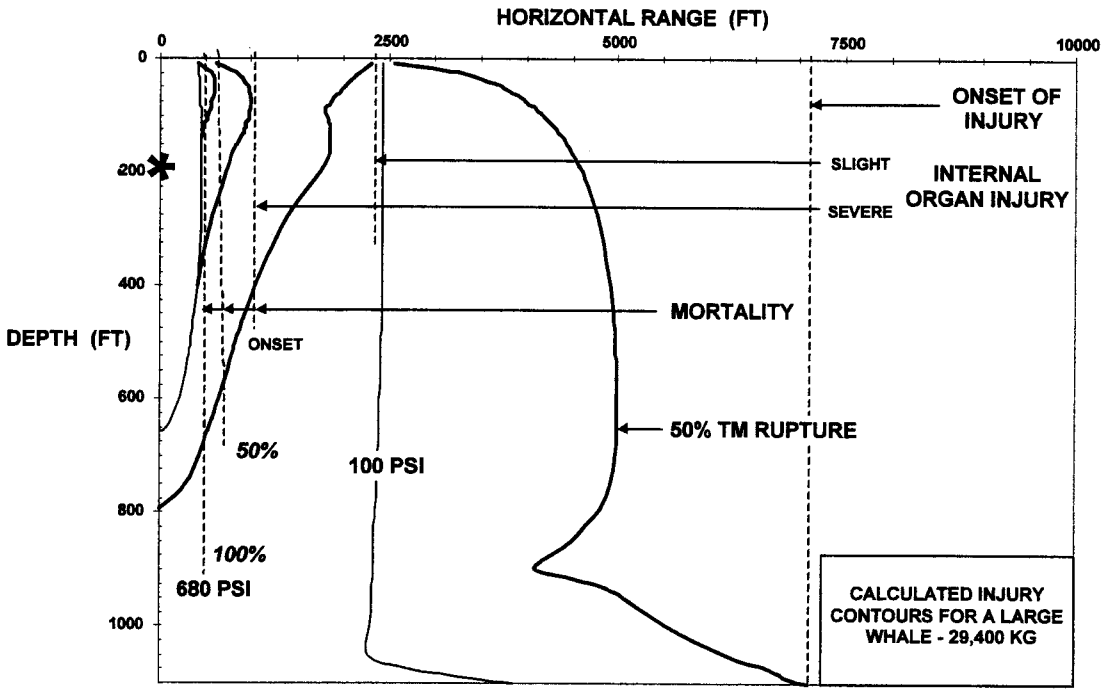


Figure D.14. Calculated injury contours for a large whale (64,800 lb or 29,400 kg) for a 10,000 lb (4,536 kg) HBX-1 charge detonated at a depth of 200 ft (61 m).

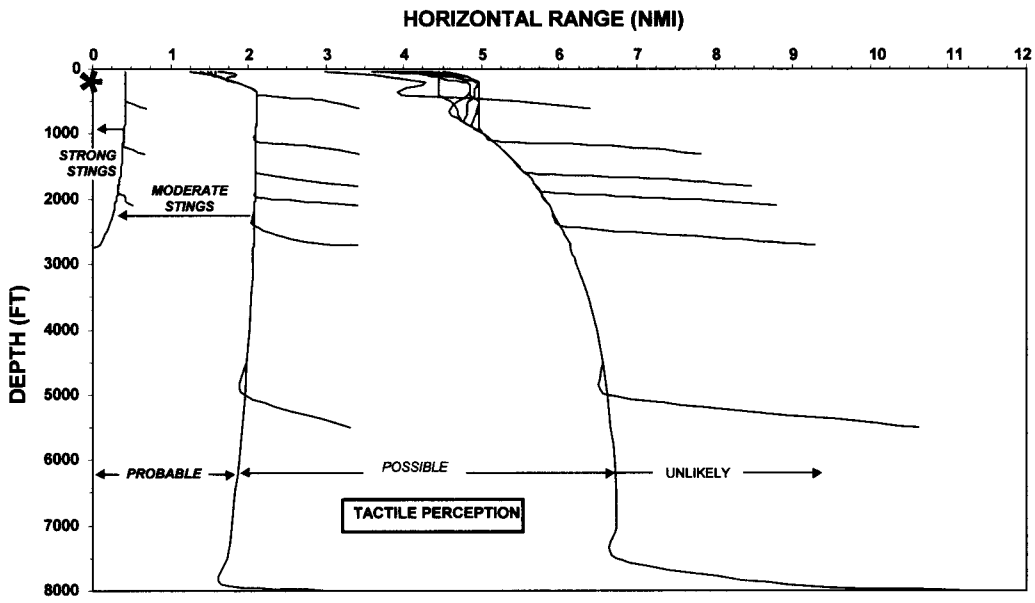


Figure D.15. Tactile perception as a function of range and depth for selected water depths. The "tail" extending to the right for each curve is the result of the bottom-reflected pressure wave that causes an increase in the impact range near the bottom for each water depth considered.

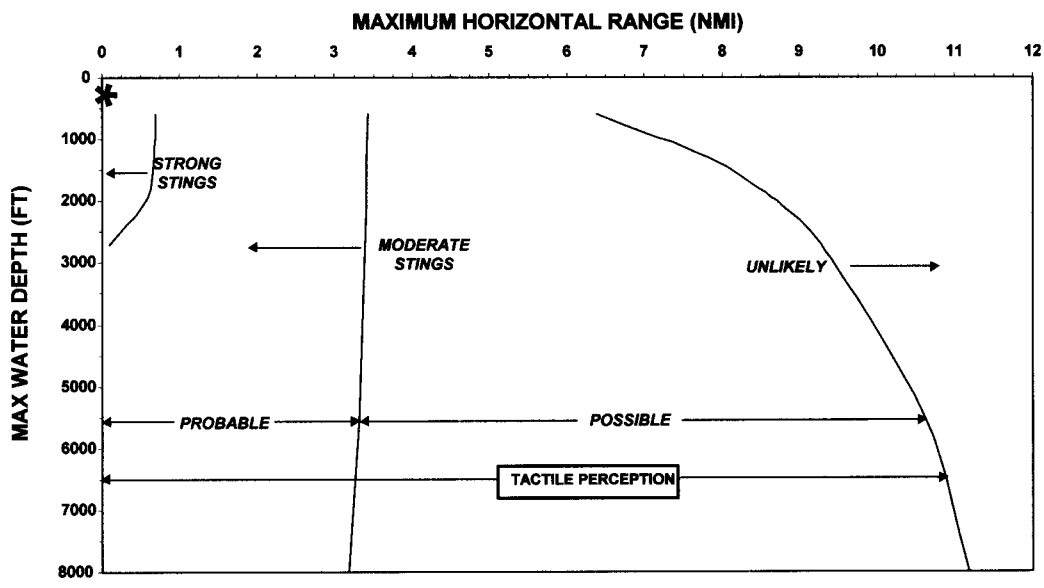


Figure D.16. Maximum ranges for tactile perception as a function of maximum water depth.

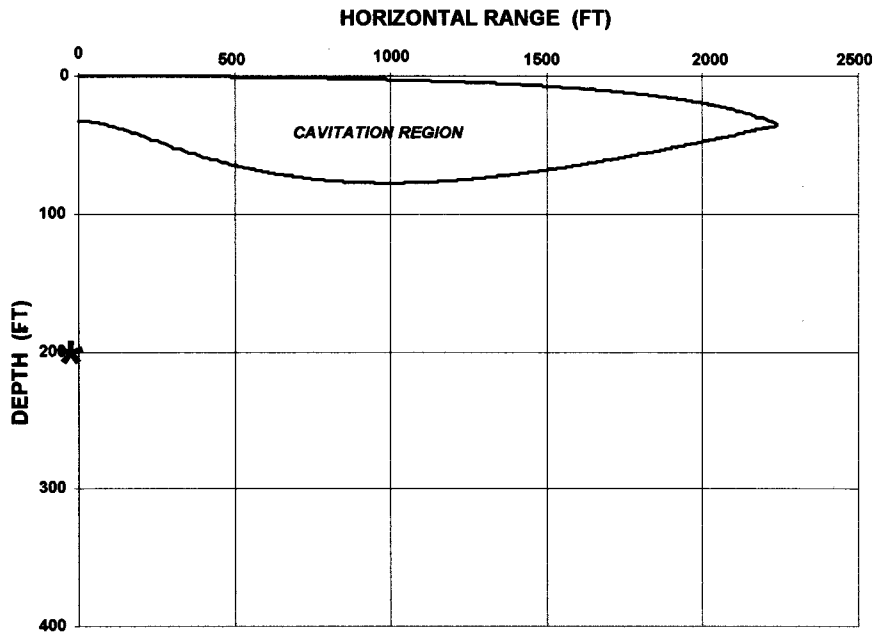


Figure D.17. Cavitation region for a 10,000-lb (4,536-kg) charge detonated at a depth of 200 ft (61 m).

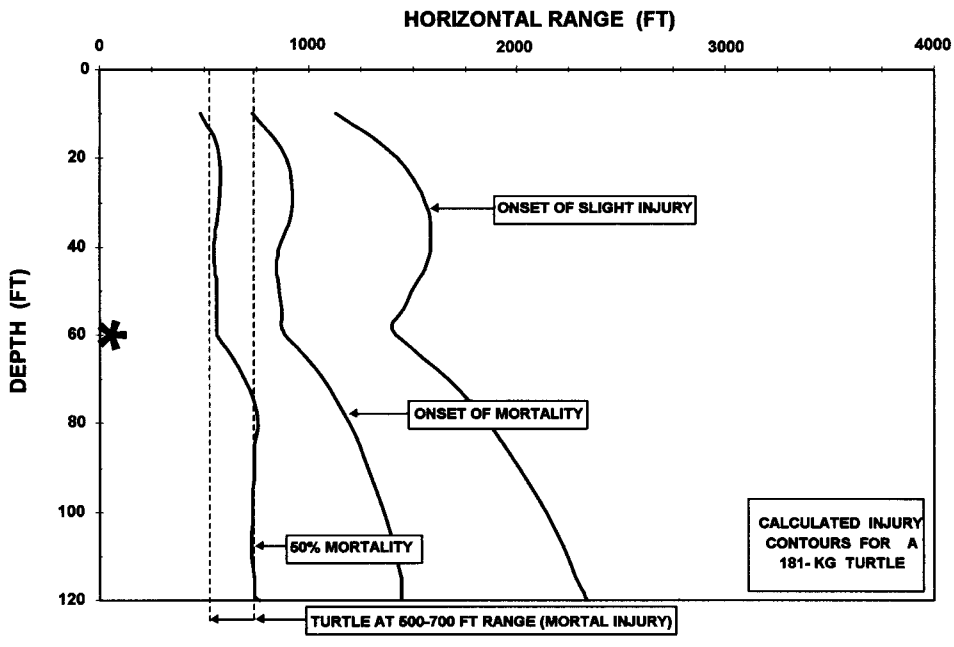


Figure D.18. Calculated injury contours for a sea turtle (400 lb or 181 kg) for a 1,200-lb (544-kg) charge detonated at a depth of 60 ft (18 m).

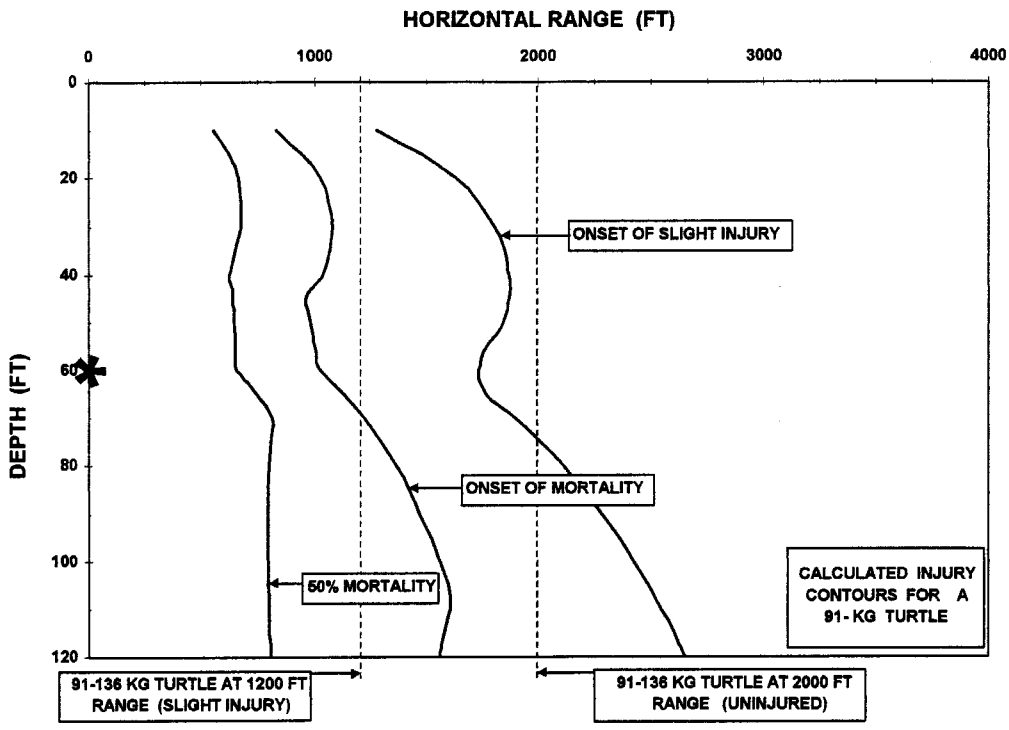


Figure D.19. Calculated injury contours for two sea turtles (200-300 lb or 91-136 kg) from a 1,200-lb (544 kg) charge detonated at a depth of 60 ft (18 m).

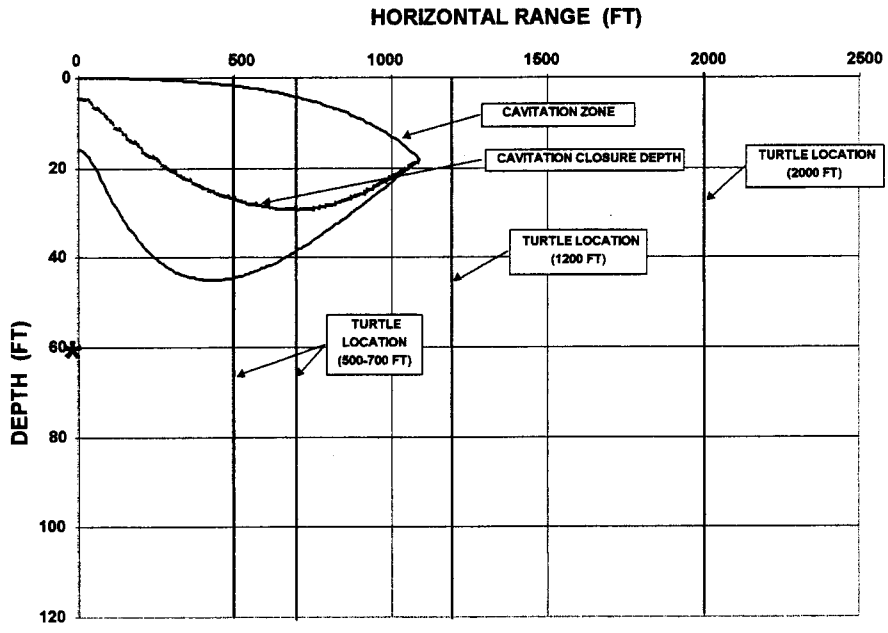


Figure D.20. Calculated bulk cavitation region and closure depth for a 1,200-lb (544-kg) charge detonated at a depth of 60 ft (18 m).

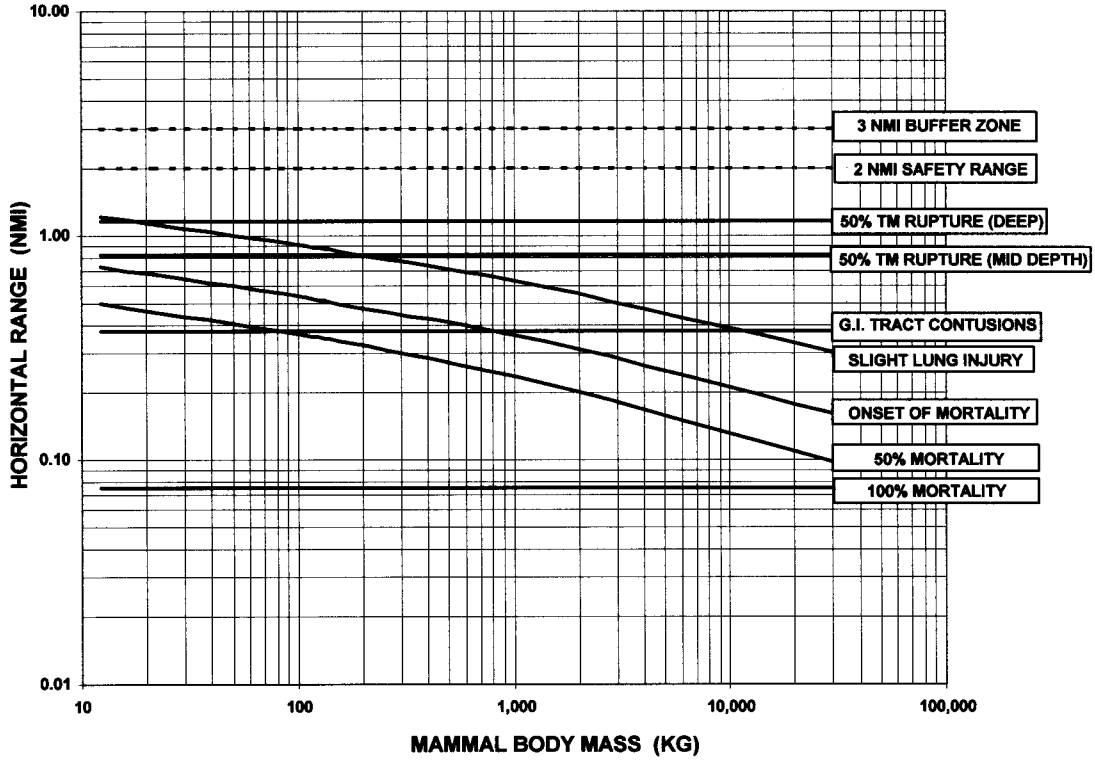


Figure D.21. Maximum calculated ranges for various effects in relation to marine mammal body mass for a 10,000 lb (4,536 kg) HBX-1 charge detonated at a depth of 200 ft (61 m).

Table D.1. Model verification for "slight lung hemorrhage."

EXPLOSIVE (Pentolite)		MAMMAL		TEST DATA[1]			MODEL PREDICTIONS		
Weight lb/(kg)	Depth ft/(m)	Body Mass lb/(kg)	Depth ft/(m)	Range ft/(m)	Peak Pressure psi/(kPa)	Impulse psi-msec/(Pa-sec)	Range[2] ft/(m)	Peak Pressure[2] psi/(kPa)	Impulse[3] psi-msec/(Pa-sec)
1.052 (0.48)	10.0 (3.0)	108 (49)	0.5 (0.15)	13 (4.0)	1,089 (7,422)	85.7 (584)	33 (10.1)	403 (2746)	20.2 (138)
1.052 (0.48)	10.0 (3.0)	101 (46)	1.0 (0.30)	16 (4.9)	987 (6,726)	99.6 (679)	44 (13.4)	290 (1976)	19.9 (136)
1.052 (0.48)	10.0 (3.0)	75 (34)	1.0 (0.30)	26 (7.9)	588 (1,007)	50.6 (345)	47 (14.3)	272 (1854)	18.0 (123)
1.052 (0.48)	10.0 (3.0)	35 (16)	1.0 (0.30)	26 (7.9)	588 (1,007)	50.6 (345)	54 (16.5)	233 (1588)	14.0 (95)
1.052 (0.48)	10.0 (3.0)	44 (20)	1.0 (0.30)	26 (7.9)	478 (3,257)	41.5 (283)	52 (15.9)	244 (1663)	15.1 (103)
1.052 (0.48)	10.0 (3.0)	13 (6)	1.0 (0.30)	26 (7.9)	478 (3,257)	41.5 (283)	65 (19.8)	191 (1302)	10.1 (69)
1.052 (0.48)	10.0 (3.0)	82 (37)	2.0 (0.61)	33 (10.1)	436 (2,971)	44.4 (303)	60 (18.3)	207 (1411)	18.9 (129)
1.052 (0.48)	10.0 (3.0)	90 (41)	2.0 (0.61)	33 (10.1)	436 (2,971)	44.4 (303)	59 (17.9)	212 (1445)	19.5 (133)
1.052 (0.48)	10.0 (3.0)	93 (42)	10.0 (3.05)	48 (14.6)	269 (1,833)	45.5 (310)	85 (25.9)	142 (968)	22.2 (151)
1.052 (0.48)	10.0 (3.0)	90 (41)	10.0 (3.05)	48 (14.6)	269 (1,833)	45.5 (310)	86 (26.2)	141 (961)	22.0 (150)
1.052 (0.48)	10.0 (3.0)	88 (40)	10.0 (3.05)	48 (14.6)	269 (1,833)	45.5 (310)	86 (26.2)	139 (947)	21.8 (149)
1.052 (0.48)	10.0 (3.0)	93[4] (42)	10.0 (3.05)	84 (25.6)	153 (1,043)	22.8[4] (155)	85 (25.9)	142 (968)	22.2 (151)
2.618 (1.19)	10.0 (3.0)	79 (36)	1.0 (0.30)	36 (11.0)	538 (3,666)	40.3 (275)	58 (17.7)	304 (2072)	18.4 (125)
2.618 (1.19)	10.0 (3.0)	75 (34)	1.0 (0.30)	36 (11.0)	538 (3,666)	40.3 (275)	58 (17.7)	301 (2051)	18.0 (123)
8.373 (3.80)	10.0 (3.0)	79 (36)	1.0 (0.30)	52 (15.8)	556 (3,789)	33.2 (226)	73 (22.3)	357 (2433)	18.4 (125)
8.373 (3.80)	10.0 (3.0)	82 (37)	1.0 (0.30)	52 (15.8)	556 (3,789)	33.2 (226)	73 (22.3)	359 (2447)	18.5 (126)
8.373 (3.80)	10.0 (3.0)	79 (36)	1.0 (0.30)	52 (15.8)	556 (3,789)	33.2 (226)	73 (22.3)	357 (2433)	18.4 (125)

[1] Occurrence of slight lung hemorrhage in test animals (Richmond et al., 1973).
[2] Peak pressure and range for a given impulse, calculated using Weak Shock Theory (Gaspin, 1983).
[3] Impulse for predicted onset of slight lung hemorrhage based on the Goertner (1982) model.
[4] Reference value for calculations.

Source: CD NSWC

Table D.2. Model verification for "onset of extensive lung hemorrhage."

EXPLOSIVE (Pentolite)		MAMMAL		TEST DATA[1]			MODEL PREDICTIONS		
Weight lb/(kg)	Depth ft/(m)	Body Mass lb/(kg)	Depth ft/(m)	Range ft/(m)	Peak Pressure psi/(kPa)	Impulse psi-msec/ (Pa-sec)	Range ft/(m)	Peak Pressure[2] psi/(kPa)	Impulse[3] psi-msec/ (Pa-sec)
1.052 (0.48)	10.0 (3.0)	95 (43)	0.5 (0.15)	13 (4.0)	1,089 (7,422)	85.7 (584)	21 (6.4)	684 (4,661)	45.8 (312)
1.052 (0.48)	10.0 (3.0)	106 (48)	0.5 (0.15)	13 (4.0)	1,089 (7,422)	85.7 (584)	20 (6.1)	702 (4,784)	47.5 (324)
1.052 (0.48)	10.0 (3.0)	110 (50)	0.5 (0.15)	13 (4.0)	1,089 (7,422)	85.7 (584)	20 (6.1)	708 (4,825)	48.2 (328)
1.052 (0.48)	10.0 (3.0)	108 (49)	0.5 (0.15)	13 (4.0)	1,089 (7,422)	85.7 (584)	20 (6.1)	705 (4,805)	47.9 (326)
1.052 (0.48)	10.0 (3.0)	95 (43)	1.0 (0.30)	16 (4.9)	987 (6,726)	99.6 (679)	26 (7.9)	522 (3,557)	46.2 (315)
1.052 (0.48)	10.0 (3.0)	99 (45)	1.0 (0.30)	16 (4.9)	987 (6,726)	99.6 (679)	26 (7.9)	528 (3,598)	46.9 (320)
1.052 (0.48)	10.0 (3.0)	75[4] (34)	2.0 (0.61)	33 (10.1)	436 (2,971)	44.4[4] (303)	34 (10.4)	394 (2,685)	43.5 (296)

[1] Occurrence of extensive lung hemorrhage in test animals (Richmond et al., 1973).
[2] Peak pressure and range for a given impulse, predicted using Weak Shock Theory (Gaspin, 1983).
[3] Impulse for predicted onset of extensive lung hemorrhage based on the Goertner (1982) model.
[4] Reference value for calculations.

Source: CD NSWC

Table D.3. Model verification for "extensive lung hemorrhage."

EXPLOSIVE (Pentolite)		MAMMAL		TEST DATA[1]			MODEL PREDICTIONS		
Weight lb/(kg)	Depth ft/(m)	Body Mass lb/(kg)	Depth ft/(m)	Range ft/(m)	Peak Pressure psi/(kPa)	Impulse psi-msec/ (Pa-sec)	Range[2] ft/(m)	Peak Pressure[2] psi/(kPa)	Impulse[3] psi-msec/ (Pa-sec)
1.052 (0.48)	10.0 (3.0)	95 (43)	0.5 (0.15)	13 (4.0)	1,089 (7,422)	85.7 (584)	14 (4.3)	1,072 (7,306)	84.1 (573)
1.052 (0.48)	10.0 (3.0)	106 (48)	0.5 (0.15)	13 (4.0)	1,089 (7,422)	85.7 (584)	14 (4.3)	1,105 (7,531)	87.3 (595)
1.052 (0.48)	10.0 (3.0)	110 (50)	0.5 (0.15)	13 (4.0)	1,089 (7,422)	85.7 (584)	14 (4.3)	1,117 (7,612)	88.5 (603)
1.052 (0.48)	10.0 (3.0)	108 (49)	0.5 (0.15)	13 (4.0)	1,089 (7,422)	85.7 (584)	14 (4.3)	1,111 (7,571)	87.9 (599)
1.052 (0.48)	10.0 (3.0)	95 (43)	1.0 (0.30)	16 (4.9)	987 (6,726)	99.6 (679)	17 (5.2)	875 (5,963)	84.9 (579)
1.052 (0.48)	10.0 (3.0)	99 (45)	1.0 (0.30)	16 (4.9)	987 (6,726)	99.6 (679)	17 (5.2)	887 (6,045)	86.2 (587)

[1] Occurrence of extensive lung hemorrhage in test animals (Richmond et al., 1973).
[2] Peak pressure and range for a given impulse, predicted using Weak Shock Theory (Gaspin, 1983).
[3] Impulse for predicted extensive lung hemorrhage using the Goertner (1982) model.

Source: CD NSWC

Table D.4. Eardrum damage test conditions and results.

DATA SET	EXPLOSIVE[1]		RANGE	PEAK PRESSURE[2]	TOTAL IMPULSE[2]	TOTAL ENERGY[2]	EARDRUMS[3]			
	Type	Weight lb / (kg)	ft / (m)	psi / (kPa)	psi-msec / (Pa-sec)	in-lb/in^2 / (milli-Joules/cm^2)	No.	Depth ft / (m)	No. Ruptured	Percent Ruptured
1	TNT	1.047 (0.47)	20 (6.1)	672 (4,580)	59.4 (405)	4.244 (74.34)	3	1 (0.3)	3	100
2	TNT	1.047 (0.47)	40 (12.2)	306 (2,085)	21.2 (144)	0.854 (14.96)	12	1 (0.3)	4 - 5[4]	33 - 42[4]
3	TNT	1.047 (0.47)	45 (13.7)	269 (1,833)	17.3 (118)	0.637 (11.16)	6	1 (0.3)	0	0
4	TNT	1.047 (0.47)	60 (18.3)	195 (1,329)	10.5 (71)	0.301 (5.27)	3	1 (0.3)	0	0
5	Pentolite	1.047 (0.47)	33 (10.1)	401 (2,733)	44.4 (303)	1.912 (33.49)	3	2 (0.6)	2	67
6	Pentolite	1.047 (0.47)	54 (16.5)	232 (1,581)	22.2 (151)	0.653 (11.44)	3	2 (0.6)	0	0
7	Pentolite	1.047 (0.47)	83 (253)	145 (988)	10.9 (74)	0.228 (3.99)	3	2 (0.6)	0	0
8	Pentolite	1.047 (0.47)	48 (14.6)	264 (1,799)	37.4 (255)	0.931 (16.31)	3	10 (3.0)	0	0
9	Pentolite	1.047 (0.47)	84 (25.6)	143 (975)	22.3 (152)	0.313 (5.48)	6	10 (3.0)	0 - 1[4]	0 - 17[4]
10	Pentolite	0.485 (0.22)	93 (28.3)	97 (661)	6.9 (47)	0.093 (1.63)	3	2 (0.6)	0	0
11	Pentolite	0.485 (0.22)	100 (30.5)	89 (607)	12.0 (82)	0.106 (1.86)	12	10 (3.0)	1	8

[1] Minimum charge weights; all tests conducted with charge at 10 ft (3.0 m) depth.
[2] Calculated values.
[3] Eardrums facing the charge.
[4] Not all eardrums were accessible or readable after a test; the second value given presumes that these eardrums were ruptured.

Source: Richmond et al. (1973), CD NSWC

Table D.5. Observed percentage of tympanic membrane (TM) ruptures for upper bound values of calculated shock wave energy flux density.

Energy Flux Density		TM Rupture Percentage	Data Set[1]
in-lb/in^2	(milli-Joules/cm^2)		
0.106	(1.86)	8	11
0.313	(5.48)	0-17	9
0.854	(14.96)	33-42	2
1.912	(33.49)	67	5
4.244	(74.34)	100	1

[1] From Table D.4.

Table D.6. Predicted ranges for small terrestrial mammal tympanic membrane (TM) rupture for a 10,000-lb (4,536-kg) charge detonated at 200-ft (61-m) depth in 1,100-ft (335-m) water depth.

Mammal Depth ft / (m)	50% TM Rupture Range[1] ft / (m)
50 / (15)	3,717 / (1,133)
200 / (61)	4,596 / (1,401)
600 / (183)	4,994 / (1,522)
1,100 / (335)	7,095 / (2,163)

[1] Based on shock wave energy flux density.

Source: CD NSWC

Table D.7. Maximum ranges for tactile perception of underwater explosion shock waves from a 10,000-lb (4,536-kg) charge detonated at 200-ft (61-m) depth.

Maximum Water Depth	Maximum Range for Probable Strong Stings	Maximum Range for Possible Tactile Perception
ft / (m)	Range ft / (m)	Range nm / (km)
600 / (183)	4,140 / (1262)	6.4 / (11.9)
2,100 / (640)	3,168 / (966)	8.8 / (16.3)
8,000 / (2438)	2,554 / (778)	11.2 / (20.8)

Source: CD NSWC, after Christian and Gaspin (1974).

Table D.8. Underwater explosion effects on sea turtles reported by O'Keeffe and Young (1984) and Klima et al. (1988).

CHARGE WEIGHT lb/(kg)	CHARGE DEPTH ft/(m)	WATER DEPTH ft/(m)	TURTLE WEIGHT Lb/(kg)	TURTLE DEPTH ft/(m)	RANGE ft/(m)	PEAK PRESSURE psi/(kPa)	INJURIES	
							Immediate	1-hr after blast
O'KEEFFE AND YOUNG (1984)								
1,200[1]/(544)	60/(18.3)	120/(36.6)	400/(181)	unknown	500-700/ (152-213)	258-178/ (1,758-1,213)[2]	Mortal injury	---
1,200[1]/(544)	60/(18.3)	120/(36.6)	200-300/ (91-136)	unknown	1,200/(366)	99/(675)[2]	Minor injury	---
1,200[1]/(544)	60/(18.3)	120/(36.6)	200-300/ (91-136)	unknown	2,000/(610)	57/(388)[2]	None	---
KLIMA ET AL. (1988)								
203[2]/(92)	14.8/(4.5)[3]	29.5/(9.5)	14.8/(6.7)	14.8/(4.5)	750/(229)	16.3/(111)[3]	Unconscious	Vasodilation around throat and flippers (lasted 2-3 wks); 2 cm of cloacal lining everted
203[2]/(92)	14.8/(4.5)[3]	29.5/(9.5)	9.3/(4.2)	14.8/(4.5)	750/(229)	16.3/(111)[3]	Unconscious	As above and including redness around eyes and nose
203[2]/(92)	14.8/(4.5)[3]	29.5/(9.5)	1.3/(0.6)	14.8/(4.5)	1,200/(366)	10.3/(70)[3]	Unconscious	Appeared normal
203[2]/(92)	14.8/(4.5)[3]	29.5/(9.5)	12.1/(5.5)	14.8/(4.5)	1,200/(366)	10.3/(70)[3]	Unconscious	Normal behavior, but vasodilation around base of flippers (lasted 2-3 wks)
203[2]/(92)	14.8/(4.5)[3]	29.5/(9.5)	2.9/(1.3)	14.8/(4.5)	1,800/(549)	6.5/(44)[3]	None visible	Appeared normal
203[2]/(92)	14.8/(4.5)[3]	29.5/(9.5)	8.8/(4.0)	14.8/(4.5)	1,800/(549)	6.5/(44)[3]	None visible	Appeared normal except for vasodilation around throat and flippers (lasted 2-3 wks)
203[2]/(92)	14.8/(4.5)[3]	29.5/(9.5)	3.3/(1.5)	14.8/(4.5)	3,000/(915)	4.1/(28)[3]	None visible	Appeared normal
203[2]/(92)	14.8/(4.5)[3]	29.5/(9.5)	15.0/(6.8)	14.8/(4.5)	3,000/(915)	4.1/(28)[3]	Unconscious	Appeared normal except for vasodilation around throat and flippers (lasted 2-3 wks)

1 TNT equivalent.
2 Four 50.75-lb (23-kg) nitromethane charges buried 16.4 ft (5 m) below the mudline.
3 Calculations for buried charges assumed a 2-lb (0.92-kg) TNT charge detonated "free-field" at mid-depth in the water column.

Table D.9. Summary of potential effects discussed in this appendix.

Criterion (Type of Effect)	Threshold	Predicted Maximum Range	FEIS Usage
Lethality from high peak pressure (100% mortality)	Peak pressure 680 psi (4,695 kPa)	456 ft (139 m)	--
Possible injury & lethality from cavitation	Maximum horizontal extent of cavitation region	2,240 ft (683 m)	--
Extensive lung hemorrhage (50% mortality)[1]	Impulse 90.0 psi-msec (621 Pa-sec)	3,034 ft (925 m)	
Tactile perception (strong stings)	Partial impulse 3.3 psi-msec (22.8 Pa-sec) within 0.035 msec	4,140 ft (1,262 m)	--
Onset of extensive lung hemorrhage[1]	Impulse 52.8 psi-msec (364 Pa-sec)	4,434 ft (1,351 m)	**Mortality criterion**
50% tympanic membrane rupture[2]	Energy flux density 1.17 in-lb/in^2 (20.44 milli-Joules/cm^2)	7,095 ft (2,163 m)	--
Onset of slight lung hemorrhage[1]	25.3 psi-msec (175 Pa-sec)	7,383 ft (2,250 m)	**Injury criterion**
Probable tactile perception (moderate stings)	Pressure >15 psi (104 kPa) and energy flux density >0.06 in-lb/in^2 (1.1 milli-Joules/cm^2)	3.4 nmi (5.5 km)	--
Tactile perception unlikely	Pressure <15 psi (104 kPa) and energy flux density <0.01 in-lb/in^2 (0.18 milli-Joules/cm^2)	11.2 nmi (20.7 km)	--

[1] Threshold varies with animal size, with smaller animals being more vulnerable. The value given is for a very small marine mammal -- a calf dolphin (27 lb or 12.2 kg). Thresholds for adult dolphins and whales would be higher and effect ranges would be lower (i.e., they would have to be closer to the detonation to be affected).

[2] Threshold is assumed independent of animal size but varies with animal depth. The maximum range (given here) is for an animal at the bottom in 1,100-ft (335-m) deep water. For any other water depths, the range would be less than or equal to the one given here, no matter the depth of the animal.

APPENDIX E

CRITERIA FOR MARINE MAMMAL AUDITORY THRESHOLD SHIFT

John E. Sigurdson, Ph.D.
Space and Naval Warfare Systems Center
Code D351
San Diego, CA 92152-6254

Joel B. Gaspin
Underwater Warheads Research and Technology Department
Indian Head Division, Naval Surface Warfare Center
Indian Head, MD 20640-5035

David A. Helweg, Ph.D.
Space and Naval Warfare Systems Center
Code D3501E
San Diego, CA 92152-6254

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Acronyms and Abbreviations

CTS	Compound threshold shift
DEIS	Draft Environmental Impact Statement
DRC	Damage risk criteria
HBX	High blast explosive
NRC	National Research Council
OSHA	Occupational Safety and Health Administration
PTS	Permanent threshold shift
TS	Threshold shift
TTS	Temporary threshold shift
SPL	Sound pressure level
SVP	Sound velocity profile

APPENDIX E
CRITERIA FOR MARINE MAMMAL AUDITORY THRESHOLD SHIFT

E.1 INTRODUCTION

Appendix D discussed criteria to predict numbers of marine mammals and turtles that may be killed or injured by DDG 81 shock-trial detonations. In **Appendix E**, we focus on the wider zone in which physical impacts decline from slight injury to negligible to unmeasureable levels, but within which behaviors may be disrupted by degraded sensory function. Specifically, the purposes of **Appendix E** are (1) to explain auditory threshold shifts as impact criteria, (2) to estimate the pressure and energy levels at which marine mammals experience temporary shifts, and (3) to predict the distances at which marine mammals and turtles will experience those levels. The greater of those two distances is used in the DEIS to estimate "Level B harassment".

As described in Appendix D, the blast wave of an underwater explosion is characterized by a fast rise time with extreme overpressure. However, over greater distances, refraction and multipath propagation combine to distort the waveform as pressure declines (see **Figures E.1** through **E.6** for examples). Near the blast, rise time and overpressure cause structural damage to many body tissues including those of the auditory pathway. At somewhat longer distances, those same factors may still cause severe structural damage to the auditory pathway alone. At still greater distances the combination of diminishing pressure, refraction, and multipath-effects present complex waveforms that are considerably different from the original blast wave. Over these latter distances, the effects on the auditory pathway may range from slight structural (permanent) damage through temporary effects to no effects. In general, animals at different distances experience different waveforms and, at greater distances, these waveforms come to resemble combinations of blast and impulse waveforms that have been related to different impacts on the auditory pathway in terrestrial species. The relative contributions of pressure and energy to auditory impact are still being studied and debated for such waveforms. While determined in terrestrial (air-adapted) mammals, the general aspects of those relationships are applicable to marine mammals as well. A growing body of comparative anatomical and physiological data on marine and terrestrial auditory systems supports this generalization. Also, specific parameter values for some relationships are beginning to emerge from recent behavioral studies on the impact of high level stimuli on marine mammal hearing.

Auditory impacts are used as criteria of explosive effects on animals because the auditory pathway experiences temporary and permanent impairments at lower levels of pressure or energy than other tissue. The criteria to be described are based on theories and data related to auditory processes and trauma in both terrestrial and marine species. Since the basic concepts, terminology, and empirical data have been derived from terrestrial species, the data of those species will, of necessity, be described. Further, most studies of auditory trauma have been directed toward the development of human damage risk criteria (DRC) and that goal has influenced the design of those studies. In general, DRC have focused primarily on protecting humans from occupational noise hazards such as long duration or intermittent noise and only secondarily on auditory impacts more relevant to the present effort – those of impulse or blast stimuli. A ship-shock trial involves exposure to single pulses that are spaced at one-week intervals.

Therefore, the DRC research on single and repeated exposure to impulse or blast stimuli is relevant to the extent that it approximates the impulses experienced by animals in shock trials or elucidates relationships that can be generalized across species. In all cases, however, determination of DRC are based on the type and degree of hearing threshold shift (TS) that results from noise exposure.

Typically, threshold is defined as the minimal level in quiet surroundings at which a sound is perceived (by measurement of trained behaviors) or evokes an auditory response (by electro-physiological measurement). The threshold varies with frequency. Temporary threshold shift (TTS) is a noise-induced threshold elevation that completely disappears over time. Greater amounts of noise exposure lead to greater degrees and longer duration of TTS. The threshold-elevating noise may reach an amount such that the shifted threshold never fully returns to the pre-exposure sensitivity. In that case, the remaining degree of TS is referred to as permanent threshold shift (PTS). The physiological mechanism underlying TTS is understood to be a temporary sensorineural impairment in the inner ear – the exact description of which is still in debate. In contrast, PTS of lesser degree is thought to be mediated by destruction and loss of those sensory cells and, at higher degrees, other auditory mechanisms as well. The primary goal of human DRC has been the prevention of PTS in varying degrees.

The most meaningful criteria for estimating impact ranges for sea animals would be based on measurements of PTS and TTS resulting from exposure to underwater noise. The range at which minimum PTS occurred would provide a safe outer limit for minimal nonrecoverable auditory impairment (with structural damage), and the range at which minimum TTS occurred, a safe outer limit for minimal recoverable auditory impairment. However, tests of minimum PTS in living marine mammals are unlikely and the relationship between minimum TTS and PTS is only recently emerging in the terrestrial literature. At present, that relationship is not firmly established. So, although this appendix focuses on TTS and its use, PTS will be described as well since the two are so closely related in theory, the empirical literature, and the concept of auditory risk criteria. Ideally, the present criteria should be based on TS measured for animals exposed to impulsive noise or explosions and, as much as possible, from data on marine animals exposed to underwater explosions. However, explicit empirical data of this type for marine animals are very limited. Therefore, extrapolations must be made from data derived from terrestrial mammals and what little is available from marine species. Data from terrestrial mammals exposed to impulsive noise or explosions are relevant despite the differences in their adaptations for airborne sound because impulsive response, unlike those to continuous sources, are to some extent media independent.

Impulse-induced TTS may range from slight to substantial hearing impairment that can last from minutes to a day or more depending on the amount of initial TS (Ahroon et al., 1996; see Section E.3.2). The impairment decays steadily over the period and, upon full recovery, the animal's hearing is restored without permanent damage to its ears or hearing. During the period of TTS, hearing-related behaviors will be disrupted to the degree of the current TS. In marine mammals, these behaviors may include communication, predator avoidance, and, for echolocators, prey detection, conspecific identification, and biosonar orientation to other objects in the environment as well. For animals experiencing only mild TTS, the effect would be close to that produced by the normal variation in background noise produced by weather and sea conditions. For those with middle or high degrees of TTS, the time-course of recovery most likely follows that of terrestrial mammals. The possible disruption of other behavior by shock-trial pulses and background on that subject are discussed in Chapter 4.

E.2 TERMINOLOGY AND METHODS

The terms TTS and PTS will be used, as defined in the introduction, to refer to alterations in threshold at the behavioral level of description and not to physiological mediating mechanisms. PTS, at all but the most extreme degrees, has a temporary component and involves some recovery from the initial degree of TS. The temporary component in PTS has lead to some confusion in the use and interpretation of the term TTS. Some earlier literature used the term TTS to describe not only a TS that fully recovered, but the temporary portion of a PTS as well. Such usage leaves a TS that fully recovers without a unique label for descriptive purposes and for that reason will be avoided in this appendix. Also, since some PTSs have temporal courses of recovery that are non-monotonic and appear to combine several simpler patterns, the term "compound threshold shift" (CTS) has come into use. That usage is supported by observations of initial damage to multiple physiological mechanisms that partially or totally recover in different ways. Thus, CTS is often used as a synonym for PTS when two or more simple patterns are observed.

Data describing the acoustic effects of sound exposure, such as TTS and PTS, in human and non-human animals are described in the following section. First, we sketch sources of hearing TSs. Then we describe TS data in human and non-human mammals, limiting our description to studies that have used impulsive stimuli or stimuli with very fast rise times. These data are then used to define a conservative TTS criterion. Lastly, we use the TTS criterion to develop estimates of acoustic impact ranges for marine mammals and sea turtles exposed to an underwater detonation of a 10,000 lb (4,536 kg) explosive charge.

The measurement of sound and selection of appropriate acoustical comparisons for consideration in this DEIS, requires that audiometric data collected in-air be extrapolated to approximate water equivalents. This requires conversion of audiometric and acoustical measurements to common referents. Sound levels often are measured in decibels (dB), a logarithmic dimensionless unit that is the ratio of the measured level to a reference level. For example, sound *pressure (P)* is converted to sound pressure level (SPL) in decibels as described in Equation 1.

$$[1] \qquad \text{SPL} = 20 \times \log_{10}\left(\frac{p}{p_{reference}}\right)$$

The standard air reference pressure is 20 μPa, as compared to 1 μPa in water, a difference of 26 dB. When comparing sound *intensities*, the acoustic impedance (ρc) of the two media also must be taken into account. The acoustic impedance of air is 415 (Pa·s)/m, as compared to 1.54×10^6 (Pa·s)/m in saltwater. Equation 2 illustrates the relationship between sound pressure, intensity magnitude, and acoustic impedance for a plane wave. By the appropriate calculations, it can be demonstrated that the intensity (I) of a sound wave in water is about 61.5 dB lower than that of a wave of equivalent pressure in air. In this appendix, wherever equivalent values between air and water stimuli are stated, the equivalence is based on equal intensities.

$$[2] \qquad I = \frac{p^2}{\rho \cdot c} \quad \text{where } p \text{ is rms pressure and } \quad I\,(\text{dB}) = 10 \times \log_{10}\left(\frac{I}{I_{reference}}\right)$$

Lastly, explosive impulses commonly are described in terms of pressure and overpressure, which can be thought of as the amount of pressure beyond the ambient pressure, and is a function of the charge weight, depth, and range. Pressure may be measured in pounds per square inch (psi) or Pascals (Pa). The energy flux transmitted is the square of the pressure integrated over an appropriate time such as the duration of the first positive pressure excursion of the shock wave – the A-duration. Equation 3 is used to convert SPL in dB re 1 μPa to energy flux (E) in units of $\mu Pa^2 \cdot s$.

[3] $E = SPL + \left[10 \times \log_{10}(t)\right]$ re: rms pressure and t in seconds.

Due to the limited amount of directly relevant data and the number of unknown variables, conservative estimates are used in all stages of the extrapolation of the acoustic criteria. Hypothetically, consider a range of sound pressure levels of 140-160 dB that were shown to induce TTS in a group of terrestrial mammals. Here, 140 dB would be used as the conservative limit, because this number is the lowest sound pressure level that induced the TTS. In effect, the low or more conservative end of each distribution of values is chosen rather than an unbiased estimate of the center. The effects of using conservative criteria on the predicted number of harassment takes are discussed below.

An important aspect of our assessment is the reliability of the data on which we based our extrapolation. Data for TTS and PTS are presented below for different species, stimuli, and exposure configurations. However, the reader should note that the incidence of PTS is not easily predicted by TTS. There may be considerable variability in the onset level and magnitude of TTS and PTS across individuals, especially for impulsive stimuli, induced in part by unpredictable factors such as the health or response time of the individual ear.

E.3 BACKGROUND ON AUDITORY THRESHOLD SHIFTS

Hearing threshold conventionally means the minimum threshold of audibility, which is experimentally determined as the minimum effective sound pressure level of a signal that evokes an auditory response (Yost, 1994). It is commonly measured in quiet conditions and as a free-field response. Thresholds vary with ambient noise level and across individuals. Reported thresholds vary also with the method used to measure them. For example, a behavioral response paradigm – in which the subject makes a trained motor response such as pushing a lever – may produce a different threshold than that in which electrical responses in the auditory nervous system are recorded directly. However, in general, the better the sensitivity of the ear, the lower the threshold (i.e., the lower the sound pressure level required to generate an auditory response).

Clinical models using small land mammals have been used to determine international standards for industrial damage risk criteria (e.g., Kryter et al., 1966; Lenhardt, 1986; National Research Council [NRC], 1992). These experiments were designed to identify the sound parameters that are central factors in TS (e.g., Kryter et al., 1966; Lenhardt, 1986; Occupational Safety and Health Administration [OSHA]; Saunders et al., 1985; NRC, 1992). The current consensus is that both the level and duration of exposure are critical factors in TS. Consequently, TS can be induced by chronic exposure to lower noise levels or brief exposure to high noise levels. These models also

indicate previous history and health of the ear as important predictors of threshold shifts, especially in inducing PTS (Lenhardt, 1986).

Threshold shifts are complex phenomena, and across the ranges of TTS and PTS there are various mechanisms that mediate different types and degrees of TS (e.g., Lenhardt, 1986; Saunders et al., 1985; Yost, 1994). Threshold shifts may be caused by sensorineural loss, damage to the transfer functions, or both. Sensorineural losses may include insult to the hair cells (or their metabolic supply) which causes temporary loss of function (TTS), or permanent damage to the substrate (PTS), which causes loss of the hair cells. Compromised transfer functions may result from mechanical damage to the middle ear ossicles or rupture of the eardrums. Often, higher levels of exposure may permanently damage some components at one place in the ear and only inflict temporary loss of function at others, leading to PTS with partial recovery or CTS. Blast overpressures may result in such structural and sensorineural effects, depending on the level of exposure (e.g., Lenhardt, 1986; Liang, 1992; Patterson and Hamernik, 1992; Saunders et al., 1985; NRC, 1992).

Signal rise-time and duration of peak pressure also are factors that affect the degree of TS. They have potential effects related to both the time and frequency domains (Clark, 1991; Hamernik and Hsueh, 1991; Hamernik et al., 1991; Henderson et al., 1974; Lenhardt, 1986; Liang, 1992; Luz and Hodge, 1971; Melnick, 1991; Patterson and Hamernik, 1992; Price, 1983; Saunders et al., 1985; Smoorenburg, 1992). In all species tested to date, TTS and PTS may result from a range of acoustic stimuli; e.g., either chronic exposure to narrowband sounds or sudden onset of intense sounds. Variables that influence the degree of TTS and PTS may include the hearing sensitivity at the range affected, the degree of the shift, and the exposure interval. The criteria for differentiating TTS and PTS zones are both species- and media-dependent and may be strongly influenced by health of the ear (Ketten, 1995).

E.3.1 Threshold Shift in Humans

Human ears, like most terrestrial mammalian ears, are adapted for sound transduction in air. There are substantial human audiometric data for in-air hearing threshold and discomfort levels (Everest, 1994; Edge and Mayes, 1966; Fay, 1988; Yost, 1994). Human subjects with normal hearing have thresholds of 0 to 20 dB sound pressure level (SPL) over the 20-20,000 Hz range. TTS generally occurs at levels of 80 to 100 dB SPL over threshold and discomfort at approximately 120 dB SPL (OSHA; Yost, 1994).

Humans are the only species for which subjective data, such as reports of discomfort, can be interpreted with any degree of consistency. Methods that rely on highly subjective phenomena such as "discomfort" or "pain" are difficult to calibrate, and results often show high variability both between subjects and within subjects across repeated testing (Green and Swets, 1966). Thus, the variability among human subjects based on individual tolerances and testing procedures makes direct extrapolation of discomfort to marine animals questionable. Available data suggests that humans report discomfort at SPLs of approximately 120 dB (re 20 μPa) regardless of frequency. That the discomfort range always lies above the SPL that can induce PTS stems from the fact that

PTS can be induced by chronic exposure to nonpainful SPLs and that PTS may not be detected until later in life (Yost, 1994).

Underwater hearing thresholds for humans show a general reduction in sensitivity across all frequencies tested (Montague and Strickland, 1961; Al-Masri et al., 1996). Threshold shifts have been reported underwater, but they are not directly relevant to the present problem as they all involve relatively long exposures to continuous pure-tones and show considerable variability. In one underwater study, humans were exposed to a 3,500 Hz pure tone for 15 minutes. Two minutes after exposure, a TS of 30 dB was measured (Smith et al., 1970). A second study investigated hearing tolerance levels by exposing hoodless divers to one-second duration 1,500 Hz tones from a source directly in front of them. The tones were gradually increased in level by 1 dB until the divers requested a halt (inference of discomfort or intensity-tolerance levels using subjective reporting has the limitations already described). An in-air-hearing test conducted within 5 minutes of the underwater test showed no TS. Smith and Wojtowicz (1985) reported TSs of 23-55 dB in bare-headed divers exposed to 700, 1,400, or 5,600 Hz tones for 25 minutes at 141-165 dB (re 20 μPa). When exposure duration was shortened to 10 minutes, Smith et al. (1988) reported moderate TSs at sound pressure levels between 125 and 150 dB (re 20 μPa).

Data describing changes in underwater auditory sensitivity and exposure effects in terrestrial mammals (including humans) are affected by the fact that their sound conduction mechanisms are air-adapted rather than water-adapted. The terrestrial mammal's auditory pathway does not have the morphological adaptations to marine environment and pressure that are present in cetacean ears (e.g., Ketten, 1994, 1995). As a result, the submerged terrestrial mammal ear may react abnormally, and therefore the appropriateness of "risk criteria" established from TS measurements on submerged terrestrial mammal ears is in debate. The human underwater results are included for the sake of completeness but were not used as definitive measure for formation of acoustic impact criteria for marine mammals.

E.3.2 Threshold Shift in Other Terrestrial Mammals

Sound-induced hearing loss has been investigated in a number of mammalian species, particularly chinchillas, as well as primates and cats (reviewed in Kryter et al., 1966; Hamernik et al., 1980; Clark, 1991). The use of animal models has allowed controlled experimental testing of acoustic parameters related to threshold shifts and correlations between noise exposure schedules, behavioral changes, and physical damage to the auditory system. However, the majority of this systematic work has been done with chronic or intermittent exposure to continuous tones. Fully developed experimental designs with sufficient controls and numbers of subjects for measuring the effects of impulse, blast-like stimuli have emerged only recently.

In general, the data show that, with exposure to continuous noise, TTS spreads upward in frequency from the center frequency of the exposure band (e.g., Lenhardt, 1986; Yost, 1994). Upward spread (in terms of frequency) is common to long and short duration exposures that induce TTS. The primary difference in terms of frequency is that the spread is greater for lower-frequency than higher-frequency signals, and that is largely because of cochlear tonotopy. High frequencies are represented in the first part of the cochlea close to the middle ear, and are

therefore exposed to all intense sound as it is transferred into the cochlea. The extent of PTS can be correlated with the extent and location of hair cell loss in the cochlea. PTS tends to occur with exposures to over 100 dB SPL for less than 6 hours that produce an initial TS of 60 dB or more (Clark, 1991). Impulse stimuli also produce frequency-spreading effects in PTS as well as hair cell loss. As noted above, recovery is in part a function of the intensity and duty cycle of the noise. Other effects of impulse stimuli are less clear.

The shapes of the recovery function in TTS and PTS as well as the correlated patterns of physiological damage have received much attention. There is agreement that, with impulsive stimuli, TSs may result from trauma to different auditory mechanisms than those that are affected by chronic exposure, in part depending on the levels to which the subject is exposed (e.g., Luz and Hodge, 1971; Henderson et al., 1974; Price, 1983; Patterson et al., 1986). There is also general agreement that injuries to different mechanisms combine to produce nonmonotonic recovery functions, but the mechanisms that are affected by the different types and levels of impulsive stimuli are only beginning to be understood. This is an important issue for determining the kinds of impairment that are suffered in TTS and PTS if they are to be used for DRC for injury and harassment. The basic model – suggested by Luz and Hodge (1971) and elaborated by Hamernik et al. (1980) – explained the time course of TS recovery following exposure to continuous and impulse stimuli. "Metabolic fatigue" caused by a continuous stimulus was evidenced by a monotonic recovery function while "structural fatigue" caused by an impulse stimulus produced a nonmonotonic rise in TS followed by either a monotonic recovery or a plateau followed by monotonic recovery. These two basic processes, alone or in combination, were responsible for the various patterns of recovery observed. While early studies (Luz and Hodge, 1971 and Henderson et al., 1974) provided some support for nonmonotonic recovery and hair cell loss in TTS, the variability in the results, the methods used and subsequent work suggest that subjects were subjected to wider levels of exposure than intended. The general model that relates physiological damage to observed recovery functions is still accepted, but appears to be more applicable to PTS level exposures than those that produce only TTS.

The role of the distribution of energy across the spectrum of an impulsive stimulus in eliciting auditory TS has been debated (Price, 1983; Lenhardt, 1986; Hamernik et al., 1991; NRC, 1992; Smoorenburg, 1992; Ahroon, 1996). As the first positive pressure phase of an impulse lengthens (i.e., the A duration increases), the amount of energy in lower frequencies increases. At distance, higher frequencies are attenuated. Hamernik et al. (1991) induced PTS in chinchillas using exposures to 150, 155, or 160 dB impulses (re 20 μPa in air; intensity equivalent to 211 to 221 dB re 1 μPa in water) with peak frequencies that varied from 0.25 to 2 kHz. Exposure was scheduled on a factorial combination of 1X, 10X, and 100X repetitions on 10/min, 1/min, and 0.1/min duty cycles. The results suggest that the degree of PTS in chinchillas was dependent on the spectral content of the impulse, with the degree of PTS proportional to the total energy of the impulses and the auditory sensitivity function. It should be emphasized that these are effects observed at PTS levels – TTS data were excluded from the analysis. At moderate PTS levels, the overpressures and broad frequency spectrum of the proposed shock-trial detonations are likely to cause similar damage to most species because impulse and shock wave trauma largely are mechanical in nature. At TTS levels and onset-PTS levels, the relationship between the spectral content of the impulse and TS is less clear. Neither peak pressure alone nor energy alone are thought to be sufficient to

explain the observed effects and various suggestions have been made for weighted energy (Patterson, 1991; Patterson et al., 1992). Continuous exposure that produces small degrees of TTS shows a strong relationship between the frequency of the stimulus and the frequency at which TS is experienced. At higher levels, that dependency diminishes and TS spreads across frequencies and toward higher frequencies in particular (Yost, 1994). To acknowledge the potential role of spectral density, two sets of risk criteria will be presented, one for high frequency "specialists" such as odontocetes, and a second for low frequency "specialists" such as baleen whales and sea turtles.

Arhoon et al. (1996) studied hearing trauma to chinchillas caused by reverberant blast waves of different spectral composition. His design was similar to Hamernik et al. (1991). In a balanced design, 18 groups of 15 animals each were exposed to combinations of 150, 155, or 160 dB SPL (re 20 μPa in air; intensity equivalent to 211 to 221 dB re 1 μPa in water) reverberant shockwaves with octave-band A-weighted, spectral peaks at 0.25 or 2.0 kHz for either 1, 10, or 100 exposures at a rate of 1/min. A horn and hard-walled chamber produced an intact pressure pulse with trailing reverberation. Post-exposure testing was at 0.5, 2.0 and 8 kHz over 30 days. The study focused on PTS and related hair cell loss, but included data for groups that experienced only TTS as well. TTS and PTS showed a very orderly progression across test frequencies as total exposure energy increased. At the highest degrees of PTS – approximately 40 dB – the higher frequency impulse produced significantly more PTS – approximately 10 dB – than the lower frequency impulse. Outer and inner hair cell loss followed the degree and frequency position of PTS closely. No PTS occurred in any group that was exposed to only a single pulse.

Although not analyzed, the graphic data presented by Ahroon et al. (1996) for the groups that exhibited TTS reveal important results as well. Initial TSs that ranged from approximately 5 to 40 dB fully recovered – the latter value being in agreement with numerous other studies. All instances of TTS were characterized by monotonic recovery functions and none exhibited "delay" or "growth" of TS following exposure. All but one PTS group exhibited some delay in recovery, but none showed strong growth. Whereas all PTS groups suffered patterns of hair cell loss that were correlated with the patterns of frequency loss, none of the groups exhibiting TTS showed hair cell loss. Unlike much previous work on impulsive stimuli, this study used mean data throughout and reported very low variability in all measures.

The study of Ahroon et al. (1996) is remarkable in several respects. Large between-subject variability in impulse-induced TS has been reported by many researchers (Hodge and McCommons, 1966; Henderson et al., 1974; Hamernik et al., 1980, 1988; Lenhardt, 1986). By consistently applying a wide range of controls, the authors demonstrated that such variability could be brought under experimental control. That is, variability is not an inherent property of TS to impulse stimuli *per se*, but of the conditions in which it is induced in normal circumstances. The causes of that variability were known to include age, incidence angle, environment, and consistency of exposure as well as individual differences in hearing and susceptibility to TS. All of these are factors in normal experience and must be taken into account when developing damage risk criteria. However, by controlling these factors while applying more complete experimental and reporting procedures than found in earlier work, the authors provide a more straightforward interpretation of their data and the phenomena.

The Ahroon et al. (1996) study also shows that TTS to impulsive stimuli can reach levels over 40 dB in the chinchilla with no accompanying loss of hair cells and that, with systematically applied stimuli, the progression to PTS and loss of hair cells is orderly. The levels used in the study were sufficient to induce TTS with an initial TS of up to 25 dB with a single presentation and up to 40 dB with multiple exposures – neither producing any permanent effects. Without detail, examination of the earlier studies that report evidence of nonmontonic recovery and hair cell loss in TTS usually had initial or delayed TS levels at or above 40 dB or reported the data in such a way to make comparisons difficult. Nevertheless, the results support the view that TTS, even by impulsive stimulation, is best understood as a temporary loss of function with no permanent damage or loss of tissue. The Ahroon et al. (1996) study uses levels of stimuli that overlap most of the nominal levels of previous studies and the differences between them deserve further study. It remains to be demonstrated whether the relationships between TTS and PTS shown in the Ahroon et al. (1996) study are found with all types of stimuli and exposure conditions.

Studies on possible permanent tissue damage resulting from TTS have used exposure to short-term continuous rather than impulsive stimuli. Liberman et al. (1987) induced 40-60 dB TS in cats to reach the upper limit of TTS. The study examined ears taken during the TTS recovery period with light and electron microscopy to find the possible mechanisms that mediate TTS. They found swelling and vacuolization as well as stereocilia-rootlet shortening to be the two most likely candidates. Liberman et al. (1987) concluded that the former would have recovered completely had the animals been allowed to survive and provided evidence suggestive of the latter's recoverability as well. Henry et al. (1995) found evidence in the alligator lizard ear that afferent synaptic fatigue (depletion of synaptic bodies and associated vesicles) as a result of intense stimulation may contribute to TTS as well. They also assumed the effect to be temporary. The combination of factors mediating TTS remains unknown and both studies lacked definitive controls to demonstrate the assumed recoveries, but the best available evidence indicates that TTS induced by short-term exposures produces no permanent damage to tissue.

Again, comparisons across species in general and from terrestrial to aquatic species in particular require caution. In marine mammals, the middle ear appears to contain air and, as such, may be susceptible to mechanical injury (e.g., Ketten, 1995). However, cetacean ears also are adapted to the high ambient pressure normally encountered in marine existence. These adaptations include occlusion of the external auditory meatus and thickened membranes (Ketten, 1991, 1992), which may confer increased resilience to pressure-related damage (Ketten, 1995). Thus, the absolute and relative values that are found in even well controlled studies of terrestrial animals should not be extrapolated to aquatic species without at least partial verification.

E.3.3 TTS in Bottlenose Dolphins

Ridgway et al. (1997) described preliminary results of the first TTS experiments in dolphins and Schlundt et al. (2000) added species and subjects as well as a reanalysis of that data. Masked TTS was induced in five Atlantic bottlenose dolphins and two white whales using intense 1 second pure-tones. Similar TTS studies with impulsive stimuli have been conducted by Finneran et al. (2000), but in that study the highest pressure and energy delivered appeared to be only

approaching the induction of criterion masked TTS (Finneran, pers. comm.). While the results reported in Schlundt et al. (2000) are based on 1-second tones, they are used as the most directly applicable data available for predicting explosive effects as described below.

TTS was measured as follows. Masked hearing thresholds were obtained for each subject, with masking noise levels of 95 dB for 0.4 kHz, 90 and 67 dB for 3 kHz, 63 dB for 10 kHz, 63 and 75 dB for 20 kHz and 70 dB for 75 kHz tone pips of 250 msec duration – masking levels were re 1 $\mu Pa^2/Hz$, and kHz values were the center frequencies of the fatiguing stimuli (S1). TTS was induced by presenting a super-threshold 1-second S1 tone, followed immediately by tests for threshold with S2 tone pips at equal and/or higher frequency. S1 levels were successively increased until TTS was observed. TTS was operationally defined as the S1 level in dB re 1 μPa that produced a 6 dB increase in masked hearing threshold of a S2 tone pip at the same or higher frequency within several minutes of S1. TTSs were generally obtained between 192 and 201 dB SPL re 1 μPa.

In contrast to findings in other species (e.g., Lenhardt, 1986; Clark, 1991), the levels for behavioral responses and TTS reported by Schlundt et al. (2000) were not strongly frequency-dependent, but the results suggest that additional data are required at low frequencies to verify this observation. However, the Schlundt et al. (2000) data are relevant because they provide quantitative experimental evidence of threshold shift to short duration stimuli in the cetacean ear *in situ* on which our predictions may be based. A subsequent study on masked TTS in the bottlenose dolphin by Au et al. (1999) addressed cumulative effects over a relatively long duration of exposure. In addition, TTS in the sea lion, harbor seal and northern elephant seal has been studied by Kastak et al. (1999) who also used relatively long duration exposure. Comparisons between the data of Schlundt et al. (2000), Kastak et al. (1999) and Au et al. (1999) are presented in Finneran et al. (2000).

The Ridgway et al. (1997) and Schlundt et al. (2000) studies were conducted specifically to address auditory criteria for SONAR's. They recognized the preliminary nature of their findings, citing the need for further investigation in more marine mammal species, replication in more subjects, and testing across greater frequency ranges, different stimulus durations, onset rise times, and other stimulus configurations. The studies indicated that, for short duration stimuli, dolphins appear to require greater sound pressure levels than do land mammals to report TTS. This is consistent with the intensity equivalents (Ketten, 1995; pers. comm.).

The 1-second pure tones differ from the broadband spectra common to impulsive noise (Hamernik et al., 1991); however, the amplitude of the TTS stimuli of Schlundt et al. (2000) rose steeply to the peak amplitude, similar to the time-course of onset in impulsive waveforms. Given the availability of this TS data and the absence of a clear TTS effect in the Finneran et al. (2000) study with impulsive stimuli, the data of Schlundt et al. (2000) will be used. The reanalysis of Schlundt et al. (2000) with the original data of Ridgway et al. (1997) indicate that the data at 75 kHz are unreliable. As a result, the animal with the next lowest S1 level at which reliable masked TTS was observed is used as the reference level for development of our criterion. That animal reached criterion TTS of 6 dB after exposure to a 1 sec, 10 kHz tonal fatiguing stimulus of 192 dB SPL re 1 μPa.

Extrapolation of these findings to longer duration stimuli currently is under study in cetaceans, but is at this time is taken to be on a roughly "equal-energy" basis (Finneran et al., 2000). That is, longer exposures with an equal amount of energy – i. e. 192 dB re 1 $\mu Pa^2 \cdot s$ – produce similar TS effects. The same cannot be said for shorter duration stimuli, especially very short transient stimuli that are known generically as impulses. That common term is somewhat misleading as a variety of waveforms with different physiological impacts are classified as impulses. This is why, as mentioned, total energy is insufficient to explain the auditory effects of the various impulsive waveforms. In addition to energy, the rise-time, peak pressure and A-duration or its spectral equivalent have each been considered as potential metrics; that is, those other features can contribute along with energy to observed TTS from impulses. When one or more of those other features are prominent, considerably less energy than is present in a TTS-inducing 1 second pure-tone may be sufficient to induce TTS. In the absence of direct impulsive data, these other features and their effect are considered along with the sufficient 1-second-tonal energy in the development of an "energy-based" onset-TTS criterion for impulses. The integration time of the ear is used as a quantitative guide to the amount of allowable energy. At threshold levels and across the range of normal hearing, the mammalian ear integrates the energy arriving within the duration of its time constant. The integration time of the dolphin ear was taken as 100 msec – slightly less than that measured by Johnson (1968). It should be noted that this use of integration time to relate tonal and impulsive stimuli is made strictly for the immediate purpose of deriving an energy-based criterion for impulsive stimuli in lieu of direct impulsive data and is not intended as a method for general use. The use of the integration time constant in this case limits the amount of allowable energy in the impulse criteria to slightly less than a demonstrated time process of the ear rather than the energy in the whole or other portion of the 1-second tone that produced the TTS. Some credence to the actual values obtained in this way can be found in Finneran et al. (2000). In that study, the subjects appeared to be approaching criterion TTS at energy levels just below those estimated here. While not a substitute for direct measurement of the effects of impulsive stimuli, the considered use of direct TS data from an aquatically adapted ear in water is more valid and useful from the standpoint of safety than prediction of TS effects from much more indirect lines of evidence.

E.4 CRITERIA CONSIDERED

Two themes are common throughout the literature on TTS and PTS associated with impulsive sounds. One is that the variability of individuals and their orientation will produce variability in the onset and degree of TTS experienced. The other concerns the effective stimulus parameters for inducing TTS and PTS. Experts in underwater-explosion acoustics and marine-mammal hearing agree that acoustic criteria for animals exposed to underwater noise should consider the amount of acoustic energy that impinges on the mammal ear (e.g., Kryter et al., 1966; Luz and Hodge, 1971; Henderson et al., 1974; Hamernik et al., 1980; Price, 1983; Saunders et al., 1985; Lenhardt, 1986; Patterson et al., 1986; Clark, 1991; Hamernik and Hsueh, 1991; Melnick, 1991; Ketten, 1995). Energy is proportional to the square of pressure integrated over time, and is commonly discussed in reference to 1/3-octave bands. This is done largely because audiometric data suggest the human cochlea can be modeled as a bank of 1/3 octave filters (Green and Swets, 1966; Fay, 1988) as can

that of dolphins (Johnson, 1968). In addition, overpressure also must be taken into account as already mentioned.

In the case of the proposed DDG 81 shock trial, the relative contribution to TTS of spectral characteristics of the stimulus compared to the contribution by the overpressures caused by the detonations are unknown. The shock wave created by HBX-1 detonations has a complex waveform over the range of distances at which it is likely to produce TTS (**Figures E.1** through **E.6**). At moderate PTS inducing levels, the pressures and broad frequency spectrum of the shock wave will likely cause equivalent damage to all species, making considerations of species-specific frequency-dependent auditory sensitivities unnecessary. In addition, models for predicting TSs in general for any specific individual would require foreknowledge of the exact acoustic characteristics of the impulses to which an animal is exposed as well as the health of the animal's ears. However, predictions for TTS in the average ear of the potentially impacted species may be made.

Marine mammals and sea turtles are of greatest concern in the test area and it is for those animals that the predictions will be made. As already described, pressure and energy must be considered in any general impulse criterion and further, with regard to energy component, there should be consideration of the high frequency "specialists" such as odontocetes, and the low frequency "specialists" such as baleen whales and sea turtles. The inference of low frequency specialization in baleen whales derives from indirect evidence such as anatomical analysis of their ears and their observed vocalization frequencies. However, the development of computational audiograms for baleen whales may enhance the prediction of acoustic performance and susceptibility to TS effects in the future. For example, Helweg (2000) has developed the first filter-bank models of the humpback whale's ear. They were derived from anatomical analyses of the humpback's ear and optimization techniques. Resonant frequencies were calculated as a function of position along the basilar membrane of the humpback's ear, and the resultant frequency topology was mapped onto a sensitivity scale derived from a mammalian audiogram. Evolutionary programming was used to derive a bank of 75 frequency-domain bandpass filters whose output matched that of the modeled audiogram. The results suggest that humpbacks are sensitive to frequencies between 40 and 16,000 Hz, but best sensitivity is likely to occur between 100 and 8,000 Hz. Absolute sensitivity was not modeled but is predicted to range over at least 60 dB. This indicates that at least humpback whales – of the baleen species – are not limited to sensitivity in their predominant vocalization range – i.e., below 1 kHz.

There are no direct data on TTS or PTS in any species of sea turtle and no data on PTS in marine mammal species. There are only data on TTS in two species of odontocete (the bottlenose dolphin and white whale – Schlundt et al., 2000) and three species of pinniped (the harbor seal, California sea lion, and northern elephant seal – Kastak et al., 1999). Two auditory criteria are evaluated in the next section. They are a criterion (1) based on pressure developed for marine mammals by Ketten (1995) and another (2) based on energy from the data of Ridgway et al. (1997) and Schlundt et al. (2000) for TTS in bottlenose dolphins and white whales. An extrapolation of potential PTS levels from human DRC by Richardson et al. (1995) was considered at length in the FEIS for the SEAWOLF shock test (Helweg et al., 1998). That derivation was for PTS, not TTS, and did not take the impedance of the media into account. For that reason, it is not used in predicting risk criteria for marine mammals.

E.4.1 Cetacean Acoustic Criteria (Ketten, 1995)

Ketten (1995) provided a theoretical model of zones of potential trauma to aquatic ears (e.g., fracture of ossicles) induced by underwater detonations. Her model is derived from comparisons of in-air versus in-water trauma studies in the comparative literature for TTS and PTS induced by impulsive stimuli, plus models of how the pressure and overpressures associated with blast exposures affect mammalian ear structure.

Ketten identified 5 to 15 psi as the range within which an outer limit for TTS may be predicted to occur. A 10,000 lb (4,536 kg) HBX-1 detonation in deep water produces maximum pressures ranging from approx. 76.8 psi at 1,000 m range down to approx. 5.4 psi at 10,000 m range (Table 2 in Ketten, 1995). From the decrement in pressure with distance, Ketten estimated that an outer limit for minimal TTS was 5 km, which was associated with a peak pressure of 12 psi.

Ketten's model is limited to an "ideal" condition in which she has assumed the detonation occurred in deep water with the charge placed below 328 ft (100 m) in depth, and that the bottom depth is at least 20 times the detonation depth. Moreover, she has assumed that the bottom substrate is thick, flat sediment. In contrast, the proposed shock trials will occur in waters from approximately 600 ft (183 m) to 7,700 ft (2,348 m) and the detonation depth is only 200 ft (61 m). For this reason, the ranges calculated by Ketten are not directly applicable to the DDG 81 shock trial conditions, but Ketten's 12 psi criterion can be used to calculate an effect range as discussed in Section E.5.

E.4.2 TTS in Bottlenose Dolphins (Schlundt et al., 2000)

Ridgway et al. (1997) provided the first direct data on TTS in marine mammals. Schlundt et al. (2000) added species and subjects as well as a reanalysis of that data. They measured TTS and associated behavioral effects in bottlenose dolphins at 0.4, 3, 10, 20 and 75 kHz. Three kHz is a clinical standard used in reference to human hearing sensitivity (e.g., Lenhardt, 1986) and is a common standard used in auditory research with animals. With the shock-trial detonation, the energy in frequencies above approximately 1 kHz will attenuate more rapidly over distance than those below 1 kHz – the exact proportion depending on the sound velocity profile and depth of the animal. However, all of the Schlundt et al. (2000) data are considered for conservative estimation as well as anatomical reasons – the high frequency end of the cochlea is closest to the middle ear and therefore is potentially susceptible to trauma from any intense stimuli regardless of spectral structure. Schlundt et al. (2000) reported consistent TTS in the range of 192-201 dB (re 1 μPa). Thus, a conservative bound for sound pressure levels for medium-sized odontocetes is taken to be 192 dB.

The measured time constant of the bottlenose dolphin ear was approximately 100 to 200 msec for brief tonal stimuli (Johnson, 1968). Using 100 msec is conservative. Thus, we estimate the allowable energy to be that which occurred within the 100 msec integration time or 182 dB $\mu Pa^2 \cdot s$ $(192\ \text{dB} + (10 \times \log(0.1\,\text{sec})))$.

Schlundt et al. (2000) described behavioral responses that occurred at lower exposure levels than TTS in some trials, and ongoing work continues to analyze and refine the measurement of those behaviors. The relationship between these behaviors and TTS as well as the consistency of those behaviors remains to be established. Also, the extrapolation of behavioral-response observations from the repetitive- to the single-exposure scenario remains to be addressed. Therefore, the most consistent, quantifiable indicator of acoustic harassment will be used, the TTS values.

In addition to the TTS study, Ridgway et al. (in press) have demonstrated that the increased pressure of depth does not affect the white whale's auditory sensitivity. Tests on two whales at four depths down to 300 m showed no significant differences in sensitivity. The authors conclude that acoustic energy is conducted directly through the head-tissues to the inner ear rather than via the drum and ossicular chain of the middle ear as in terrestrial mammals. Whether susceptibility to TTS is equally insensitive to depth is not directly addressed in the study. If TTS were also so insensitive, the finding would not alter the present predictions of TTS at depth since the near-surface estimate of TTS susceptibility is applied at all depths.

E.5 METHOD OF CALCULATING TTS IMPACT ZONES

In this and the following sections, we will determine the critical distances from the explosion for TTS in marine mammals (and by extrapolation, sea turtles). The critical distance is the shortest distance at which no TTS is expected to occur. Two criteria based on the preceding discussion will be used. At a given position in the water column, TTS would not be expected to occur if (1) the peak pressure is less than 12 psi (Section E.4.1) and (2) the energy density in all 1/3 octave bands is less than 182 dB re 1 $\mu Pa^2 \cdot s$ (Section E.4.2). The PTS criterion extrapolated from human DRC as suggested by Richardson et al. (1995) is not used as it refers to the more severe effects of PTS already described.

In calculating the range for the energy-based TTS criterion, different frequency ranges will be considered for odontocetes and mysticetes due to their differences in low frequency hearing sensitivity. For small- and medium-sized odontocetes, whose range of best hearing is above 10,000 Hz, the frequency range considered will be 100 Hz and up. At 100 Hz, the sensitivity of bottlenose dolphin hearing is down by more than 70 dB from the peak sensitivity (Richardson et al., 1995). Extension to lower frequencies was not deemed necessary.

Although audiograms have been measured for some odontocetes, the only information available for baleen whales is based on vocalization recordings, anatomical models of hearing ranges, playback experiments and computational modeling (Clark, 1990; Ketten, 1991, 1992, 1994; Richardson et al., 1995; Helweg, 1999). The majority of sound energy produced by baleen whales lies between approximately 15 to 1,000 Hz (Clark, 1990; Richardson et al., 1995). In the light of this, and to be conservative, we will extend the frequency range considered for the energy criterion for mysticetes down to 10 Hz.

Note that the prior calculations and those to be described likely overestimate the critical distances for TTS and the resultant area that is affected. Subsequently, that area will be used with estimates of population densities to predict the number of affected animals. Given that the affected area

varies with critical distance, a small difference in distance can produce a large difference between the estimated numbers of animals affected. The assumptions leading up to the estimate of 182 dB $\mu Pa^2 \cdot sec$ for minimum TTS are conservative. Using the 10 kHz data from Schlundt et al. (2000) for the initial TTS level (192 dB) may overestimate the direct mechanical effects of the impulse at minimum TTS levels. Subsequent use of a 100 msec integration-time constant (vice a value between 100 and 200 msec from the literature – or the entire 1-second signal) reduces to a minimum the estimate of allowable energy that might cause TTS. Together, these assumptions probably underestimate the energy required for minimum TTS and thus overestimate the distance at which it might occur. As will be described, the subsequent analysis of impulse propagation uses worst-case criteria in selecting the 1/3 octave frequency-band of highest energy, the sound velocity profile of greatest propagation, the greater propagation of either critical energy or pressure, and the depth of greatest propagation. It is highly unlikely that these conditions would coincide at the time of a test to produce critical distances as long as those estimated – and even less likely that those conditions would coincide with the most disadvantageous distribution of animals in the water column. Nevertheless, the estimates are made in this way to compensate for sparse data and the number of unknown factors in psychophysics, biology, and ocean acoustics as they pertain to marine mammals and shock-trial impulses. In the future, as more complete information becomes available, these quantitative estimates of worst-case distances will be replaced with unbiased estimates of mean critical-distances and realistic measures of variance.

The pulse train from an underwater explosion in water of moderate depth consists of the direct shock wave followed by companion surface- and bottom-reflected waveforms. There will generally be a series of higher order reflections: bottom-surface, surface-bottom, bottom-surface-bottom, etc. There may be significant energy that travels largely through the bottom. In addition, at the ranges of interest for sea mammal TTS, the arrivals will generally be modified by refraction due to the variation of sound speed with depth in the water column. All these transmission paths must be considered to produce an accurate model of the pressure vs. time signature at locations of interest.

For these calculations, the contribution of the bubble pulse can be ignored. The bubble pulse period for a 10,000 lb. HBX-1 charge at a depth of 200 ft (61 m) is about 1.04 sec, which corresponds to a bubble pulse frequency of 0.96 Hz. Since the effect of the bubble pulse on the spectrum is minimal at frequencies above 10 times the bubble pulse frequency (Weston, 1960), it would have negligible effects in this application. Note that for other situations, involving smaller or deeper explosions, the bubble pulse effect on the spectrum may have to be taken into account.

The procedure for calculating the critical distance for TTS is as follows:

1. At a given assumed animal position in the water, for a particular sound speed profile, calculate the pressure vs. time waveform expected at that position.
2. Note the peak pressure in that waveform and compare with the 12-psi criterion for TTS.
3. Calculate the energy density spectrum for the waveform.
4. Integrate the spectrum in 1/3 octave bands.
5. For each combination of test area, water depth, sound speed profile and horizontal distance, the maximum pressure and spectral energy were determined without regard to the animal depth(s) at which they occurred. This was done to eliminate animal depth as a variable in the results, and is a highly conservative approach.

6. Determine if the energy density in any 1/3-octave band for any of the three SVPs used for a given test area/water depth/distance combination exceeds 182 dB re 1 $\mu Pa^2 \cdot sec$ (considering frequency ranges of $\geq$100 Hz for odontocetes and $\geq$10 Hz for mysticetes), or if the peak pressure exceeds 12 psi.
7. By performing a large number of calculations at different positions for different sound speed profiles, determine the shortest distance at which neither criterion is exceeded for each combination of test area and water depth.

The pressure-time waveforms were calculated using the REFMS computer model for shock wave transmission (Britt et al., 1991). Validation studies of this model are listed at the end of this appendix. The model includes the effects of multiple surface and bottom reflections of the shock wave, as well as refraction effects. Although this is largely an acoustic model, non-linear effects on shock wave transmission near the charge are included. The explosive charge weight, type of explosive and charge depth are input into the calculation. A sound speed profile in the water is required for the calculation, as are bottom depth and properties. For a given range, waveforms were calculated at assumed animal depths of 50 to 500 ft (15 to 152 m). Energy spectra were obtained from the pressure-time waveforms by standard methods.

The water depth may be an important factor in the calculation of the explosive waveforms. Since the shock trial may occur at any point within each test area, three water depths were considered for each of the three proposed test areas. The depths were chosen to be geographically representative of each test area. For all three test areas, the shallowest water depth considered was 600 ft (183 m), the minimum depth at which the shock trial would be conducted. Two other depths were chosen in each test area to represent (approximately) the geographic middle and the deepest part of the test area, respectively. The other two depths at each test area were as follows: Norfolk – 6,000 and 7,700 ft (1,829 and 2,348 m); Mayport – 1,200 and 2,300 ft (366 and 700 m); and Pascagoula – 1,200 and 2,200 ft (366 and 670 m). Some calculations were performed at other water depths to more closely examine the effect of water depth variation. For each combination of test area and water depth, three archival sound speed profiles were used. Only profiles measured from June through September were used. Bottom slope was not considered in the calculations. To be conservative, the complete calculated pulse train was used to compute the spectrum, even if it contained pulses separated by more than 0.1 seconds, the integration time of the dolphin ear for brief tone pips.

In all areas, vortices from the Gulf Stream can cause major swings in sound speed profiles in as little as 24 hours. For all areas, the archival profiles can give only an indication of the situation one might expect during a given time period.

E.6 RESULTS

In this section, we will present the computational results for predicting the critical distance. The effect of animal depth, water depth, and SVP variability will be demonstrated. The critical distance, for odontocetes and mysticetes, for each test area and water depth combination will be given.

Effect of Animal Depth. **Figures E.1** through **E.3** show the effect of the depth of the animal on the peak pressure and spectral energy determinations. In each of these figures, the graph on the left shows the computed pressure-time waveforms for a particular water depth and SVP, at a given range. On the right, we show the corresponding 1/3rd octave band energy spectra. **Figure E.1** is for the Norfolk test area at a water depth of 600 ft (183 m). The range from the explosion is seven nautical miles. It is clear that at a depth of 200 ft (61 m), the loading on the animal is most severe. In the time domain, there is a significant negative pressure spike at 200 ft (61 m) that does not appear at any other depth. The energy spectrum for this depth is significantly higher than for the other depths calculated. It is the only depth for which the energy significantly exceeds the 182 dB criterion. The energy values used to characterize this condition were 191 dB for mysticetes and 185 dB for odontocetes. These values are much higher than those for any depth except for 200 ft (61 m). This demonstrates the conservative nature of our procedure for eliminating animal depth as a variable in the results. A very similar situation exists for the Pascagoula test area at a distance of 9 nmi (16.7 km) and a water depth of 1,200 ft (366 m), as shown in **Figure E.2.** Again, the 200 ft (61 m) depth shows the highest loading in both the time and frequency domains. **Figure E.3** is for the Mayport test area at a distance of 11 nmi (20.4 km) and a water depth of 2,300 ft (700 m). Here the spectra for 200 to 500 ft (61 to 152 m) animal depths cluster closely together, especially at 10 to 100 Hz. The spectra at 50 and 100 ft (15 and 30 m) depths tend to be somewhat lower.

Effect of Water Depth. **Figures E.4** through **E.6** examine the effect of water depth on the critical distances for TTS. **Figure E.4** is for the Norfolk test area at a distance of 11 nmi (20.4 km). The animal depth is 300 ft (91 m). At a water depth of 600 ft (183 m), all the significant shock arrivals occur within about 140 msec. As the depth increases the bottom and bottom-surface reflections occur later in time, corresponding to the greater distances these arrivals must travel relative to the direct arrivals. At a water depth of 7,700 ft (2,348 m), these reflections come in over 400 msec after the main body of direct arrivals. The peak pressures for 1,200 and 7,700 ft (366 and 2,348 m) depth remain roughly constant, while that at 600 ft (183 m) is somewhat lower. Examining the corresponding spectra, at low frequencies the 7,700 ft (2,348 m) depth gives the highest levels and the 6,000 ft (1,830 m) depth the next highest. The 600 and 1,200 ft (183 and 366 m) depths have the lowest levels, with the 2,200 ft depth somewhat higher. This demonstrates that the critical distance tends to increase with water depth for a given test area and SVP. This is not always the case, as the 1,200 ft (366 m) depth tends to give lower energy levels than those for 600 ft (183 m) for this particular test area/range/animal depth/SVP combination. **Figure E.5** shows the water depth effect for the Pascagoula test area, for a range of 11 nmi (20.4 km) and an animal depth of 50 ft (15 m). The three water depths are 600, 1,200, and 2,300 ft (183, 366, and 700 m). In the time domain, the spreading out in time of the reflected arrivals is evident, as described above. There is no significant change in the peak pressure as the depth increases. The spectra tend to cluster very closely together and there is no clear variation of level with water depth. **Figure E.6** is for the Mayport test area at 11 nmi, for an animal depth of 500 ft (152 m). We again see the spreading of the arrivals as the water depth increases. In this case, the highest peak pressure occurs at the deepest water depth (2,300 ft or 700 m). This depth tends to give the highest spectral energy levels, as well. The 600 ft (183 m) depth tends to give the lowest energy levels. It is clear that water depth is a significant variable in these calculations, with the critical distance tending to increase with water depth (with all other variables held constant). This relationship is not always

true, with intermediate or shallow water depths having greater critical distances for some combinations of input variables.

Effect of SVP Variability. **Figures E.7** through **E.9** demonstrate the effect of variability in the SVP on the critical distance calculations. **Figure E.7**, for the Mayport test area, shows the calculated pressure-time signal and 1/3rd octave band spectra for three SVPs at a distance of 9 nmi from the explosion. The water depth is 600 ft (183 m) and the animal depth is 200 ft (61 m). For this particular set of parameters, spectra for two of the SVPs exceed the 182 dB criterion in the 10 to 100 Hz interval. The spectra for the other SVP stays below 180 dB. In this instance, the peak spectral energy level for frequencies greater than 10 Hz (mysticetes) is about 183 dB, and this position would be considered to be within the distance at which TTS would be expected to occur. For this case, the three SVPs show a spread of about 3 dB in their peak levels. The lower levels exhibit a spread of as much as 12-14 dB in some bands. **Figure E.8** shows a similar set of calculations for the Pascagoula test area. The water depth is 2,200 ft (670 m), the animal depth is 100 ft (30 m), and the distance is 9 nmi (16.7 km). The variation in peak level for the three SVPs is about 2 dB (176-178 dB), with a maximum spread of about 14 dB, similar to the situation shown in **Figure E.7**. **Figure E.9** shows a situation with much more variation among the results for the three SVPs. In this figure, for the Norfolk test area, the water depth is 6,000 ft (1,830 m), the animal depth is 100 ft (30 m) and the distance is 9 nmi (16.7 km). Here, one of the spectra shows a peak of about 187 dB. The highest levels for the other two SVPs are about 180 and 177 dB, respectively. At some frequencies, the spread in levels is as much as 22-24 dB. The peak pressure for the pressure-time history corresponding to the SVP taken on 85/09/08 is much higher than that for the other two SVPs. This is due to the phase relationship of the various shock arrivals at this position and the way the pressures happen to add up. This high peak pressure spike is reflected in the high energy levels at frequencies from 1-5 kHz in the corresponding spectrum.

Determination of Critical Distance for TTS. **Figures E.12** through **E.14** demonstrate the procedure for determining the critical distance for TTS for a given set of conditions. These figures are for the Mayport test area, with a water depth of 600 ft (183 m). **Figure E.12** shows the variation of peak pressure with distance for three different SVPs. The 12 psi peak pressure criterion is also indicated in this figure. The greatest distance at which the criterion is reached is 7.0 nmi (13.0 km). **Figure E.13** shows the peak 1/3rd octave band energy for baleen whales (frequency >10 Hz) for the same set of conditions. The 182 dB criterion is also shown. The greatest distance at which the criterion is reached is 13.0 nmi (24.0 km). Since this is greater than the critical distance based on the peak pressure criterion, the distance for baleen whales for the Mayport test area at 600 ft (183 m) is established through the peak energy criterion to be 13.0 nmi (24.0 km). **Figure E.14** shows the peak energy for odontocetes (frequency >100 Hz). The maximum distance at which the criterion is reached is 7.2 nmi (13.3 km). Since this is greater than the distance derived from the peak pressure criterion, 7.2 nmi (13.3 km) is established as the critical TTS distance for odontocetes at Mayport for 600 ft (183 m) water depth. This procedure was repeated for each combination of test area and water depth. **Figures E.15**, **E.16**, and **E.17** show other examples of how peak pressure and energy vary with distance from the charge for the other test areas. The results of the TTS critical distance calculations are given in **Table E.1**. The critical distance was usually governed by the energy criteria and not by the peak pressure criterion. Exceptions to this are indicated in the table.

Table E.1. Calculated maximum TTS distances.

	Norfolk			Mayport			Pascagoula		
Depth (ft):	600	6,000	7,700	600	1,200	2,300	600	1,200	2,200
Odontocete TTS range (nmi)	9.0	17.4	17.7	7.2	11.0	13.6*	8.6	10.0	13.3*
Mysticetes TTS range (nmi)	14.0	23.0	21.0	13.0	13.0	15.0	12.3	16.0	14.4

*Determined from peak pressure criterion. All others determined by 1/3rd octave band energy.

E.7 CONCLUSIONS

The most meaningful criteria for estimating auditory impact ranges for marine mammals and turtles would be based on measurements of TTS resulting from exposure to impulsive noise (ideally, underwater explosions). Since these data do not exist, we have developed auditory criteria based on the best available data. This includes results from TTS studies with bottlenose dolphins and white whales (Schlundt et al., 2000). In addition, acoustic impact zones developed for marine mammals by Ketten (1995) provide an independent basis for an auditory impact criterion.

In this Appendix, a dual criterion has been developed: (1) an energy-based TTS criterion of 182 dB re 1 $\mu Pa^2 \cdot sec$ derived from the Schlundt et al. (2000) bottlenose dolphin and white whale data; and (2) 12 psi peak pressure, cited by Ketten (1995) as associated with an "outer limit for the 10,000 lb. charge for minimal, recoverable auditory trauma." The effect range is the minimum distance at which neither criterion is exceeded. The same TTS criterion is used for both odontocetes and mysticetes, a reasonable approach based on the best available data. However, different frequencies were used to calculate TTS ranges based on their differing sensitivity to low frequencies. For odontocetes, we included all frequencies greater than or equal to 100 Hz. For mysticetes, we included all frequencies greater than or equal to 10 Hz. These are highly conservative lower frequency bounds, especially for odontocetes.

There are no data for TTS or PTS in sea turtles. Ridgway et al. (1969) reported maximal sensitivity for green sea turtles occurred at 300 to 400 Hz, with a rapid decline in sensitivity for lower and higher tones. Similarly, Moein et al. (1994) reported a hearing range of about 250 to 1,000 Hz for loggerhead sea turtles, and Lenhardt (1994) stated that maximal sensitivity in sea turtles generally occurs in the range from 100 to 800 Hz. Calculated in-water hearing thresholds within the useful range appear to be high (e.g., about 160 to 200 dB re 1 μPa; Lenhardt, 1994). Based on this information, the TTS critical distance for odontocetes using frequencies $\geq$100 Hz should be conservative for sea turtles. It should be noted that, in contrast to marine mammals, little is known about the role of sound and hearing in sea turtle survival.

Finally, it should be noted that calculations made using archival information provide only an estimate of what may occur. The actual acoustic field on any given day will depend on the sound-velocity structure at that time and on the actual bottom sediment and structure in the area. *In situ* profile measurements and calculations made on site during shock trials will improve future model predictions.

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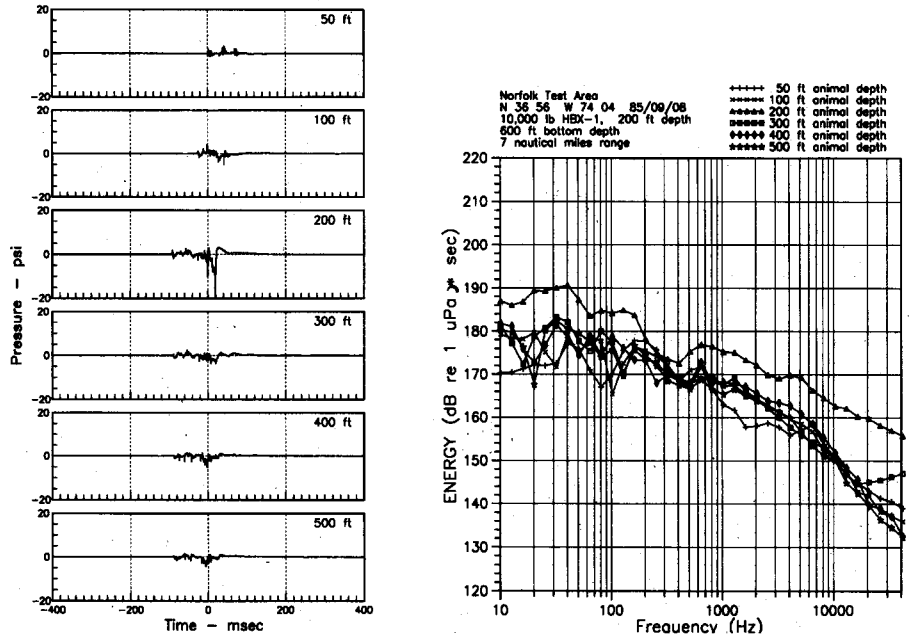

Figure E.1. Effect of animal depth – Norfolk, 9 nmi range.

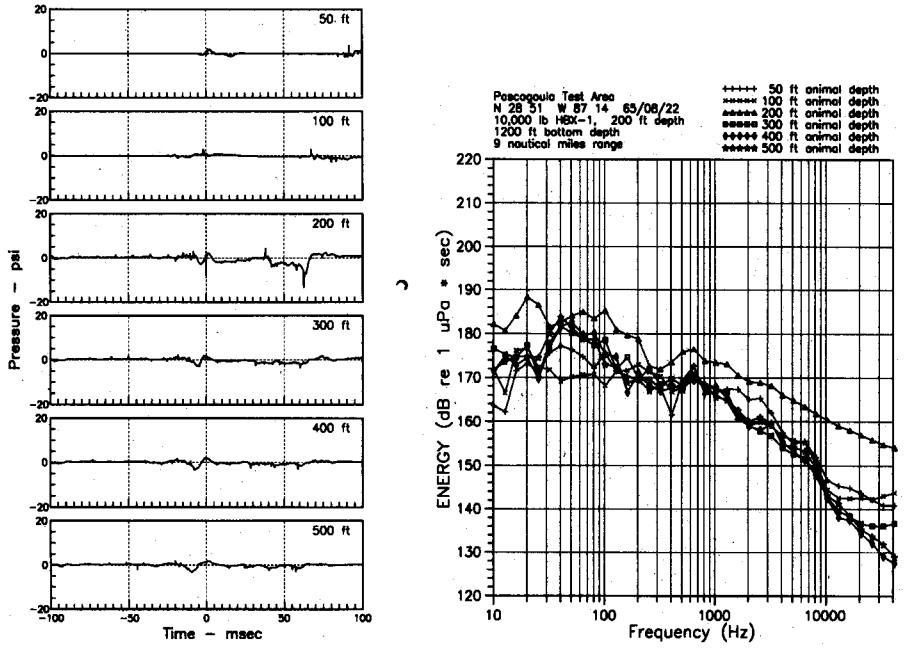

Figure E.2. Effect of animal depth – Pascagoula, 9 nmi range.

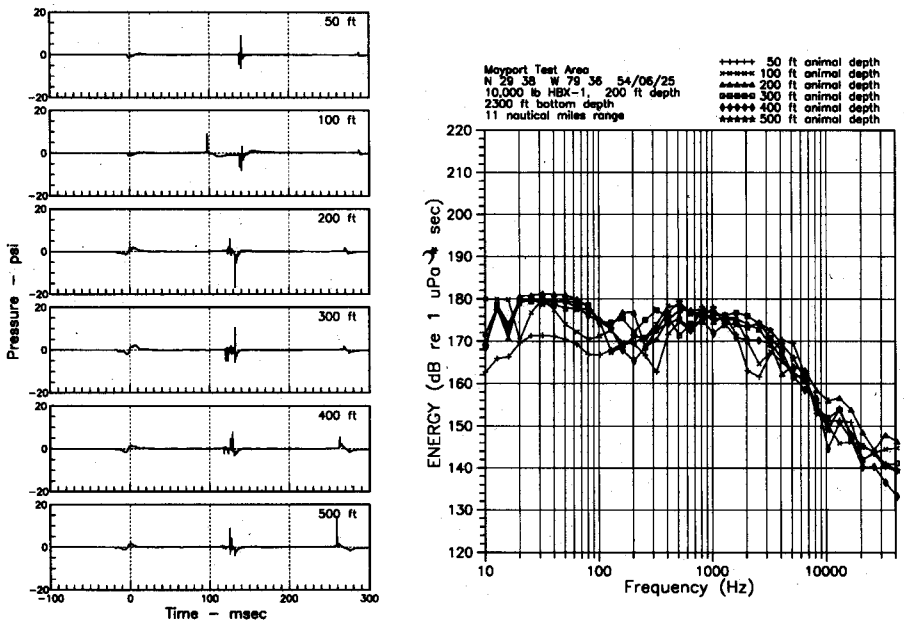

Figure E.3. Effect of animal depth – Mayport, 11 nmi range.

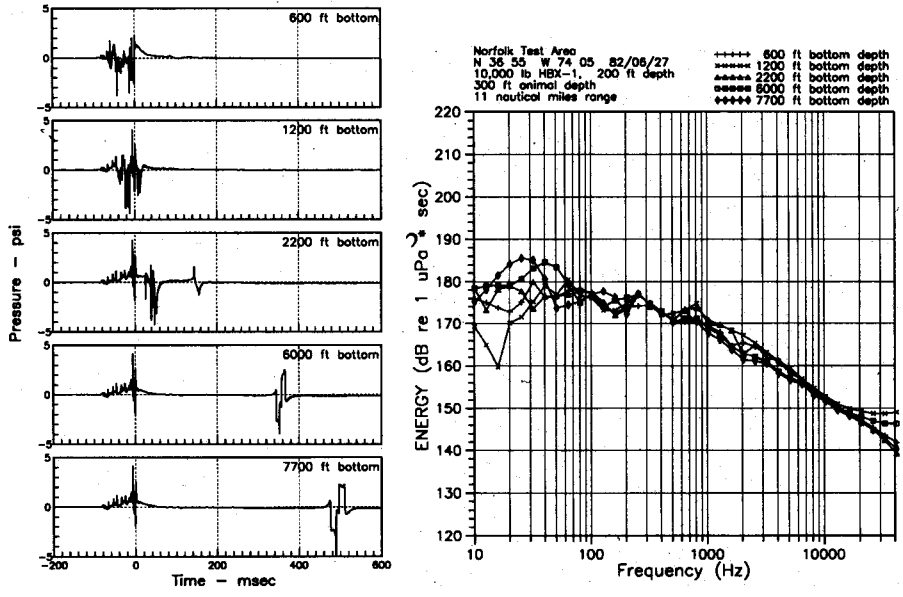

Figure E.4. Effect of water depth – Norfolk, 11 nmi range.

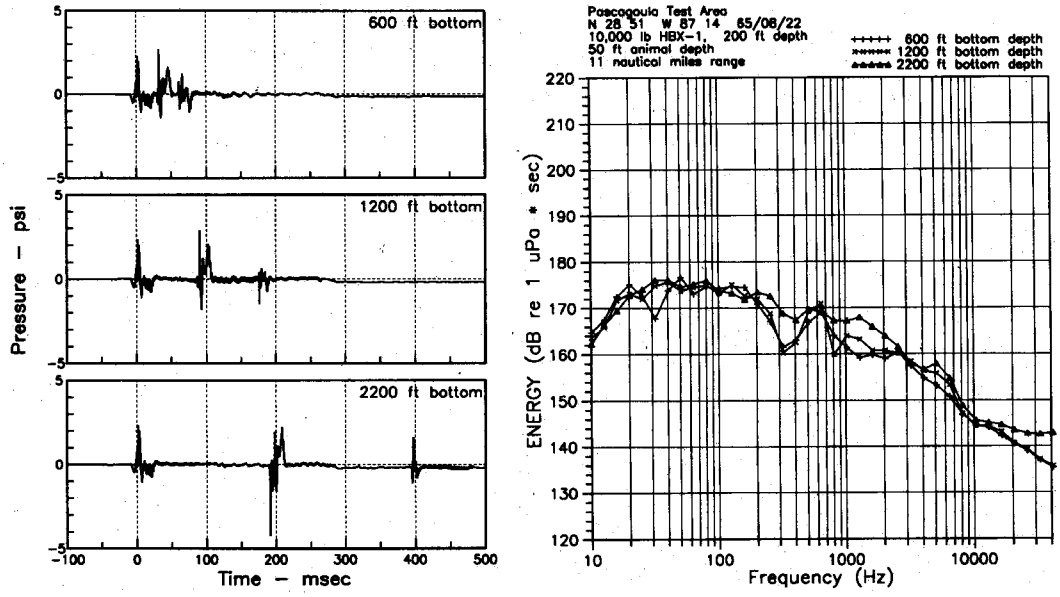

Figure E.5. Effect of water depth – Pascagoula, 11 nmi range.

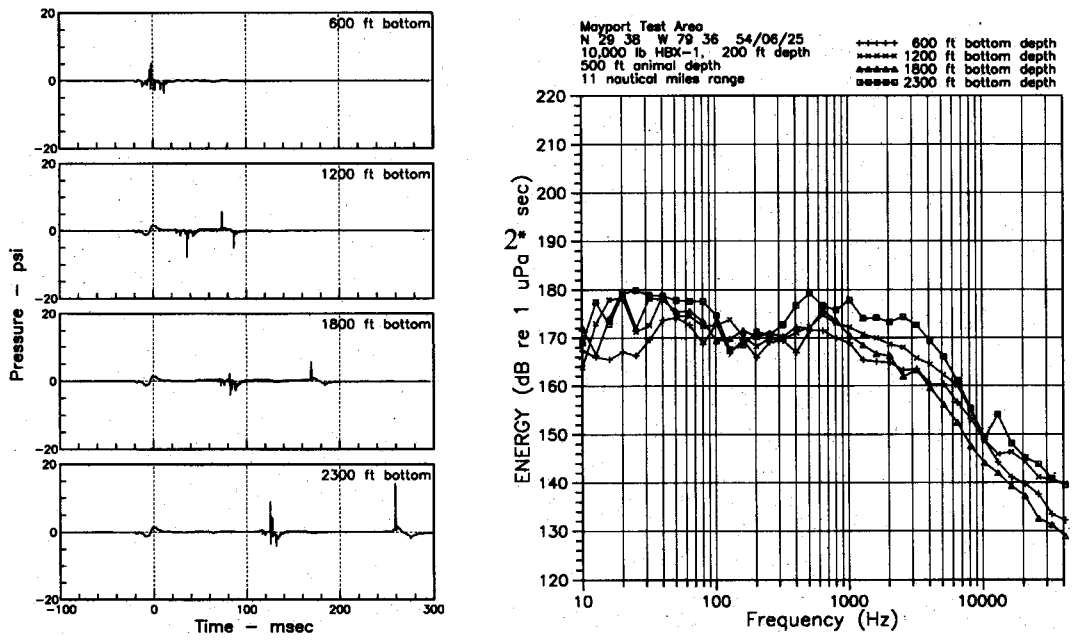

Figure E.6. Effect of water depth – Mayport, 11 nmi range.

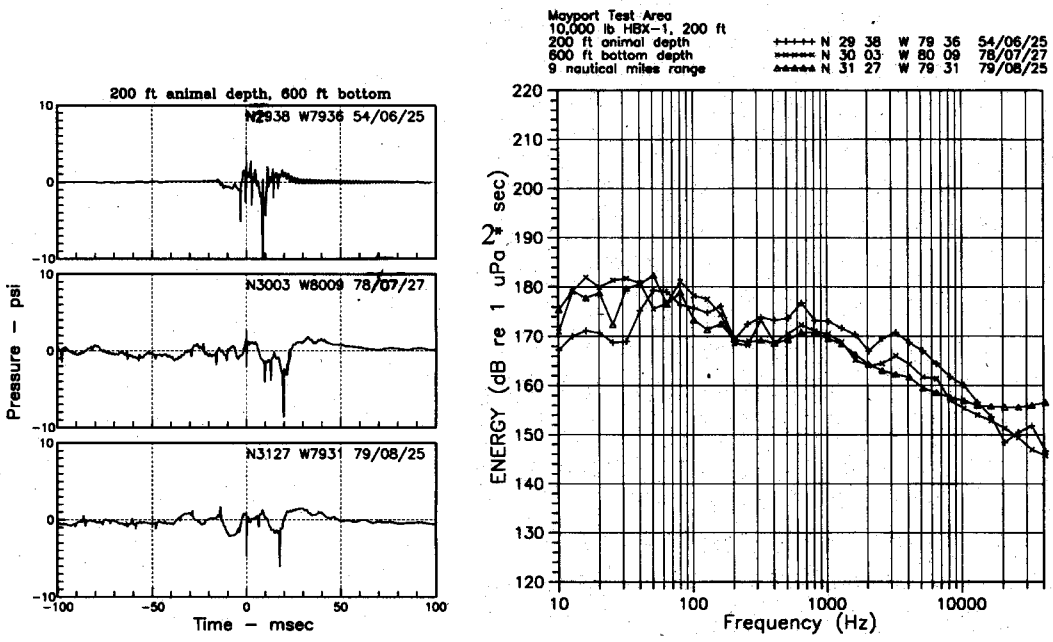

Figure E.7. Effect of SVP variation – Mayport, 9 nmi range.

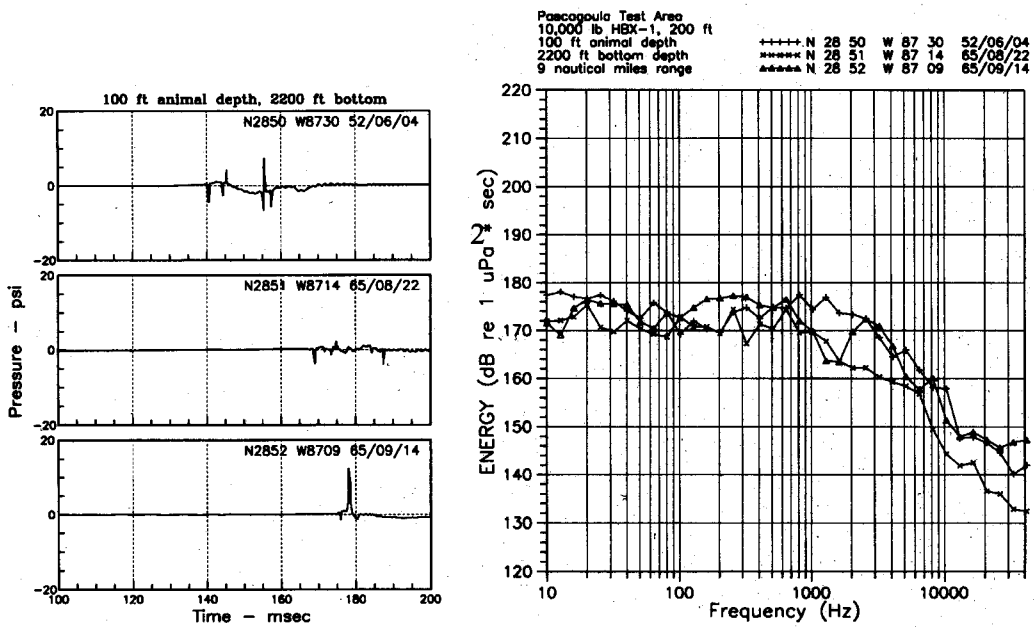

Figure E.8. Effect of SVP variation – Pascagoula, 9 nmi range.

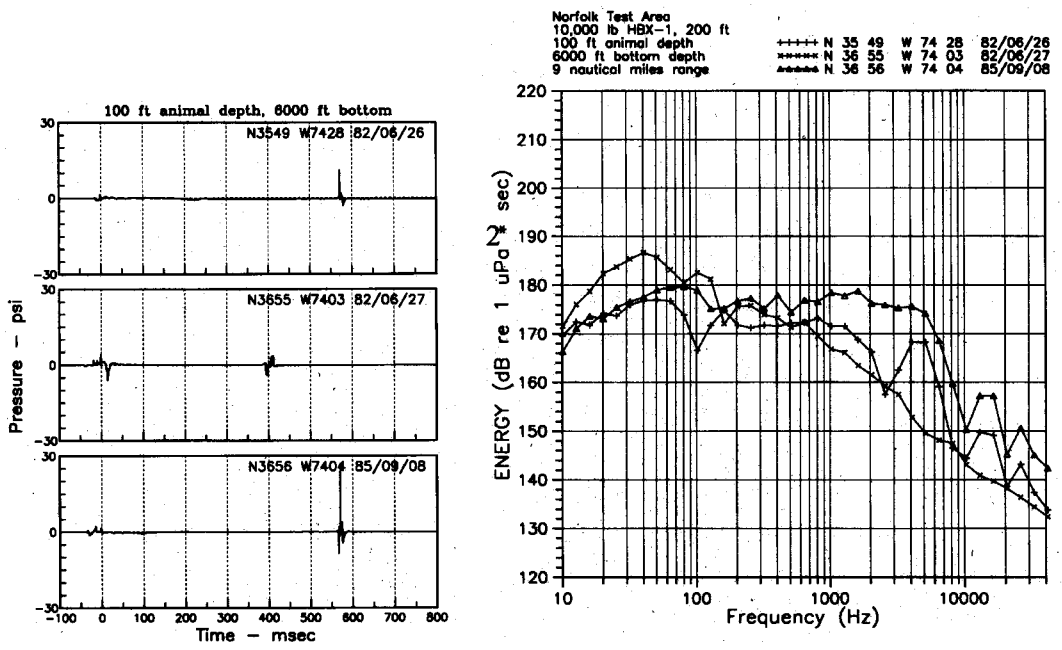

Figure E.9. Effect of SVP variation – Norfolk, 9 nmi range.

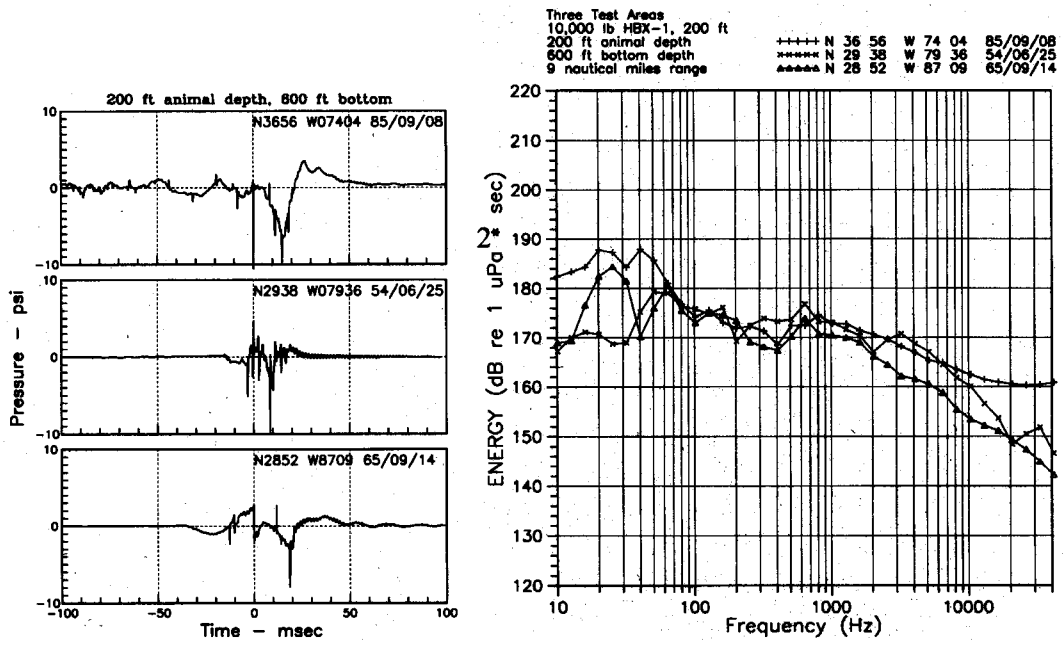

Figure E.10. Effect of site – 600 ft water depth, 9 nmi range.

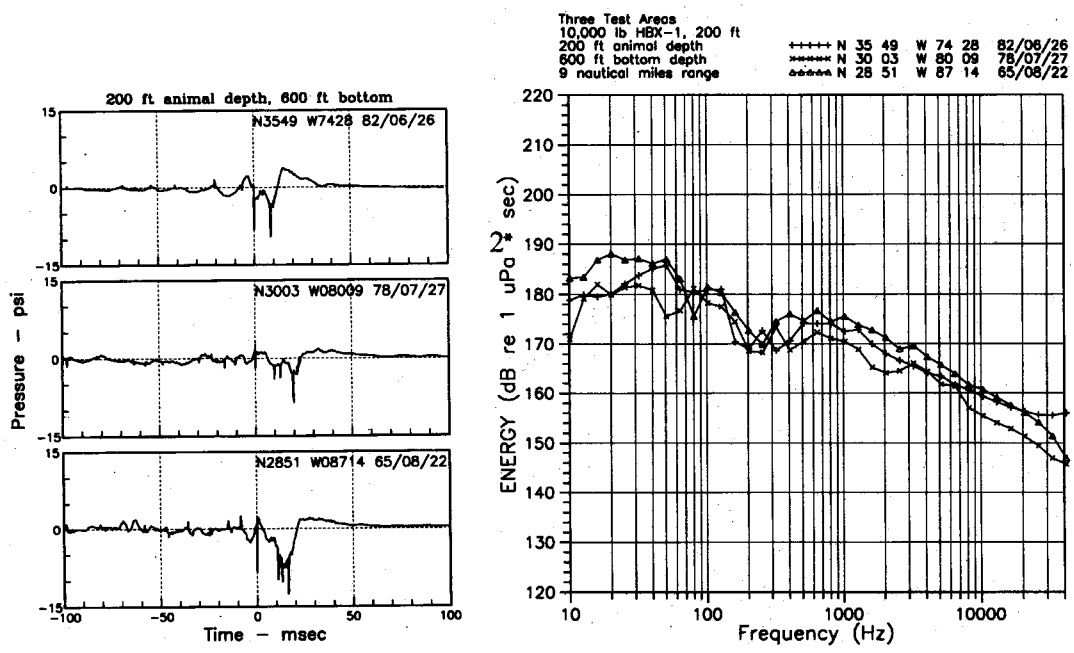

Figure E.11. Effect of site – 600 ft water depth, 9 nmi range.

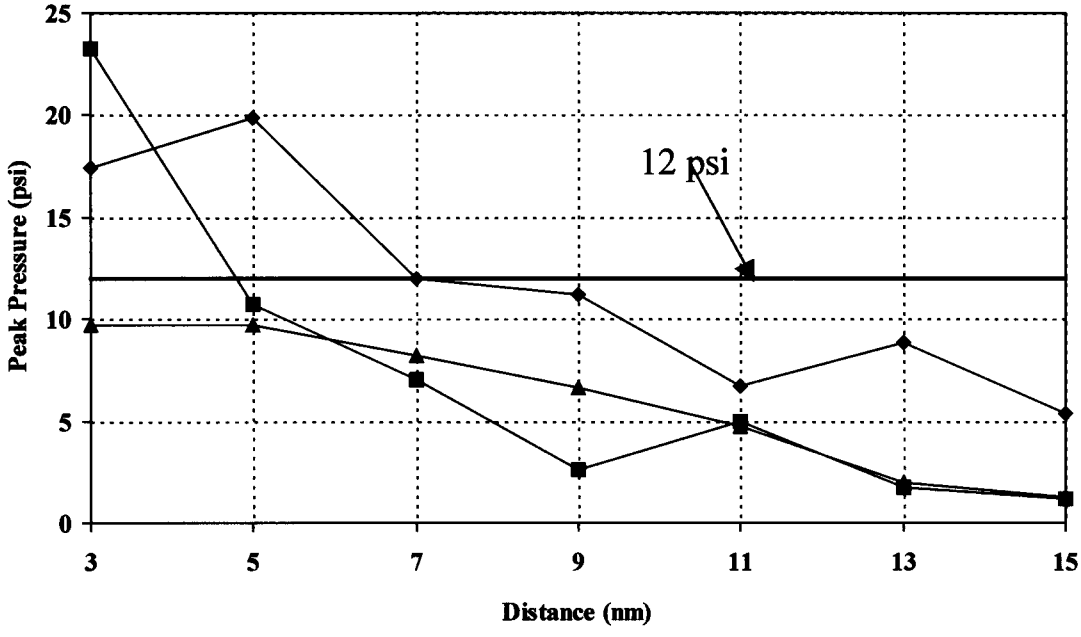

Figure E.12. Peak pressure vs. distance – Mayport, 600 ft water depth.

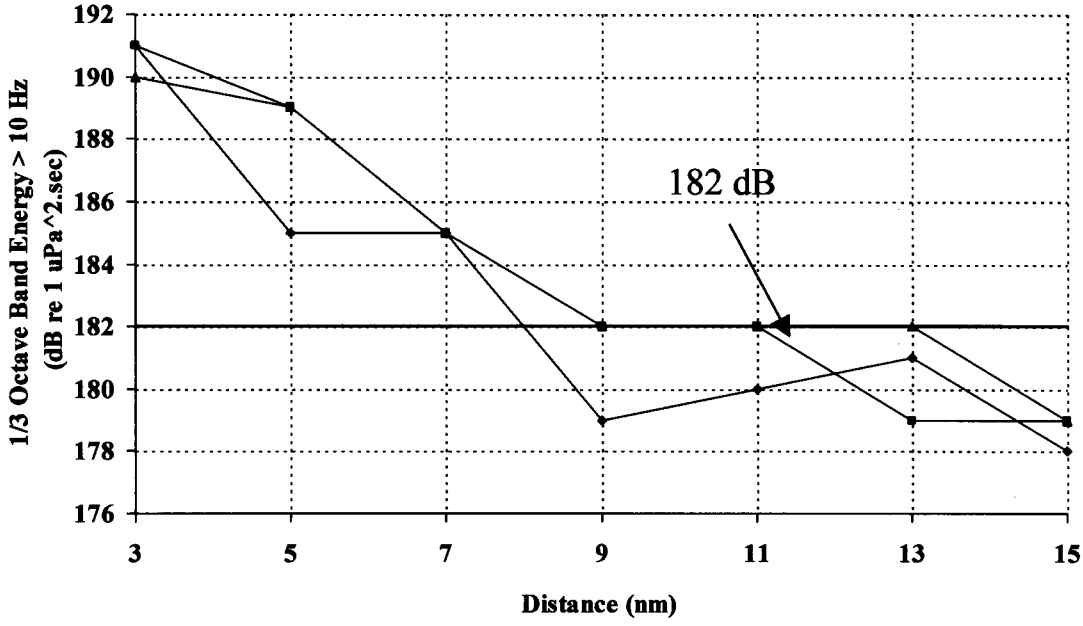

Figure E.13. Peak energy for mysticetes vs. distance, Mayport – 600 ft water depth.

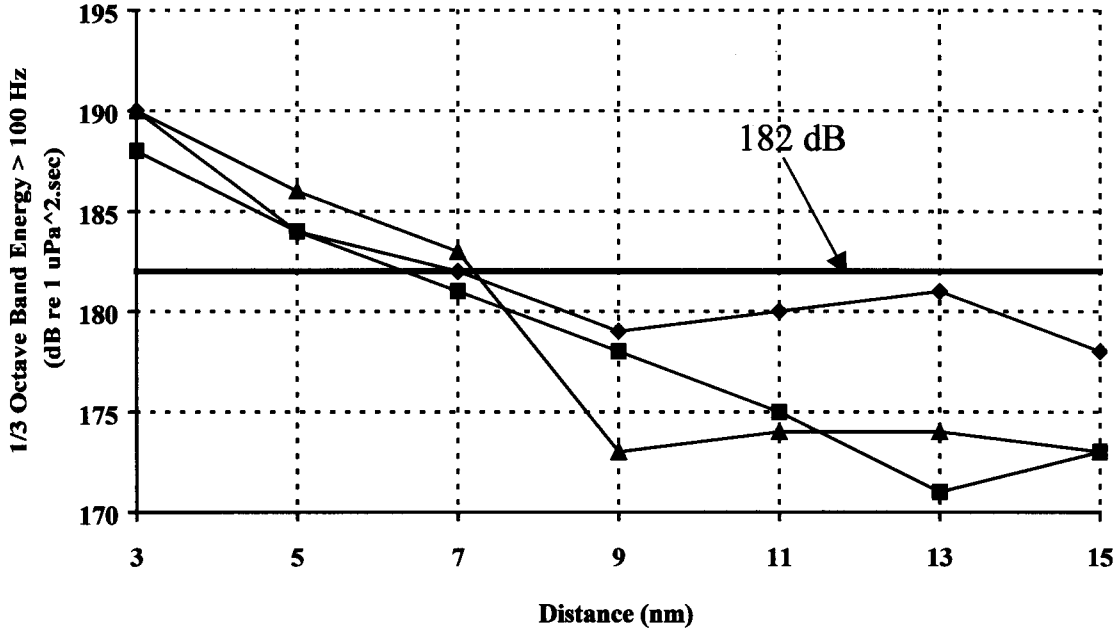

Figure E.14. Peak energy for odontocetes vs. distance, Mayport – 600 ft water depth.

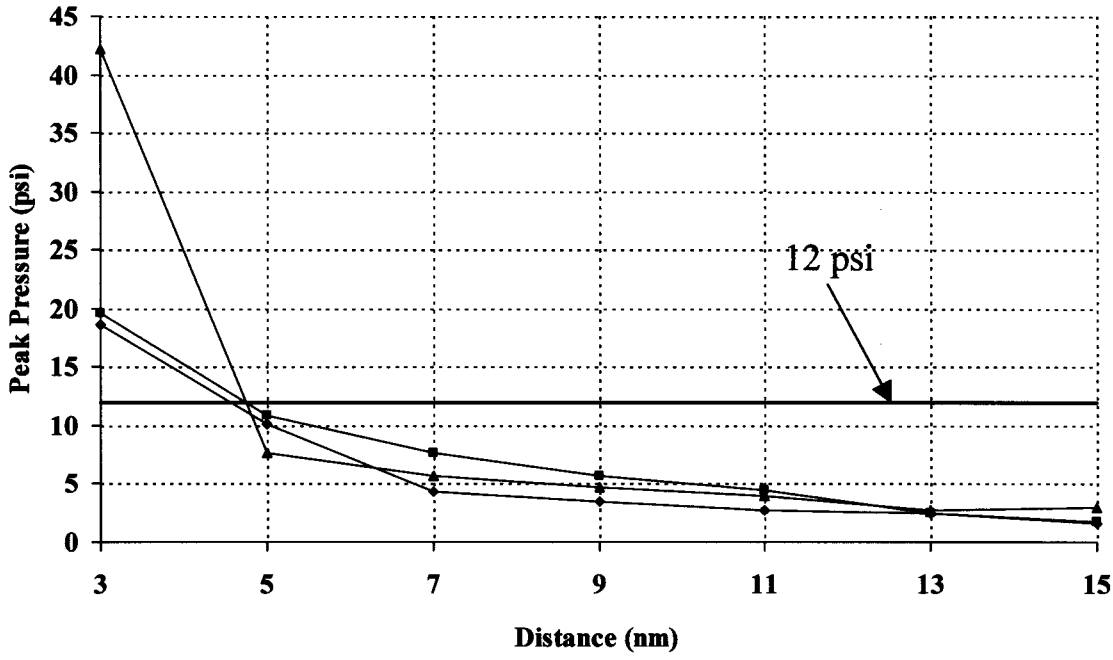

Figure E.15. Peak pressure vs. distance, Norfolk – 600 ft water depth.

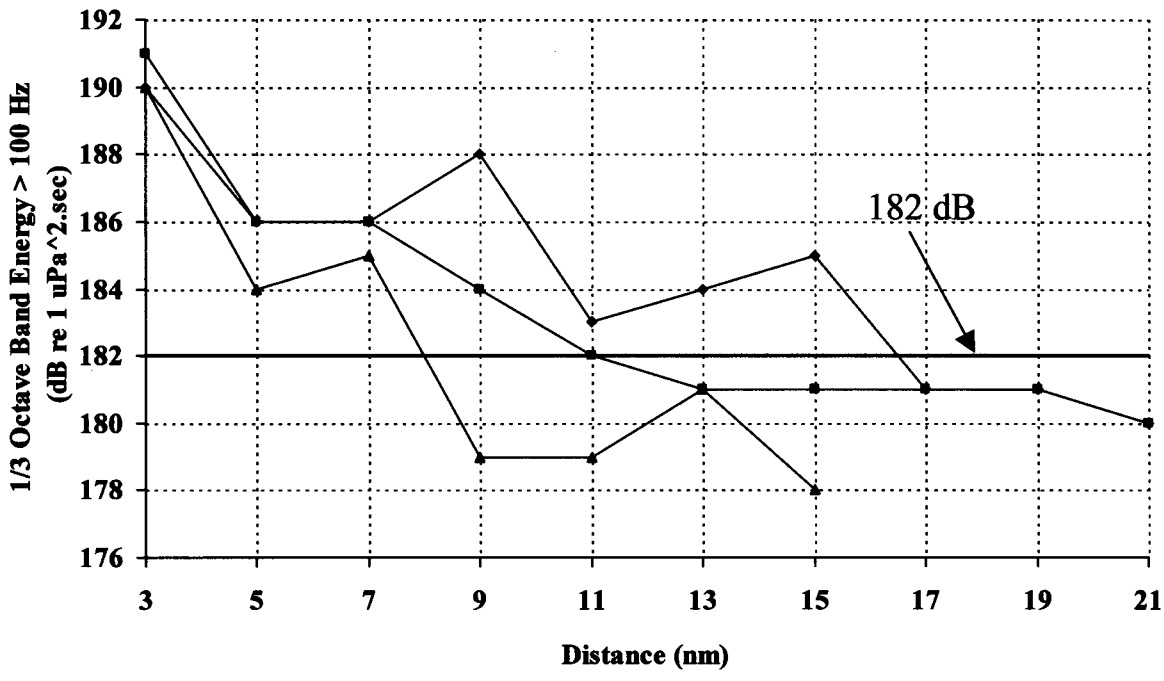

Figure E.16. Peak energy for odontocetes vs. distance, Norfolk – 6,000 ft water depth.

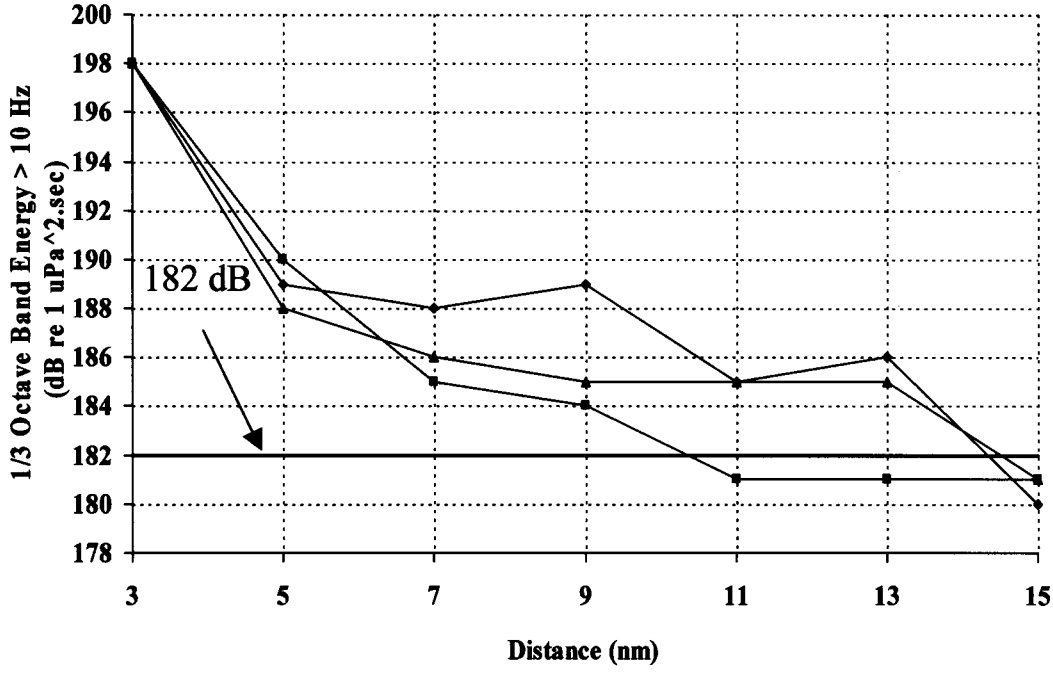

Figure E.17. Peak energy for mysticetes vs. distance, Pascagoula – 2,200 ft water depth.

APPENDIX F

ENDANGERED SPECIES ACT CONSULTATION LETTERS

APPENDIX F
ENDANGERED SPECIES ACT CONSULTATION LETTERS

This appendix contains copies of informal Endangered Species Act consultation letters written prior to the release of the Draft Environmental Impact Statement (DEIS). There are 10 letters in all, each numbered in the upper right-hand corner.

- Letter #1 is the initial request from the Department of the Navy to the National Marine Fisheries Service (NMFS) for information on endangered or threatened species under its jurisdiction. Similar letters (not shown) were sent to U.S. Fish and Wildlife Service (USFWS) offices in Gloucester, Virginia; Raleigh, North Carolina; Jacksonville, Florida; Panama City, Florida; and Daphne, Alabama.
- Letter #2 is the NMFS response, which includes tables of threatened and endangered species and critical habitat under its jurisdiction. The Navy subsequently determined that three of the species (Gulf sturgeon, shortnose sturgeon, and Johnson's seagrass) would not be affected by the proposed action. The Navy determined that the other species identified by the NMFS (various marine mammals and sea turtles) may be affected by the proposed action, and therefore the DEIS was submitted to the NMFS as a Biological Assessment. The NMFS subsequently prepared a Biological Opinion which is included in Appendix G.
- Letters #3, 4, and 5 are responses from USFWS offices in Gloucester, Virginia; Daphne, Alabama; and Panama City, Florida. The first two indicate no endangered or threatened species under USFWS jurisdiction near the proposed test areas, and they refer the Navy to the NMFS for further information on marine species. The third cites only the Gulf sturgeon, which is under shared USFWS-NMFS jurisdiction, but states that consultation for this species would be deferred to the NMFS. As noted previously, the Navy subsequently determined that the Gulf sturgeon would not be affected by the proposed action.
- Letters #6 and 7 are correspondence with the Jacksonville office of the USFWS. The initial letter from the USFWS identifies the Florida manatee as an endangered species potentially affected by the proposed action. In the second letter, the Navy states its determination that the proposed action would not adversely affect the Florida manatee or its critical habitat, and the USFWS concurs (see stamp in lower left corner).
- Letters #8, 9, and 10 are correspondence with the Raleigh office of the USFWS. The initial letter from the USFWS identifies the Bermuda petrel as an endangered species potentially occurring at or near the Norfolk test area. A second letter from the Navy states its determination that the proposed action is not likely to adversely affect listed species or critical habitat under USFWS jurisdiction. The response from the USFWS concurs that, given the Navy's conclusion that the shock trial would not be conducted at Norfolk, the project is not likely to adversely affect any endangered or threatened species or critical habitat under USFWS jurisdiction.

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
P.O. BOX 190010
2155 EAGLE DRIVE
NORTH CHARLESTON, S.C. 29419-9010

1

11000
Code 064/WS
18 MAR 99

National Marine Fisheries Services
Southeast Regional Office
Attn: Dr. Andrew Kemmerer
9721 Executive Center Drive North
St. Petersburg, FL 33702

Dear Dr. Kemmerer:

The Navy would like to initiate informal consultation with the NMFS, as required by Section 7 of the Endangered Species Act (ESA) of 1973, for the proposed shock trial of the USS WINSTON S. CHURCHILL, DDG 81. The shock trial would occur at a site to be located off the East or Gulf coasts of the United States. We are in the process of producing an Environmental Impact Statement (EIS), to satisfy the requirements of the National Environmental Policy Act (NEPA). Pursuant to 40 CFR 1501.6, the National Marine Fisheries Service (NMFS) has agreed to be a cooperating agency in the preparation and development of the EIS. The EIS will also provide requisite information under 50 CFR I 216.104 for the application of a Letter of Authorization from the NMFS for small takes of marine mammals under Section 101 (a)(5)(A) of the Marine Mammal Protection Act of 1972, and for a biological assessment to fulfill requirements listed in the ESA for the incidental take of listed species (50 CFR 402.12).

The WINSTON S. CHURCHILL is the third in a new Flight of 23 AEGIS destroyers, referred to as the Flight IIA Destroyer class. Each ship constructed for the Navy must undergo sea trials to ensure seaworthiness, safety, and combat readiness. Typically, one of the first ships of each class undergoes a shock trial to assess the survivability of the hull, all ship systems, and the crew. The WINSTON S. CHURCHILL was chosen as it has additional design changes that are not included in DDG 79 or DDG 80. A shock trial consists of a series of underwater detonations that are used to propagate a shock wave through a ship's hull, thus simulating underwater detonations, which are similar to those encountered in combat. To approximate actual conditions and provide the best information, a ship shock trial is conducted in offshore waters by exploding underwater charges and measuring the effects on the ship. The trial provides important information, which is used to improve the initial design and enhance the effectiveness and overall survivability of the crew and ship. These improvements are applied to follow-on ships of the same class. Each detonation of the shock trial will involve exploding a 10,000-pound charge at an approximate depth of 200 feet below the water surface. An operations vessel will tow the charge approximately 2,000 feet behind it. For each detonation, the WINSTON S. CHURCHILL will cruise in the same direction as the operations vessel with the charge immediately abeam of it. After an initial inspection for damage, the WINSTON S. CHURCHILL will travel back to the

shore facility for detailed post-test inspections and preparations for the next detonation. For each subsequent detonation, the charge will be moved closer to the WINSTON S. CHURCHILL so that it will experience a more severe shock level. The program is planned for up to four detonations, occurring at the rate of one detonation per week.

Candidate shock trial areas that are being considered are off the coast of Mayport, Florida, Norfolk, Virginia, and Pascagoula, Mississippi (see Figures 1, 2, & 3). These areas were selected based on a number of important logistical considerations that include: a) closeness of a naval base with maintenance and depot level support, a dry-dock, and special trades; b) availability of necessary Navy assets including aircraft, ships, and a tug. A minimum water depth of 600 feet is required to ensure that bottom conditions do not affect the shock trial. Depths and approximate distances from shore are as follows:

	DEPTH RANGE (Approx.)	**DISTANCE FROM SHORE (Approx.)**
Mayport	600 to 2,880 ft	45 to 100 NMI
Norfolk	600 to 8,400 ft	33 to 100 NMI
Pascagoula	600 to 2,280 ft	28 to 90 NMI

The operational area around the test site, which will move as the vessels move, is planned to be a 1 nautical mile diameter zone centered on the explosive charge. An exclusion zone of 5 nautical miles will be established around the test site to exclude all non-test ship, submarine, and aircraft traffic. This zone will be maintained free of radio communications and other electromagnetic interferences. Any traffic within a 10 nautical mile radius will be warned to alter course or will be escorted from the area. A Notice to Airmen and Mariners will be published in advance of the first test.

The WINSTON S. CHURCHILL will be ready for shock trial between May 1 and September 30, 2001. The shock trial must be completed by October 1, 2001 due to the decrease in favorable weather conditions, which occurs after this date.

The Navy is presently awaiting data from the *Relentless* Cruise and GulfCet II to use in defining densities of marine mammals and sea turtles in the three candidate test areas. Results of the surveys will be incorporated into the Draft EIS (DEIS) and will be used to propose the most appropriate area for the shock trial. In addition, a thorough review of the existing literature and data of marine mammal, sea turtle, and marine bird populations in the candidate test areas will be presented in the Existing Environment Section of the DEIS. A plan for mitigating and monitoring potentially adverse effects from the shock trial will also be described in the DEIS. Elements of this plan include the selection of a test site, or sites, which would minimize the likelihood of encountering marine mammals and sea turtles, and a program involving extensive aerial and shipboard surveillance for species of concern which could be conducted prior to and after detonation. Pre-detonation surveillance or monitoring would delay a detonation if a marine mammal or sea turtle is within the predetermined safety zone of the shock trial site. The DEIS will also discuss additional specific mitigation measures.

For this stage of the project and the development of the DEIS, the Navy would like to request initial background information which includes the following items:

- A listing of listed, proposed, and candidate species of concern for the proposed action, including known temporal and spatial movements; and

- A listing of designated or proposed critical habitats for the above listed species.

This information would provide a basis for descriptions of the existing environment with respect to federally protected and listed species. Your assistance in expediting this request is greatly appreciated.

Sincerely,

L. M. PITTS
Director, Environmental Planning Division

ENCLOSURE:
(1) Figure 1 - Proposed test area off Mayport, Florida
(2) Figure 2 - Proposed test area off Norfolk, Virginia
(3) Figure 3 - Proposed test area off Pascagoula, Mississippi

COPY TO: (W/O ENCLOSURES)
NMFS Gloucester, MA (Northeast Regional Office, Dr. Jon Rittgers)
NMFS Silver Spring, MD (Office of Protected Resources, Hilda Diaz-Soltero)

2

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, FL 33702
(727) 570-5312; FAX 570-5517

MAR 31 1999 F/SER3:BH

Mr. L. M. Pitts
Director, Environmental Planning Division
Naval Facilities Engineering Command
P.O. Box 190010
North Charleston, S.C. 29419-9010

Dear Mr. Pitts:

Thank you for your letter dated March 18, 1999, requesting informal consultation under section 7 of the Endangered Species Act (ESA) for the proposed shock trial of the USS Winston Churchill, DDG 81. We appreciate that an Environmental Impact Statement (EIS) and an application for a letter of authorization for small takes of marine mammals are being prepared in relation to your proposed ship shock trial. The EIS may serve as the biological assessment required for us to have the necessary information from which to initiate consultation under section 7 of the ESA. As a point of clarification regarding formal vs. informal consultation, Federal agencies have an obligation under section 7(a)(2) of the ESA to determine whether their actions may affect listed species and whether formal consultation is required. Federal agencies must initiate formal consultation if their proposed action may affect listed species or critical habitat. Formal consultation must be initiated unless, with the written concurrence of the National Marine Fisheries Service (NMFS), the Federal agency can determine through informal consultation that its action is not likely to adversely affect listed species or critical habitat. If the Navy finds that the proposed action may affect listed species or critical habitat, the Navy should initiate formal consultation by providing to NMFS the information required by 50 CFR 402.14(c). However, past experience with similar actions demonstrates that the proposed ship shock trial is likely to result in injury or mortality to sea turtles, thus requiring an authorization for this incidental take. Such an authorization can only be provided through an Incidental Take Statement concluding formal consultation.

Your letter also requests information on listed species that may be found in the proposed action areas and regarding designated or proposed critical habitat for these species. The enclosed lists include the species protected by the ESA under NMFS purview for the Gulf of Mexico and Atlantic Ocean as well as information on critical habitat.

If you have any questions please call Bob Hoffman, Fishery Biologist.

Sincerely yours,

Charles A. Oravetz

Charles A. Oravetz
Assistant Regional Administrator
Protected Resources Division

Enclosures

cc: F/PR3

Revised 1/12/98

Endangered and Threatened Species and Critical Habitats
Under the Jurisdiction of the National Marine Fisheries Service

Gulf of Mexico

Listed Species	Scientific Name	Status	Date Listed
Marine Mammals			
blue whale	*Balaenoptera musculus*	Endangered	12/02/70
finback whale	*Balaenoptera physalus*	Endangered	12/02/70
humpback whale	*Megaptera novaeangliae*	Endangered	12/02/70
right whale	*Eubalaena glacialis*	Endangered	12/02/70
sei whale	*Balaenoptera borealis*	Endangered	12/02/70
sperm whale	*Physeter macrocephalus*	Endangered	12/02/70
Turtles			
green sea turtle	*Chelonia mydas*	Threatened[1]	07/28/78
hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	06/02/70
Kemp's ridley sea turtle (Atlantic)	*Lepidochelys kempii*	Endangered	12/02/70
leatherback sea turtle	*Dermochelys coriacea*	Endangered	06/02/70
loggerhead sea turtle	*Caretta caretta*	Threatened	07/28/78
Fish			
gulf sturgeon[2]	*Acipenser oxyrhynichus desotoi*	Threatened	09/30/91

Species Proposed for Listing
None

Proposed Critical Habitat
None

Designated Critical Habitat
None

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[1] Green turtles are listed as threatened, except for breeding populations of green turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

[2] Range encompasses the states of Florida, Alabama, Mississippi and Louisiana from the mouth of the Mississippi River to Tampa, Florida.

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Revised 12/15/98

Endangered and Threatened Species and Critical Habitats
Under the Jurisdiction of the National Marine Fisheries Service

South Atlantic (North Carolina to Key West, Florida)

Listed Species	Scientific Name	Status	Date Listed
Marine Mammals			
blue whale	*Balaenoptera musculus*	Endangered	12/02/70
finback whale	*Balaenoptera physalus*	Endangered	12/02/70
humpback whale	*Megaptera novaeangliae*	Endangered	12/02/70
right whale	*Eubalaena glacialis*	Endangered	12/02/70
sei whale	*Balaenoptera borealis*	Endangered	12/02/70
sperm whale	*Physeter macrocephalus*	Endangered	12/02/70
Turtles			
green sea turtle	*Chelonia mydas*	Endangered[1]	07/28/78
hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	06/02/70
Kemp's ridley sea turtle (Atlantic)	*Lepidochelys kempii*	Endangered	12/02/70
leatherback sea turtle	*Dermochelys coriacea*	Endangered	06/02/70
loggerhead sea turtle	*Caretta caretta*	Threatened	07/28/78
Fish			
shortnose sturgeon	*Acipenser brevirostrum*	Endangered	03/11/67
Plants			
Johnson's seagrass	*Halophila johnsonii*	Threatened	09/14/98

Species Proposed for Listing

None

Proposed Critical Habitat

None

Designated Critical Habitat

Right whale: Between 31°15'N (approximately the mouth of the Altamaha River, Georgia) and 30°15'N (approximately Jacksonville, Florida) from the coast out to 15 nautical miles offshore; the coastal waters between 30°15'N and 28°00'N (approximately Sebastian Inlet, Florida) from the coast out to 5 nautical miles.

[1] Green turtles are listed as threatened, except for breeding populations of green turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

3

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
6669 Short Lane
Gloucester, Virginia 23061

April 29, 1999

L.M. Pitts
Department of the Navy
Southern Division
P.O. Box 190010
North Charleston, South Carolina 29419-9010

Re: USS Winston S. Churchill Shock Trial, Atlantic Ocean off of Norfolk, Virginia

Greetings:

The U.S. Fish and Wildlife Service has received your request for information on federally listed or proposed endangered or threatened species and designated critical habitat for the referenced project. This letter constitutes the report of the Service on this project and is submitted in accordance with provisions of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.).

The Service does not have any information on rare species or habitats in the Atlantic Ocean 33 to 100 nautical miles off the coast of Norfolk, Virginia. Such information can be obtained from the National Marine Fisheries Service at the following address.

National Marine Fisheries Service
Railroad Ave.
Oxford, MD 21654

If you have any questions or need further assistance, contact Cindy Schulz at (804) 693-6694, extension 127.

Sincerely,

Karen L. Mayne

Karen L. Mayne
Supervisor
Virginia Field Office

4

United States Department of the Interior

FISH AND WILDLIFE SERVICE
[redacted]
P. O. Drawer 1190
Daphne, Alabama 36526

IN REPLY REFER TO:
99-1048a

May 3, 1999

U.S. Department of the Navy
Director, Environmental Planning Division
P.O. Box 190010
North Charleston, SC 29419-9010

Dear Mr. Pitts:

We are responding to your letter, dated March 18, 1999, requesting comments on your plans to conduct shock trials for the USS Winston S. Churchill, DDG 81 off the coast of Alabama - Mississippi. We have reviewed the information you enclosed and are providing the following comments in accordance with the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.).

Potential concerns exist about project impacts to the green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempi*), leatherback (*Dermochelys coriacea*), and loggerhead (*Caretta caretta*) sea turtles, all endangered or threatened species. Since the National Marine Fisheries Service has jurisdiction for these species in the test area, we recommend you contact their St. Petersburg, Florida office.

If you have any questions or need additional information, please contact Mr. Bruce Porter at (334) 441-5181, ext. 37. Please refer to the reference number located at the top of this letter.

Sincerely,

Larry E. Goldman
Field Supervisor

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IN REPLY REFER TO:

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Field Office
1612 June Avenue
Panama City, FL 32405-3721

Tel: (850) 769-0552
Fax: (850) 763-2177

June 9, 1999

Ms. L.P. Pitts
Director, Environmental Planning Division
Naval Facilities Engineering Command
P.O. Box 190010
North Charleston, South Carolina 29419

Re: FWS Log. No. 4-P-99-138
Ship Shock Trials
USS WINSTON S. CHURCHILL, DDG 81
Gulf of Mexico, Panhandle Florida

Dear Ms. Pitts:

Thank you for your May 28, 1999, letter regarding federally protected endangered or threatened species and the subject project. You have requested a listing of listed, proposed, and candidate species of concern including designated or proposed critical habitats for the species. The project is to conduct ship shock sea trials for a new destroyer, the USS WINSTON S. CHURCHILL. The trials would be conducted in the Gulf of Mexico, approximately 30 to 90 nautical miles offshore the Pensacola Naval Air Station in 600 to 2,280 feet of water depth. This response is provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and Section 7 of the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 et seq.).

Enclosed is a table of Federal and State protected species within our geographic work jurisdiction. Of the Federal species on the list, the Gulf sturgeon *Acipenser oxyrinchus desotoi* is the only species that may be potentially impacted by the proposed action. We have enclosed a recovery plan for the species and additional information that has been collected since the issuance of the plan. Please be advised that the Fish and Wildlife Service (Service) and the National Marine Fisheries Service (NMFS) share jurisdiction for the Gulf sturgeon. For this proposed work, the Service will defer consultation for the Gulf sturgeon to NMFS.

The State-listed species was compiled using information from the Florida Natural Areas Inventory (FNAI) and the Florida Game and Fresh Water Fish Commission (GFC). The FNAI is a statewide database housing extensive information on the occurrence and quality of rare and

endangered species and high quality natural communities in Florida. The FNAI can be contacted at 1018 Thomasville Road, Suite 200-C, Tallahassee, Florida 32303, (850) 224-8207. The GFC may have additional information on state-listed species and important habitats. The GFC Environmental Services Division is located at 620 South Meridian Street, Tallahassee, Florida 32399-1600, (850) 488-6661. We suggest coordinating with the FNAI and the GFC.

The Service will also review the draft Environmental Impact Statement for the proposed work when it becomes available. Our review and comments will address other trust resources under our jurisdiction (migratory birds, anadromous fish, wetlands).

If you have any questions concerning this matter, please Ms. Lorna Patrick of this office at ext. 229.

Sincerely yours,

Gail A. Carmody
Project Leader

Enclosures:
FWS T&E Species List
Gulf Sturgeon Information

cc:
NMFS, St. Petersburg, FL (Charles Oravetz, Bob Hoffman)
Steve Forsythe, FWS, State Administrator, SFEO, FL

LAP/lp/kh/te13 or c:wp/te/99-138-1.wpd

6

United States Department of the Interior

FISH AND WILDLIFE SERVICE
6620 Southpoint Drive South
Suite 310
Jacksonville, Florida 32216-0912

IN REPLY REFER TO:
FWS/R4/ES-JAFL

MAR 25 1999

Mr. L. M. Pitts
Director, Environmental Planning Division
Naval Facilities Engineering Command
Southern Division
P.O. Box 190010
2155 Eagle Drive
North Charleston, S.C. 29419-9010

Re: Information Request for Input into Draft Environmental Impact Statement (DEIS) on Shock Trial of USS Winston S. Churchill, DDG 81 (FWS Log No. 99-460)

Dear Mr. Pitts:

Our office is responding to your March 18, 1999 correspondence in which you requested information on federally listed, proposed, and candidate species, and designated or proposed critical habitat for those species, within three coastal sites. These sites represent potential bases near which to conduct offshore shock trial tests for the latest line of Flight IIA Destroyers. Our response is limited to the Mayport Florida site, located at the mouth of the St. Johns River in Duval County.

The only species under our purview potentially affected by the proposed action is the Florida manatee (*Trichechus manatus latirostris*). The major concern for this species is the risk of injury and death from collisions with project ships and vessels transiting manatee areas. In Duval County, the manatee occurs throughout the lower St. Johns River and its tributaries, the Nassau and St. Mary's Rivers, the Intracoastal Waterway (IWW) and associated tidal waters, as well as in nearshore coastal waters. Individuals readily enter the ship basin at Naval Station, Mayport, where a total of six carcasses have been recovered since 1974. Manatees in general are present in northeast Florida from March through November. They typically migrate south during September, October, and part of November seeking warmer waters. The return migration usually begins in March and continues through May. The intersection of the IWW and St. Johns River, approximately 6.5 km (4 mi) from the river mouth, is an important migration corridor. This intersection is also the likely location of a naval-contracted, floating dry dock. The IWW north and

south of this intersection, and the St. Johns River west of the intersection, are part of designated critical habitat for this species.

We have enclosed some pamphlets containing additional general information on the Florida manatee. If you have any questions regarding this information or the preceding response, please contact Mr. John Milio of my staff at (904) 232-2580, ext. 112.

Sincerely,

Michael M. Bentzen

for David L. Hankla
Field Supervisor

Enclosures

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
P.O. BOX 190010
2155 EAGLE DRIVE
NORTH CHARLESTON, S.C. 29419-9010

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11000
Code 064/WS
05 OCT 99

U.S. Fish & Wildlife Service
6620 Southpoint Drive, South
Suite 310
Jacksonville, FL 32216-0912

Ref: Environmental Impact Statement for Proposed Shock Trial of the USS WINSTON S. CHURCHILL, DDG 81

Dear Sirs:

By previous correspondence the U.S. Navy had requested information concerning threatened and endangered species under the jurisdiction of the U.S. Fish & Wildlife Service (USF&W). The same request for information was made to the National Marine Fisheries Service (NMFS). The Jacksonville office of USF&W responded with information in a letter dated 25 March 1999. In that letter USF&W identified the Florida manatee (*Trichechus manatus latirostris*) as the only species under its purview that might potentially be affected by the proposed action.

The Navy has evaluated the impacts and effects of the proposed action on the biologic environment based on the information provided by both services. The proposed action would take place a minimum of 40 miles off the coast of Florida, on the eastern side of the Gulf Stream. Ship movements in and out of the Mayport Naval Station in support of the shock trial are not unusual or extraordinary and are part of the routine operations associated with the naval station.

Because the normal range of the manatee is limited to nearshore waters and the mitigation and monitoring program used during the shock trial would identify any present in the test area, we have determined that the proposed action is not likely to have an adverse affect on the Florida manatee or it's critical habitat. Therefore, we have concluded that formal consultation with the U.S. Fish & Wildlife Service under Section 7(a)(2) of the Endangered Species Act is not required for this project. The Navy, however, will be initiating formal consultation with NMFS.

We ask that you provide written concurrence with our conclusions. Should you have any questions regarding the proposed action, please contact Will Sloger at (843) 820-5797.

Sincerely,

L. M. PITTS
Director, Environmental Planning Division

U.S. FISH & WILDLIFE SERVICE

FWS Log. No. 99-318

The Proposed action is not likely to adversely affect resources protected by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). This finding fulfills the requirements of the Act.

U.S. Fish & Wildlife Service
6620 Southpoint Drive South, Suite 310
Jacksonville, Florida 32216
(904) 232-2580 (FAX) (904) 232-2404

for David L. Hankla
Field Supervisor

30 Oct 99
Date

United States Department of the Interior

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FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

April 4, 1999

Mr. L. M. Pitts
Director, Environmental Planning Division
Naval Facilities Engineering Command
P.O. Box 190010
2155 Eagle Drive
North Charleston, South Carolina 29419-9010

Dear Mr. Pitts:

The U.S. Fish and Wildlife Service (Service) has reviewed your letter dated March 18, 1999, concerning the proposed shock trial of the USS WINSTON S. CHURCHILL, DDG 81 off the East or Gulf coasts of the United States. Our comments are provided in accordance with Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1543) (Act).

As stated in your letter, three different test areas are currently being considered for the shock trial. Our comments pertain only to the Norfolk, Virginia test area. The Norfolk test area would range from 33 to 100 NMI offshore, in water depths ranging from 600 to 8,400 feet. The boundaries of the test area would extend from Norfolk, Virginia southward into offshore North Carolina (seaward of coastal Dare County).

In an effort to assist you in the preparation of an Environmental Impact Statement for the proposed action, the Service wishes to draw your attention to the presence of two petrel species that have been confirmed in offshore areas seaward of the North Carolina coast. The Bermuda petrel (*Pterodroma cahow*) is federally-listed as endangered. The black-capped petrel (*Pterodroma hasitata caribbaea*) is not federally-listed at the present time nor has it been designated as a candidate species. It is considered to be vulnerable at the present time however, and it is our understanding that a petition for listing is currently under consideration for this petrel. The presence of both petrel species have been confirmed off of North Carolina along the western edge of the Gulf stream (particularly in an area east of Hatteras Island known as "The Point").

According to information obtained from Mr. David Lee of the North Carolina State Museum of Natural Sciences, the areas utilized by these petrel species in offshore North Carolina are reasonably specific, and could be easily avoided when actually selecting the specific location of the proposed shock trial. For this reason, we suggest that you contact Mr. Lee for further information as follows:

Mr. David Lee
North Carolina State Museum of Natural Sciences
P.O. Box 27687
Raleigh, North Carolina 27611 Telephone: (919) 715-2605

Other federally-listed species under the Act which could potentially be affected by a shock trial off the North Carolina coast fall within the purview of the National Marine Fisheries Service. We recommend that you coordinate with them concerning impacts to federally-listed species and marine mammals. Thank you for the opportunity to review and provide comments concerning the proposed shock trial.

Sincerely,

John M. Hefner
Ecological Services Supervisor

CC: Mr. Bob Hoffman, NMFS, St. Petersburg, FL
Mr. David Lee, State Museum, Raleigh, NC
Mr. Chuck Hunter, FWS, Atlanta, GA

FWD/R4:Graham:kg:4-6-99:919-856-4520:WPWIN6.1/3NAVYSHOK.RSP

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
P.O. BOX 190010
2155 EAGLE DRIVE
NORTH CHARLESTON, S.C. 29419-9010

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Code 064/WS
05 OCT 99

U.S. Fish & Wildlife Service
Raleigh Field Office
P. O. Box 33726
Raleigh, NC 27636-3726

Ref: Environmental Impact Statement for Proposed Shock Trial of the USS WINSTON S. CHURCHILL, DDG 81

Dear Sirs:

By previous correspondence the U.S. Navy had requested information concerning threatened and endangered species under the jurisdiction of the U.S. Fish & Wildlife Service. The same request for information was made to the National Marine Fisheries Service (NMFS). Based on the information provided by both services the Navy has evaluated the impacts and effects of the proposed action on the biologic environment.

We have determined that the proposed action is not likely to have an adverse affect on listed species or critical habitat under U.S. Fish & Wildlife jurisdiction. Therefore, we have concluded that formal consultation with the U.S. Fish & Wildlife Service under Section 7(a)(2) of the Endangered Species Act is not required for this project. The Navy will initiate formal consultation with NMFS.

We ask that you provide written concurrence with our conclusions. Should you have any questions regarding the proposed action, please contact Will Sloger at (843) 820-5797.

Sincerely,

L. M. PITTS
Director, Environmental Planning Division

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

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October 25, 1999

L. M. Pitts, Director, Environmental Planning Division
Department of the Navy
Naval Facilities Engineering Command
P. O. Box 190010
North Charleston, South Carolina 29419-9010

RE: Concurrence Letter for the Department of the Navy's EIS for Proposed Shock Trial of the USS Winston S. Churchill, DDG 81

Dear Mr. Pitts:

The U.S. Fish and Wildlife Service (Service) has reviewed your October 5, 1999 letter requesting our concurrence with your conclusions regarding the above-referenced project. Our comments are provided in accordance with Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1543) (Act).

Based on the DEIS conclusion that the Norfolk, Virginia project location is unsuitable, provided by Will Sloger to Service biologist Ms. Candace Martino on October 25 over the phone, the Service concurs with the Navy's conclusion that this project is not likely to adversely affect any federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for federal listing under the Service jurisdiction, under the Act, as amended.

We believe that the requirements of Section 7 of the Act have been satisfied. We remind you that obligations under Section 7 consultation must be reconsidered if: (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is subsequently modified in a manner that was not considered in this review; (3) a new species is listed or critical habitat determined that may be affected by the identified action.

Thank you for your cooperation with our agency. If you have any questions, please contact Candace Martino at (919) 856-4520 ext. 18.

Sincerely,

John M. Hefner
Ecological Services Supervisor

FWS/R4:CMartino:cm:10-25-99:919/856-4520:WP51:\Work\Navy.ne

APPENDIX G

BIOLOGICAL OPINION

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

OCT 10 2000

Mr. L. M. Pitts
Department of the Navy
Naval Facilities Engineering Command
P.O. Box 190010
2155 Eagle Drive
North Charleston, SC 29419-9010

Dear Mr. Pitts:

The attached document constitutes the National Marine Fisheries Service's (NMFS) biological opinion based on our review of the shock trial of the Winston S. Churchill (DDG 81), and its effects on loggerhead, Kemp's ridley, green, leatherback, and hawksbill sea turtles and sperm, fin, right, and humpback whales, in accordance with section 7 of the Endangered Species Act of 1973 as amended. Your December 20, 1999, request for formal consultation, along with an accompanying draft environmental impact statement (DEIS), was received on December 23, 1999. Formal consultation was initiated upon receipt of additional information provided on January 21, 2000.

The biological opinion concludes that the proposed shock testing of the Winston S. Churchill off Mayport, Florida, is not likely to jeopardize the continued existence of the above named listed species. The biological opinion includes an Incidental Take Statement which anticipates that the proposed activities will incidentally take, by injury or mortality, up to eight sea turtles during the proposed activity. In addition to the conservation measures proposed by the Navy, the Incidental Take Statement identifies several reasonable and prudent measures and terms and conditions to minimize the effects of the anticipated take of sea turtles.

Although the biological opinion anticipates that the proposed action will also take by harassment 14 sperm whales, NMFS has not included incidental take for this species at this time since the take of marine mammals has not yet been authorized under section 101(a)(5) of the Marine Mammal Protection Act (MMPA) and/or its 1994 amendments. Following issuance of such regulations or authorizations, NMFS will amend this Opinion to include the incidental take by harassment of sperm whales. We acknowledge that the Navy has submitted an application to this office for the

required authorization and this application is currently under review.

We look forward to further cooperation with you on other Navy projects to ensure the conservation and recovery of our threatened and endangered marine species.

Sincerely,

Donald R. Knowles
Director
Office of Protected Resources

Enclosure

NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

AGENCIES: United States Department of the Navy

ACTIVITY CONSIDERED: Shock Trial of the Winston S. Churchill

CONDUCTED BY: National Marine Fisheries Service, Southeast Regional Office

DATE ISSUED: OCT 10 2000

APPROVED BY:

This document constitutes the National Marine Fisheries Service's (NMFS) biological opinion (Opinion) based on our review of the U.S. Navy's (Navy) proposed shock trial of the Winston S. Churchill (DDG 81) offshore of Mayport, Florida, and its effects on blue whales *(Balaenoptera musculus)*, humpback whales *(Megaptera novaeangliae)*, fin whales (*Balaenoptera physalus*), right *whales (Eubalaena glacialis)*, sei whales *(Balaenoptera borealis)*, sperm whales *(Physeter macrocephalus)*, right whale critical habitat, loggerhead turtles (*Caretta caretta*), Kemp's ridley turtles (*Lepidochelys kempi*), green turtles *(Chelonia mydas)*, leatherback turtles (*Dermochelys coriacea*), and hawksbill turtles (*Eretmochelys imbricata*), in accordance with section 7 of the Endangered Species Act of 1973 as amended. The Navy's December 20, 1999, request for formal consultation was received on December 23, 1999. Formal consultation was initiated on January 21, 2000 [Consultation number F/FPR/2000/01030].

This Opinion is based on information provided in the December 1999 draft environmental impact statement (DEIS) and supplemental information received on January 21, 2000, for the shock trial of the Winston S. Churchill (DDG 81). A complete administrative record of this consultation is on file at the NMFS, Southeast Regional Office.

Consultation History

The Winston S. Churchill (DDG 81) is the third ship in a new flight[1] of 23 Arleigh Burke (DDG 51) class guided missile destroyers being acquired by the Navy. These are referred to as the Flight IIA ships and they represent the largest single upgrade to the original DDG 51 class destroyer.

It is the Navy's policy to shock test each new class of ships or major upgrade to assess the survivability of the hull, the ship's systems, and the capability of the ship to protect the crew after a near miss from an underwater explosion. A shock trial is a series of underwater detonations that propagate a shock wave through the ship's hull under deliberate and controlled conditions. The Navy can then measure the effect of the shock wave on the hull, equipment, and personnel safety features.

NMFS issued an Opinion on December 12, 1996, on shock testing for the Seawolf Submarine in the summer months offshore of Mayport, Florida, however, due to Congressional issues this shock trial has not yet taken place. That Opinion concluded the following:

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[1] *a flight is a subset of a class of ships to which significant modifications/upgrades have been made.*

(1) The conduct of shock trials off of Mayport, Florida, during the summer of 1997, may affect, but is not likely to jeopardize, sea turtle species within our purview. Eight to 35 sea turtles, primarily loggerheads, may occur within the safety area identified by the Navy and therefore may be vulnerable to take by injury or mortality during each detonation. Avoidance of jellyfish, *Sargassum*, and the western edge of the Gulf Stream would provide important mitigation measures that would significantly reduce the likelihood of take and are provided as reasonable and prudent measures.

(2) Conducting the shock trial with the mitigation measures proposed in waters off Mayport, Florida between the months of May through September is unlikely to jeopardize the continued existence of listed marine mammal populations (based on available sighting data) due to the highly unlikely event of their occurrence in the study area during the time of the detonations.

The Navy requested initiation of formal consultation for the shock trial of the Winston S. Churchill under section 7 of the Endangered Species Act (ESA) by letter dated December 20, 1999, with an attached DEIS, which NMFS received on December 23, 1999. After review of the DEIS, NMFS requested additional information from the Navy on January 18, 2000, and received this information on January 21, 2000. NMFS has determined that the DEIS and supplemental information received are a complete initiation package for the purpose of conducting formal consultation under the Endangered Species Act. Formal consultation was initiated on January 21, 2000.

I. Description of the Proposed Action

The proposed actions considered in this biological opinion are the U.S. Navy's proposal to conduct a shock test on the Winston S. Churchill. The U.S. Navy's proposed action is to conduct a shock trial offshore of Mayport, Florida. The plan is to subject the Winston S. Churchill to three nearby, underwater 10,000 lb explosive charge detonations, which is the minimum number of detonations needed to collect adequate data on survivability. A fourth detonation would be conducted only if one of the planned three detonations fails to provide technically acceptable data (e.g., due to equipment failure or some other technical problem). The series of detonations would be conducted at a rate of one per week to allow time to perform detailed inspections of the ship's systems prior to the next detonation. The shock trial would occur sometime between May 1 and September 30, 2001. This time period is based on the Navy's operational and scheduling requirements. The purpose of the shock trial test is to test the survivability of the ship's hull, systems, and capabilities to protect it's crew from a near miss from an underwater explosion.

Prior to the shock trial, the ship would be examined, configured, and prepared to accommodate the shock testing equipment. The status of each ship compartment would be documented. Shore support and facilities would be readied, and the crew would be trained for the trial.

An exclusion zone with a 5 nautical mile (nm) radius would be established around the detonation point to exclude all nontest ship, submarine, and aircraft traffic for up to 12 hours per detonation. *Notices to Airmen and Mariners* would be published in advance of each detonation. Any traffic entering a 10 nm radius around the detonation point would be warned to alter course or would be escorted from the site. Since the Winston S. Churchill and the operations vessel would be moving during the shock trial, these zones around the detonation point would also be moving.

An operations vessel would tow the explosive charge in parallel with the Winston S. Churchill using the parallel tow method. The charge would be approximately 2,000 ft behind the operations vessel and suspended from a pontoon at a depth of 200 ft below the water surface. For each detonation, Winston S. Churchill would cruise in the same direction as the operations vessel at a speed of 5 to up to 7 knots with the charge directly abeam of it. After an initial inspection for damage, Winston S. Churchill would travel back to the shore facility for detailed post-detonation inspections and preparations for the next detonation. For each subsequent detonation, the charge would be moved closer to Winston S. Churchill so the ship experiences a more severe shock level.

A conventional Navy explosive High Blast Explosive 1 (HBX-1) would be used for each detonation. HBX-1 consists of the following components (by weight): cyclotrimethylene trinitramine – 39.32%; trinitrotoluene – 37.76%; aluminum powder – 17.10%; wax – 4.57%; and miscellaneous fillers – 1.25%. The charge would be held in a cylindrical steel container measuring 5 ft in diameter by 5.6 ft long with a total weight of 2,860 lbs in air. The largest possible unrecoverable fragment from the explosion that would settle to the seafloor after each detonation would be the top plate and crossbar (charge container components), which together weigh 450 lbs. After each detonation, the test array would be recovered and floats and rigging debris would be removed.

Description of the Test Area

Naval Station Mayport is the proposed support facility and would provide frigates, cruisers, or destroyers capable of handling helicopter landings. Helicopters would operate from Naval Station Mayport, while F-14 and F/A-18 aircraft deployed from either Naval Air Station (NAS) Oceana or Marine Corps Air Station, Beaufort would conduct day operations out of NAS Jacksonville. A Military Sealift Command tug would be deployed out of the Naval Amphibious Base Little Creek (Virginia) to Mayport for the duration of the trial. Explosives would be stored at Naval Weapons Station Charleston and then transported to Mayport for immediate loadout prior to each test day. Ship repair facilities consist of one floating drydock in Mayport (to be completed by 2000) and one contract shipyard in Savannah.

Due to the proximity of the two air bases (Naval Station Mayport for helicopters, NAS Jacksonville for F-14 and F/A-18 aircraft), the 100 nm arc was drawn from Naval Station Mayport. This arc and the 600 ft depth contour were used to initially bound the test area. The northern tip of the available area was excluded to avoid an explosives dumping area. The coordinates of the test area are:

31°05'N	79°50.5'W
31°05'N	79°38.5'W
30°0.5'N	79°31'W
29°9.7'N	80°05'W
30°16.3'N	80°10.8'W

The concept of a safety range is an integral part of the mitigation plan. The area within the safety range would be monitored by all components of the mitigation team and detonation would not occur until it is clear of detectable marine mammals and sea turtles, as well as indicators of sea turtle presence such as large *Sargassum* rafts and jellyfish aggregations. The purpose of the safety range is to prevent deaths and serious injuries to marine mammals and sea turtles. The safety range radius of 2 nm around the

detonation point exceeds the estimated ranges for mortality and injury to a marine mammal or sea turtle associated with detonation of a 10,000 lb explosive.

For mitigation monitoring purposes, a 1 nm buffer zone has also been added to the 2 nm safety range to account for the possible movement of marine mammals and sea turtles towards the safety range. Specifically, the area encompassed within a 3 nm radius from the detonation point would be visually monitored to detect any marine mammals or sea turtles approaching the 2 nm safety range.

The mitigation plan includes four components: (1) pre-detonation aerial surveys/monitoring; (2) pre-detonation shipboard monitoring from the Winston S. Churchill and the Marine Animal Recovery Team (MART) vessel; (3) pre-detonation passive acoustic monitoring; and (4) post-detonation aerial and shipboard monitoring.

The aerial survey/monitoring team would consist of three observers and a pilot familiar with flying marine mammal/turtle aerial surveys. The survey aircraft would be a Partenavia or similar, with bubble windows allowing for 90° downward visibility and a belly port to allow for centerline viewing. A second aircraft of similar configuration and crew of observers would also be available on shot day to relieve the primary aircraft when the primary aircraft needs to refuel.

Standard line transect aerial surveying methods, as used by NMFS (Blaylock and Hoggard 1994; Buckland et al. 1993) will also be used for all mitigation aerial surveys and monitoring. All surveys and monitoring would be flown at an altitude of 750 ft and a speed of 110 knots. Lower altitudes (500 ft) are preferable for turtle aerial surveys, particularly for identifying turtles to species level. However, since there will be a centerline observer capable of viewing directly below the aircraft and since turtles do not necessarily need to be identified to species for mitigation, a higher altitude (750 ft) will be maintained to maximize area coverage. Pre-detonation monitoring on the day of the test would be conducted in the primary test site, and secondary test sites if necessary. Observed marine mammals and turtles would be identified to species or the lowest possible taxonomic level and their relative positions recorded. Detonations would occur no earlier than three hours after sunrise and no later than three hours prior to sunset to ensure adequate daylight for pre- and post-detonation monitoring.

Shipboard monitoring would be staged from the shock trial ship, the Winston S. Churchill, and the MART vessel. The lead scientist would be located on the shock trial ship with the Officer in Tactical Command, as well as the Mitigation Team Coordinator and at least six observers experienced in shipboard surveys and familiar with the marine life of the area. The Winston S. Churchill would be outfitted with two sets of 25X power binoculars (Bigeyes), which would allow the observers to sight surfacing mammals from as far as 6 nm and provide 360° overlapping coverage. As with the aerial monitoring team sightings, the lead scientist would enter this information into the marine animal tracking and sighting program. The species, number of animals sighted, and swim direction would also be recorded. The lead scientist would ensure that the Officer in Tactical Command and the Shock Test Director are aware of all animals in or approaching the test site.

A passive marine mammal acoustic monitoring system to detect and locate calling marine mammals, similar to the type of system that was successfully used during the USS John Paul Jones shock trial, would be used during the trial. The acoustic monitoring system would consist of Navy passive

sonobuoys dropped from an aircraft for acoustic detection and a digital signal processing system to locate the position of the animals and allow a team of bioacousticians onboard the aircraft to listen to the calls to identify the species. The processing system would be capable of calculating the latitude and longitude of the animal. The bioacousticians would then communicate the location and species to the lead scientist onboard the Winston S. Churchill.

Post-detonation monitoring would commence immediately following each detonation. Post-detonation monitoring is designed to determine the effectiveness of pre-detonation mitigation by reporting any sightings of dead or injured marine mammals or sea turtles. Dead animals would be retrieved, if possible, to evaluate blast damage and determine the cause of death. After each detonation, an aerial monitoring team would resume transects in the area of the detonation and continue monitoring for at least three hours on shot day. Aerial monitoring would also take place for two days immediately following the detonation, for a minimum of three hours at and down current from the detonation site. The aerial monitoring team would be assisted by the MART based onboard a separate vessel. The MART would consist of a veterinarian, a veterinary technician, and a marine mammal behavior specialist. The MART would remain in the area of and down current from the detonation for 48 hours after each detonation (and for seven days following the last detonation) to allow sufficient time for a mortally wounded animal to submerge and resurface due to a buildup of decomposition gases.

Detonation would be postponed if:

(1) Any marine mammals or sea turtles are visually detected within the safety range (i.e., within 2 nm of the detonation point). The "hold detonation" would continue until the marine mammal or sea turtle that caused the postponement is confirmed to be outside of the safety range either due to the animal swimming out of the safety range or due to the safety range moving to beyond the animal's last verified location.

(2) Any marine mammals are acoustically detected within 2.25 nm of the detonation point (it would be assumed that the animal is within the 2 nm safety range). The "hold detonation" would continue until the marine mammal that caused the postponement is confirmed to be outside of the safety range either due to the animal swimming out of the safety range or due to the safety range moving to beyond the animal's last verified location.

(3) Any listed (endangered or threatened) marine mammal is visually or acoustically detected within the buffer zone and subsequently cannot be reacquired. The shot would not occur until the last verified location is outside of the moving safety range and buffer zone, so that the new detonation point would be 3 nm from that location. Sighting and acoustic teams would continue to attempt to reacquire the animal.

(4) Any northern right whale is detected within the safety range or buffer zone. The shot would not occur until the right whale is positively reacquired outside of the buffer zone and no other right whales are detected visually or acoustically during subsequent monitoring of the entire 3 nm

radial area. If the right whale cannot be positively reacquired, the shot will be postponed until the following day.

(5) Large *Sargassum* rafts or large concentrations of jellyfish are observed within the safety range (i.e., within 2 nm of the detonation point). The "hold detonation" would continue until the *Sargassum* rafts or jellyfish that caused the postponement are confirmed to be outside of the safety range either due to the current moving the *Sargassum* and/or jellyfish or the safety range moving away from their last verified location.

(6) Flocks of seabirds or large schools of fish are observed in the water within 1 nm of the detonation point. The "hold detonation" would continue until the seabird flocks or large fish schools are confirmed to be more than 1 nm from the detonation point either due to the fish or birds moving out of the safety range or the safety range moving away from their last verified location.

Detonation would also be postponed if a sea turtle or nonlisted marine mammal detected within the buffer zone (i.e., from 2 to 3 nm of the detonation point) was moving toward and could enter the safety range prior to detonation. Depending on the position of the sighting relative to the ship, the ship's course may be altered slightly to increase the distance to the animal, or the detonation may remain postponed until the animal is no longer heading toward the safety range.

In the event of a postponement, pre-detonation monitoring would continue as long as weather and daylight hours allow. Aerial monitoring is limited by fuel and the on-station time of the monitoring aircraft, which is approximately 4 to 5 hours depending on the exact location of the test site. To prevent delays due to aircraft refueling, the second survey aircraft would commence evaluating the secondary test site for environmental suitability (transect lines spaced 1 nm apart) while the primary survey aircraft continues pre-detonation monitoring of the primary site. The two survey aircraft would maintain a separation of at least 5 nm, and the primary survey aircraft would depart the test area once it is apparent that the detonation will not occur in the primary test site. The second survey aircraft would then commence the monitoring of the safety range and buffer zone surrounding the Winston S. Churchill while the primary aircraft returned to refuel. Unless marine mammal or turtle detections persisted in the safety range for several hours, the detonation would not be cancelled for the day, only delayed until animals are clear of the safety range.

Action Area

The specific site would be selected from offshore of Mayport, Florida (see Map # 1). Due to the proximity of the two air bases (Naval Station Mayport for helicopters, NAS Jacksonville for F-14 and F/A-18 aircraft), the 100 nm arc was drawn from Naval Station Mayport. This arc and the 600 ft depth contour were used to initially bound the test area. The northern tip of the available area was excluded to avoid an explosives dumping area.

31°05'N	79°50.5'W
31°05'N	79°38.5'W
30°0.5'N	79°31'W
29°9.7'N	80°05'W
30°16.3'N	80°10.8'W

The final site for the shock trial would be selected 1 to 2 days before the first detonation, based on satellite imagery and aerial surveys for marine mammals and turtles. An exclusion zone within a 5 nm radius would be established around the detonation point to exclude all non-test ship, submarine, and aircraft traffic for up to 12 hours per detonation.

II. Status of Listed Species and Critical Habitat

The following listed species under the jurisdiction of NMFS are known to occur Atlantic Ocean offshore of the southeastern United States and may be affected by the proposed action:

Endangered

Blue whale	*Balaenoptera musculus*
Humpback whale	*Megaptera novaeangliae*
Fin whale	*Balaenoptera physalus*
Right whale	*Eubalaena glacialis*
Sei whale	*Balaenoptera borealis*
Sperm whale	*Physeter macrocephalus*
Leatherback sea turtle	*Dermochelys coriacea*
Hawksbill sea turtle	*Eretmochelys imbricata*
Green sea turtle	*Chelonia mydas*[2]
Kemp's ridley sea turtle	*Lepidochelys kempi*

Threatened

Loggerhead sea turtle *Caretta caretta*

Critical Habitat Designations

Right Whale

Six species of endangered marine mammals may be found seasonally in the waters offshore northern Florida. Although only the sperm whale has a significant likelihood to be within the shock trial area during the shock trial, right, humpback and fin whales are discussed below because of their possible, but not probable, appearance at the time of the shock trial. Due to their known distribution and frequency in the Mayport action area, blue, and sei whales are extremely unlikely to be present within a detectable range of activities associated with the proposed action. As a result, NMFS has determined that although the Navy's proposed action may affect these species, conduct of the proposed shock test and associated activities in the Mayport action area is not likely to adversely affect blue and sei whales. Blue and sei whales will not be discussed further in this Opinion. Additional information on these species, and the other species discussed below, can be found in Waring *et al.* (1999).

Right Whale

Right whales have occurred historically in all the world's oceans from temperate to subarctic latitudes. NMFS recognizes three major populations of right whales: North Pacific, North Atlantic, and Southern

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2 *Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters.*

Hemisphere. NMFS further recognizes two extant subpopulations in the North Atlantic: eastern and western. A third subpopulation may have existed in the central Atlantic (migrating from east of Greenland to the Azores or Bermuda), but this stock appears to be extinct (Perry *et al.* 1999). Because of our limited understanding of the genetic structure of the entire species, the most conservative approach to this species would treat these right whale subpopulations as distinct populations whose survival and recovery is critical to the survival and recovery of the species. Further, any action that appreciably reduced the likelihood that one or more of these subpopulations would survive and recover in the wild would appreciably reduce the species' likelihood of survival and recovery in the wild. Consequently, this biological opinion will focus on the western north Atlantic population of right whales, which occurs in the action area.

The scarcity of right whales is the result of an 800-year history of whaling that continued into the 1960s (Klumov 1962). Of all of the large whales, the northern right whale has the highest risk of extinction in the near future. Recent data indicate that there are an estimated 300 individuals in the North Atlantic and a small, unknown number of individuals in the North Pacific. The southern right whale, in contrast, has shown signs of slow recovery over the past 20 years. Illegal takes by Soviet whaling fleets operating in the North Pacific and Southern Hemisphere are now known to have continued until as recently as 1980 (Zemsky *et al.* 1995). Northern right whales have been protected for more than 50 years from the pressures of whaling, yet most stocks show no evidence of recovery.

Right whales appear to prefer shallow coastal waters, but their distribution is also strongly correlated to the distribution of their prey (zooplankton). In both northern and southern hemispheres, right whales have been observed in the lower latitudes and more coastal waters during winter, where calving takes place, and then tend to migrate to higher latitudes during the summer. In summer and fall in both hemispheres, the distribution of right whales appears linked to the distribution of their principal zooplankton prey (Winn *et al.*1986). The western north Atlantic stock of right whales generally occurs in Northwest Atlantic waters west of the Gulf Stream and are most commonly associated with cooler waters ($\leq$ 21°C). They are not found in the Caribbean and have been recorded only rarely in the Gulf of Mexico.

NMFS designated right whale critical habitat on June 3, 1994 (59 FR 28793). These waters, which lie within the action area, include the waters of Cape Cod Bay and the Great South Channel off the coast of Massachusetts, and off the coasts of southern Georgia and northern Florida, where the species is concentrated at different times of the year. Whales are most abundant in Cape Cod Bay between February and April (Hamilton and Mayo 1990; Schevill *et al.* 1986; Watkins and Schevill 1982), in the Great South Channel in May and June (Kenney *et al.* 1986, Payne *et al.* 1990), and off Georgia/Florida from mid-November through March (Slay *et al.* 1996). Right whales also frequent the Bay of Fundy, Browns and Baccaro Banks (in Canadian waters), Stellwagen Bank and Jeffrey's Ledge in the spring and summer months, and use mid-Atlantic waters as a migratory pathway between the winter calving grounds and their spring and summer nursery/feeding areas in the Gulf of Maine. During the winter of 1999/2000, appreciable numbers of right whales were recorded in the Charleston, SC area. Because survey efforts in the mid-Atlantic have been limited, it is unknown whether this is typical or whether it represents a northern expansion of the normal winter range, perhaps due to unseasonably warm waters. However, historical sighting data uncorrected for effort do show a concentration of sightings in this area. In addition, recent satellite tracking efforts have identified individual animals embarking on far-ranging foraging episodes not previously known (Knowlton, pers. comm.).

Right whales in the Gulf of Maine feed on zooplankton, primarily copepods, by skimming at or below the water's surface with open mouths (see NMFS 1991b, Kenney *et al.* 1986, Murison and Gaskin 1989, Mayo and Marx 1990).

There has been significant discussion regarding attempts to determine the current status and trend of this very small population and to make valid recommendations on recovery requirements. Knowlton *et al.* (1994) concluded, based on data from 1987 through 1992, that the western North Atlantic right whale population was growing at a net annual rate of 2.5% (CV = 0.12). This rate was also used in NMFS' marine mammal Stock Assessment Reports, e.g., Blaylock *et al.* 1995, Waring *et al.* 1997. Since then, the data used in Knowlton *et al.* (1994) have been re-evaluated, and new attempts to model the trends of the western North Atlantic right whale population have been published (e.g., Kraus 1997; Caswell *et al.* 1999) and additional works are in progress (Caswell *et al.*, in prep.; Wade and Clapham, in prep).

Recognizing the precarious status of the right whale, the continued threats present in its coastal habitat throughout its range, and the uncertainty surrounding attempts to characterize population trends, the International Whaling Commission (IWC) held a special meeting of its Scientific Committee from March 19-25, 1998, in Cape Town, South Africa, to conduct a comprehensive assessment of right whales worldwide. The workshop's participants reviewed available information on the northern right whale, including Knowlton *et al.* (1994), Kraus (1997), and Caswell *et al.* (1999). After considering this information, the workshop attendees concluded that it is unclear whether the western North Atlantic subpopulation of the right whale is "declining, stationary or increasing, and [that] the best estimate of current population size is only 300 animals." Maintaining a conservative stance due to these uncertainties, participants concluded that the growth rate of this population "is both low and substantially less than that of the southern right whale populations" (IWC, 1998).

The IWC Workshop participants expressed "considerable concern" in general for the status of the Western North Atlantic population. Based on recent (1993-1995) observations of near-failure of calf production, the significantly high mortality rate, and an observed increase in the calving interval, it was suggested that the slow but steady recovery rate published in Knowlton *et al.* (1994) may not be continuing. Workshop participants urgently recommended increased efforts to determine the trajectory of the this right whale population, and NMFS' Northeast Fisheries Science Center has initiated several efforts to implement that recommendation.

Caswell *et al.* (1999), using data on reproduction and survival through 1996, determined that the western North Atlantic right whale population was declining at a rate of 2.4% per year. One model they used suggested that the mortality rate of the right whale population has increased five-fold in less than one generation. According to Caswell *et al.* (1999), if the mortality rate as of 1996 does not decrease and the population performance does not improve, extinction could occur within 100 years and would be certain within 400 years, with a mean time to extinction of 191 years.

It should be noted that no information is currently available on the response of the right whale population to recent (1997-1999) efforts to mitigate the effects of entanglement and ship strikes. Therefore, it is not possible to determine whether the trend through 1996, as reported in Caswell *et al.* (1999), is continuing. Furthermore, results reported in Caswell *et al.* (1999) suggest that it is not possible to determine that anthropogenic mortalities alone are responsible for the decline in right whale survival. However, they conclude that reduction of anthropogenic mortalities would significantly improve the species' survival probability. Given the uncertainty regarding effects of natural phenomena such as demographic and

environmental stochasticity, which can influence the northern right whale population -- and assuming that the right whale population, is in fact, declining -- it is impossible to determine whether the western North Atlantic right whale population has reached the point where it would continue to decline even if all human-induced mortalities ceased.

At the 1998 IWC workshop, an inter-sessional Steering Group was established to review Caswell *et al.* (1999) and several other ongoing assessment efforts to identify the best and most current available scientific information on population status and trends. The IWC Scientific Committee met in May 1999 and discussed the Steering Group's report. Committee members noted that there were several potential negative biases in Caswell *et al.* (1999) but agreed that the results of the study should be considered in management actions.

For the purposes of this Biological Opinion -- and until the new status and trend information has been thoroughly reviewed for assimilation into NMFS management programs -- NMFS will continue to adopt the risk averse assumption that the northern right whale population is declining.

General human impacts and entanglement

The major known sources of anthropogenic mortality and injury of right whales include entanglement in commercial fishing gear and ship strikes. Right whales may also be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources due to trophic effects resulting from a variety of activities including the operation of commercial fisheries.

Based on photographs of catalogued animals from 1959 and 1989, Kraus (1990) estimated that 57% of right whales exhibited scars from entanglement and 7% from ship strikes (propeller injuries). This work was updated by Hamilton *et al.* (1998) using data from 1935 through 1995. The new study estimated that 61.6% of right whales exhibit injuries caused by entanglement, and 6.4 % exhibit signs of injury from vessel strikes. Hamilton *et al.* (1998) also reported that the increase in entanglement scarring since 1989 is a significant trend which is not attributable to increases in sighting effort or population size. In addition, several animals have apparently been entangled on more than one occasion. Some right whales that have been entangled were subsequently involved in ship strikes. These scarring percentages are primarily based on sightings of free-swimming animals that initially survive the impact which resulted in the scar. Because some animals may drown or be killed immediately, the actual number of interactions may be slightly higher. Following is a summary of recent documented cases of human interaction.

Many of the reports of mortality cannot be attributed to a particular source. The following deaths or injuries were reported between 1996 and 1999 (these numbers should be viewed as absolute minimum numbers; the total number of deaths and injuries cannot be estimated):

1996: one right whale was killed by a ship strike, a second right whale was killed by a ship after having been entangled in 1995. In addition to these mortalities, there were two confirmed reports of right whales becoming entangled in fishing gear.

1997: another right whale was killed by a ship strike in the Bay of Fundy, and there were 8 confirmed reports of whale entanglements. Six of the entanglements were reported in Canadian waters and 2 in U.S. waters; it should be noted that we only know where 2 of the 8 entanglements occurred (one in U.S. and one in Canadian waters), and one of the reports may represent a resighting of an earlier entanglement.

1998: 2 adult female right whales were discovered in a weir off Grand Manan Island in the Bay of Fundy on July 12, 1998, and were released two days later; no residual injuries of concern were reported. On July 24, 1998, the Disentanglement Team removed line from around the tail stock of a right whale which was originally seen entangled in the Bay of Fundy on August 26, 1997. This same whale, apparently debilitated from the earlier entanglement, became entangled in lobster pot gear twice in one week in Cape Cod Bay in September 1998. The gear from the latter two entanglements was completely removed, but line from the 1997 entanglement remained in the animal's mouth. On August 15, 1998, a right whale was observed entangled in the Gulf of St. Lawrence; the animal apparently freed itself of most of the gear, but some gear may remain.

1999: Two right whale mortalities were documented, including an adult female found floating near Truro, Massachusetts, that was towed to the beach for necropsy. Based on the necropsy, scientists concluded that the whale died from complications resulting from injuries caused by a ship strike. In the fall, a second adult female died of complications caused by entanglement.

Four new right whale entanglements were confirmed in 1999. There were several attempts to disentangle two of the whales. A whale sighted in the Bay of Fundy in June was nearly completely disentangled; a small piece of line remains in the mouth.

2000: This year there has been one right whale mortality to date. A whale identified as #2701 was found floating dead 10 miles SE of Block Island, RI on 1/19/00. Although entangling gear (line) was seen around the tail stock, cause of death is uncertain. NMFS was unable to retrieve the carcass for examination due to extreme winter storms.

Several right whale entanglements have been reported in 2000 thus far as well, but disentanglement personnel have met with little success in relocating/disentangling these animals so it is unclear how many animals are involved.

The available information makes it reasonable to conclude that the current death rate far exceeds the birth rate in the western North Atlantic right whale population. The nearly complete reproductive failure in this population from 1993 to 1995 and again in 1998 and 1999 suggests that this pattern has continued for almost a decade. Because no population can sustain a high death rate and low birth rate for long without becoming extinct, this combination places the North Atlantic right whale population at high risk of extinction. Coupled with an increasing calving interval, the relatively large number of adult, female right whales that are killed, and these human-related deaths, the right whale's probability of extinction in the next 100 years is very high.

Humpback Whale

Humpback whales feed in the northwestern Atlantic during the summer months and migrate to calving and mating areas in the Caribbean. Five separate feeding areas are utilized in northern waters after their return; one of which, the Gulf of Maine feeding population, lies within U.S. waters and is within the action area of this consultation. Most of the humpbacks that forage in the Gulf of Maine visit Stellwagen Bank and the waters of Massachusetts and Cape Cod bays. Sightings are most frequent from mid-March through November between 41°N and 43°N, from the Great South Channel north along the outside of Cape Cod to Stellwagen Bank and Jeffreys Ledge (CeTAP 1982), and peak in May and August. Small numbers of individuals may be present in this area year-round, including the waters of Stellwagen Bank.

Katona and Beard (1990) summarized information gathered from a catalogue of photographs of 643 individuals from the western North Atlantic population of humpback whales. These photographs indicated reproductively mature western North Atlantic humpbacks winter in tropical breeding grounds in the Antilles, primarily on Silver and Navidad Banks, north of the Dominican Republic. The primary winter range also includes the Virgin Islands and Puerto Rico (see NMFS, 1991). In general, it is believed that calving and copulation take place on the winter range. Calves are born from December through March and are about 4 meters at birth. Sexually mature females give birth approximately every 2 to 3 years. Sexual maturity is reached between 4 and 6 years of age for females and between 7 and 15 years for males. Size at maturity is about 12 meters.

Swingle *et al.* (1993) identified a shift in distribution of juvenile humpback whales in the nearshore waters of Virginia, primarily in winter months. Those whales using this mid-Atlantic area that have been identified were found to be residents of the Gulf of Maine feeding group, suggesting a shift in distribution that may be related to winter prey availability. Studies conducted by the Virginia Marine Science Museum indicate that these whales are feeding on, among other things, bay anchovies and menhaden. Researchers theorize that juvenile humpback whales, which are unconstrained by breeding requirements that result in the migration of adults to relatively barren Caribbean waters, may be establishing a winter foraging area in the mid-Atlantic (Mayo pers. comm.). In concert with the increase in mid-Atlantic whale sightings, strandings of humpback whales have increased between New Jersey and Florida since 1985. Strandings were most frequent during September through April in North Carolina and Virginia waters, and were composed primarily of juvenile humpback whales of no more than 11 meters in length (Wiley *et al.* 1995). Six of 18 humpbacks (33 percent) for which the cause of mortality was determined were killed by vessel strikes. An additional humpback had scars and bone fractures indicative of a previous vessel strike that may have contributed to the whale's mortality. Sixty percent of those mortalities that were closely investigated showed signs of entanglement or vessel collision (Wiley *et al.* 1993).

Since the 1997 Opinion, on HMS, new information has become available on the status and trends of the humpback whale population, although there are still insufficient data to determine population trends for the Western North Atlantic stock (Waring *et al.* 1997). The current rate of increase of the North Atlantic humpback whale population has been estimated at 9.0% (CV=0.25) by Katona and Beard (1990) and at 6.5% by Barlow and Clapham (1997). Palsboll *et al.* (1997) studied humpback whales through genetic markers to identify individual humpback whales in the northern Atlantic Ocean. Using breeding ground samples from 1992–1993, Palsboll *et al.* (1997) estimated the North Atlantic humpback whale population at 4,894 (95% confidence interval 3,374 - 7,123) males and 2,804 females (95% confidence interval 1,776 4,463), for a total of 7,698 whales. However, since the sex ratio in this population is known to be 1:1 (Palsboll *et al.*, 1997), the lower figure for females is presumed to be a result of sampling bias or some other cause for partitioning of the sampling. Photographic mark-recapture analyses from the YONAH (Years of the North Atlantic Humpback) project gave an ocean-basin-wide estimate of 10,600 (95% c.i. = 9,300 - 12,100) and an additional genotype-based analysis yielded a similar but less precise estimate of 10,400 (95% c.i. = 8,000 - 13,600) (Smith *et al.* 1999). The estimate of 10,600 is regarded as the best available estimate for this population. The minimum population estimate for the North Atlantic humpback whale population is 10,019 animals (CV=0.067) (Waring *et al.* 1999).

The Northeast Fisheries Science Center recommended that NMFS identify the Gulf of Maine feeding stock as the management stock for this population in U.S. waters, although a population estimate for the Gulf of Maine portion of the population is not available at this time. Stock identity of the juveniles found

in the Mid-Atlantic is also unknown at this time. The NEFSC is funding a study to determine stock identity of these individuals. The results from this work will assist NMFS in determining whether multiple management units are necessary for the U.S. East Coast.

General human impacts and entanglement
The major known sources of anthropogenic mortality and injury of humpback whales include entanglement in commercial fishing gear and ship strikes. Humpback whales may also be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources due to trophic effects resulting from a variety of activities including the operation of commercial fisheries.

Based on photographs of the caudal peduncle of humpback whales, Robbins and Mattila (1999) estimated that at least 48% -- and possibly as many as 78% -- of animals in the Gulf of Maine exhibit scarring caused by entanglement. Several animals have apparently been entangled on more than one occasion. These estimates are based on sightings of free-swimming animals that initially survive the scarring encounter. Because some animals may drown immediately, the actual number of interactions may be slightly higher. Following is a summary of recent documented cases of human interaction.

Many of the reports of mortality cannot be attributed to a particular impact source. The following injury/mortality events are those reported from 1996 to the present for which impact source was determined. These numbers should be viewed as absolute minimum numbers; the total number of mortalities and injuries cannot be estimated but is believed to be higher. In 1996, 3 humpback whales were killed in collisions with vessels and at least 5 were seriously injured by entanglement in the same year. Three confirmed humpback whale entanglements were reported in 1997. Stranding records from January through December 1997 for the U.S. Atlantic coast include seven stranded/dead floating humpback whales. Two of these mortalities were attributed to ship strikes. For 1998, 14 confirmed humpback whale entanglements resulting in injury (n=13) or mortality (n=1) were reported. One of the animals with entanglement injuries stranded dead, but the role of the entanglement in the whale's death has not been determined. Three of the injured animals were completely disentangled, one partially disentangled, one partially disentangled and later shed the remaining gear, and one shed the gear without assistance from the Disentanglement Team. One injury from a vessel interaction was reported in 1998; the whale was seen several times after the injury, which exhibited some healing. Three incidents of dead floating humpback whales were also reported in 1998; however, cause of death has not been determined for any of these animals. Nine humpback entanglements were reported to the Center for Coastal Studies whale disentanglement team in 1999, including one mortality. This does not include Canadian entanglements.

Fin Whale
The fin whale is ubiquitous in the North Atlantic and occurs from the Gulf of Mexico and Mediterranean Sea northward to the edges of the arctic ice pack (Waring *et al.* 1999). The overall pattern of fin whale movement is complex, consisting of a less obvious north-south pattern of migration than that of right and humpback whales. Based on acoustic recordings from hydrophone arrays, however, Clark (1995) reported a general southward "flow pattern" of fin whales in the fall from the Labrador/Newfoundland region, south past Bermuda, and into the West Indies. The overall distribution may be based on prey availability. This species preys opportunistically on both invertebrates and fish (Watkins *et al.* 1984). As with humpback whales, they feed by filtering large volumes of water for the associated prey. Fin whales are larger and faster than humpback and right whales and are less concentrated in nearshore

environments. Due to these traits, fin whales are less prone to entanglements than are right and humpback whales, but because they do occur in many of the same areas, the potential exists.

Hain *et al.* (1992) estimated that about 5,000 fin whales inhabit the northeastern United States continental shelf waters. Shipboard surveys of the northern Gulf of Maine and lower Bay of Fundy targeting harbor porpoise for abundance estimation provided an imprecise estimate of 2,700 (CV=0.59) fin whales (Waring *et al.* 1997).

General human impacts and entanglement
Of 18 fin whale mortality records collected between 1991 and 1995, four were associated with vessel interactions, although the proximal cause of mortality was not known. In 1996, three reports of ship strikes were received, although this was only confirmed as cause of death for one of the incidents. One entanglement report was received in 1996.

At least five reports of entangled fin whales were received by NMFS in 1997. Four fin whales were reported as having stranded in the period from January 1, 1997, to January 1, 1998, in the Northeast Region; the cause of death was not determined for these animals. One ship strike mortality was documented in 1998 in the Virginia-North Carolina border area. One entanglement mortality was reported in September 1998. Three entanglements were reported to the Center for Coastal Studies disentanglement team in 1999.

Sperm Whale
There are estimated to be approximately two million sperm whales worldwide with a population of 130,000 or more thought to occur in the North Atlantic (IWC 1983). In the western North Atlantic they range from Greenland to the Gulf of Mexico and the Caribbean. The sperm whales that occur in the eastern US EEZ are believed to represent only a portion of the total stock (Blaylock *et al.* 1995). Sperm whales generally occur in waters greater than 180 meters in depth. While they may be encountered almost anywhere on the high seas their distribution shows a preference for continental margins, sea mounts, and areas of upwelling, where food is abundant (Leatherwood and Reeves 1983). Waring *et al.* (1993) suggest sperm whale distribution is closely correlated with the Gulf Stream edge. Like swordfish, which feed on similar prey, sperm whales migrate to higher latitudes during summer months, when they are concentrated east and northeast of Cape Hatteras. Bull sperm whales migrate much farther poleward than the cows, calves, and young males. Because most of the breeding herds are confined almost exclusively to warmer waters many of the larger mature males return in the winter to the lower latitudes to breed.

Sperm whale sightings recorded from the NOAA vessel Oregon II from 1991 - 1997 are concentrated just beyond the 100 m depth contour in the northern Gulf of Mexico, east of the Mississippi River Delta. Recent studies conducted jointly by researchers from NMFS and Texas A&M indicate that these offshore waters are an important area for Gulf sperm whales. In fact, researchers with Texas A & M believe that the area should be considered as critical habitat for sperm whales (R. Davis, pers. comm.), as it is the only known breeding and calving area in the Gulf, for what is believed to be an endemic population.

Sperm whales feed primarily on medium to large-sized mesopelagic squids *Architeuthis* and *Moroteuthis*. Sperm whales, especially mature males in higher latitude waters, also take significant quantities of large demersal and mesopelagic sharks, skates, and bony fishes (Clarke 1962, 1980). Sperm whale populations are organized into two types of groupings: breeding schools and bachelor schools. Older males are often

solitary (Best 1979). Breeding schools consist of females of all ages and juvenile males. The mature females ovulate April through August in the Northern Hemisphere. During this season one or more large mature bulls temporarily join each breeding school. A single calf is born at a length of about 4 meters after a 15 month gestation period. A mature female will produce a calf every 3-6 years. Females attain sexual maturity at the mean age of nine years and a length of about nine meters. Males have a prolonged puberty and attain sexual maturity at about age 20 and a body length of 12 meters. Bachelor schools consist of maturing males who leave the breeding school and aggregate in loose groups of about 40 animals. As the males grow older they separate from the bachelor schools and remain solitary most of the year (Best 1979).

Sperm whales were hunted in America from the 17th century through the early 1900's. The International Whaling Commission estimates that nearly a quarter-million sperm whales were killed worldwide in whaling activities between 1800 and 1900 (IWC 1971). With the advent of modern whaling the larger rorqual whales were targeted. However as their numbers decreased, greater attention was paid to smaller rorquals and sperm whales. From 1910 to 1982 there were nearly 700,000 sperm whales killed worldwide from whaling activities (Clarke 1954; Committee for Whaling Statistics 1959 -1983). In recent years the catch of sperm whales has been drastically reduced as a result of the imposition of catch quotas. NMFS believes there are insufficient data to determine population trends for this species (Blaylock *et al.* 1995).

Because of their generally more offshore distribution and their benthic feeding habits, sperm whales are less subject to entanglement than are right or humpback whales. Sperm whales have been taken in the pelagic driftnet fishery for swordfish, and could likewise be taken in the shark gillnet fishery on occasions when they may occur more nearshore, although this likely does not occur often. Also, interactions between sperm whales and longlines for sable fish have been noted in Alaska waters.

Loggerhead turtle (*Caretta caretta*)

Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans and are the most abundant species of sea turtle occurring in U.S. waters. Loggerhead sea turtles concentrate their nesting in the north and south temperate zones and subtropics, but generally avoid nesting in tropical areas of Central America, northern South America, and the Old World (NRC 1990). The largest known nesting aggregation of loggerhead sea turtles occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani 1982). In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the gulf coast of Florida. The best scientific and commercial data available on the genetics of loggerhead sea turtles suggests there are four major subpopulations of loggerhead sea turtles in the northwest Atlantic: (1) a northern nesting subpopulation that occurs from North Carolina to northeast Florida, about 29° N; (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota on the west coast; (3) a Florida panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida; and (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez 1990). This biological opinion will focus on the northwest Atlantic subpopulations of loggerhead sea turtles, which occur in the action area.

Although NMFS has not completed the administrative processes necessary to formally recognize populations or subpopulations of loggerhead sea turtles, these sea turtles are generally grouped by their nesting locations. Based on the most recent reviews of the best scientific and commercial data on the population genetics of loggerhead sea turtles and analyses of their population trends (TEWG, 1998;

TEWG in prep), NMFS treats these loggerhead turtle nesting aggregations as distinct sub- populations whose survival and recovery is critical to the survival and recovery of the species. Further, any action that appreciably reduced the likelihood that one or more of these nesting aggregations would survive and recover would appreciably reduce the species' likelihood of survival and recovery in the wild. Consequently, this biological opinion will focus on the four nesting aggregations of loggerhead sea turtles identified in the preceding paragraph (which occur in the action area) and treat them as subpopulations for the purposes of this analysis. Natal homing to the nesting beach provides the genetic barrier between these subpopulations, preventing recolonization from turtles from other nesting beaches. The importance of maintaining these subpopulations in the wild is shown by the many examples of extirpated nesting assemblages in the world.

The loggerhead sea turtles in the action area are likely to represent differing proportions of the four western Atlantic subpopulations. Although the northern nesting subpopulation produces about 9 percent of the loggerhead nests, they comprise more of the loggerhead sea turtles found in foraging areas from the northeastern U.S. to Georgia: between 25 and 59 percent of the loggerhead sea turtles in this area are from the northern subpopulation (Bass *et al.*, 1998; Norrgard, 1995; Rankin-Baransky, 1997; Sears 1994, Sears *et al.* 1995). About 10 percent of the loggerhead sea turtles in foraging areas off the Atlantic coast of central Florida are from the northern subpopulation (Witzell *et al.*, in prep). In the Gulf of Mexico, most of the loggerhead sea turtles in foraging areas will be from the South Florida subpopulation, although the northern subpopulation may represent about 10 percent of the loggerhead sea turtles in the gulf (Bass pers. comm). In the Mediterranean Sea, about 45 - 47 percent of the pelagic loggerheads are from the South Florida subpopulation and about 2% are from the northern subpopulation, while only about 51 percent originated from Mediterranean nesting beaches (Laurent *et al.* 1998). In the vicinity of the Azores and Madiera Archipelagoes, about 19 percent of the pelagic loggerheads are from the northern subpopulation, about 71 percent are from the South Florida subpopulation, and about 11 percent are from the Yucatán subpopulation (Bolten *et al.*, 1998).

Loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years. Turtles in this life history stage are called "pelagic immatures" and are best known from the eastern Atlantic near the Azores and Madeira and have been reported from the Mediterranean as well as the eastern Caribbean (Bjorndal *et .al.* in press). Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm SCL they recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico.

Benthic immatures have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico (R. Márquez-M., pers. comm.). Large benthic immature loggerheads (70-91 cm) represent a larger proportion of the strandings and in-water captures (Schroeder *et al.* 1998) along the south and western coasts of Florida as compared with the rest of the coast, but it is not known whether the larger animals actually are more abundant in these areas or just more abundant within the area relative to the smaller turtles. Benthic immature loggerheads foraging in northeastern U.S. waters are known to migrate southward in the fall as water temperatures cool (Epperly *et al.* 1995; Keinath 1993; Morreale and Standora 1999; Shoop and Kenney 1992), and migrate northward in spring. Given an estimated age at maturity of 21-35 years (Frazer and Ehrhart 1985; Frazer and Limpus 1998), the benthic immature stage must be at least 10-25 years long.

Although loggerhead sea turtles are most vulnerable to pelagic longlines during their pelagic, immature

life history stage, there is some evidence that benthic immatures may also be captured, injured, or killed by pelagic fisheries. Recent studies have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic immatures, followed by permanent settlement into benthic environments. Some may not totally circumnavigate the north Atlantic. In addition, some of these turtles may either remain in the pelagic habitat in the north Atlantic longer than hypothesized or they may move back and forth between pelagic and coastal habitats (Witzell in prep.). Any loggerhead sea turtles that follow this developmental model would be adversely affected by shark gill nets and shark bottom longlines set in coastal waters, in addition to pelagic longlines.

Adult loggerhead sea turtles have been reported throughout the range of this species in the U.S. and throughout the Caribbean Sea. As discussed in the beginning of this section, they nest primarily from North Carolina southward to Florida with additional nesting assemblages in the Florida Panhandle and on the Yucatán Peninsula. Non-nesting, adult female loggerheads are reported throughout the U.S. and Caribbean Sea; however, little is known about the distribution of adult males who are seasonally abundant near nesting beaches during the nesting season. Aerial surveys suggest that loggerheads (benthic immatures and adults) in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Based on the data available, it is not possible to estimate the size of the loggerhead sea turtle population in the U.S. or its territorial waters. There is, however, general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage. Nesting data collected on index nesting beaches in the U.S. from 1989-1998 represent the best dataset available to index the population size of loggerhead sea turtles. Between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,016-89,034 annually, representing, on average, an adult female population of 44,780 [(nests/4.1) * 2.5]. On average, 90.7% of the nests were from the South Florida subpopulation, 8.5% were from the northern subpopulation, and 0.8% were from the Florida Panhandle subpopulation. There is limited nesting throughout the Gulf of Mexico west of Florida, but it is not known to what subpopulation they belong. There are only an estimated 3,700 nesting females in the northern loggerhead subpopulation, and the status of this population is officially documented as stable at best (TEWG in prep.).

From a global perspective, the southeastern U.S. nesting aggregation is critical to the survival of this species: it is second in size only to the nesting aggregations in the Arabian Sea off Oman and represents about 35 and 40 percent of the nests of this species. The status of the Oman nesting beaches has not been evaluated recently, but they are located in a part of the world that is vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills), the resulting risk facing this nesting aggregation and these nesting beaches is cause for considerable concern (Meylan *et al.* 1995).

Loggerhead sea turtles face a number of threats in the marine environment, including oil and gas exploration, development, and transportation; marine pollution; trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries; underwater explosions; dredging, offshore artificial lighting; power plant entrapment; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; and poaching. On their nesting beaches in the U.S., loggerhead sea turtles are threatened with beach erosion, armoring, and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; exotic dune and beach vegetation; predation by exotic species such as fire ants, raccoons (*Procyon lotor*), armadillos (*Dasypus*

novemcinctus), opossums (*Didelphus virginiana*); and poaching.

Large numbers of loggerhead sea turtles from the four subpopulations that occur in the action area are captured, injured, or killed in a wide variety of fisheries. Virtually all of the pelagic immature loggerheads taken in the Portuguese longline fleet in the vicinity of the Azores and Madiera are from western North Atlantic nesting subpopulations (Bolten *et al.* 1994, 1998) and about half of those taken in both the eastern and western basins of the Mediterranean Sea are from the western North Atlantic subpopulations (Bowen *et al.* 1993; Laurent *et al.* 1998). Aguilar *et al.* (1995) estimated that the Spanish swordfish longline fleet, which is only one of the many fleets operating in the region, alone captures more than 20,000 juvenile loggerheads annually (killing as many as 10,700). Estimated bycatch of marine turtles by the U.S. Atlantic tuna and swordfish longline fisheries, based on observer data, was significantly greater than reported in logbooks through 1997 (Johnson *et al.* 1999; Witzell 1999), but was comparable by 1998 (Yeung, 1999). Observer records indicate that an estimated 6,544 loggerheads were captured by the U.S. fleet between 1992-1998, of which an estimated 43 were dead (Yeung *et al.* in prep.). For 1998 an estimated 510 loggerheads (225-1250) were captured and, based on serious injury criteria developed for marine mammals (which may be inappropriate for sea turtles), all were presumed dead or were expected to die subsequent to being captured. Logbooks and observer records indicated that loggerheads readily ingest hooks (Witzell 1999). Aguilar *et al.* (1995) reported that hooks were removed from only 171 of 1,098 loggerheads captured in the Spanish longline fishery, describing that removal was possible only when the hook was found in the mouth, the tongue or, in a few cases, externally (flippers, *etc.*); the presumption is that all others had ingested the hook.

Loggerhead sea turtles also face numerous threats from natural causes. For example, there is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November) and loggerhead sea turtle nesting season (March to November); hurricanes can have potentially disastrous effects on the survival of eggs in sea turtle nests. In 1992, Hurricane Andrew affected turtle nests over a 90-mile length of coastal Florida; all of the eggs were destroyed by storm surges on beaches that were closest to the eye of this hurricane (Milton *et al.* 1992). On Fisher Island near Miami, Florida, 69 percent of the eggs did not hatch after Hurricane Andrew, probably because they were drowned by the storm surge. Nests from the northern subpopulation were destroyed by hurricanes which made landfall in North Carolina in the mid to late 1990s. Sand accretion and rainfall that result from these storms can appreciably reduce hatchling success. These natural phenomena probably have significant, adverse effects on the size of specific year classes; particularly given the increasing frequency and intensity of hurricanes in the Caribbean Sea and northwest Atlantic Ocean.

Status and trend of loggerhead sea turtles

Several published reports have presented the problems facing long-lived species that delay sexual maturity in a world replete with threats from a modern, human population (Congdon et al. 1993, Congdon and Dunham 1994, Crouse *et al.* 1987, Crowder *et al.* 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high, annual survival as juveniles through adults to ensure that enough juvenile sea turtles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes. This general rule applies to sea turtles, particularly loggerhead sea turtles, because the rule originated in studies of sea turtles (Crouse *et al.* 1987, Crowder *et al.* 1994, Crouse 1999). Heppell *et al.* (in prep.) specifically showed that the growth of the loggerhead sea turtle population was particularly sensitive to changes in the annual survival of both juvenile and adult sea turtles and that the adverse effects of the pelagic longline fishery on loggerheads from the pelagic immature phase appeared critical to the survival and recovery of the

species. Crouse (1999) concluded that relatively small changes in annual survival rates of both juvenile and adult loggerhead sea turtles will adversely affect large segments of the total loggerhead sea turtle population.

The four major subpopulations of loggerhead sea turtles in the northwest Atlantic — northern, south Florida, Florida panhandle, and Yucatán — are all subject to fluctuations in the number of young produced annually because of natural phenomena like hurricanes as well as human-related activities. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast (in areas like Merrit Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection and probably cause fluctuations in sea turtle nesting success. Volusia County, Florida, for example, allows motor vehicles to drive on sea turtle nesting beaches (the County has filed suit against the FWS to retain this right) and sea turtle nesting in Indian River, Martin, West Palm, and Broward counties of Florida can be affected by beach armoring, beach renourishment, beach cleaning, artificial lighting, predation, and poaching.

As discussed previously, the survival of juvenile loggerhead sea turtles is threatened by a completely different set of threats from human activity once they migrate to the ocean. Pelagic immature loggerhead sea turtles from these four subpopulations circumnavigate the North Atlantic over several years (Carr 1987, Bjorndal 1994). During that period, they are exposed to a series of long-line fisheries that include an Azorean long-line fleet, a Spanish long-line fleet, and various fleets in the Mediterranean Sea (Aguilar *et al.* 1995, Bolten *et al.* 1994, Crouse 1999). Based on their proportional distribution, the capture of immature loggerhead sea turtles in long-line fleets in the Azores and Madiera Archipelagoes and the Mediterranean Sea will have a significant, adverse effect on the annual survival rates of juvenile loggerhead sea turtles from the western Atlantic subpopulations, with a disproportionately large effect on the northern subpopulation that may be significant at the population level.

In waters off coastal U.S., the survival of juvenile loggerhead sea turtles is threatened by a suite of fisheries in Federal and State waters. Loggerhead turtles are captured, injured, or killed in shrimp fisheries off the Atlantic coast; along the southeastern Atlantic coast, loggerhead turtle populations are declining where shrimp fishing is intense off the nesting beaches (NRC 1990). Conversely these nesting populations do not appear to be declining where nearshore shrimping effort is low or absent. The management of shrimp harvest in the Gulf of Mexico demonstrates the correlation between shrimp trawling and impacts to sea turtles. Waters out to 200nm are closed to shrimp fishing off of Texas each year for approximately a 3 month period (mid May through mid July) to allow shrimp to migrate out of estuarine waters; sea turtle strandings decline dramatically during this period (NMFS, STSSN unpublished data). Loggerhead sea turtles are captured in fixed pound-net gear in the Long Island Sound, in pound-net gear and trawls in summer flounder and other finfish fisheries in the mid-Atlantic and Chesapeake Bay, in gill net fisheries in the mid-Atlantic and elsewhere, in fisheries for monkfish and for spiny dogfish, and in northeast sink gillnet fisheries (see further discussion in the *Environmental Baseline* of this Opinion). Witzell (1999) compiled data on capture rates of loggerhead and leatherback turtles in U.S. longline fisheries in the Caribbean and northwest Atlantic; the cumulative takes of these fisheries approach those of the U.S. shrimp fishing fleet (Crouse 1999, NRC 1990).

Leatherback turtle (*Dermochelys coriacea*)

The Recovery Plan for Leatherback Turtles (*Dermochelys coriacea*) contains a description of the natural history and taxonomy of this species (FWS and NMFS 1992). Leatherbacks are widely distributed throughout the oceans of the world, and are found throughout waters of the Atlantic, Pacific, Caribbean,

and the GOM (Ernst and Barbour 1972). They are predominantly distributed pelagically, feeding primarily on jellyfish such as *Stomolophus, Chryaora,* and *Aurelia* (Rebel 1974). Leatherbacks are deep divers, with recorded dives to depths in excess of 1000 m (Eckert *et al.* 1998), but they may come into shallow waters if there is an abundance of jellyfish nearshore. Leary (1957) reported a large group of up to 100 leatherbacks just offshore of Port Aransas, Texas associated with a dense aggregation of *Stomolophus*. They also occur annually in places such as Cape Cod and Narragansett bays during certain times of the year, particularly the fall.

The leatherback is the largest living turtle and it ranges farther than any other sea turtle species, exhibiting broad thermal tolerances (NMFS and USFWS 1995). Leatherback turtles feed primarily on cnidarians (medusae, siphonophores) and tunicates (salps, pyrosomas) and are often found in association with jellyfish. TDR data recorded by Eckert *et al.* (1998) indicate that leatherbacks are night feeders. Of the turtle species common to the action area, leatherback turtles seem to be the most susceptible to entanglement in lobster gear and, along with loggerheads, to longline gear. This susceptibility may be the result of attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, and perhaps to the lightsticks used to attract target species in the longline fishery.

Although leatherbacks are a long lived species (> 30 years), they are somewhat faster to mature than loggerheads, with an estimated age at sexual maturity reported as about13-14 years for females, and an estimated minimum age at sexual maturity of 5-6 years, with 9 years reported as a likely minimum (Zug and Parham 1996).

Compared to the current knowledge regarding loggerhead populations, the genetic distinctness of leatherback populations is less clear. However, genetic analyses of leatherbacks to date indicate that within the Atlantic basin significant genetic differences occur between St. Croix, U.S. V.I. and mainland Caribbean populations (Florida, Costa Rica, Suriname and French Guiana) and between Trinidad and the same mainland populations (Dutton *et al.* 1999), leading to the conclusion that there are at least 3 separate subpopulations of leatherbacks in the Atlantic. Much of the genetic diversity is contained in the relatively small insular subpopulations. To date, no studies have been published on pelagic or benthic foraging leatherbacks in the Atlantic and thus is it not known what populations are being impacted by the pelagic longline fishery (or other HMS fisheries, for that matter).

Although populations or subpopulations of leatherback sea turtles have not been formally recognized, based on the most recent reviews of the analysis of population trends of leatherback sea turtles, and due to our limited understanding of the genetic structure of the entire species, the most conservative approach would be to treat leatherback nesting populations as distinct populations whose survival and recovery is critical to the survival and recovery of the species. Further, any action that appreciably reduced the likelihood for one or more of these nesting populations to survive and recover in the wild, would appreciably reduce the species' likelihood of survival and recovery in the wild.

Nest counts are currently the only reliable indicator of population status available for leatherback turtles. Recent declines have been seen in the number of leatherbacks nesting worldwide (NMFS and USFWS 1995). The status of the leatherback population in the Atlantic is difficult to assess since major nesting beaches occur over broad areas within tropical waters outside the United States. The nesting population within US jurisdiction is presumed to be stable. Numbers at some nesting beaches (e.g. St. Croix, Florida, Puerto Rico, are increasing; P. Dutton, pers. comm.), although some nesting beaches in the U.S. Virgin Islands have been extirpated including nesting assemblages in other areas of the Caribbean such

as St. John and St. Thomas. The nesting beach at Sandy Point, St. Croix, which has witnessed an increase in the population, has been subject to intensive conservation management efforts since 1981. However, it is not known whether the observed increase is due to improved adult survival or recruitment of new nesters, since flipper tag loss is so high in this species. Better data collection methods implemented since the late 1980s may soon help to answer these questions. Based on an expected inter-nesting interval of one to five years, Dutton *et al.* (in press) estimate a 19 - 49% mortality rate for re-migrating females at Sandy Point. Researchers are currently unable to explain the underlying mechanisms which somehow are resulting simultaneously in such high mortality levels to nesting age females, and yet exponential growth in the nesting population. In the western Atlantic, the primary nesting beaches occur in French Guiana, Suriname, and Costa Rica.

The nesting population of leatherback sea turtles in the Suriname-French Guiana trans-boundary region has been declining since 1992 (Chevalier and Girondot, (1998). The current status of nesting populations in French Guiana and Suriname is difficult to interpret because these beaches are so dynamic geologically. Chevalier (pers. comm.) in a talk at the recent Annual Sea Turtle Symposium on March 2, 2000, entitled "Driftnet Fishing in the Marconi Estuary: the Major Reason for the Leatherback Turtle's Decline in the Guianas," stated that since the middle 1970's leatherback nesting has declined (1987-1992 mean = 40,950 nests and 1993-1998 mean = 18,100 nests). He states that there is very little shifting in nesting from French Guiana and Suriname to other Caribbean sites (there has only been 1 tag recapture elsewhere).

The nesting population of leatherback sea turtles in Suriname is also decreasing. Chevalier claims that there is no human-induced mortality on the beach in French Guiana, and natural mortality of adults should be low. There has been very low hatchling success on beaches used for the last 25 years. Chevalier believes that threats to the population include fishing (longlines, drift nets, and trawling), pollution (plastic bags and chemicals), and boat propellers. Around 90% of the nests are laid within 25 km from the Marconi estuary. Strandings in 1997, 98, and 99 in the estuary were 70, 60, and 100, which Chevalier considers underestimates. He questioned the fishermen and actually observed a 1 km (gill) net with 7 dead leatherbacks. This observation, coupled with the strandings, led him to conclude that there were large numbers captured incidentally in large mesh nets. There are protected areas nearshore in French Guiana; offshore, driftnets are set. There are no such protected areas off Suriname, and fishing occurs at the beach. Offshore nets soak overnight in Suriname; many boats fish overnight. According to Chevalier, the French Guiana government is starting up a working group to deal with accidental capture and to enforce the legislation. They will work towards the management of the fishery activity and collaborate with Suriname. They plan to study the accidental capture by the fishermen, satellite track turtles, and study strandings. The main problem appears to be the close proximity of the driftnet fishery to the nesting areas.

Swinkels (pers. comm.) also gave a presentation at the symposium on March 3, 2000 entitled "The Leatherback on the Move? Promising News from Suriname." Swinkels stated that from 1995- 1999 there was a large increase in leatherback nesting in Suriname. There is a nature reserve in two parts: one in Suriname and one in adjacent French Guiana. There were increasing trends observed on 3 beaches but poaching was 80%. Samsambo is a very dynamic beach, which has been newly created (by natural events) and now is a nesting beach. In 1999 there were >4000 nests of which about 50% were poached. In 1995 very few were poached (very little poaching effort was then concentrated there because at the time there wasn't much beach or nesting). Swinkels indicated that since that time, however, poaching has been increasing. The beach has naturally been renourished over this period. Swinkels' null

hypothesis was that there had been a shift in nesting activity (from other nesting areas). His alternate hypothesis was that the new nesting represented new recruitment to the population.

The status of leatherbacks in the Pacific appears more dire than the Atlantic. The East Pacific leatherback population was estimated to be over 91,000 adults in 1980 (Spotila 1996). Declines in nest abundance have been reported from primary nesting beaches. At Mexiquillo, Michoacan, Mexico, Sarti *et al.* (1996) reported an average annual decline in nesting of about 23% between 1984 and 1996. The total number of females nesting on the Pacific coast of Mexico during the 1995-1996 season was estimated at fewer than 1,000. Less than 700 females are estimated for Central America (Spotila 2000). In the western Pacific, the decline is equally severe. Current nestings at Terengganu, Malaysia represent 1% of the levels recorded in the 1950s (Chan and Liew 1996).

Globally, leatherback populations have been decimated worldwide. The population was estimated to number approximately 115,000 adult females in 1980 (Pritchard 1982) and only 34,500 by 1995 (Spotila *et al.* 1996). The decline can be attributed to many factors including fisheries as well as intense exploitation of the eggs (Ross, 1979). On some beaches nearly 100% of the eggs laid have been harvested (Eckert, 1996). Eckert (1996) and Spotila *et al.* (1996) record that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries. The Pacific population appears to be in a critical state of decline, now estimated to number less than 3,000 total adult and subadult animals (Spotila 2000). The status of the Atlantic population is less clear. In 1996, it was reported to be stable, at best (Spotila 1996), but numbers in the Western Atlantic at that writing were reported to be on the order of 18,800 nesting females. According to Spotila (pers.comm.), the Western Atlantic population currently numbers about 15,000 nesting females, whereas current estimates for the Caribbean (4,000) and the Eastern Atlantic (*i.e.* off Africa, numbering ~ 4,700) have remained consistent with numbers reported by Spotila *et al.* in 1996. Between 1989 and 1995, marked leatherback returns to the nesting beach at St. Croix averaged only 48.5%, but that the overall nesting population grew (McDonald, *et. al,* 1993). This is in contrast to a Pacific nesting beach at Playa Grande, Costa Rica, where only 11.9% of turtles tagged in 1993-94 and 19.0% of turtles tagged in 1994-95 returned to nest over the next five years. Characterizations of this population suggest that is has a very low likelihood of survival and recovery in the wild under current conditions.

Spotila (2000) states that a conservative estimate of annual leatherback fishery-related mortality (from longlines, trawls and gillnets) in the Pacific during the 1990s is 1,500 animals. He estimates that this represented about a 23% mortality rate (or 33% if most mortality was focused on the East Pacific population). Spotila (2000) asserts that most of the mortality associated with the Playa Grande nesting site was fishery related. As noted above, leatherbacks normally live at least 30 years, usually maturing at about 12-13 years. Such long-lived species can not withstand such high rates of anthropogenic mortality.

Spotila *et al.* (1996) describe a hypothetical life table model based on estimated ages of sexual maturity at both ends of the species' natural range (5 and 15 years). The model concluded that leatherbacks maturing in 5 years would exhibit much greater population fluctuations in response to external factors than would turtles that mature in 15 years. Furthermore, the simulations indicated that leatherbacks could maintain a stable population only if both juvenile and adult survivorship remained high, and that if other life history stages (*i.e.* egg, hatchling, and juvenile) remained static, "stable leatherback populations could not withstand an increase in adult mortality above natural background levels without decreasing...Even the Atlantic populations are being exploited at a rate that cannot be sustained." Model simulations indicated that an increase in adult mortality of more than 1% above background levels in a

stable population was unsustainable. Spotila *et al.* (1996) recommended not only reducing mortalities resulting from fishery interaction, but also advocated protection of eggs during the incubation period and of hatchlings during their first day, and indicated that such practices could potentially double the chance for survival and help counteract population effects resulting from adult mortality. They conclude "the Atlantic population is the most robust, but it is being exploited at a rate that cannot be sustained and if this rate of mortality continues, these populations will also decline. Leatherbacks are on the road to extinction."

Zug and Parham (1996) point out that the combination of the loss of long-lived adults in fishery related mortality, and the lack of recruitment stemming from elimination of annual influxes of hatchlings because of intense egg harvesting has caused the sharp decline in leatherback populations. The authors state that "the relatively short maturation time of leatherbacks offers some hope for their survival if we can greatly reduce the harvest of their eggs and the accidental and intentional capture and killing of large juveniles and adults."

Summary

The conflicting information regarding the status of Atlantic leatherbacks makes it difficult to conclude whether or not the population is currently in decline. Numbers at some nesting sites are up, while at others it is down. At one site (St. Croix), population growth has been documented despite large apparent mortality of nesting females; where data are available, population numbers are down in the Western Atlantic, but stable in the Caribbean and Eastern Atlantic. It does appear, however, that the Western Atlantic portion of the population is being subjected to mortality beyond sustainable levels, resulting in a continued decline in numbers of nesting females.

In the absence of any other population models, the population cannot withstand more than a 1% human-related mortality level which translates to 150 nesting females (Spotila *et al.* 1996; Spotila pers. comm.). As noted above, there are many human-related sources of mortality to leatherbacks; a tally of all leatherback takes anticipated annually under current biological opinions yields a potential for up to 801 leatherback takes, although this sum includes many takes expected to be nonlethal. In 1999 there were 19 animals observed taken dead, or by hook or ingestion, in the longline fishery. Scientific extrapolation of these data has not yet been completed so an accurate estimation of how many animals this represents across the entire fishery is currently unavailable. However, the observed sets represent approximately 3% of total effort for 1999; therefore a direct scaling to total effort would estimate that approximately 633 leatherbacks may have been taken dead or seriously injured by the fishery. A direct scaling to 100% effort is inappropriate, as take rates vary widely across different geographical areas of the fishery (as well as seasonally and inter-annually), but it may at least provide an idea of the potential order of magnitude of dead or seriously injured animals associated with this fishery. Perhaps a better way of looking at the data is to apply the 29% mortality estimate provided by Aguilar (1995) to the average annual estimated take of 715 animals (Yeung *et al.* in prep.), which indicates that an average of 207 animals annually either die or are seriously injured by pelagic longlines in the U.S. fleet.

Based on the information outlined above, the pelagic longline fishery alone may be killing leatherback sea turtles at levels equal to or greater than the 1% maximum sustainable level of total human-related mortality supported by the work of Spotila *et al.* (1996). When other pressures on leatherback sea turtle populations, including the number of leatherbacks that are injured or killed in other fisheries and other federal activities (*e.g.* military activities, oil and gas development, *etc.*), the continued harvest of eggs and adults turtles for meat in some Caribbean and Latin nations, the effects of ocean pollution, natural

disturbances such as hurricanes (which may wipe out nesting beaches), the total number of turtles that die in any given year reduces the leatherback turtles reproduction, numbers, or distribution in a way that would be expected to appreciably reduce their likelihood of survival and recovery in the wild.

Green turtle (*Chelonia mydas*)
Green turtles are distributed circumglobally, mainly in waters between the northern and southern 20° C isotherms (Hirth 1971). Green turtles were traditionally highly prized for their flesh, fat, eggs, and shell, and fisheries in the United States and throughout the Caribbean are largely to blame for the decline of the species.

In the western Atlantic, several major nesting assemblages have been identified and studied (Peters 1954, Carr and Ogren 1960, Parsons 1962, Pritchard 1969, Carr *et al.* 1978). In the continental United States, green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart 1979). Occasional nesting has been documented along the Gulf coast of Florida, at Southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan *et al.* 1995). Most documented green turtle nesting activity occurs on Florida index beaches, which were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of the index beaches in 1989, perhaps due to increased protective legislation throughout the Caribbean (Meylan *et al.* 1995).

While nesting activity is obviously important in identifying population trends and distribution, the majority portion of a green turtle's life is spent on the foraging grounds. Green turtles are herbivores, and appear to prefer marine grasses and algae in shallow bays, lagoons and reefs (Rebel 1974). Some of the principal feeding pastures in the Gulf of Mexico include inshore south Texas waters, the upper west coast of Florida and the northwestern coast of the Yucatan Peninsula. Additional important foraging areas in the western Atlantic include the Indian River Lagoon System in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito coast of Nicaragua, the Caribbean coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). The preferred food sources in these areas are *Cymodocea, Thalassia, Zostera, Sagittaria,* and *Vallisneria* (Babcock 1937, Underwood 1951, Carr 1952, 1954).

Green turtles were once abundant enough in the shallow bays and lagoons of the Gulf to support a commercial fishery, which landed over one million pounds of green turtles in 1890 (Doughty 1984). Doughty reported the decline in the turtle fishery throughout the Gulf of Mexico by 1902. Currently, green turtles are uncommon in offshore waters of the northern Gulf, but abundant in some inshore embayments. Shaver (1994) live-captured a number of green turtles in channels entering into Laguna Madre, in South Texas. She noted the abundance of green turtle strandings in Laguna Madre inshore waters and opined that the turtles may establish residency in the inshore foraging habitats as juveniles. Algae along the jetties at entrances to the inshore waters of South Texas was thought to be important to green turtles associated with a radio-telemetry project (Renaud *et al.* 1995). Transmitter-equipped turtles remained near jetties for most of the tracking period. This project was restricted to late summer months, and therefore may reflect seasonal influences. Coyne (1994) observed increased movements of green turtles during warm water months.

Hawksbill turtle (*Eretmochelys imbricata*)
The hawksbill turtle is relatively uncommon in the waters of the continental United States, preferring coral reefs, such as those found in the Caribbean and Central America. Hawksbills feed primarily on a

wide variety of sponges but also consume bryozoans, coelenterates, and mollusks. Nesting areas in the western North Atlantic include Puerto Rico and the Virgin Islands. NMFS has designated the coastal waters surrounding Mona and Monito Islands, off the west coast of Puerto Rico, as critical habitat for hawksbills. Mona Island supports the largest population of nesting hawksbills in the U.S. Caribbean. In the northern Gulf of Mexico, a surprising number of small hawksbills are encountered in Texas. Most of the Texas records are probably in the 1-2 year class range. Many of the individuals captured or stranded are unhealthy or injured (Hildebrand 1983). The lack of sponge-covered reefs and the cold winters in the northern Gulf of Mexico probably prevent hawksbills from establishing a strong presence in that area. Of the 65 geopolitical units worldwide, where estimates of relative hawksbill nesting density exists, 38 of them have hawksbill populations that are suspected or known to be in decline and an additional 18 have experienced "well-substantiated declines" (NMFS and USFWS 1995).

Kemp's ridley turtle (*Lepidochelys kempi*)

Of the seven extant species of sea turtles of the world, the Kemp's ridley has declined to the lowest population level. The Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempi*) (FWS and NMFS 1992b) contains a description of the natural history, taxonomy, and distribution of the Kemp's ridley turtle. Kemp's ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico. Most of the population of adult females nest in this single locality (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the early 1970s, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid-1980s. Recent observations of increased nesting suggest that the decline in the ridley population has stopped and there is cautious optimism that the population is now increasing.

The nearshore waters of the Gulf of Mexico are believed to provide important developmental habitat for juvenile Kemp's ridley and loggerhead sea turtles. Ogren (1988) suggests that the Gulf coast, from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult ridleys in the northern Gulf of Mexico. Stomach contents of Kemp's ridleys along the lower Texas coast consisted of a predominance of nearshore crabs and mollusks, as well as fish, shrimp and other foods considered to be shrimp fishery discards (Shaver 1991). Analyses of stomach contents from sea turtles stranded on upper Texas beaches apparently suggest similar nearshore foraging behavior (Plotkin pers. comm.).

Research being conducted by Texas A&M University has resulted in the intentional live-capture of hundreds of Kemp's ridleys at Sabine Pass and the entrance to Galveston Bay. Between 1989 and 1993, 50 of the Kemp's ridleys captured were tracked (using satellite and radio telemetry) by biologists with the NMFS Galveston Laboratory. The tracking study was designed to characterize sea turtle habitat and to identify small and large scale migration patterns. Preliminary analysis of the data collected during these studies suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NMFS Galveston Laboratory, pers. comm.).

In recent years, unprecedented numbers of Kemp's ridley carcasses have been reported from Texas and Louisiana beaches during periods of high levels of shrimping effort. NMFS established a team of population biologists, sea turtle scientists, and managers, known as the Turtle Expert Working Group (TEWG) to conduct a status assessment of sea turtle populations. Analyses conducted by the group have indicated that the Kemp's ridley population is in the early stages of recovery; however, strandings in

some years have increased at rates higher than the rate of increase in the Kemp's population (TEWG 1998). While many of the stranded turtles observed in recent years in Texas and Louisiana are believed to have been incidentally taken in the shrimp fishery, other sources of mortality exist in these waters. These stranding events illustrate the vulnerability of Kemp's ridley and loggerhead turtles to the impacts of human activities in nearshore Gulf of Mexico waters.

The TEWG (1998) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the TEWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment, where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20-60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the U.S. Fish and Wildlife Service (FWS) and Mexico's Instituto Nacional de Pesca to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of turtle excluder devices (TEDs). Adult ridley numbers have now grown from a low of approximately 1,050 adults producing 702 nests in 1985, to greater than 3,000 adults producing 1,940 nests in 1995 and about 3,400 nests in 1999.

The TEWG (1998) was unable to estimate the total population size and current mortality rates for the Kemp's ridley population. However, the TEWG listed a number of preliminary conclusions. The TEWG indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Over the period 1987 to 1995, the rate of increase in the annual number of nests accelerated in a trend that would continue with enhanced hatchling production and the use of TEDs. Nesting data indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and a low of 702 nests in 1985. This the trajectory of adult abundance tracks trends in nest abundance from an estimate of 9,600 in 1966 to 1,050 in 1985. The TEWG estimated that in 1995 there were 3,000 adult ridleys. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6% to 28% from 1981 to 1989 and from 23% to 41% from 1990 to 1994. The population model in the TEWG projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan, of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. It determined that the data reviewed suggested that adult Kemp's ridley turtles were restricted somewhat to the Gulf of Mexico in shallow near shore waters, and benthic immature turtles of 20-60 cm straight line carapace length are found in nearshore coastal waters including estuaries of the Gulf of Mexico and the Atlantic.

The TEWG (1998) identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase. However, the 1996 and 1997 nest numbers reflected a slower rate of growth, while the increase in the 1998 nesting level has been much higher and decreased in 1999. The population growth rate does not appear as steady as originally forecasted by the TEWG, but annual fluctuations, due in part to irregular internesting periods, are normal for other sea turtle populations. Also, as populations increase and expand, nesting activity would be

expected to be more variable.

The area surveyed for ridley nests in Mexico was expanded in 1990 due to destruction of the primary nesting beach by Hurricane Gilbert. The TEWG (1998) assumed that the increased nesting observed particularly since 1990 was a true increase, rather than the result of expanded beach coverage. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather than an expanding ridley nesting range. As noted by TEWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's Ridley Recovery Plan.

Critical Habitat (Right Whale)
The nearshore waters of northeast Florida and southern Georgia were formally designated as critical habitat for right whales on June 3, 1994 (59 FR, 28793). These waters were first identified as a likely calving and nursery area for right whales in 1984. Since that time, Kraus *et al.* (1993) have documented the occurrence of 74 percent of all the known mature females from the North Atlantic population in this area. While sightings off Georgia and Florida include primarily adult females and calves, juveniles and adult males have also been observed.

There are five well-known habitats used annually by right whales, including 1) coastal Florida and Georgia, 2) the Great South Channel, east of Cape Cod, 3) Cape Cod and Massachusetts bays, 4) the Bay of Fundy and, 5) Browns and Baccaro Banks, south of Nova Scotia. The first three areas occur in U.S. waters and have been designated by NMFS as critical habitat (59 FR, 28793).

Species Likely to Be Adversely Affected
Of the above-listed species occurring in the Atlantic Ocean offshore of the Southeastern United States NMFS believes that the five sea turtle species are vulnerable to injury and death from some of the activities associated with the proposed action in all three possible action areas. NMFS also believes that the sperm whales, and to a much lesser extent, fin, humpback and right whales may be adversely affected by activities associated with the proposed action. These effects would be a result of acoustic harassment.

In the Mayport test area the endangered marine mammal most likely to be present is the sperm whale. Based on aerial surveys conducted by the Navy (April-September 1995, May-September 1997, and June and August 1999) sperm whales have been documented in the action area but in relatively low concentrations (Navy 1999). However sperm whales produce a distinctive clicked vocalization (Jefferson *et al.* 1993) and are very likely to be detected by the passive acoustic monitoring system described in the Proposed Action section of the Opinion. These factors are expected to greatly minimize, but not eliminate, the potential for this species to be adversely impacted by the proposed action. NMFS believes that sperm whales are not likely to be injured or killed as a result of the proposed action but harassment is likely. The other endangered whales potentially occurring at Mayport (fin, humpback, and right whales) generally inhabit northern feeding grounds during the proposed time frame for the shock trial and were never observed in the action area during the above mentioned surveys. However, since their possible occurrence in the action area cannot be ruled as extremely unlikely to occur, effects to these species are considered herein.

Designated right whale critical habitat is located along the northeast Florida Coast well inshore of the

Mayport test area. The critical habitat is 47 nm away from the nearest part of the Mayport test area. NMFS has reviewed information submitted by the Navy regarding anticipated distances at which the proposed activities may be detected by listed species and concludes that activities associated with the proposed action are not likely to affect critical habitat designated for the right whale. Therefore the proposed action as it relates to right whale critical habitat will not be discussed further in this Opinion.

IV. Environmental Baseline

This section contains an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, their habitat (including designated critical habitat), and ecosystem, within the action area. The environmental baseline is a snapshot of a species' health at a specified point in time and includes state, tribal, local and private actions already affecting the species, or that will occur contemporaneously with the consultation in progress. Unrelated Federal actions affecting the same species or critical habitat that have completed formal or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat.

The environmental baseline for this Biological Opinion includes the effects of several activities that affect the survival and recovery of threatened and endangered species in the action area. The activities that shape the environmental baseline in the action area of this consultation generally fall into the following three categories: vessel operations, fisheries, and recovery activities associated with reducing those impacts. Other environmental impacts include effects of discharges, dredging, ocean dumping, sonic activity, and aquaculture.

Status of the Species within the Action Area

The listed species occurring in the action area are all highly migratory, and the scope of the action area includes all pelagic areas within which these species may be found within the U.S. EEZ. Therefore, the range-wide status of the species given in Section II above most appropriately reflects the species' status within the action area.

(a) Factors Affecting Species within the Action Area

In recent years, NMFS has undertaken several ESA section 7 consultations to address the effects of vessel operations and gear associated with Federally-permitted fisheries on threatened and endangered species in the action area. Each of those consultations sought to develop ways of reducing the probability of adverse effects of the action on large whales and sea turtles. Similarly, recovery actions NMFS has undertaken under both the MMPA and the ESA are addressing the problem of take of whales in the fishing and shipping industries. Incidental take levels anticipated under the incidental take statements associated with these existing biological opinions are summarized in Table 1. below, followed by a brief discussion of each action consulted on. The following summary of anticipated incidental take of turtles includes only those federal actions which have undergone formal section 7 consultation.

(1) *Vessel Operations*. Potential adverse effects from Federal vessel operations in the action area of this consultation include operations of the USN and USCG, which maintain the largest Federal vessel fleets, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration (NOAA), and the ACOE. NMFS has conducted formal consultations with the USCG, the USN (described below) and is currently in early phases of consultation with the other Federal agencies on their vessel operations.

In addition to operation of ACOE vessels, NMFS has consulted with the ACOE to provide recommended permit restrictions for operations of contract or private vessels around whales. Through the section 7 process, where applicable, NMFS has and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. At the present time, however, they represent potential for some level of interaction. Refer to the Biological Opinions for the USCG (NMFS 1995, 1996b, and 1998) and the USN (NMFS 1997a) for detail on the scope of vessel operations for these agencies and conservation measures being implemented as standard operating procedures.

Table 1. Summary of annual incidental take levels anticipated under the incidental take statements associated with NMFS' existing biological opinions in the US Atlantic and Gulf of Mexico.

Federal Action	Annual Anticipated Incidental Take Level (lethal or non)				
	Loggerhead	Leatherback	Green	Kemp's	Hawksbill
Coast Guard Vessel Operation	1[1]	1[1]	1[1]	1[1]	1[1]
Navy – SE Ops Area	84	12	12[1]	12[1]	0
Shipshock – Seawolf	50	6	4[1]	4[1]	4[1]
COE Dredging – S. Atlantic	35	0	7	7	2
COE Dredging - N & W Gulf of Mexico	30	0	8	14	2
COE Dredging - E Gulf of Mexico	2 + 8[2]	0 + 5[2]	1 + 5[2]	1 + 5[2]	1 + 5[2]
COE Rig Removal, Gulf of Mexico	1[1]	1[1]	1[1]	1[1]	1[1]
MMS Rig Removal, Gulf of Mexico	10[3]	5[3]	5[3]	5[3]	5[3]
NE Multispecies Sink Gillnet Fishery	100[4]	10[4]	10[4]	10[4]	10[4]
ASMFC Lobster Plan	0[5]	0[5]	0[5]	0[5]	0[5]
Monkfish Fishery[7]	6	1	1	1	0
Dogfish Fishery	6	1	1	1	0
Summer Flounder, Scup & Black Sea Bass	15	3[1]	3[1]	3[1]	3[1]
Shrimp Fishery	3550[1]	650	3550[1]	3550[1]	3550[1]
HMS - Pelagic Longline Fishery	468[1](7)	358[1](6)	46[1](2)	23[1](1)	46[1](2)
HMS - Shark gillnet Fishery	20	2	2	2	2
HMS - Bottom Longline Fishery	12	2	2	2	2
NRC – St. Lucie, FL	5	1	10	1	1
NRC – Brunswick, NC	50[1] (6)	50[1] (0)	50[1] (3)	50[1] (2)	50[1] (0)
NRC – Crystal River, FL	55[1] (1)	55[1] (1)	55[1] (1)	55[1] (1)	55[1] (1)
Total (maximum anticipated[6])	**4508**	**1163**	**3774**	**3748**	**3740**

[1]Up to this amount for these species, in combination. In most cases, it is expected that takes of turtle species other than loggerheads will be minimal. Parentheses indicate expected mortalities, where provided in the BO. Other numbers represent "takes", including non-lethal captures.
[2]Up to 8 turtles total, of which, no more than 5 may be leatherbacks, greens, Kemp's or hawksbill, in combination.
[3]Not to exceed 25 turtles, in total.
[4]As part of the 1989 biological opinion on the Issuance of Exemptions for Commercial Fishing Operations under MMPA Section 114.
[5]Included in totals noted above.
[6]Maximum values given for non-loggerhead hardshell turtles are extreme, due to lumping of anticipated takes across species under ITSs.
[7]Due to the implication of this fishery's involvement in the recent NC strandings, this consultation must be reinitiated and will likely result in higher anticipated take levels.

Operations of vessels by other Federal agencies within the action area (NOAA, EPA, ACOE) may affect whales and sea turtles. However, the in-water activities of those agencies are limited in scope, as they operate a limited number of vessels or are engaged in research/operational activities that are unlikely to contribute a large amount of risk. Those activities which are determined to be likely to adversely affect listed species will be subject to future section 7 consultation requirements.

(2) *Additional military activities*, including vessel operations and ordnance detonation, also affect listed species of whales and sea turtles. USN aerial bombing training in the ocean off the southeast U.S. coast, involving drops of live ordnance (500 and 1,000-lb bombs) is estimated to have the potential to injure or kill, annually, 84 loggerheads, 12 leatherbacks, and 12 greens or Kemp's ridley, in combination (NMFS, 1997a). The USN will also conduct ship-shock testing for the new Seawolf submarine off the Atlantic coast of Florida, using 5 submerged detonations of 10,000 lb explosive charges. This testing is estimated to injure or kill 50 loggerheads, 6 leatherbacks, and 4 hawksbills, greens, or Kemp's ridleys, in combination (NMFS, 1996c). Operation of the USCG's boats and cutters in the U.S. Atlantic, meanwhile, is estimated to take no more than one individual turtle—of any species—per year (NMFS, 1995). Formal consultation on USCG or USN activities in the Gulf of Mexico has not been conducted.

The construction and maintenance of Federal navigation channels has also been identified as a source of turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly (compared to sea turtle swimming speeds) and can entrain and kill sea turtles, presumably as the drag arm of the moving dredge overtakes the slower moving turtle. Along the Atlantic coast of the southeastern United States, NMFS estimates that annual, observed injury or mortality of sea turtles from hopper dredging may reach 35 loggerheads, 7 greens, 7 Kemp's ridleys, and 2 hawksbills (NMFS, 1997b). Along the north and west coasts of the Gulf of Mexico, channel maintenance dredging using a hopper dredge may injure or kill 30 loggerhead, 8 green, 14 Kemp's ridley, and 2 hawksbill sea turtles annually (NMFS, 1997c). Additional incidental take statements for dredging of Charlotte Harbor and Tampa Bay, FL anticipate this project may incidentally take, by injury or mortality, of two (2) loggerheads or one (1) Kemp's ridley or one (1) green or one (1) hawksbill sea turtle for Charlotte Harbor and eight (8) sea turtles, including no more than five (5) documented Kemp's ridley, hawksbill, leatherback, or green turtles, in any combination, for Tampa Bay.

US Army Corps of Engineers (COE) and Minerals Management Service (MMS) (the latter is non-military) rig removal activities also adversely affect sea turtles. For the COE activities, an incidental take (by injury or mortality) of one documented Kemp's ridley, green, hawksbill, leatherback, or loggerhead turtle is anticipated under a rig removal consultation for the New Orleans District (NMFS 1998b). MMS activities are anticipated to result in annual incidental take (by injury or mortality) of twenty five sea

turtles, including no more than five Kemp's ridley, green, hawksbill, or leatherback turtles and no more than ten loggerhead turtles, due to MMS' OCS oil and gas exploration, development, production, and abandonment activities.

(3) Federal Fishery Operations. Adverse effects on threatened and endangered species from several types of fishing gear occur in the action area. Efforts to reduce the adverse effects of commercial fisheries are addressed through both the MMPA take reduction planning process and the ESA section 7 process. Gillnet, longline, trawl gear, and pot fisheries have all been documented as interacting with either whales or sea turtles or both. Other gear types are known to impact whales as well. For all fisheries for which there is a Federal fishery management plan (FMP) or for which any Federal action is taken to manage that fishery, impacts have been evaluated under section 7.

Several formal consultations have been conducted on the following fisheries that NMFS has determined are likely to adversely affect threatened and endangered species: American Lobster, Monkfish, Dogfish, Northeast Multispecies, Atlantic Pelagic Swordfish/Tuna/Shark, and Summer Flounder/Scup/ Black Sea Bass fisheries. These consultations are summarized below; for more detailed information, refer to the respective Biological Opinions.

The *Northeast Multispecies Sink Gillnet Fishery* is one of the other major fisheries in the action area of this consultation that is known to entangle whales and sea turtles. This fishery has historically occurred from the periphery of the Gulf of Maine to Rhode Island in water to 60 fathoms. In recent years, more of the effort in this fishery has occurred in offshore waters and into the Mid-Atlantic. Participation in this fishery declined from 399 to 341 permit holders in 1993 and is expected to continue to decline as further groundfish conservation measures are implemented. The fishery operates throughout the year with peaks in the spring and from October through February. Data indicate that gear used in this fishery has seriously injured right whales, humpback whales, fin whales, and loggerhead and leatherback sea turtles. Waring *et al.* (1997) reports that 17 serious injuries or mortalities of humpback whales from 1991 to 1996 were fishery interactions (not necessarily multispecies gear), the majority of which indicated some kind of monofilament like that used in the multispecies fishery. It is often difficult to assess gear found on stranded animals or observed at sea and assign it to a specific fishery. Only a fraction of the takes are observed, and the catch rate represented by the majority of takes, which are reported opportunistically, *i.e.*, not as part of a random sampling program, is unknown. Consequently, the total level of interaction cannot be determined through extrapolation. The incidental take level established for this fishery is in the July 5, 1989 BO on the Issuing of Exemptions for Commercial Fishing Operations under Section 114 of the MMPA (NMFS, 1989), which estimated that 10 documented Kemp's ridleys, 10 green, 10 hawksbill, 10 leatherback, and 100 loggerhead sea turtles would be killed or injured by the fishery annually.

The *American Lobster pot fishery* is the largest fixed gear fishery in the action area. This fishery is known to take endangered whales and sea turtles. In 1998, NMFS reinitiated formal consultation on the federally regulated lobster fishery to consider potential effects of the transfer of management authority from the Magnuson-Stevens Act to the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA), the implementation of new lobster management actions under the ACFCMA, and recent takes of endangered whales in the fishery. The previous formal consultation on the fishery under the MSFCMA had reached a jeopardy conclusion for the northern right whale with the Biological Opinion issued December 13, 1996. As a result of the RPA included with the 1996 Biological Opinion, an emergency regulation under the MMPA (Emergency Interim Final Rule, 62 FR 16108) was published

implementing restrictions on the use of lobster pot gear in the federal portion of the Cape Cod Bay right whale critical habitat and in the Great South Channel right whale critical habitat during periods of expected peak right whale abundance.

The proposed ACFCMA plan contains measures to limit the number of lobster traps that can be deployed during the first two years of the plan, and further trap reduction measures may be chosen as default effort reduction measures during subsequent plan years. The reduction in the number of traps fished is expected to result in a reduction of entanglement risk. The interaction between the lobster trap fishery and endangered whales is addressed in the Atlantic Large Whale Take Reduction Plan (ALWTRP) implemented via an interim final rule November 15, 1997, followed by a final rule issued February 16,1999. The ALWTRP incorporated the RPA issued with the 1996 Biological Opinion and implemented additional restrictions. Because of the greater protection provided by the ALWTRP, NMFS substituted the ALWTRP for the RPA issued with the 1996 Biological Opinion and has concluded that the lobster fishery in the context of the ALWTRP is likely to adversely affect but is not likely to jeopardize the northern right whale. As with the multispecies BO noted above, the level of incidental take anticipated for this fishery is incorporated within the July 5, 1989 BO on the Issuing of Exemptions for Commercial Fishing Operations under Section 114 of the MMPA, as detailed above (NMFS, 1989).

The monkfish and dogfish fisheries are prosecuted with Multispecies-type gear, and therefore have potential to interact with large whales and are also known to interact with sea turtles. After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, NMFS concluded in a Biological Opinion issued December 21, 1998, that conduct of the monkfish fishery, with modification to reduce impacts of entanglement through the whale and porpoise TRPs, may adversely affect but is not likely to jeopardize the continued existence of endangered and threatened species under NMFS jurisdiction and is not likely to destroy or adversely modify right whale critical habitat.

The *Monkfish Fishery Management Plan* was recently completed by the New England and Mid-Atlantic Fishery Management Councils. This fishery uses several gear types which may entangle protected species, and takes of shortnose sturgeon and sea turtles have been recorded from monkfish trips. The monkfish gillnet sector is included in either the northeast sink gillnet or mid-Atlantic coastal gillnet fisheries and is therefore regulated by the Atlantic Large Whale and Harbor Porpoise Take Reduction Plans. NMFS completed a formal consultation on the Monkfish FMP on December 21, 1998, which concluded that the fishery, with modification under the take reduction plans, is not likely to jeopardize listed species or adversely modify critical habitat. The ITS provided under this BO anticipates up to 6 incidental takes of loggerhead turtles (no more than 3 lethal), 1 lethal or non-lethal take of a green sea turtle, 1 lethal or non-lethal take of a Kemp's ridley, and 1 lethal or non-lethal take of a leatherback. However, the implication of this fishery in the recent pulse of sea turtle strandings in North Carolina noted elsewhere in this Opinion necessitate reinitiation of consultation and likely the current incidental take levels will be revised in a new incidental take statement.

A consultation was recently concluded for *the Spiny Dogfish Fishery.* This fishery is similar to the monkfish fishery, but uses somewhat smaller mesh gear. The recent Biological Opinion prepared for the FMP for this fishery anticipates 6 takes (no more than 3 lethal) of loggerheads, and 1 take (lethal or non-lethal) each for Kemp's ridley, leatherbacks and green sea turtles.

The *Summer Flounder, Scup and Black Sea Bass fisheries* are known to interact with sea turtles. While not documented, the gear-types used in this fishery could entangle endangered whales, particularly humpback whales. Significant measures have been developed to reduce the take of sea turtles in summer flounder trawls and trawls that meet the definition of a summer flounder trawl (which would include fisheries for other species like scup and black sea bass) by requiring TEDs in nets in the area of greatest bycatch off the North Carolina and southern Virginia coast. NMFS is considering a more geographically inclusive regulation to require TEDs in trawl fisheries that overlap with sea turtle distribution to reduce the impact from this fishery. Developmental work is also ongoing for a TED that will work in the flynets used in the weakfish fishery. These fisheries are subject to the requirements of the ALWTRP for gillnets and lobster pots in the Mid-Atlantic. The anticipated observed annual take rates for turtles in this multispecies fishery is 15 loggerheads and 3 leatherbacks, hawksbills, greens, or Kemp's ridley, in combination annually (NMFS, 1997a).

The *Southeast U.S. Shrimp Fishery* is known to incidentally take high numbers of sea turtles. Shrimp trawlers in the southeastern U.S. are required to use TEDs, which reduce a trawler's capture rate by 97%. Even so, NMFS estimated that 4,100 turtles may be captured annually by shrimp trawling, including 650 leatherbacks that cannot be released through TEDs, 1,700 turtles taken in try nets, and 1,750 turtles that fail to escape through the TED (NMFS, 1998d), including large loggerheads. Henwood and Stuntz (1987) reported that the mortality rate for trawl-caught turtles ranged between 21% and 38%, although Magnuson *et al.* (1990) suggested Henwood and Stuntz's estimates were very conservative and likely an underestimate of the true mortality rate.

On November 15, 1997, NMFS implemented the interim final rule for the *Atlantic Large Whale Take Reduction Plan* and issued the final rule February 16, 1999. This plan is designed to reduce the rate of serious injury and mortality of right, humpback, fin, and minke whales incidental to the Northeast sink gillnet, lobster pot, Southeast shark gillnet, and Mid-Atlantic gillnet fisheries to acceptable removal levels as defined in the MMPA. A section 7 consultation was conducted on this Plan, including the operation of the four fisheries regulated by the Plan, which concluded, with a Biological Opinion on the interim final rule issued on July 15, 1997 (NMFS 1997e) (and with an informal consultation on the final rule concluded February 16, 1999 (NMFS 1999a), which determined that the basis upon which the previous consultation was concluded was unchanged) that the implementation of the ALWTRP and continued operation of these fisheries may adversely affect, but is not likely to jeopardize the continued existence of any listed species of large whales or sea turtles under NMFS jurisdiction. The primary take reduction measures of the plan include closures and modification of fishing gear and practices to reduce the adverse impacts of entanglement. Since no changes were anticipated from the existing operations of these fisheries, no additional incidental take was anticipated or authorized in this Opinion.

(4) Other – Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling-water systems of electrical generating plants. At the St. Lucie nuclear power plant at Hutchinson Island, Florida, large numbers of green and loggerhead turtles have been captured in the seawater intake canal in the past several years. Annual capture levels from 1994-1997 have ranged from almost 200 to almost 700 green turtles and from about 150 to over 350 loggerheads. Almost all of the turtles are caught and released alive; NMFS estimates the survival rate at 98.5% or greater (see NMFS 1997e). A biological opinion completed in January 2000 estimates that the operations at the Brunswick Steam Electric Plant in Brunswick, North Carolina, may take 50 sea turtles in any combination annually, that are released alive. NMFS also estimated the total lethal take of turtles at this plant may reach 6 loggerhead, 2 Kemp's ridley or 3 green turtles annually. A biological opinion completed in June 1999 on the operations at the Crystal

River Energy Complex in Crystal River, Florida, estimated the level of take of sea turtles in the plant's intake canal may reach 55 sea turtles with an estimated 50 being released alive biennially.

(b) *State or private actions*

(1) *Private and commercial vessels.* Private and commercial vessels operate in the action area of this consultation and also have the potential to interact with whales and sea turtles. For example, shipping traffic in Massachusetts Bay is estimated at 1,200 ship crossings per year with an average of three per day. More than 280 commercial fishing vessels fish on Stellwagen Bank in the Gulf of Maine, and sportfishing contributes more than 20 vessels per day from May to September. Similar traffic may exist in many other areas within the scope of this consultation which overlap with whale high-use areas. The invention and popularization of new technology resulting in high speed catamarans for ferry services and whale watch vessels operating in congested coastal areas contributes to the potential for impacts from privately-operated vessels in the environmental baseline.

In addition to commercial traffic and recreational pursuits, private vessels participate in high speed marine events concentrated in the southeastern United States that are a particular threat to sea turtles, and occasionally to marine mammals as well. The magnitude of these marine events is not currently known. NMFS and the USCG are in early consultation on these events, but a thorough analysis has not been completed. The Sea Turtle Stranding and Salvage Network (STSSN) also reports many records of vessel interaction (propeller injury) with sea turtles off coastal states such as New Jersey and Florida, where there are high levels of vessel traffic.

(2) *State fishery operations.* Very little is known about the level of take in fisheries that operate strictly in state waters. In addition, depending on the fishery in question, many state permit holders also hold Federal licenses; therefore, section 7 consultations on Federal action in those fisheries address some state-water activity. Impacts of state fisheries on endangered whales are addressed as appropriate through the MMPA take reduction development process. For example, the Atlantic Large Whale Take Reduction Team addresses the mid-Atlantic coastal gillnet fishery, which is largely prosecuted in state waters. NMFS is also actively participating in a cooperative effort with ASMFC to standardize and/or implement programs to collect information on level of effort and bycatch in state fisheries. When this information becomes available, it can be used to refine take reduction plan measures in state waters. With regard to whale entanglements, vessel identification is occasionally recovered from gear removed from entangled animals. With this information, it is possible to determine whether the gear was deployed by a Federal or state permit holder and whether the vessel was fishing in Federal or state waters. In 1998, 3 entanglements of humpback whales were documented in state-water fisheries.

In 1998, East Coast states from Maine through North Carolina began implementing regulations pursuant to the Year 1 requirements of *Amendment 3 to the Atlantic States Marine Fisheries Commission's Coastal Fishery Management Plan for American Lobster* (ASMFC 1997). The proposed Federal ACFCMA plan is designed to be complementary to the ASMFC plan, and the two plans are largely similar in structure. Regulations will be geared toward reducing lobster fishing effort by 2005 to reverse the overfished status of the resource. States in the 6 coastal areas must implement regulations according to a compliance schedule established in Amendment 3. Effort reduction measures will be similar to those proposed in the Federal ACFCMA plan. Several states have implemented trap caps for 1998. Further trap limits, which the compliance schedule requires for Area 1 and the Outer Cape Lobster Management Area in 1999, will generate some localized risk reduction for protected species in those areas. If all states

elect to implement a significant trap reduction program, the overall entanglement risk would be substantially reduced. As the definition of the fishery in the MMPA includes state water effort, vessels fishing in state waters will be required to comply with MMPA take reduction plan regulations designed to reduce entanglement risk to whales.

Early in 1997, the *Commonwealth of Massachusetts* implemented restrictions on lobster pot gear in the state water portion of the Cape Cod Bay critical habitat during the January 1 - May 15 period to reduce the impact of the fishery on right whales. The regulations were revised prior to the 1998 season. State regulations impact state permit holders who also hold Federal permits, although effects would be similar to those resulting from Federal regulations during the January 1 - May 15 period. Massachusetts has also implemented winter/spring gillnet restrictions similar to those in the ALWTRP and the MSFCMA for the purpose of right whale and/or harbor porpoise conservation. Lobster pots are fished in areas outside of Massachusetts where sea turtles and the depleted stock of bottlenose dolphin are present. Entanglement has been documented for both species.

A Biological Opinion on the *NMFS/ASMFC interjurisdictional FMP for weakfish* was conducted in June 1997. Weakfish are caught in the summer flounder fishery and are also fished with flynets. Analyses of the NMFS' observer data showed 36 incidental captures of sea turtles for trawl and gillnet vessels operating south of Cape May, New Jersey from April 1994 through December 1996. Of those turtles taken, 28 loggerheads were taken in trawls that also caught weakfish, and resulted in two deaths. Most of the sea turtle takes occurred in late fall. In all cases, weakfish landings were second in poundage behind Atlantic croaker and summer flounder (NEFSC, unpub. data).

The North Carolina Observer program documented 33 flynet trips from November through April of 1991 – 1994 and recorded no turtles caught in 218 hours of trawl effort. However, a NMFS observed vessel fished for summer flounder for 27 tows with an otter trawl equipped with a TED and then fished for weakfish and Atlantic croaker with a fly net that was not equipped with a TED. They caught one loggerhead in 27 TED equipped tows and seven loggerheads in nine fly net tows without TEDs. In addition, the same vessel using the fly net in a previous trip took 12 loggerheads in 11 out of 13 observed tows targeting Atlantic croaker. Weakfish landings from these fly net tows were second in poundage (NEFSC, unpub.data).

A slight potential does exist for interaction between this fishery and humpback whales, particularly in the mid-Atlantic, but no documentation of such interactions is available.

Georgia and South Carolina prohibit gillnets for all but the shad fishery. This fishery was observed in South Carolina for one season by the NMFS Southeast Fisheries Science Center (McFee et al. 1996). No takes of protected species were observed. Florida has banned all but very small nets in state waters, as has the state of Texas. Louisiana, Mississippi and Alabama have also placed restrictions on gillnet fisheries within state waters such that very little commercial gillnetting takes place in southeast waters, with the exception of North Carolina. Most pot fisheries in the southeast are prosecuted only in areas not likely to be frequented by whales, but in areas frequented by sea turtles.

Pulses of greatly elevated sea turtle strandings occur with regularity in the Mid-Atlantic area, particularly along North Carolina through southern Virginia in the late fall/early spring, coincident with their migrations. For example, in the last weeks of April through early May, 2000, approximately 300 turtles, mostly loggerheads, stranded north of Oregon Inlet, NC. Gillnets were found with four of the carcasses.

These strandings are likely caused by state fisheries as well as federal fisheries, although not any one fishery has been identified as the major cause. Fishing effort data indicate that fisheries targeting monkfish, dogfish, and bluefish were operating in the area of the strandings. Strandings in this area represent at best, 7-13% of the actual nearshore mortality (Epperly *et al.*, 1996). Studies by Bass *et al.* (1998), Norrgard (1995) and Rankin-Baransky (1997) indicate that the percentage of northern loggerheads in this area is highly over-represented in the strandings when compared to the ~ 9% representation from this subpopulation in the overall U.S. sea turtle nesting populations. Specifically, the genetic composition of sea turtles in this area is 25-54% from the northern subpopulation, 46 - 64% from the South Florida sub-population, and 3-16% from the Yucatan subpopulation. The cumulative removal of these turtles on an annual basis would severely impact the recovery of this species.

(c). *Conservation and recovery actions shaping the environmental baseline*

A number of activities are in progress that ameliorate some of the potential threat from the aforementioned activities. Education and outreach are considered one of the primary tools to reduce the threat of impact from private and commercial vessels. The USCG has provided education to mariners on whale protection measures and uses their programs such as radio broadcasts and notice to mariner publications to alert the public to potential whale concentration areas. The USCG is also participating in international activities (discussed below) to decrease the potential for commercial ships to strike a whale. In addition, outreach efforts for fishermen under the ALWTRP are increasing awareness and fostering a conservation ethic among fishermen that is expected in the long run to help reduce overall probability of adverse impacts in the environmental baseline from these commercial fishing activities.

In addition to the ESA measures for Federal actions mentioned in the previous section, numerous recovery activities are being implemented to decrease the level of impacts from private and commercial vessels in the action area. These include the early warning system (EWS), other activities recommended by the Northeast Recovery Plan Implementation Team for the Right and Humpback Whale Recovery Plans (NEIT) and Southeast Recovery Plan Implementation Team for the Right Whale Recovery Plan (SEIT), and NMFS regulations.

(1) The Northeast and Southeast Early Warning Systems. Due to concern over potential collisions between right whales and hopper dredges operating in what is now designated critical habitat for right whales in southeast waters, monitoring requirements placed on the ACOE under a Biological Opinion resulted, in the 1980's, in the first regular aerial survey flights for right whales in waters off the Southeast United States. These surveys evolved over the years and, since late 1993/early 1994, have been officially sponsored by NMFS, the USCG, USN, and ACOE, and became known as the "Early Warning System" or EWS. The surveys were designed as daily reconnaissance flights to detect the presence of whales in and around a number of busy southeast shipping ports, USN vessel and submarine bases, and ACOE dredging sites, in order to alert vessels of the whales' presence and prevent potential whale/vessel collisions. The EWS, with the assistance of the USN and USCG, has evolved a sophisticated communication network which alerts not only dredges and military vessels in the area, but provides broadcasts to mariners via NAVTEX, NOAA Weather Radio, and other means, and even contacts vessels directly via radio when urgently necessary to prevent imminent collision.

Using the SEUS aircraft survey program as a model, efforts were initiated in 1997 to develop a similar program in the Cape Cod Bay (CCB) and the Great South Channel in late winter and early spring. The program is a cooperative effort by NMFS, the USCG, Massachusetts Division of Fisheries, the

Massachusetts Environmental Trust, the Center for Coastal Studies, the USN and MASSPORT (the Boston port authority). As a result of recommendations by the ALWTRT, a similar EWS, known as the "Sighting Advisory System," was established in the northeast in late 1996. NMFS has the ability under the ESA to impose emergency regulations which may be used to protect unusual congregations of right whales. Through a fax-on-demand system, fishermen can obtain SAS sighting reports and, in some cases, can make necessary adjustments in fishing practices to decrease the potential for entanglements. The Commonwealth of Massachusetts was a key collaborator in the 1996-1997 SAS effort and expanded the effort during the 1997-1998 season. The USCG has played a key role in this effort all along, providing both air and sea support, and their continued cooperation is expected throughout. The State of Maine and the Canada Department of Fisheries and Oceans have expressed interest in conducting this type of EWS along their coastal waters. It is expected that other potential sources of sightings such as the U.S. Navy may contribute to this effort following NMFS' commitment to support the SAS over the long-term. The NMFS Maine ALWTRP Coordinator is also working with local aquaria to collect whale sightings from fishing vessels in the Gulf of Maine. All this cooperation will increase the chance of success of this program in diverting potential impacts in the environmental baseline.

(2) The Northeast and Southeast Whale Recovery Implementation Teams. In order to address the known impacts to right and humpback whales described in the Recovery Plans, NMFS established the Northeast and Southeast Recovery Plan Implementation Teams (NEIT and SEIT). The Recovery Plans describe steps to reduce human impacts to levels that will allow the two species to recover and rank the various recovery actions in order of importance. The Implementation Teams provide advice to the various Federal and state agencies or private entities on achieving these national goals within their respective regions. The teams both agreed to focus primarily on habitat and vessel related issues and rely on the take reduction plan process under the MMPA for reducing takes in commercial fisheries.

As part of NEIT activities, a Ship Strike Workshop was held in December 1996 to inform the shipping community of their need to participate in efforts to reduce the impacts of commercial vessel traffic on right whales. The workshop summarized current research efforts using new shipboard and moored technologies as deterrents, and a report was given on ship design studies currently being conducted by the New England Aquarium and Massachusetts Institute of Technology. This workshop increased awareness among the shipping community and has further contributed to reducing the threat of ship strikes of right whales. In addition, a Cape Cod Canal Tide Chart that included information on critical habitat areas and the need for close watch during peak right whale activity was distributed widely to professional mariners and ships passing through the canal. A radio warning transmission was transmitted by Canal traffic managers to vessels transiting the Canal during peak Northern right whale activity periods. Follow-up meetings were held with New England Port Authority and pilots to notify commercial ship traffic to keep a close watch during peak right whale movement periods. In response to current needs, the NEIT is reconfiguring its ship strike subcommittee to address these impacts on a more formal basis. In addition to its ship strike prevention activities, the SEIT established a GIS subcommittee and is progressing with work to analyze right whale sightings, vessel traffic information, and pertinent environmental data in order to better understand right whale distribution patterns in southeast waters and ultimately prevent human interactions with these whales.

(3) The Whale Disentanglement Network. The Center for Coastal studies (CCS), under NMFS authorization, has responded to numerous calls to disentangle various whales entrapped in gear since 1984, and has developed considerable expertise in whale disentanglement. NMFS has supported this effort financially since 1995. The ALWTRP identifies whale disentanglement as an important

component of the take reduction plan. As a result, NMFS greatly increased funding for this network, purchasing equipment caches to be located at strategic spots along the Atlantic coastline, supporting training for fishers and biologists, purchasing telemetry equipment, etc. This has resulted in a greatly expanded capacity for disentanglement along the entire Atlantic seaboard, including offshore areas. MOUs developed with the US Coast Guard ensure their participation and assistance in the disentanglement effort. As a result, NMFS believes that many whales which may otherwise have succumbed to complications from entangling gear, are being set free to survive the ordeal.

(4) Reducing Potential for Vessel Related Impacts. As part of recovery actions aimed at reducing vessel related impacts, NMFS published a proposed rule in August 1996 restricting vessel approach to right whales (61 FR 41116) to distances outside of 500 yards in order to minimize human-induced disturbance. The Recovery Plan for the Northern Right Whale identified disturbance as one of the principal human-related factors impeding right whale recovery (NMFS 1991b). Following public comment, NMFS published an interim final rule in February 1997 codifying the regulations. With certain exceptions, the rules prohibit both boats and aircraft from approaching any right whale closer than 500 yds. The regulations are consistent with the Commonwealth of Massachusetts' approach regulations for right whales. These are expected to reduce the potential for vessel collisions inherent in the environmental baseline.

In April 1998, the USCG submitted, on behalf of the United States, a proposal to the International Maritime Organization (IMO) requesting approval of a mandatory ship reporting system in two areas off the east coast of the United States. The USCG worked closely with NMFS and other agencies on technical aspects of the proposal. The proposal was submitted to the IMO's Subcommittee on Safety and Navigation for consideration and submission to the Marine Safety Committee at IMO and approved in December 1998. The system will require all vessels over 300 tons to report to a shore-based station, thereby prompting a return message which provides precautionary measures to be taken to reduce the likelihood of a ship strike and locations of recent right whale sightings. The reporting system was initially implemented on July 1, 1999. The USCG and NOAA are playing important roles in helping to implement the system.

(5) Measures to Reduce Incidental Takes of Sea Turtles in Commercial Fisheries. NMFS implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles in commercial fisheries. In particular, NMFS has required the use of TEDs in southeast U.S. shrimp trawls since 1989 and in summer flounder trawls in the mid-Atlantic area (south of Cape Charles, Virginia) since 1992. It has been estimated that TEDs exclude 97% of the turtles caught in such trawls. These regulations have been refined over the years to ensure that TED effectiveness is maximized through proper placement and installation, configuration (e.g., width of bar spacing), floatation, and more widespread use. Recent analyses by Epperly and Teas (1999) indicate that the minimum requirements for the escape opening dimensions are too small, and that as much as 47% of the loggerheads stranding annually along the Atlantic seaboard and Gulf of Mexico were too large to fit through existing openings. On April 5, 2000, NMFS published an Announcement of Proposed Rulemaking to require larger escape openings (65 FR 17852).

In 1993 (with a final rule implemented 1995), NMFS established a Leatherback Conservation Zone to restrict shrimp trawl activities from off the coast of Cape Canaveral, Florida, to the North Carolina/Virginia border. This provides for short-term closures when high concentrations of normally pelagically distributed leatherbacks are recorded in more coastal waters where the shrimp fleet operates.

This measure is necessary because, due to their size, adult leatherbacks are larger than the escape openings of most NMFS-approved TEDs. This rule was originally established because of coastal concentrations of leatherbacks which sometimes appear during their spring northward migration, but the rule was also recently implemented in the fall of 1999 off the coast of northern Florida due to unseasonal concentrations there, and leatherback TEDs were also required off the coast of Texas in the spring of 2000 due to unusual numbers of leatherback strandings there.

NMFS is also working to develop a TED which can be effectively used in a type of trawl known as a flynet, which is sometimes used in the mid-Atlantic and northeast fisheries to target sciaenids and bluefish. Limited observer data indicate that takes can be quite high in this fishery. A prototype design has been developed, but testing under commercial conditions is still necessary.

NMFS closed part of Pamlico Sound to the setting of gill nets targeting southern flounder in fall 1999 after the strandings of relatively large numbers of loggerhead and Kemp's ridley sea turtles on inshore beaches. This is a state regulated fishery. NMFS also closed the waters north of Cape Hatteras to 38° N., including the mouth of the Chesapeake Bay, to large (> 6 inch stretched) mesh gillnets for 30 days in mid-May 2000 due to the large numbers of loggerhead strandings in North Carolina. A large proportion of these loggerheads was assumed to be from the northern subpopulation. NMFS will continue to implement such proactive measures as necessary.

In addition, NMFS has been active in public outreach efforts to educate fishermen regarding sea turtle handling and resuscitation techniques. As well as making this information widely available to all fishermen, NMFS recently conducted a number of workshops with longline fishermen to discuss bycatch issues including protected species, and to educate them regarding handling and release guidelines. NMFS intends to continue these outreach efforts and hopes to reach all fishermen participating in the pelagic longline fishery over the next 1 to 2 years.

(6) Sea Turtle Stranding and Salvage Network Activities. There is an extensive network of sea turtle stranding and salvage network (STSSN) participants along the Atlantic and Gulf of Mexico which not only collects data on dead sea turtles, but also rescues and rehabilitates any live stranded turtles. In most states, the STSSN is coordinated by state wildlife agency staff, although some state stranding coordinators are associated with academic institutions. Data collected by the STSSN are used to monitor stranding levels and compare them with fishing activity in order to determine whether additional restrictions on fishing activities are needed. These data are also used to monitor incidence of disease, study toxicology and contaminants, and conduct genetic studies to determine population structure. All of the states that participate in the STSSN are collecting tissue for and/or conducting genetic and ageing studies to better understand the population dynamics of the small subpopulation of northern nesting loggerheads. These states also tag turtles as live ones are encountered (either via the stranding network through incidental takes or in-water studies). Tagging studies help provide an understanding of sea turtle movements, longevity, reproductive patterns, *etc.*

(d). *Other potential sources of impacts in the environmental baseline.*

A number of activities that may indirectly affect listed species in the action area of this consultation include discharges from wastewater systems, dredging, ocean dumping and disposal, and aquaculture. The impacts from these activities are difficult to measure. Where possible, however, conservation actions are being implemented to monitor or study impacts from these elusive sources. For example,

extensive monitoring is being required for a major discharge in Massachusetts Bay (Massachusetts Water Resources Authority) in order to detect any changes in habitat parameters associated with this discharge. Close coordination is occurring through the section 7 process on both dredging and disposal sites to develop monitoring programs and ensure that vessel operators do not contribute to vessel-related impacts.

NMFS and the U.S. Navy have been working cooperatively to establish a policy for monitoring and managing *Acoustic Impacts from Anthropogenic Sound Sources* in the marine environment. Acoustic impacts can include temporary or permanent injury, habitat exclusion, habituation, and disruption of other normal behavior patterns. It is expected that the policy on managing anthropogenic sound in the oceans will provide guidance for programs such as the use of acoustic deterrent devices in reducing marine mammal-fishery interactions and review of Federal activities and permits for research involving acoustic activities. The Office of Naval Research hosted a meeting in March 1997 to develop scientific and technical background for use in policy preparation. NMFS hosted a workshop in September 1998 to gather technical information which will support development of new acoustic criteria.

Aquaculture is currently not concentrated in whale high-use areas, but some projects have begun in Cape Cod Bay Critical Habitat and in other inshore areas off the Massachusetts and New Hampshire coast. Acknowledging that the potential for impacts is currently unknown, NMFS is coordinating research to measure habitat related changes in Cape Cod Bay and is ensuring through the section 7 process that these facilities do not contribute to the entanglement potential in the baseline. Many applicants have agreed to alter the design of their facilities to minimize or eliminate the use of lines to the surface that may entangle whales and/or sea turtles.

The *Massachusetts Environmental Trust and Massachusetts Division of Marine Fisheries* have funded several projects to investigate fixed fishing gear and potential modifications to reduce the risk of entanglement to whales. These projects are an important complement to the NMFS research effort and have yielded valuable information on the entanglement problem. The Trust has also funded research on right whales in the Cape Cod Bay critical habitat area.

Summary and synthesis of the status of species and environmental baseline

In summary, the potential for vessels, military activities, fisheries, *etc.* to adversely affect whales and sea turtles remains throughout the action area of this consultation. However, recovery actions have been undertaken as described and continue to evolve. Although those actions have not been in place long enough for a detectable change in the northern right whale population (or other listed species populations) to have occurred, those actions are expected to benefit the northern right whale and other listed species in the foreseeable future. These actions should not only improve conditions for listed whales and sea turtles, they are expected to reduce sources of human-induced mortality as well.

However, a number of factors in the existing baseline for right whales, loggerhead sea turtles and leatherback sea turtles leave cause for considerable concern regarding the status of these populations, the current impacts upon these populations, and the impacts associated with future activities planned by the USN and other federal agencies.

- The northern right whale population continues to be declining. Based on recent estimates this population currently numbers fewer than 300 individuals and only one calf was observed in 1999. Losses of adult whales due to ship strikes and entanglements in fishing gear continue to

depress the recovery of this species.

- The leatherback sea turtle is declining worldwide. Not considering takes associated with the NMFS HMS fisheries, other sources of mortality incurred by this population exceed the 1% sustainable level projected by Spotila *et al.* (1996).

- The northern subpopulation of loggerhead sea turtles is declining and currently numbers only about 3,700 nesting females. The percent of northern loggerheads represented in sea turtle strandings in northern U.S. Atlantic states is over-representative of their total numbers in the overall loggerhead population. Pelagic immature phase animals are critical to growth of the population as a whole. Current take levels from other sources, particularly fisheries (especially trawl and gillnet fisheries), are high.

IV. Effects of the Proposed Action

General Effects (Injury or Death)
The effects of an underwater explosion on marine mammals and sea turtles are dependent upon many factors, including the size, type, and depth of both the animal and the explosive, the depth of the water column, and the standoff distance from the charge to the animal. Potential impacts can range from brief acoustic effects, tactile perception, and physical discomfort to both nonlethal and lethal injuries. Annoyance and discomfort of marine mammals and turtles could occur as a result of noninjurious physiological responses to both the acoustic signature and the shock wave from the underwater explosion. Nonlethal injury includes slight injury to internal organs and the auditory system; however, delayed mortality can be a result of complications from individual or cumulative sublethal injuries. Short-term or immediate lethal injury would be a result of massive combined trauma to internal organs as a direct result of proximity to the point of detonation. It is very unlikely that injury would occur from exposure to the chemical by-products released into surface waters (Young 1984; Naval Surface Warfare Center (NSWC) 1992).

The following describes the general effects of the underwater detonations on green turtles and marine mammals. Data is limited regarding the effects of underwater explosions on marine mammals, and even less is known about the effects on sea turtles.

Marine Mammals. Early studies conducted in the 1970s showed that the principal sites for damage in marine mammals from explosives would be the lungs and the hollow viscera. Lung injury is manifested by alveolar ruptures and lacerations resulting in massive hemorrhage. Damage to the viscera is usually limited to the portions of the lower intestine containing gas and is characterized by contusions and rupture of the intestinal walls.

For marine mammal species, the pressure wave from the explosive can impact air cavities, such as lungs and intestines causing instantaneous or proximate mortality. Extensive hemorrhaging into the lungs due to underwater shock waves may cause death to a marine mammal through suffocation (Hill, 1978). Other common injuries which may result in mortality include circulatory failure, broncho-pneumonia in damaged lungs, or peritonitis resulting from perforations of the intestinal wall (Hill 1978). The degree of injury associated with impulse levels and increased mammal mass is believed directly proportional (Yelverton, et al. 1973), therefore, conservative criteria for the impulse effect are based on the lowest possible affected mammalian weight (e.g. calf dolphin)(U.S. Navy, 1998).

Non-lethal injuries include slight lung hemorrhage and tympanic membrane (TM) rupture from which the mammal is expected to recover (Yelverton, et al. 1973; Richmond, et al. 1973). Eardrum damage criteria are based upon a limited number of small charge tests (Yelverton, et al. 1973; Richmond et al. 1973). Ranges for percent TM rupture incurred by underwater explosives can be calculated by a conservative TM damage model (U.S. Navy 1996). General criteria for TM damage have been reported to occur at impulse levels down to 20 psi-msec (Yelverton, et al. 1973).

Because eardrum (e.g. TM) rupture, rather than slight lung hemorrhage usually occurs at lower impulse levels, TM rupture is used by NMFS and others to conservatively define the non-lethal injury zone. A maximum impulse of 10 psi-msec is often considered to demarcate the non-lethal injury zone, where a very low instance of blast injuries are likely to occur (Yelverton, et al. 1973). A level of pressure impulse at which marine mammals are not expected to experience non-lethal injury (nor instantaneous mortality or lethal injury) is reported to be 5 psi-msec (Yelverton, et al. 1973). This was the impulse level adopted by the Air Force to designate no injurious takings in the explosive testing of obstacle and mine clearance systems at Eglin Air Force Base to be conducted in cooperation with the Naval Surface Warfare Center-Coastal Systems Station (NSWC-CSS) for which the U.S. Navy received a small take authorization pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361, *et seq*).

Based upon information provided in the USS Seawolf shock trial final environmental impact statement (U.S. Navy, 1998), a dual criteria for marine mammal acoustic harassment was developed for explosive-generated signals: (1) An energy-based temporary threshold shift (TTS) injury criterion of 182 dB re 1 micro-pascal squared - second derived from bottlenose dolphins (Ridgeway, et al. 1997); and (2) a 12 - lbs/in2 (psi) peak pressure cited by Ketten (1995) as associated with a "safe outer limit (for the 10,000 lb charge for the minimal, recoverable auditory trauma" (i.e., TTS)).

The USS John Paul Jones shock trial analyses predicted safety ranges for smaller charges calculated for distances based on slight lung injury associated with a 10,000 lb charge, slant range, doubled.[3] (NMFS, 1993)

Charge Weight (lbs)	Safety Range (feet)	Maximum Pressure (psi)
1	600	18
10	1,500	16
100	3,000	17
1000	6,076	19

Based on a parametric evaluation of the effects of charge weight and depth using the Goertner (1982) model, Young (1991) concluded that a conservative safe range for noninjury to a small mammal (such as a dolphin calf) was approximated by $R=578w^{0.28}$ (R is in feet and w is in pounds of explosive). The injury mortality contours developed for the proposed USS Winston S. Churchill ship shock trial also

[3]Each calculation is scaled by the cube root for the different charge weights.

considered the impacts of a 10,000 lb charge at a depth of 1,100 ft. For the DDG 81 shock trial, this equation yields a nominal "safe" standoff range of 7,620 ft or 1.25 nm for small marine mammals, which would be the most vulnerable to blast injury.

Goertner (1982) modeled safe-ranges for large and small whales for different charge weights and depths. For a 1,200 lb. charge the safe range for a 55 ft. long generic whale was estimated at about 900+ ft. from the charge at 125 ft. depth. For a 20 ft. long whale the safe range extended to 1,800+ ft. The safe ranges become shorter above 125 ft. depth up to a minimum of about 200 ft. horizontal distance at the surface.

Injury contours developed for the Naval vessel USS Seawolf ship shock program show a safe range (no injury) of 6,086 ft. for a 10,000 lb. charge at a 100 ft. depth and the cetacean on the bottom. This range is the same for all sizes of cetaceans, from a dolphin calf (27 lbs.) to a large whale (64,800 lbs.). The 50% mortality contour for the same size charge is 2,442 ft. for the dolphin calf and about 1,000 ft. for the large whale.

Injury contours developed for the Naval vessel USS Winston S. Churchill ship shock program calculated a safe range for 27 lb calf dolphin of 3.4 nmi ft. for a 10,000 lb. charge at a 1,100 ft. depth and the cetacean on the bottom. The U.S. Navy assumes the injury threshold range is independent of the size of animal, but varies with animal depth. For any size animal, the threshold would be less than or equal to the threshold as calculated for the bottom positioned cetacean. At this threshold (pressure is greater than 15 psi and the energy flux density is greater than 0.06 in-lb/in^2 or 1.1 milli-Joules/cm^2), the injury sustained is predicted to be moderate stings (tactile perception). Since tactile perceptions which could cause behavioral disruption might be considered harassment, the Navy developed a different, more conservative, threshold for marine mammal harassment based on auditory effects. This threshold is calculated so that the maximum dB level caused by the explosion outside the safety range is 182 dB. This distance to the threshold is called the critical distance and it represents the shortest distance at which a TTS is not expected to occur in marine mammals (and, by extrapolation, sea turtles). As discussed above, the injury contours for smaller charges that have been established for smaller charges are applied herein to analyze the effects of the explosions marine mammals.

Sea turtles. There are no comparable data for sea turtles, although some information on impacts to turtles from explosions are reported by the National Research Council (1996), Klima *et al.* (1988), and O'Keeffe and Young (1984). Therefore, we will assume that the distances provided above represent "safe" distances for sea turtles, since the safety ranges are approximately four times the approximate range for minor injury and three times the non-injury range for a 200-300 lb sea turtle (O'Keefe and Young, 1981).[4] These calculated ranges, however, are based upon impacts assessed at depths different

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[4]For more information regarding the type of injury associated with charge weight and distance, please see Table 2 of the Environmental Assessment on the Proposed Regulations Governing the Taking of Marine Mammals Incidental to Underwater Detonation of Conventional Explosives in the Offshore Waters of the Outer Sea Test Range of the Naval Air Warfare Center, Pt. Mugu, Californaia. The harassment calculations are based on single pulse level of 160 dB,

than those expected in the proposed trials, and are not, therefore, directly applicable to the proposed action.

As stated above, there are few reports on injuries and virtually no quantitative data concerning the direct effects of underwater explosions on sea turtles. Turtles might sustain a number of effects ranging from physical shattering to effects (permanent to temporary) on auditory system and other internal systems. For completeness, the following summarizes the information on impacts to turtles from explosions as reported by the National Research Council (1996), U.S. Army at Kwajelein Atoll, Klima et al. (1988), and O'Keeffe and Young (1984).

The National Research Council (1996) reports that two immature green turtles (100 to 150 feet away) were killed when 20 lbs NEW of plastic explosives (C-4) were detonated in open water. Necropsies revealed extensive internal damage, particularly to the lungs. Water, charge and turtle depths are unknown. Turtle body mass is also unknown, but is assumed the turtles were small or immature.

Reports from a project at Kwajalein Atoll to remove two coral heads from entrance channels to the fuel pier at U.S. Army Kwajalein Atoll (USAKA) indicate that explosive charges of 40 pounds at depths of less than 40 feet can injure or stun small hawksbill turtles of a carapace length of approximately 19 inches at a range of 700 feet (U.S. Army Kwajalein Atoll unpub. memorandum of record, 1992).

Klima *et. al.* (1988) conducted an experiment in which Kemp's ridley and loggerhead turtles were placed in cages at four distances from a oil platform to be removed with explosives. The cages were submerged to a depth of 15 ft over the 30 ft sea bottom just prior to the simultaneous explosion of four 50.75 lb charges of nitromethane placed inside the platform pilings at a depth of 16 ft below the mudline. Loggerhead and Kemp's ridley turtles at 750 ft and 1,200 ft, as well as one loggerhead at 3,000 ft were rendered unconscious. The Kemp's ridley turtle closest to the explosion (range of 750 ft) was slightly injured, with an everted cloacal lining; ridleys at ranges of 1,200 ft, 1,800 ft and 3,000 ft were apparently unharmed. All loggerheads displayed abnormal pink coloration caused by dilated blood vessels at the base of the throat and flippers, a condition that persisted for about 3 weeks.

O'Keeffe and Young (1984) analyzed data from three underwater shock tests carried out off Panama City, Florida in 1981. During each test, a charge equivalent of 1,200 lb of TNT was detonated at mid-depth in water about 120 ft deep. At least three turtles were noted in the area following the detonations. One turtle at a range of 500 to 700 ft was killed. A second turtle at a range of 1,200 ft received minor injuries. A third turtle at 2,000 ft was apparently unaffected. At a depth of 60 ft, calculated shock wave pressures are 239, 161, 85, and 47 psi at ranges of 500, 700, 1,200, and 2,000 ft, respectively.

As noted above, Young (1991) concluded that a conservative safe range for non-injury to a small mammal (representative of a calf dolphin) was approximated by $R=578w^{0.28}$ (R is in feet and w is in

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not the 182 dB level considered in this analysis.

pounds of explosive). O'Keeffe and Young (1984) proposed that a safe range for turtles from an underwater explosion could be expressed by $R = 200\ w^{1/3}$, where R is the safe range in feet and w is the charge weight in pounds. This equation was subsequently modified by Young (1991) based on safe ranges established by the NMFS for platform removal operations using explosives. The revised equation is $R = 560\ w^{1/3}$. Applied to the Klima *et. al.* (1988) observations, this equation predicts a safe range of 3,291 ft, which exceeds the greatest distance at which an effect was observed (turtle unconscious at 3,000 ft). Applied to the O'Keeffe and Young (1984) report, this equation predicts a safe range of 5,951 ft, nearly triple the range from the charge of the uninjured turtle. For the conditions of the proposed Winston S. Churchill action, this equation would predict a safe range of 12,065 ft or 2 nm, which is the same as the safety range established for the proposed action. At this range, the modified Goertner model predicts the onset of slight lung injury only for those animals weighing less than 0.5 lb.

The above calculated safe ranges addressed physical injury to sea turtles but did not include reference to the difficult to detect physical effects on the auditory system. These effects include physical change to the auditory system which results in a permanent or temporary threshold shift of hearing capability. 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 extra-columella, a cartilaginous disk, located at the entrance to the columella, a long, thin bone that extends from the middle ear cavity to the entrance of the inner ear or otic cavity (Ridgway et al., 1969). Sound arriving at the inner ear via the columella is transduced by the bones of the middle ear. Sound also arrives by bone conduction through the skull. Low frequency sounds at high source levels can also be detected by vibration-sensitive touch receptors in various other parts of the turtle's body (mechano-reception). Any disruption (permanent or temporary) of this system may result in injury and/or death of the animal. On the other hand, some effects may be temporary and/or slight and will not impact the survivorship of animal. These effects could, however, result in the harassment of animals.

General Effects (Acoustical Harassment)

Direct effects of low frequency noise and blast effects include the potential for injury and mortality, auditory permanent threshold shifts (PTS), auditory temporary threshold shifts (TTS), and behavioral disruption and habituation, including long-term effects.

Marine mammals. To date, there have been no controlled studies on the hearing capabilities of sperm, humpback, fin, or right whales. Data from the limited studies on bottlenose dolphins (Ridgeway et al. 1997) and beluga whales (Ridgeway, in press) indicate that the auditory effects of underwater noise on cetaceans differ from the more studied terrestrial mammals. Although marine mammals possess auditory mechanics similar to terrestrial mammals (air filled middle ear), the cetacean ear is adapted to accommodate rapid pressure changes. The extent and result of that accommodation, however, is unknown. At least one researcher has concluded that it is possible that cetaceans, because of their marine adaptations, are more vulnerable to blast injury (Richardson et al. 1995). In 1996 Todd et al. described the effects of construction site underwater explosions on humpback whales. The explosions

took place in a narrow, shallow fjord-like area and ranged from charges of 2,200 lb to 12,125 lb. The same 1 nmi detonation unsafe zone was instituted for all explosions. Detonations occurred repeatedly over a period of months. Humpback whales did not display overt behavioral responses, but did, over a period of time, experience an increased entrapment rate in fishing gear. Damage to the eardrums were discovered in the entraped whales. Ketten et al. (1993) concluded that the increased entrapment could have been due to cumulative effects of repeated exposure to explosions, the effects of which were increased in intensity due to the shape and constitution of the blast area.

In addition to mortal injury, other physical auditory effects might be sustained by cetaceans. Both sensorineural loss (insult, loss of ear hairs) and permanent damage to middle ear mechanics (rupture of ossicles, eardrums) might be sustained. Marine Mammals have morphological adaptations to the marine environment whereby energy is conducted through head tissues to the inner ear rather than through the drum and ossicles. Damage to the auditory complex at any pathway may result in either a permanent (non-recoverable) threshold (PTS)shift or a temporary threshold shift (TTS). Threshold shifts affect an animal's ability to hear and echolocate. Effects to the auditory systems of marine mammals such as permanent threshold shift (PTS) or permanent loss of all hearing, may also eventually lead to mortality if sufficiently severe. The loss of ability to hear environmental cues, communicate with conspecifics, or forage could result in compromised body condition, increased susceptibility to entanglement or entrapment, collision with ships, or reduced reproductive success.

Possible short-term reactions of mysticetes disturbed by human-made noise include interruption of feeding, resting, or social activities, and abrupt diving or swimming away (Finley, 1982; Calkins, 1983). Various studies and reported observations for a number of different mysticete species indicate variability in the responses to sounds of relatively high intensity (Bowles, et al., 1994; Malme et al., 1984; Maybaum, 1989; Mobley et al., 1988; Richardson et al., 1985; Richardson et al., 1991). In most instances, responses are affected by species, age and sex class, social context, habitat, habituation, and sound source characteristics. Observed effects are generally fewer and less pronounced with respect to constant and predictable acoustic characteristics.

There is variability in sensitivity and response to human-made noise between and within marine mammal species and a paucity of information about the consequences of short-term disruptions on marine mammals. Disturbance of marine mammals as a result of human-made noise, if intense enough, can result in interruption (at least briefly) of normal behavioral and social interactions with conspecifics, an increase in energy cost (whether or not feeding was disrupted or a flee response was elicited), and displacement to a less preferred habitat. Displacement can also have the benefit of removing the animal from a location where there might be more serious consequences had the animal remained (e.g., by reducing the potential for serious injury and death from the effect of the exploding ordnance or the physiological stress that might continue if the animal remained close to the source).

Although there is little definitive information about the long-term effects of short-term disturbance reactions, isolated disturbances probably have minimal or no lasting effects and the energetic consequences of most single disturbance incidents are likely insignificant.

Site-specific hydrographic data from the Mayport test area was used to calculate the harassment range. Separate ranges were calculated for odontocetes and mysticetes based on their differing sensitivity to low frequencies. For odontocetes, all frequencies greater than or equal to 100 Hz were included. For mysticetes, the frequency range was extended down to 10 Hz.

Sea turtles. Sea turtle auditory sensitivity has not been well studied. A few preliminary investigations suggest that it is limited to low frequency band-widths, such as the sounds of waves breaking on a beach. The role of underwater low frequency hearing in sea turtles is unclear. It has been suggested that sea turtles may use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Moein et al., 1983).

Although it is possible that green turtles in the vicinity of an in-water detonation might experience a temporary or permanent threshold shift, it is not known what energy levels and received levels are necessary to induce threshold shifts. The few studies completed on the auditory capabilities of sea turtles (adult green, loggerhead, and Kemp's ridley *(Lepidochelys kempii)* suggest that they could be capable of hearing low frequency sounds (Ridgway et al.,1969; Moein et al., 1983; Lenhardt,1994) Ridgway *et al.* (1969) reported maximal sensitivity for green sea turtles occurred at 300 to 400 Hz, with a rapid decline in sensitivity for lower and higher tones. Similarly, Moein *et al.* (1994) reported a hearing range of about 250 to 1,000 Hz for loggerhead sea turtles, and Lenhardt (1994) stated that maximal sensitivity in sea turtles generally occurs in the range from 100 to 800 Hz. Calculated in-water hearing thresholds within the useful range appear to be high (e.g., about 160 to 200 dB re 1 μPa; Lenhardt, 1994). Based on this and other information, the U.S. Navy determined that the acoustical harassment range predicted for odontocetes using frequencies ≥100 Hz should be accepted as the conservative measure for sea turtles.

Moein et al. (1983) and O'Hara and Wilcox (1990) indicate that low frequency acoustic sound transmissions at source levels of 141-150 dB could potentially cause increased surfacing behavior and deterrence from the area near a sound source. In this instance, if they surface more frequently, turtles will not be at a greater risk of collision with transiting vessels as vessel traffic will be halted during detonation operations.

Deterrence from the area could result in temporary or permanent displacement of individuals. Individual green turtles that forage or rest within vicinity of the explosion may relocate due to startle responses from sensing the blast impulse waves through the substrate.

The concept of a safety range is an integral part of the proposed action. The area within the safety range would be monitored by all components of the mitigation team and detonation would not occur until it is clear of detectable marine mammals and sea turtles, as well as indicators of sea turtle presence such as large *Sargassum* rafts and jellyfish aggregations. The purpose of the safety range is to prevent deaths and serious injuries to marine mammals and sea turtles. The safety range radius of 2 nm around the detonation point exceeds the estimated ranges for mortality and injury to a marine mammal or sea turtle associated with detonation of a 10,000 lb explosive.

For mitigation monitoring purposes, a 1 nm radius buffer zone has also been added to the 2 nm radius safety range to account for the possible movement of marine mammals and sea turtles towards the safety range. Specifically, the area encompassed within a 3 nm radius from the detonation point would be visually monitored to detect any marine mammals or sea turtles approaching the 2 nm safety range There are no data for acoustical harassment in sea turtles. Therefore, the criterion developed for odontocete marine mammals has been applied to estimate potential harassment. Ridgway *et al.* (1969) reported maximal sensitivity for green sea turtles occurred at 300 to 400 Hz, with a rapid decline in sensitivity for lower and higher tones. Similarly, Moein *et al.* (1994) reported a hearing range of about 250 to 1,000 Hz for loggerhead sea turtles, and Lenhardt (1994) stated that maximal sensitivity in sea turtles generally occurs in the range from 100 to 800 Hz. Calculated in-water hearing thresholds within the useful range appear to be high (e.g., about 160 to 200 dB re 1 μPa; Lenhardt 1994). Based on this information, the acoustical harassment range predicted for odontocetes using frequencies ≥100 Hz should be conservative for sea turtles.

Water depth is an important factor in the calculation of the harassment range. Since the shock trial may occur at any point within the test area, three water depths were chosen to be geographically representative of the test area. The shallowest water depth considered was 600 ft, the minimum depth at which the shock trial would be conducted. Two other depths were chosen to represent (approximately) the geographic middle and the deepest part of the test area.

The depth with the highest calculated harassment range was used to calculate the numbers of harassed animals as a result of the proposed action. Expected numbers of marine mammals and turtles within this range were calculated using mean densities from the various surveys discussed in this Opinion, adjusted to account for submerged (undetectable) individuals. Nearly all of the harassment area is expected to be outside the safety range. The harassment areas is 13.6 nm for odontocetes and sea turtles and 15.0 nm for mysticetes.

Effects on Specific Species

Sperm Whales

Although sperm whales are the most likely of the marine mammals considered in this Opinion to be exposed to the proposed activities, NMFS does not expected sperm whales to be injured or killed as a result of the proposed action. The anticipated effects to any sperm whales within the action area during the detonation might include any one or a combination of the following effects: serious injury or mortality, premanent threshold shifts, temporary threshold shifts, and a temporary change in behavior. As there have been infrequent observations of sperm whales in the action area, it is not expected that the proposed activities associated with the Winston S. Churchill will cause injury or mortality to this species. In the event that a sperm whale is observed in or near the action area, the Navy has proposed conservation measures that will involve suspension of operations until the whale has left the safety range and buffer zone. Thus, the low likelihood of occurrence of a sperm whale in the action area, combined with a suspension of operations if one is sighted, should effectively negate the possibility of injury or mortality of sperm whales as a direct result of the proposed activities. As discussed below, however, non-injurious take of sperm whales due acoustic harrassment is likely outside of the safety and buffer

areas.

Site-specific hydrographic data from the Mayport test area was used to calculate the harassment range for listed whales. Separate ranges were calculated for odontocetes and mysticetes based on their differing sensitivity to low frequencies. For sperm whales and other odontocetes, all frequencies greater than or equal to 100 Hz were included. For right, fin, and humpback whales and other mysticetes, the frequency range was extended down to 10 Hz. Using densities based on aerial surveys conducted by the Navy (April-September 1995, May-September 1997, and June and August 1999) NMFS predicts that 14 sperm whales may be acoustically harassed as a result of the four detonations resulting from the proposed action in the Mayport action area. This harassment is expected to be in the form of a temporary threshold shift (TTS), which is a change in the threshold of hearing which could temporarily affect an animal's ability to hear calls, echolocation, and other ambient sounds. These effects are not expected to affect the sperm whales' likelihood of survival and recovery in the wild, by adversely affecting birth rates, death rates, or recruitment rates of this endangered whale. Specifically, NMFS does not expect the proposed activities will affect adult female whales in a way that reduces the number of young born in a particular year, the survival of young whales under the care of an adult female, or the number of sperm whales that recruit into the adult breeding population.

Fin, humpback and right whales. Since fin, humpback, and right whales are not expected to be present in the action area and be exposed to the proposed activities, NMFS does not anticipate these species will be injured or killed as a result of the proposed action. The anticipated effects to any fin, humpback, or right whales which could occur within the action area during the detonation might include the same effects described above for sperm whales: serious injury or mortality, premanent threshold shifts, temporary threshold shifts, and a temporary change in behavior. As there have been rare to very infrequent observations of these species in the action area, it is not expected that the proposed activities associated with the Winston S. Churchill will likely be detected by any of these species. However, in the unlikely event that one of these species is observed in or near the action area, the Navy has proposed conservation measures that will involved suspension of operations until the whale has left the safety range and buffer zone. Thus, the already low likelihood of occurrence of a fin, humpback or right whale in the action area, combined with a suspension of operations if one is sighted, should effectively negate the possibility of injury or mortality of these species as a direct result of the proposed activities. As discussed below, however, non-injurious take of fin, humpback, or right whales due acoustic harrassment is more likely outside of the safety and buffer areas.

Site-specific hydrographic data from the Mayport test area was used to calculate the harassment range for listed whales. Separate ranges were calculated for odontocetes and mysticetes based on their differing sensitivity to low frequencies. For sperm whales and other odontocetes, all frequencies greater than or equal to 100 Hz were included. For right, fin, and humpback whales and other mysticetes, the frequency range was extended down to 10 Hz. However, using densities based on aerial surveys conducted by the Navy (April-September 1995, May-September 1997, and June and August 1999) NMFS does not predict that fin, humpback, or right whales may be acoustically harassed as a result of the four detonations resulting from the proposed action in the Mayport action area. In the unlikely event that an individual whale is harassed, effects are also expected to be in the form of a temporary threshold shift (TTS), which

could change the threshold of hearing and temporarily affect an animal's ability to hear calls, echolocation, and other ambient sounds. These effects are not expected to affect fin, humpback, or right whales' likelihood of survival and recovery in the wild, by adversely affecting birth rates, death rates, or recruitment rates of these endangered whales. However, based on the best available information regarding the distribution of these species within the action area, NMFS does not anticipate that harrassment of fin, humpback, or right whales will occur.

Sea Turtles

Two turtle species, leatherback and loggerhead, were sighted during the Navy's June and August 1999 surveys. Unidentified turtles were also sighted. Leatherbacks and loggerheads accounted for 56% and 30%, respectively, of the total estimated density of 0.288 turtles/100 km^2 (100 km^2 is approximately the size of the buffer zone and safety range combined). These density calculations are based on what is seen at the surface during the respective surveys and do not take into account animals submerged during these surveys, therefore these are minimum estimates.

The 1999 Mayport densities were considerably lower than those estimated previously during 1995 and 1997 Seawolf surveys (0.830 and 1.780 turtles/100 km^2, respectively). However, the Seawolf surveys covered only the shallowest portion of the current test area and the higher densities may be related to the position of the Gulf Stream western wall. Previous observations (Hofmann and Fritts 1982; Fritts *et al.* 1983; Thompson 1984) have shown that turtles are concentrated inshore of the western wall, with very low densities in the Gulf Stream itself. The position of the western wall varies but is generally inshore of the test area. Satellite imagery of sea surface temperature taken during both June and August 1999 surveys show the Gulf Stream flowing directly over the Mayport test area.

Loggerhead turtles were by far the most abundant in the Mayport Seawolf data, whereas leatherbacks were more abundant in the Mayport 1999 surveys (although one loggerhead and no leatherbacks were seen in June). Higher abundance of leatherbacks offshore is consistent with the more pelagic nature of leatherback distribution.

Some turtle densities observed during the Southeast Turtle Surveys (SETS) conducted in 1982 and 1983 were 20 to 40 times higher than those observed in the Mayport test area during 1999 aerial surveys (Thompson 1984; Thompson and Huang 1993). The SETS densities may not be representative of the Mayport test area because the surveys were generally limited to the continental shelf (defined by the western edge of the Gulf Stream). The only observations in the Gulf Stream were mainly to the south of the test area, offshore of southeast Florida nesting beaches where high turtle abundances are common.

Although the 1999 aerial surveys show low turtle densities in the Mayport test area, both the Seawolf and SETS data show that much higher turtle densities can be encountered nearby. These data indicate that within the Mayport action area, the selected test site should be located in deep water seaward of the Gulf Stream western wall (i.e., within or east of the Gulf Stream). The Navy's final site selection process includes both aerial surveys and a review of satellite imagery to aid in selecting a test site with low turtle densities.

In estimating the proposed action's effects on sea turtles in the Mayport action area, NMFS is using the highest estimated densities of the three Navy surveys, the 1997 Seawolf survey which estimated turtle density at 1.780 turtles/100 km^2 (rounded up to 2 turtles/100 km^2). NMFS is also making the following assumptions in its estimate of effects: that the Navy will choose a site that is either in or east of the Gulf Stream, that the turtles taken will be undetected by mitigation measures and are in the safety zone during the detonations, that the turtles taken in the safety zone will be killed or seriously injured as a result of the detonation, and that four detonations will be required. Therefore NMFS expects that up to eight sea turtles may be taken by injury or mortality as a result of the proposed action in the Mayport action area. These turtles would most likely be leatherback or loggerhead sea turtles. In the worse case, all eight sea turtles would die and all of them would be females of breeding age. If all of the turtles were of the same species, this would not represent an appreciable reduction in the numbers, distribution, and reproduction of that species in the wild.

Using densities based on the Navy's June and August 1999 aerial surveys the Seawolf aerial surveys conducted in 1995 and 1997, NMFS estimates 128 leatherback, 68 loggerhead, and 32 unidentifiable turtles may be acoustically harassed as a result of the four detonations resulting from the proposed action, if the Mayport action area is chosen. This harassment is expected to be in the form of a TTS. This harassment is expected to be in the form of a temporary threshold shift (TTS), which could change the threshold of hearing and temporarily affect the individual sea turtles's ability to hear ambient sounds. These effects are not expected to affect loggerhead, leatherback, green, hawksbill, or Kemp's ridley sea turtles' likelihood of survival and recovery in the wild, by adversely affecting birth rates, death rates, or recruitment rates of these endangered sea turtles. Specifically, NMFS does not expect the proposed activities will affect adult female sea turtles in a way that reduces their reproduction, numbers, or distibution in the wild.

Summary of Effects

Species	Mayport
Sperm whale	0 im[a]/14 ah[b]
Sea Turtles[c]	8 im/228 ah

a. im= injury or mortality
b. ah=acoustic harassment
c. Turtles most likely affected would be leatherback or loggerhead turtles

A maximum incidental take, by injury or mortality, of 8 sea turtles (in any combination of the five species found in the three possible action areas) is expected as a result of the proposed action. NMFS believes that this amount of take is not likely to jeopardize the continued existence of any of the five species (loggerhead, Kemp's ridley, green, leatherback, and hawksbill turtles) even if all 8 are from the same species. Based on aerial survey observations, NMFS believes that the most likely turtles to be taken would be leatherbacks and loggerheads. Kemp's ridleys, greens, and hawksbill are less likely to be in the action area.

In this Opinion, NMFS has anticipated that sea turtles and sperm whales may be subjected to acoustical

harassment as a result of the proposed action. Due to their low likelihood of being present in the action area, NMFS has also anticipated that humpback, fin, and right whales will not experience harassment by activities associated with the proposed action. Based on information provided by the Navy, NMFS expects a maximum 228 sea turtles and 14 sperm whales will experience some type of acoustic harassment. This harassment is expected to be in the form of a TTS and is not expected to cause long-term effects. NMFS concludes that the acoustic harassment of these species is not likely to appreciably reduce the likelihood of both the survival and recovery of any of the five sea turtle species found in the action area (loggerhead, Kemp's ridley, green, leatherback, and hawksbill turtles) or sperm whales in the wild by reducing their reproduction, numbers, or distribution.

VI. Cumulative Effects

Cumulative effects are the effects of future state, local, or private activities that are reasonably certain to occur within the action area considered in this biological opinion. Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Within the action area, major future changes are not anticipated in ongoing human activities described in the environmental baseline. The present, major human uses of the action area -- commercial fishing and oil and gas exploration and extraction -- are expected to continue at the present levels of intensity in the near future. As discussed in Section IV, however, listed species of turtles and whales migrate throughout the GOM and Atlantic Ocean and may be affected during their life cycles by nonFederal activities outside the action area.

Beachfront development, lighting and beach erosion control all are ongoing activities along the Gulf and Atlantic coasts. These activities potentially reduce or degrade sea turtle nesting habitats or interfere with hatchling movement to sea. Nocturnal human activities along nesting beaches may also discourage sea turtles from nesting sites. The extent to which these activities reduce sea turtle nesting and hatchling production is unknown. However, more and more coastal counties are adopting more stringent protective measures to protect hatchling sea turtles from the disorienting effects of beach lighting. Some of these measures are being drafted in response to ongoing law suits brought against the counties by concerned citizens who charged the counties with failing to uphold the Endangered Species Act by allowing unregulated beach lighting which resulted in takes of hatchlings.

State-regulated commercial and recreational fishing activities in the Atlantic and GOM waters currently result in the incidental take of threatened and endangered species. Other recreational activities such as whale watch cruises have also resulted in the incidental take of endangered whales. It is expected that states will continue to license/permit large vessel and thrill craft operations which do not fall under the purview of a Federal agency and will issue regulations that will affect fishery activities. NMFS will continue to work with states to develop ESA Section 6 agreements and Section 10 permits to enhance programs to quantify and minimize these takes. Any increase in recreational vessel activity in inshore and offshore waters of the GOM and Atlantic Ocean will likely increase the number of turtles and whales taken by injury or mortality in vessel collisions. Recreational hook-and-line fisheries have been known to lethally take sea turtles, including Kemp's ridleys. Future cooperation between NMFS and the states on these issues should help decrease take of sea turtles and whales caused by state authorized activities.

VII. Conclusion

After reviewing the current status of the endangered green, leatherback, hawksbill, and Kemp's ridley sea turtles, the endangered sperm, fin, right, and humpback whales and the threatened loggerhead sea turtle in the GOM and Atlantic Ocean, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the implementation of the Navy's Shock Trial of the Winston S. Churchill (DDG 81) offshore of Mayport, Florida as described in the Proposed Action section of this Opinion, is not likely to jeopardize the continued existence of the endangered green, leatherback, hawksbill, and Kemp's ridley sea turtles; endangered sperm, fin, right, and humpback whales; or the threatened loggerhead sea turtle. Critical habitat for the right whale has been designated in areas onshore of the proposed activities, however, this action is not anticipated to adversely affect that area.

Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, spawning, rearing, migrating, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken by Navy so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Navy has a continuing duty to regulate the activity covered by this incidental take statement. If the Navy fails to assume and implement the terms and conditions the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Navy must report the progress of the action and its impact on the species to NMFS as specified in the Incidental Take Statement.

Amount or extent of anticipated take

Based on stranding records, incidental captures aboard commercial shrimp vessels and historical data, five species of sea turtles are known to occur in GOM and Atlantic Ocean waters. Current available information on the relationship between sea turtle mortality with regard to the use of explosives indicates that injury and/or death of sea turtles is likely to occur from the use of explosives associated with the proposed action. In those cases where exact numerical limits on the amount of incidental taking will be difficult to determine, NMFS may specify the extent of incidental take that will not violate section 7(a)(2) of the ESA (50 CFR 402.14(i)). When estimating the extent of incidental take, we may specify the extent of land or marine area that may be affected by the proposed action. Since NMFS cannot

accurately quantitatively estimate the number of endangered whales or sea turtles that are likely to be incidentally taken within the action area as a result of the proposed action, we have based the following estimates on the area that is likely to be affected by the proposed action, and the likely distribution of listed species.

Therefore, pursuant to section 7(b)(4) of the ESA, NMFS anticipates an incidental take (by injury or mortality) of up to **eight** documented sea turtles in any combination of loggerhead, Kemp's ridley, green, leatherback and hawksbill turtles. NMFS also anticipates an incidental take (by acoustic harassment in the form of a TTS) of up to **two hundred twenty eight** sea turtles in combination. This level of take is anticipated for the Navy's Shock Trial of the Winston S. Churchill (DDG 81).

NMFS anticipates that no endangered marine mammals will be injured or killed by the detonation of four 10,000 lb. explosive charges in the offshore waters of Mayport, Florida. NMFS also estimates that 14 sperm whales may be harassed by acoustic discomfort NMFS is not including an incidental take statement for the incidental take of whale species due to acoustic harassment at this time because the take of marine mammals has not yet been authorized under section 101(a)(5) of the Marine Mammal Protection Act (MMPA) and/or its 1994 amendments. Following issuance of such regulations or authorizations, NMFS may amend this Opinion to include the incidental take by harassment of sperm whales.

Effect of the Take

In the accompanying Opinion, NMFS determined that this level of anticipated take is not likely to jeopardize the continued existence of sperm, fin, humpback, or right whales, or Kemp's ridley, green, loggerhead, leatherback, or hawksbill sea turtles.

Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the sperm, fin, humpback, and right whales; and Kemp's ridley, green, loggerhead, leatherback, and hawksbill sea turtles:

1. The Navy shall have a plan in place to minimize the possibility of incidental take of listed species as a consequence of the proposed action.

2. The Navy shall record where possible the incidental take of any listed species, including incidental take by acoustic harassment.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Navy must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting and monitoring requirements. These terms and conditions are nondiscretionary.

1. The Navy shall have a safety range with a 2 nm radius with a buffer zone that extends out an

additional 1 nm radius from the center of the area where the shock trial will take place.

2. The safety range and the buffer zone will be monitored by air and ship before and after each detonation. This area will also be monitored with passive acoustic equipment before and after each detonation. The monitoring efforts will be conducted as explained in Chapter 5 of the Navy's draft environmental impact statement for the Shock Trial of the Winston S. Churchill (DDG81), dated December 1999.

3. The Navy shall postpone any detonation associated with the proposed action if the following occur:

   (a) Any marine mammals or sea turtles are visually detected within the safety range (i.e., within 2 nm of the detonation point). The "hold detonation" would continue until the marine mammal or sea turtle that caused the postponement is confirmed to be outside of the safety range either due to the animal swimming out of the safety range or due to the safety range moving to beyond the animal's last verified location.

   (b) Any marine mammals are acoustically detected within 2.25 nm of the detonation point (it would be assumed that the animal is within the 2 nm safety range). The "hold detonation" would continue until the marine mammal that caused the postponement is confirmed to be outside of the safety range either due to the animal swimming out of the safety range or due to the safety range moving to beyond the animal's last verified location.

   (c) Any listed (endangered or threatened) marine mammal is visually or acoustically detected within the buffer zone and subsequently cannot be reacquired. The shot would not occur until the last verified location is outside of the moving safety range and buffer zone, so that the new detonation point would be at least 3 nm from that location. Sighting and acoustic teams would continue to attempt to reacquire the animal.

   (d) Any northern right whale is detected within the safety range or buffer zone. The shot would not occur until the right whale is positively reacquired outside of the buffer zone and no other right whales are detected visually or acoustically during subsequent monitoring of the entire 3 nm radial area. If the right whale cannot be positively reacquired, the shot will be postponed until the following day.

   (e) Large *Sargassum* rafts or large concentrations of jellyfish are observed within the safety range (i.e., within 2 nm of the detonation point). The "hold detonation" would continue until the *Sargassum* rafts or jellyfish that caused the postponement are confirmed to be outside of the safety range either due to the current moving the *Sargassum* and/or jellyfish or the safety range moving away

from their last verified location.

(f) Flocks of seabirds or large schools of fish are observed in the water within 1 nm of the detonation point. The "hold detonation" would continue until the seabird flocks or large fish schools are confirmed to be more than 1 nm from the detonation point either due to the fish or birds moving out of the safety range or the safety range moving away from their last verified location.

(g) Detonation would also be postponed if a sea turtle or nonlisted marine mammal detected within the buffer zone (i.e., from 2 to 3 nm of the detonation point) was moving toward and could enter the safety range prior to detonation. Depending on the position of the sighting relative to the ship, the ship's course may be altered slightly to increase the distance to the animal, or the detonation may remain postponed until the animal is no longer heading toward the safety range.

4. The detonation would be delayed until animals are clear of the safety range.

5. Any injured or dead sea turtle resulting from the proposed action will be collected if possible and the National Sea Turtle Salvage and Stranding Network (STSSN) coordinator will be contacted as soon as possible to obtain the carcass. If the turtle can not be collected the STSSN coordinator still must be notified as soon as possible and given the last known location of the turtle. The Navy shall send a report detailing the take to the NMFS Assistant Regional Administrator for Protected Resources, Southeast Regional Office, within 14 days of the incident (NMFS Protected Resources Section, 9721 Executive Center Drive, North, St. Peterburg, Florida 33702). This report will contain: the cause of the take, location, species, and final disposition of the turtle.

6. The Navy shall document any evidence of acoustic harassment that may be noted by comparing pre- and post-survey results. The Navy shall also document the number of listed species seen (to species if possible) during aerial surveys that are within the calculated acoustic harassment zones. This documentation shall be sent to the NMFS Assistant Regional Administrator for Protected Resources, Southeast Regional Office, within 60 days of the completion of the proposed action (NMFS Protected Resources Section, 9721 Executive Center Drive, North, St. Peterburg, Florida 33702).

NMFS believes that up to **eight** documented sea turtles, of the five species found in the action area, in combination, may be taken by injury or mortality during the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Navy must immediately request initiation of formal consultation, provide an explanation of the causes of the taking, and review with NMFS the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authority to further the purposes of the

ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

(1). Conduct or support studies to determine the structure and capabilities of the auditory systems in marine mammals and sea turtles; and

(2). Conduct, during the first explosive charge detonation, an acoustic transmission loss study of the charge's pressure wave. Measurements should be made at distances of 2, 6, 8 and 10 nm from the detonation.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

Reinitiation of Consultation

This concludes formal consultation on the actions outlined in the Navy's letter dated December 20, 1999. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if (1) the amount or extent of taking specified in the incidental take statement is met or exceeded, (2) new information reveals effects of the action that may affect listed species or critical habitat (when designated) in a manner or to an extent not previously considered, (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, the Navy must immediately request reinitiation of formal consultation.

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APPENDIX H

ESSENTIAL FISH HABITAT INFORMATION

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Acronyms and Abbreviations

EFH	Essential fish habitat
FEIS	Final Environmental Impact Statement
FMP	Fishery Management Plan
GMFMC	Gulf of Mexico Fishery Management Council
MAFMC	Mid-Atlantic Fishery Management Council
NMFS	National Marine Fisheries Service
SAFMC	South Atlantic Fishery Management Council

APPENDIX H
ESSENTIAL FISH HABITAT INFORMATION

H.1 INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801-1882) established regional Fishery Management Councils and mandated that Fishery Management Plans (FMPs) be developed to responsibly manage exploited fish and invertebrate species in Federal waters of the United States. When Congress reauthorized this act in 1996, several reforms and changes were made. One change was to charge the National Marine Fisheries Service (NMFS) with designating and conserving Essential Fish Habitat (EFH) for species managed under existing FMPs. This is intended to minimize, to the extent practicable, any adverse effects on habitat caused by fishing or non-fishing activities, and to identify other actions to encourage the conservation and enhancement of such habitat. See Section 11.10 of the Final Environmental Impact Statement (FEIS) for further information on EFH and the Magnuson-Stevens Act.

"**Essential fish habitat**" as defined in the Magnuson-Stevens Act includes "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The interim final rules promulgated by the NMFS in 1997 (50 CFR Sections 600.805 - 600.930) further clarify EFH with the following definitions: "**waters**" refers to aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "**substrate**" refers to sediment, hard bottom, structures underlying the waters, and associated biological communities; "**necessary**" refers to the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "**spawning, breeding, feeding, or growth to maturity**" refers to stages representing a species' full life cycle.

The purpose of this appendix is to evaluate if the proposed action would have an "**adverse effect**" on EFH at each of the proposed test areas. The interim final EFH rules define an adverse effect as "any impact which reduces quality and/or quantity of EFH...[and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions."

The FEIS as a whole provides all of the information required for an EFH Assessment. This appendix gathers the most pertinent information in one place. Within this appendix, reference is made, where necessary, to other EIS sections and appendices which provide further details. The appendix concludes that the proposed action is not expected to have adverse effects on EFH at the Mayport, Norfolk, or Pascagoula test areas.

H.2 PROPOSED ACTION AND GEOGRAPHIC LOCATION

The proposed action is to conduct a shock trial of the WINSTON S. CHURCHILL at an offshore location. A description of the proposed action is included in FEIS Section 2.2.1. The ship would be subjected to a series of up to four 4,536 kg (10,000 lb) explosive charge detonations sometime between 1 May and 30 September 2001. The detonations would be conducted at a rate of one detonation per week to allow time to perform detailed inspections of the ship's systems prior to the ship experiencing the next level of shock intensity. The FEIS focuses on alternative areas offshore of Naval Station Mayport, Florida; Naval Station Norfolk, Virginia; and Naval Station Pascagoula, Mississippi (**Figure H.1**). The three test area are shown in more detail in FEIS Figures 2.3, 2.4, and 2.5.

H.3 SYNOPSIS OF ALTERNATIVES

Section 2 of the FEIS presents a detailed analysis of alternatives. The DEIS evaluates a "no action" alternative and three alternative areas for the proposed shock trial (Mayport, Norfolk, and Pascagoula). Alternative offshore areas for the shock trial are compared from operational and environmental perspectives.

Under the "no action" alternative, no new activities affecting the physical environment would be conducted to predict the response of Flight IIA ships to underwater detonations. This alternative would avoid all environmental impacts of the shock trial. However, the "no action" alternative would not meet the project purpose and need because it would prevent the Navy from being able to adequately assess the survivability of Flight IIA ships. A shock trial at sea provides the only means to assess the shock response of the entire ship and the interaction of the ship's systems and components.

Within the alternative of conducting a shock trial at an offshore location, the Navy has identified three offshore test areas (Mayport, Norfolk, and Pascagoula) that meet certain operational criteria. The final test site would be selected within one of these test areas if this alternative is selected. The site would be selected shortly before the trial based on satellite imagery and aerial surveys for marine mammals and turtles (see Section 5.0 of the DEIS). A detailed operational analysis concluded that all three test areas (Mayport, Norfolk, and Pascagoula) could support the shock trial. From an operational perspective, the Mayport and Norfolk test areas rank highest and are about equal, whereas the Pascagoula test area is minimally suitable for supporting the shock trial.

The preferred alternative is to conduct a shock trial at the Mayport test area with mitigation to minimize risk to marine mammals and turtles. The risk of impacts to marine mammals and turtles is higher at the Norfolk test area and is lower at, and about equal between, Mayport and Pascagoula. Therefore, considering that Mayport ranks higher operationally than Pascagoula, conducting the shock trial at Mayport would meet the project purpose and need, satisfy operational requirements, and minimize environmental impacts.

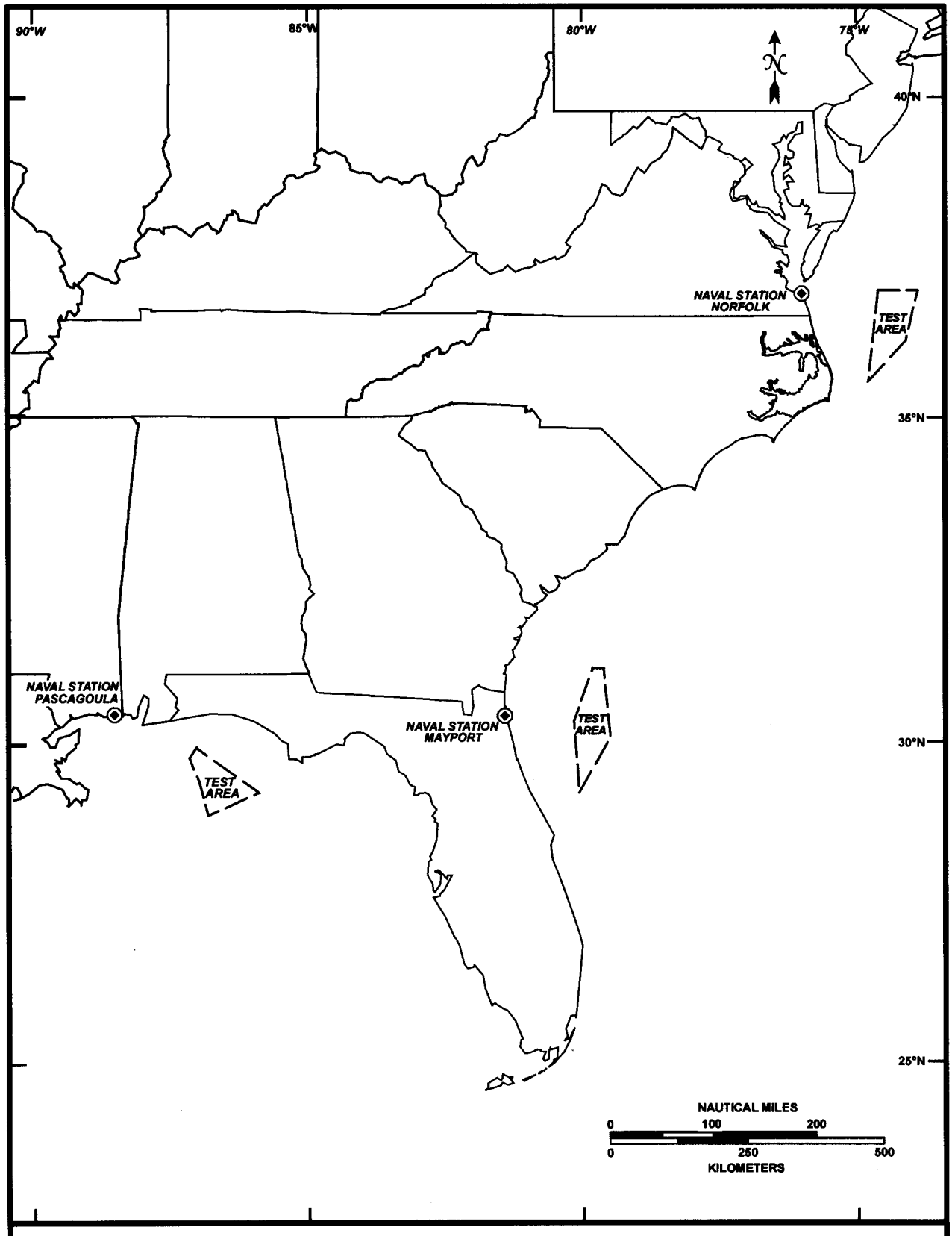

Figure H.1. Potential test areas for the DDG 81 shock trial.

H.4 EFH PRESENCE AT THE TEST AREAS

Each of the three test areas, Norfolk, Mayport, and Pascagoula, falls under the jurisdiction of a different regional Fishery Management Council. Fishery species in the Norfolk area are managed by the Mid-Atlantic Fishery Management Council (MAFMC). Those in the Mayport area are managed by the South Atlantic Fishery Management Council (SAFMC). Finally, fishery species in the Pascagoula area are managed by the Gulf of Mexico Fishery Management Council (GMFMC). In addition to these regional councils, the NMFS Highly Migratory Species Management Division, Office of Sustainable Fisheries manages Atlantic tunas, swordfish, and sharks within a broad geographic region that encompasses all three test areas (NMFS, 1999a).

All existing FMPs prepared by the three regional councils were recently amended to address EFH for managed species. The SAFMC and GMFMC prepared single documents to cover all existing FMPs (SAFMC, 1998a; GMFMC, 1998), whereas the MAFMC prepared individual amendments for each FMP (e.g., MAFMC, 1998). These documents were consulted to gather information on EFH for the three test areas. The FMPs provided maps and tabular information on the geographical distribution of various life stages of the managed species. Tables were prepared listing those species and life stages whose EFH overlapped each test area. For each species, the tables also indicate whether the habitat for the appropriate life stage is pelagic (water column), soft bottom benthic, or hard bottom benthic.

Table H.1 lists EFH information for the Mayport test area. This test area includes EFH for royal red shrimp, golden crab, groupers, tilefish, and dolphin (SAFMC, 1998a); and several highly migratory species such as bluefin tuna, sharks, and swordfish (NMFS, 1999a). Royal red shrimp (adults), golden crab (adults), and tilefish are benthic species associated with soft bottom habitats. Groupers are benthic species associated with hard bottom habitats. Sharks, dolphin, bluefin tuna, and swordfish are pelagic species, as are the larval stages of royal red shrimp and golden crab.

Pelagic *Sargassum* is also a managed fishery species for which EFH has been designated which includes the Mayport test area (SAFMC, 1998b). In addition, since many fish species are associated with it, *Sargassum* has been designated as EFH and an EFH "habitat area of particular concern" for snapper-grouper and coastal migratory pelagic species (NMFS, 1999b).

Table H.2 lists the species and life stages for which EFH was identified in the vicinity of the Norfolk test area. The Norfolk test area encompasses EFH for long-finned and short-finned squid (MAFMC, 1998), several highly migratory fish species (sharks, tunas, and swordfish) (NMFS, 1999a), and *Sargassum* (SAFMC, 1998b). All of these are pelagic species.

An EFH "habitat area of particular concern" referred to as "The Point" is located just south of the Norfolk test area offshore of Cape Hatteras. This applies to coastal migratory pelagic fish, snapper-grouper species, and coral and live/hard bottom habitat (SAFMC 1998a,b). "The Point" is a highly productive and highly dynamic oceanic area due to the confluence of as many as four water masses. Adults of highly migratory species congregate in this area, the diversity of larval fishes is high, and pelagic *Sargassum* is concentrated there (SAFMC, 1998b).

Table H.1. Managed species for which Essential Fish Habitat has been identified in the vicinity of the Mayport test area (From: South Atlantic Fishery Management Council, 1998a; National Marine Fisheries Service, 1999a).

Species	Life Stages (Reproductive Activity)	Habitat
INVERTEBRATES		
Royal red shrimp (*Pleoticus robustus*)	Adults; larval stages	Soft bottom; Pelagic
Golden crab (*Chaceon fenneri*)	Adults; larval stages	Soft bottom; Pelagic
FISH [a]		
Longfin mako (*Isurus paucus*)	Adults; late juveniles/subadults; neonates/early juveniles	Pelagic
Silky shark (*Carcharhinus falciformis*)	Late juveniles/subadults	Pelagic
Oceanic whitetip shark (*Carcharhinus longimanus*)	Adults; late juveniles/subadults	Pelagic
Night shark (*Carcharhinus signatus*)	Adults	Pelagic
Tiger shark (*Galeocerdo cuvier*)	Adults	Pelagic
Wreckfish (*Polyprion americanus*)	Adults	Hard bottom
Yellowedge grouper (*Epinephelus flavolimbatus*)	Adults	Hard bottom
Warsaw grouper (*Epinephelus nigritus*)	Adults	Hard bottom
Snowy grouper (*Epinephelus niveatus*)	Adults	Hard bottom
Blueline tilefish (*Caulolatilus microps*)	Adults	Soft bottom
Tilefish (*Lopholatilus chamaeleonticeps*)	Adults	Soft bottom
Dolphin (*Coryphaena hippurus*)	Adults; juvenile/subadult, larvae and eggs (spawning area)	Pelagic
Bluefin tuna (*Thunnus thynnus*)	Larvae and eggs (spawning area)	Pelagic
Swordfish (*Xiphias gladius*)	Adults; larvae and eggs (spawning area)	Pelagic
OTHER		
Sargassum (*Sargassum natans and S. fluitans)*	All life stages	Pelagic

[a] Fish species are listed in phylogenetic order.

Table H.2. Managed species for which Essential Fish Habitat has been identified in the vicinity of the Norfolk test area (From: Mid-Atlantic Fishery Management Council, 1998; National Marine Fisheries Service, 1999a).

Species	Life Stages	Habitat
INVERTEBRATES		
Long-finned squid (*Loligo pealei*)	Adults; juveniles	Pelagic
Short-finned squid (*Illex illecebrosus*)	Adults; juveniles	Pelagic
FISH [a]		
Bigeye thresher (*Alopias superciliosus*)	Late juveniles/subadults	Pelagic
Shortfin mako (*Isurus oxyrinchus*)	Adults; late juveniles/subadults; neonates/early juveniles	Pelagic
Longfin mako (*Isurus paucus*)	Adults; late juveniles/subadults; neonates/early juveniles	Pelagic
Bignose shark (*Carcharhinus altimus*)	Adults; late juveniles/subadults; neonates/early juveniles	Pelagic
Silky shark (*Carcharhinus falciformis*)	Adults; late juveniles/subadults; neonates/early juveniles	Pelagic
Sandbar shark (*Carcharhinus plumbeus*)	Adults	Pelagic
Night shark (*Carcharhinus signatus*)	Late juveniles/subadults	Pelagic
Tiger shark (*Galeocerdo cuvier*)	Adults	Pelagic
Blue shark (*Prionace glauca*)	Adults; late juveniles/subadults	Pelagic
Albacore (*Thunnus alalunga*)	Adults	Pelagic
Yellowfin tuna (*Thunnus albacares*)	Adults; subadults; juveniles	Pelagic
Bigeye tuna (*Thunnus obesus*)	Adults; subadults; juveniles	Pelagic
Bluefin tuna (*Thunnus thynnus*)	Adults	Pelagic
Swordfish (*Xiphias gladius*)	Adults; subadults; juveniles	Pelagic
OTHER		
Sargassum (*Sargassum natans and S. fluitans)*	All life stages	Pelagic

[a] Fish species are listed in phylogenetic order.

Table H.3 lists EFH information for the Pascagoula test area. EFH was identified for royal red shrimp, groupers, tilefish, red snapper, and dolphin (GMFMC, 1998). For highly migratory species, EFH was recognized for silky shark, tunas, and swordfish (NMFS, 1999a). Royal red shrimp (adults) and tilefish are soft bottom benthic species. Groupers and red snapper are benthic species associated with hard bottom habitats. Sharks, dolphin, tunas, and swordfish are pelagic species, as are the larval stages of royal red shrimp.

H.5 ANALYSIS OF EFFECTS

The purpose of this section is to evaluate if the proposed action would have an adverse effect on EFH, including managed and associated species, at any of the alternative test areas. The EFH rules define an adverse effect as "any impact which reduces quality and/or quantity of EFH...[and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions."

Three types of habitat are included in this analysis: pelagic (water column), soft bottom benthic, and hard bottom benthic. Impacts on the water column habitat would be localized and transient, with no significant adverse effect on EFH for any pelagic species. Minor disturbance of soft bottom areas beneath the charge may occur, but no adverse effects on soft bottom benthic habitats are expected due to the water depth (minimum of 183 m or 600 ft). Hard bottom habitats have been avoided through an exclusionary mapping process, and no adverse effects are anticipated.

H.5.1 Pelagic Habitat

Pelagic species with EFH near the test areas include sharks, dolphin, bluefin tuna, swordfish, and *Sargassum* at Mayport; long-finned and short-finned squid, sharks, tunas, swordfish, and *Sargassum* at Norfolk; and sharks, dolphin, tunas, and swordfish at Pascagoula. In addition, two benthic species have pelagic larvae whose EFH overlaps the test areas (golden crab at Mayport, royal red shrimp at Mayport and Pascagoula).

<u>Effects on Managed and Associated Species</u>. Effects of underwater explosions on fish have been studied extensively (Yelverton et al., 1975; O'Keeffe and Young, 1984; Young, 1991; Goertner et al., 1994). Studies have shown that the fish most vulnerable to death and injury are those with swimbladders. A swimbladder is a gas-filled organ used to control buoyancy. Relevant species in this category include dolphin, tunas, and swordfish. Fish without swimbladders, such as sharks, generally are very resistant to explosions (Goertner et al., 1994). Vulnerability also depends on fish size and shape; smaller fish and those that are laterally compressed are more susceptible to injury.

Based on theoretical models and experimental evidence, Young (1991) developed equations to predict a 10% mortality range for fish (i.e., a distance beyond which at least 90% of fish would survive). **Table H.4** lists the 10% mortality range for pelagic fish whose EFH overlaps one or

Table H.3. Managed species for which Essential Fish Habitat has been identified in the vicinity of the Pascagoula test area (From: Gulf of Mexico Fishery Management Council, 1998; National Marine Fisheries Service, 1999a).

Species	Life Stages (Reproductive Activity)	Habitat
INVERTEBRATES		
Royal red shrimp (*Pleoticus robustus*)	Adults; larvae	Soft bottom; Pelagic
FISH [a]		
Silky shark (*Carcharhinus falciformis*)	Neonates/early juveniles	Pelagic
Yellowedge grouper (*Epinephelus flavolimbatus*)	Adults	Hard bottom
Warsaw grouper (*Epinephelus nigritus*)	Adults	Hard bottom
Snowy grouper (*Epinephelus niveatus*)	Adults	Hard bottom
Tilefish (*Lopholatilus chamaeleonticeps*)	Adults	Soft bottom
Dolphin (*Coryphaena hippurus*)	Adults; juveniles/subadults; larvae and eggs (spawning area)	Pelagic
Red snapper (*Lutjanus campechanus*)	Adults	Hard bottom
Skipjack tuna (*Katsuwonus pelamis*)	Larvae and eggs (spawning area)	Pelagic
Yellowfin tuna (*Thunnus albacares*)	Adults; juveniles/subadults; larvae and eggs (spawning area)	Pelagic
Bluefin tuna (*Thunnus thynnus*)	Larvae and eggs (spawning area)	Pelagic
Swordfish (*Xiphias gladius*)	Adults; larvae and eggs (spawning area)	Pelagic

[a] Fish species are listed in phylogenetic order.

Table H.4. Estimated 10% mortality range for managed species of pelagic fish whose Essential Fish Habitat overlaps the Mayport, Norfolk, and/or Pascagoula test areas. Beyond this distance from the detonation point, it is estimated that 90% or more of the fish would survive. Calculations are based on Young (1991), assuming a 4,536 kg (10,000 lb) charge detonated 61 m (200 ft) below the sea surface.[a]

Common Name	EFH Occurrence			Swim Bladder	Schooling Behavior	Adult Weight	10% Mortality Range
	Mayport	Norfolk	Pascagoula			(lb)	(ft)
Sharks	X	X	X	No	Some species	30-300	73
Dolphin	X	X	X	Yes	Yes	10	2,978
Albacore	--	X	--	Yes	Yes	18	2,759
Bluefin tuna	X	X	X	Yes	Yes	300-1,200	1,598-1,914
Bigeye tuna	--	X	--	Yes	Yes	80	2,273
Skipjack tuna	--	--	X	Yes	Yes	12	2,908
Yellowfin tuna	--	X	X	Yes	Yes	60	2,359
Swordfish	X	X	X	Yes	No	150	2,094

[a] The equation used to predict the 10% mortality range for swimbladder fish is:

$$R_{10\%} = 95\ W_F^{-0.13}\ W_E^{0.28}\ (DOB)^{0.22}$$

where $R_{10\%}$ is 10% mortality range (ft), W_F is fish weight (lb), W_E is explosive weight (lb), and DOB is charge depth (ft). For non-swimbladder fish, the equation is:

$$R_{10\%} = 3.38\ W_E^{0.333}$$

more of the test areas. The distances range from 22 m (73 ft) for sharks (non-swimbladder fish) to 908 m (2,978 ft) for dolphin (relatively small swimbladder fish).

Schooling and non-schooling fish may differ in vulnerability. Because non-schooling species (such as swordfish) are usually widely dispersed, few individuals are likely to be present at the test site. For schooling fish such as dolphin, tunas, and some sharks, it is more likely that either several or none could be killed. However, detonation would be postponed if large schools of fish were observed within 1.85 km (1 nmi) of the detonation point (see FEIS Section 5.0). Therefore, a large fish kill would not be expected.

It is not possible to accurately estimate the number of fish that would be within the 10% mortality range, because the abundance of fish in the open ocean is extremely variable. Monitoring following detonation of a 4,536 kg (10,000 lb) charge for the shock trial of the USS JOHN PAUL JONES revealed about 100 dead fish (Naval Air Warfare Center, 1994). Previous observations following explosives testing near Key West, Florida have shown "very few" floating dead fish (Department of the Navy, 1981).

Although the number of fish that would be killed or injured is not known, overall impacts on individual species are expected to be insignificant based on the relatively small area affected. The area within the 10% mortality range would represent a small percentage of the pelagic fish habitat. The Mayport test area, after environmental exclusions, is 7,856 km^2 (2,294 nmi^2). The Norfolk test area is 6,393 km^2 (1,867 nmi^2). The Pascagoula test area is 5,480 km^2 (1,600 nmi^2). From **Table H.4**, the maximum radius of the 10% mortality range is 908 m (2,978 ft, or 0.49 nmi). The area within this radius is 2.59 km^2 (0.75 nmi^2), which is less than 0.05% of each test area.

The distances listed in **Table H.4** apply to fish in the upper water column, where the reflected shock wave produces a region of negative pressure (see Appendix D for a description of the cavitation region). Pelagic fish in deep water or near the bottom could survive much closer to the blast. These fish would experience only the direct, positive pressure wave and reflections from the bottom. Under these conditions, there would not be much difference in survival between swimbladder and non-swimbladder species.

Ichthyoplankton (eggs and larvae), *Sargassum*, and other organisms floating on or near the water surface are unlikely to be affected unless they are close to the detonation point. As explained in Appendix D, the maximum extent of the cavitation region is predicted to occur at a depth of 23 m (77 ft). Within the top few meters of the ocean, its horizontal extent would be 305 m (1,000 ft) or less. The area within this radius would be 0.29 km^2 (0.09 nmi^2), which is 0.005% or less of each test area. Therefore, only a small percentage of the ichthyoplankton and *Sargassum* population would be affected.

Effects on Pelagic Habitat. Important aspects of the water column habitat for pelagic species include physical and chemical properties such as salinity, temperature, dissolved oxygen, nutrient concentrations, and contaminant concentrations. Important biological properties of the water column habitat include abundances of prey, predators, competitors, and the web of biological and ecological interactions that make up the water column ecosystem.

Potential effects of shock trial detonations on the water column habitat include physical disruption of the water column due to the shock wave and bubble pulse; release of chemical products from the explosive charge; and destruction of water column biota, including prey species (generally smaller fish and invertebrates) and other components of the pelagic food web.

Physical Disruption: Physical disruption of the water column by the shock wave and bubble pulse is a localized, transient effect. Effects would be limited to within several hundred meters of the charge and would persist for a matter of minutes. Physical and chemical properties would be temporarily affected (e.g., oxygen concentrations increased due to turbulent mixing with the atmosphere), but there would be no lasting adverse effect on the water column habitat from this physical disruption.

Chemical Contamination: Chemical products of deep underwater explosions are initially confined to a thin, circular area called the surface pool. It is estimated that 100% of the solid explosion products and 10% of the gases remain in the pool (Young, 1984). This surface pool is fed by an upwelling current of water entrained by the rising bubble produced by the detonation. After the turbulence of the explosion has dispersed, the pool stabilizes and chemical products become uniformly distributed. The surface pool is usually not visible after about five minutes. As the pool continues to grow, the chemical products are diluted and become undetectable. Because of continued dispersion and mixing, there would be no buildup of explosion products in the water column. Adverse effects of chemical products on marine biota are considered negligible because the initial concentrations are not hazardous to marine life and the products are rapidly dispersed in the ocean [see FEIS Section 4.1.5(c)].

Effects on Prey Populations and the Food Web: The reflected shockwave from a detonation produces a region of negative pressure or "bulk cavitation." This is a region of near total physical trauma within which no animals would be expected to survive. Based on calculations in Appendix D, the maximum horizontal extent of the cavitation region is estimated to be 683 m (2,240 ft) for the proposed detonations. This region would extend from the surface to a maximum depth of about 23 m (77 ft). Pelagic fish and invertebrates within the cavitation region at the time of detonation are expected to be killed or injured. In addition, calculations in FEIS Section 4.1.3(b) predict that small pelagic fish may be killed within a distance ranging from a few tens of meters (for those without swimbladders) to about 1.7 km (0.9 nmi) depending on the species and individual fish size. Effect ranges for invertebrates would generally be in the low end of this range because they do not have swimbladders.

Based on these calculations, abundances of various fish and invertebrates near the detonation point, including prey species, could be altered for a few hours before animals from surrounding areas repopulated the area. However, these populations would be replenished as waters near the detonation point were mixed with adjacent waters. Due to the localized and transient nature of this process, no lasting adverse effect on prey availability or the pelagic food web would be expected.

Effects on "The Point". As noted previously, an EFH "habitat area of particular concern" referred to as "The Point" is located just south of the Norfolk test area offshore of Cape Hatteras. "The Point" is a highly productive and highly dynamic oceanic area due to the confluence of as many as four water masses. Adults of highly migratory species congregate in this area, the diversity of larval fishes is high, and pelagic *Sargassum* is concentrated there (SAFMC, 1998b). Based on the limited radius of water column effects from each detonation as discussed in the preceding paragraphs, no adverse effects on pelagic biota or habitat associated with "The Point" are expected.

H.5.2 Soft Bottom Benthic Habitat

Direct effects on managed and associated species in soft bottom habitats are expected to be minimal. Potential effects on the soft bottom benthic habitat include physical disruption by the shock wave and deposition of charge debris. Neither is considered a significant adverse effect. This applies to royal red shrimp (adults), golden crab (adults), blueline tilefish, and tilefish at Mayport and royal red shrimp (adults) and tilefish at Pascagoula.

Effects on Managed and Associated Species. Demersal (bottom dwelling) fish and invertebrates are unlikely to be killed or injured by the detonations, as explained in Section 4.1.3(d) of the FEIS. Due to the water depth (at least 183 m or 600 ft), the shock wave is not expected to adversely affect these species or their habitat. The effect ranges listed in **Table H.4** apply to fish in the upper water column, where the reflected shock wave produces a region of negative pressure. Fish in deep water or on the bottom could survive much closer to the blast. These fish would experience only the direct, positive pressure wave and reflections from the bottom. Under these conditions, there would not be much difference in survival between swimbladder and non-swimbladder species.

Mortality contours were calculated for tilefish in a previous environmental assessment (Department of the Navy, 1981). The calculations assumed a 4,536 kg (10,000 lb) charge detonated at a depth of 61 m (200 ft). Only the 10% mortality contour approaches the bottom and only in the shallowest water depth of 183 m (600 ft). Therefore, few if any tilefish or other bottom dwelling fish would be killed by the detonations.

Experimental studies have shown that benthic invertebrates, including crabs, lobsters, and bivalves are very resistant to underwater explosions (Aplin, 1947; Chesapeake Biological Laboratory, 1948; Linton et al., 1985). Based on these studies, Young (1991) developed equations which predict a safe range of 22 m (73 ft) for benthic organisms exposed to a 4,536 kg (10,000 lb) charge. That is, organisms more than this distance from the detonation

point would not be killed. Because the blast would be at least 122 m (400 ft) above the bottom, no benthic organisms are likely to be killed or injured.

Effects on Soft Bottom Habitat. Minimal disruption of bottom sediments is expected due to the water depth of the three test areas in relation to the charge depth. The minimum water depth at all three test areas is 183 m (600 ft). The maximum water depth is 878 m (2,880 ft) at Mayport, 2,560 m (8,400 ft) at Norfolk, and 695 m (2,280 ft) at Pascagoula. The shock wave from a charge detonated at 61 m (200 ft) below the sea surface is not expected to affect the bottom at these depths [see Section 4.1.5(a)]. No cratering of the seafloor is expected because the bubble would not contact the bottom.

The seafloor at both the Mayport and Norfolk areas is predominantly sand bottom. Fragments of steel charge casings that settle to the bottom would provide hard substrate for epibiota and would attract fish (Marine Resources Research Institute, 1984). The largest possible fragment from each explosion would be the top plate and crossbar, which together weigh 204 kg (450 lb). Due to low oxygen levels in bottom sediments, the steel fragments would likely corrode very slowly; any solubilized material would be quickly diluted by the surrounding water and not significantly alter the general chemistry of the water column nor bottom sediments. Only a small area of soft bottom habitat would be altered due to deposition of charge fragments, and the effect would not be adverse. Therefore, there would be no significant impacts on soft bottom benthic biota.

H.5.3 Hard Bottom Benthic Habitat

Hard bottom habitats have been avoided through the exclusionary mapping process summarized in Section 2.2.3 of the FEIS. Known artificial reefs, shipwrecks, and hard bottom or coral areas were mapped and excluded along with a 1.85 km (1 nmi) buffer zone. In addition, no significant benthic effects are expected due to the water depth of at least 183 m (600 ft) at each test area, as discussed in the previous section. Therefore, no impacts on hard bottom habitat or on managed or associated species is expected. This would include groupers at Mayport and Pascagoula and red snapper at Pascagoula.

H.5.4 Potential for Cumulative Effects

As described in the Section 4 of the FEIS, the main impacts of the proposed shock testing relevant to this EFH assessment would include release of chemical products into the ocean and atmosphere; deposition of metal fragments on the seafloor; and mortality and injury of plankton and fish near the detonation point. All three test areas are in deep, oceanic waters where the explosion products would be rapidly dispersed and mixed. Gases released into the atmosphere would also be rapidly dispersed and mixed. Metal fragments from the explosions would accumulate on the seafloor but would not be expected to produce adverse impacts; they would provide a substrate for growth of epibiota and attract fish. Because of the short-term nature of the proposed action and the localized and transient nature of the environmental effects, the potential for incremental or synergistic impacts in combination with present or reasonably foreseeable future uses of the Mayport, Norfolk, or Pascagoula test area is minimal.

H.6 MITIGATION

Mitigation and monitoring for the proposed shock trial are described in Section 5.0 of the FEIS. The proposed action includes the following mitigation measures that are relevant to potential impacts on EFH:

1. Detonation would be postponed if large schools of fish were present within the Safety Range. This would help to minimize the potential for direct impacts to schooling pelagic species such as dolphin (Mayport and Pascagoula) and tunas (Mayport, Norfolk, and Pascagoula), as well as their EFH. In addition, because the presence of fish schools could indicate the presence of prey concentrations, this measure would reduce the potential for effects on other pelagic species and their EFH.

2. Detonation would be postponed if large *Sargassum* rafts or debris lines were present within the Safety Range. Although this measure is designed particularly to protect juvenile and hatchling sea turtles, it would directly protect a managed species (*Sargassum*) and would also protect EFH for pelagic fish species such as dolphin (Mayport and Pascagoula) and tunas (Mayport, Norfolk, and Pascagoula), which are often attracted to *Sargassum* and other flotsam.

3. Hard bottom features that attract large numbers of fish, such as artificial reefs, hard bottom areas, and shipwrecks, were avoided through environmental mapping and establishment of 1 nmi buffer zones around these features (see FEIS Section 2.2.3). Effects on EFH for hard bottom species such as groupers (Mayport and Pascagoula) and red snapper (Pascagoula) would therefore be avoided.

4. Convergence zones and biologically productive oceanographic features would be avoided during site selection. The site selection process includes aerial surveys and review of satellite and other oceanographic data to identify a test site with low densities of marine mammals and turtles (see Section 5.0). Convergence zones such as the western wall of the Gulf Stream and boundaries between cold and warm core rings would be avoided. Cold core rings would also be avoided as these have been shown to be more biologically productive (Biggs, 2000) and to attract concentrations of marine mammals (Davis et al., 2000). Avoidance of convergence zones and biologically productive features such as cold core rings will also likely reduce the chance of encountering high densities of pelagic fish and their prey populations. Potential effects on EFH for pelagic species such as squid (Norfolk), dolphin (Mayport and Pascagoula), tunas (Mayport, Norfolk, and Pascagoula), and swordfish (Mayport, Norfolk, and Pascagoula) would be minimized.

5. Detonation would be postponed if marine mammals were detected within the Safety Range. In addition to directly avoiding impacts on these animals, this measure would minimize effects on EFH for pelagic species because the presence of marine mammals could indicate the presence of prey concentrations.

6. Detonation would be postponed if flocks of seabirds were present within the Safety Range. In addition to directly avoiding impacts on seabirds, this measure would minimize effects on EFH for pelagic species because the presence of seabird flocks could indicate the presence of prey concentrations.

H.7 CONCLUSIONS

Based on the analysis in the preceding sections and the information presented in the FEIS as a whole, the proposed action is not expected to have adverse effects on EFH at the Mayport, Norfolk, or Pascagoula test areas. Impacts on the water column habitat would be localized and transient, with no significant adverse effect on EFH for any pelagic species. Minor disturbance of soft bottom areas beneath the charge may occur, but no adverse effects on soft bottom benthic habitats are expected due to the water depth (minimum of 183 m or 600 ft). Hard bottom habitats have been avoided through an exclusionary mapping process, and no adverse effects are anticipated.

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APPENDIX I

COMMENTS AND RESPONSES

This appendix presents and addresses public comments on the Draft Environmental Impact Statement (DEIS). Comment sets are assigned letters from A to P. Within each set, comments are assigned a unique identifying number (for example, A1, A2, etc. in the first set). Each set of comments is followed by the corresponding Navy responses. Spoken comments received at public hearings in Norfolk (set A) and Mayport (set B) are excerpted from full transcripts of each hearing. A public hearing was also held at Pensacola, but no comments were received.

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PUBLIC HEARING COMMENTS

A

EXCERPT FROM TRANSCRIPT OF NORFOLK PUBLIC HEARING (March 13, 2000)

MS. BARCO: I work with the Virginia Marine Science Museum in Virginia Beach, Virginia, and we're part of both the sea turtle and the marine mammal stranding network, which is mentioned in here.

And I'm curious about your preferred alternative, whether even though the environmental impacts appear to be higher in Norfolk, if there is any chance that budgetary limitations or something else might possibly make the logistics -- let Norfolk be the preferred alternative because of logistics requirements. A1

I'm also concerned about your impacts. It looks like your buffer zone and safety zone were based on lung damage to animals, both mortal lung damage and your serious injury. However, we really know very little about acoustic damage to these animals.

And short of shattered ear bones and ear drums, which you do discuss, it's very possible that minor damage to the acoustic system of the marine mammal may eventually result in its death or an impairment of the animal that does not allow it to continue to function normally. A2

And because we know very little about acoustics, particularly in large whales, I'm really concerned that your buffer zone is too small. Because these animals are very acoustically sensitive, and even with the temporary threshold shift, that may not allow them to function normally in their environment.

And we don't know, even though they have a temporary threshold shift from acoustics, from the shock, whether that would, in fact -- how long that would last and how that would affect them as far as being able to feed normally and avoiding the kinds of threats and communicate with other animals. A2

So I'm concerned about that, and I'm also wondering what your take levels were based on, whether these were just endangered species or whether these are all marine mammals. A3

And also regarding the large fish schools, I'm wondering how you're going to monitor those. I think visually large fish schools might be difficult to determine, whether you're going to be using depth sounders or some type of sonogram device to determine whether there are large schools of fish in the area. A4

I'm also wondering if you're going to provide any kind of support for stranding network groups that might have to respond to these animals, whether the Marine Science Museum would be involved in that if it occurs in Norfolk, and how you would deal with an injured live whale. A5

Thank you.

LCDR RIEDEL: Thank you. I have one other here that I'm not sure whether -- I'm not uncertain whether they wanted to speak or not, Pamela Snyder.

MS. SNYDER: I will write mine.

NAVY RESPONSES

A. Norfolk Public Hearing (March 13, 2000)

Susan Barco

A1. Response: The Norfolk test area meets all of the operational requirements for the shock trial and has various operational advantages and disadvantages (see Section 2.0 of the FEIS). However, the FEIS identifies Mayport as the preferred alternative based on consideration of both operational and environmental factors. The Navy's Record of Decision (ROD) will specify the alternative ultimately selected by the Navy.

A2. Response: While it is true that little is known about acoustic damage to marine mammals and turtles, the DEIS incorporated the best available data to determine at what distance mortality and injury were likely to occur (Appendix D). The probability of auditory impact (eardrum rupture) was considered in developing impact estimates and establishing the Safety Range. Onset of slight lung injury was chosen as the injury criterion because it is more conservative (i.e., has a greater range) than eardrum rupture in this particular case.

The size of the Safety Range (2 nmi radius) was chosen to minimize the likelihood of injury to the extent practicable. It is not feasible to mitigate for all possible impacts, including individual instances of minor, recoverable injuries and temporary auditory impairment. Based on the analysis presented in **Appendix D**, the maximum range for mortality (onset of extensive lung injury) is 1.35 km (0.73 nmi) and the maximum range for injury (onset of slight lung injury) is 2.25 km (1.22 nmi). These are conservative ranges, and take into account the worst-case depth effects. The Safety Range extends well beyond these ranges to encompass the maximum area that can be effectively monitored both visually and acoustically. Its radius is approximately 2.7 times the mortality range and 1.6 times the range for onset of slight lung injury. See responses J2 and K9 for additional information relevant to this comment.

The duration of temporary threshold shift (TTS) effects could differ from animal to animal and from species to species, also varying with animal depth, water depth, and sound velocity profile (see Appendix E). Generally, the animals' hearing would be expected to recover over a period lasting from hours to days.

A3. Response: The incidental take calculations include all species of marine mammals likely to occur at each test area, not just endangered species.

A4. Response: During pre-detonation monitoring, observers onboard both the ship and the monitoring aircraft would look for large schools of fish at or near the surface. Detonation would be postponed if such schools were observed within 1.85 km (1 nmi) of the detonation point (see Section 5.0). In addition, large floating mats of sargassum and debris that attract pelagic fish would be avoided during site selection and would result in postponement of detonation if present within the Safety Range. Hard bottom areas and artificial reefs that attract fish schools near the bottom have been avoided in exclusionary mapping of each test area (see Section 2.0). Use of a depth sounder or fish-finding sonar is not operationally feasible prior to or at the time of detonation.

A5. Response: The Navy would be cooperating with the marine mammal and sea turtle stranding networks that are coordinated by the National Marine Fisheries Service (NMFS). If there is a high occurrence of marine mammal and sea turtle strandings that can be directly attributed to the shock trial during or after the shock trial period, the Navy would work together with the NMFS to determine the best course of action for support to the stranding networks. Standard stranding necropsy protocols have been modified to include collection of tissue samples related to potential shock damage, and these protocols would be distributed to the stranding networks via the NMFS stranding coordinators. All tissues would be sent to the Armed Forces Institute of Pathology (AFIP) for analysis, which is standard operating procedure for marine mammal and sea turtle stranding tissues under normal conditions.

The Navy would have a veterinarian and a marine mammal behavioral specialist onboard the MART vessel at all times. The nature of marine mammal behavior is such that detecting a minor injury in a marine mammal is not highly likely – wild animals are highly adept at hiding injury so as to avoid attracting potential predators. If a marine mammal is seen that appears noticably injured, the veterinarian and behavioral specialist would determine to the best of their ability if the animal is mortally injured. Mortally injured animals would be humanely euthanized (see FEIS Section 5.0). If the animal does not appear mortally injured, the MART vessel, together with the post-detonation aircraft, would note the species, any identifiable markings, behavior, and monitor the animal's movements. All sightings would be reported to NMFS and the information distributed to stranding networks.

Pamela Snyder

Declined to speak, but later provided a written comment letter (comment set M).

B

EXCERPT FROM TRANSCRIPT OF MAYPORT PUBLIC HEARING (March 15, 2000)

REAR ADMIRAL COLEMANS: My only statement is has there been any formal legal objection to the tests? B1

LCDR RIEDEL: Our second speaker is David Van Saun.

MR. VAN SAUN: Yes. David Van Saun, and I represent the Beaches Chamber of Commerce and my company, George Sharp, Incorporated. We have a business out here at the Beach. I've been in the maritime environment for over 30 years and I'm a strong supporter for you to have the test here in the Mayport area. It's good to bring the Navy -- anything the Navy -- to bring more Navy activity into the Jacksonville area I am for. B2

LCDR RIEDEL: Our third speaker is John Haley.

MR. HALEY: I'm John Haley and I'm vice president for economic development with the Jacksonville Chamber of Commerce. I'm also the chief staff person for the military affairs task force for the Chamber of Commerce. Normally, our procedure would be that we would take this issue to our task force and they would consider it and make a recommendation to our Board of Governors. We were not aware of this Public Hearing until only probably last, mid-last week. So we did not have an opportunity to formally carry out the process for our Board of Governors. So I can't make an official statement on behalf of the Board of Governors of the Chamber of Commerce. However, we have conferred with members of our task force. We have been in receipt of materials that were provided to us about the test. B3

It's our opinion that these tests are necessary, that the Navy is taking every reasonable precaution that they can to ensure that there's minimal ecological impact, including the death of marine mammals. And most importantly, we feel that preserving the safety of our sailors, our men and women who are sailing on a Navy ship, is the most important thing that we can do. And that these tests need to go forward at the time that they're slated to go forward and we support this.

NAVY RESPONSES

B. Mayport Public Hearing (March 15, 2000)

Rear Admiral Colemans

B1. Response: There has not been any formal legal objection to the tests at this time (up to date of issuance of the FEIS).

David Van Saun

B2. Response: Comment noted.

John Haley

B3. Response: Comment noted.

FEDERAL AGENCIES

C

MARINE MAMMAL COMMISSION
4340 EAST-WEST HIGHWAY, ROOM 905
BETHESDA, MD 20814

30 March 2000

Marconi Systems Technologies
2611 Jefferson Davis Highway
Suite 5000
Arlington, Virginia 22202

Attn: DDG 81 Shock Team

To Whom It May Concern:

The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed those portions of the "Draft Environmental Impact Statement [DEIS] for the Shock Trial of the WINSTON S. CHURCHILL (DDG 81)" concerning marine mammals. Overall, the Commission believes that the DEIS provides a thorough and objective assessment of the species and numbers of marine mammals likely to be present in and near the three prospective test areas, and how the various species could be affected by the shock trial. Further, the Commission believes that, if the mitigation measures described in the DEIS are carried out, the number of marine mammals that could be killed or injured incidental to the trial will be minimized and documented to the extent practicable. C1

Although the Commission believes that the mitigation program described in the DEIS would minimize the number of marine mammals that could be killed or injured incidental to the trial, we believe that the assessment of potential harassment fails to appropriately reflect the definition of the term in the Marine Mammal Protection Act. We agree that, because the activities potentially causing disturbance will last only a short time and occur no more than once each week over a period of four weeks, the anticipated disruption of behavior patterns beyond that caused by temporary hearing threshold shifts is unlikely to have biologically significant effects - e.g., to affect survival or productivity. If, however, available data are insufficient to enable the Navy to reliably estimate the species and the number of marine mammals whose behavior could be temporarily disrupted by the trial, we suggest that the environmental impact statement note that, although the data are insufficient for this purpose, there is no reason to believe that the length and frequency of disruptions could have biologically significant effects, and therefore no effort was made to estimate the precise number of marine mammals that potentially could be taken by Level B harassment. C2

The Commission believes that the individuals responsible for compiling and analyzing the marine mammal distribution, abundance, and effects data presented in this DEIS should be commended for a job well done. C3

Specific Comments

Pages ES-12 and 13 (Marine Mammals): The fourth sentence in the first paragraph of this section states that "[a]coustic harassment is estimated using a model to predict the range for temporary threshold shifts (TTS)." As noted below, it appears that acoustic harassment can occur at sound levels substantially less than that which can cause temporary hearing threshold shifts. C4

Also, it would be useful if the table in this section indicated the species, as well as the number, of marine mammals that could be killed, injured, or harassed incidental to the shock trial. C5

Page ES-14 (Fishing and Shipping Activities): As noted below, it is not clear why the safety range for ships is five nautical miles while the safety range for marine mammals is two nautical miles plus a one nautical mile buffer zone. C6

Page ES-15, par. 4: The fifth sentence in this paragraph states that "[b]ased on the analysis presented in Appendix D, the maximum range for mortality (onset of extensive lung injury) is 1.35 km (0.73 nmi) and the maximum range for injury (onset of slight lung injury) is 2.25 km (1.22 nmi)." As noted below, a convincing case is not make that the onset of slight lung injury is an appropriate and conservative indicator of the types of injury that could occur. C7

Page 1-1, par. 3: The first sentence in this paragraph states that "[i]t is the Navy's policy to shock test each new class of ships or major upgrade (Flight IIA ships in this case) to assess the survivability of the hull, the ship's systems, and the capability of the ship to protect the crew after a near miss from an underwater explosion." It is the Commission's understanding that shock tests are required by statute. In either case, it would seem useful to cite the relevant statutes, regulations, or policies. C8

Page 2-25, last par.: The first sentence in this paragraph states that "[a]ctive petroleum lease blocks within and on the periphery of the Pascagoula test area were not excluded because there are no oil and gas pipelines or platforms at present." It is not clear from this statement whether consideration was given to the possibility that pipeline construction or other development could be undertaken in or near the Pascagoula test area before the scheduled test date in 2001. For example, the Pascagoula test area appears near the Destin Dome 56 Unit where the Chevron U.S.A. Production Company and two partners have proposed to develop and construct a pipeline to transport natural gas reserves. Thus, if it has not already done so, the Navy should consult with the Minerals Management Service to confirm that there will be no oil and gas platforms or pipelines in the Pascagoula area when the tests would be conducted in 2001. C9

Page 2-36 (Table 2.9): Here and elsewhere, the DEIS provides estimates to three decimal points of the number of marine mammals that could be killed, injured, or harassed incidental to the tests, and the probability of taking and other events occurring. It is not clear whether the estimates are in fact significant to three decimal points. If they are not significant to this level, the numbers should be rounded to the appropriate level. C10

Page 3-17, par. 2: The first sentence in this paragraph states that "[s]perm whales and fin whales are the most likely endangered cetaceans to occur at the Norfolk test area (Winn, 1982)." Since the referenced 1982 publication, substantial numbers of humpback whales have stranded in the Norfolk area (see for example: Wiley, D.N., R.A. Asmutis, T.D. Pitchford, and D.P. Gannon. 1995. Stranding and mortality of humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States, 1985-1992. Fishery Bulletin 93:196-205.). It is not clear whether these stranding or other more recent observational data have been considered. C11

Page 3-23 (Table 3.3): The middle set of columns in this table presumably should be titled Pascagoula, not Mayport. C12

Pages 4-1 and 4-6 (Marine Mammals): Among other things, this section states that --

> At greater distances, up to 32.8 km (17.7 nmi) for odontocetes and 42.6 km (23.0 nmi) for mysticetes depending on the test area and the water depth of the specific test site, marine mammals may experience temporary hearing loss which could lead to temporarily altered behavior. As discussed later, this auditory impact is considered "harassment" as defined in the Marine Mammal Protection Act of 1972 (MMPA).

The wording implies that behavioral changes not related to temporary hearing loss do not constitute harassment as defined in the Marine Mammal Protection Act. This implication is misleading and should be corrected here and elsewhere in the environmental impact statement. C13

Pages 4-2 to 4-5 (Table 4.1): Among other things, this table indicates that marine mammals could be killed within 0.73 nmi of the detonation site, be injured seriously within 1.22 nmi of the site, suffer minor injuries -- *e.g.*, low probability of eardrum rupture and permanent hearing loss -- out to several nautical miles, be exposed to acoustic harassment -- as indicated by temporary hearing threshold shift -- to distances of 18 nmi and 23 nmi depending on the species, and could have possible spontaneous behavioral responses tens to hundreds of nautical miles from the detonation site. It also indicates that charges will not be detonated if non-military vessels are present within 5 nmi of the detonation site and that vessels will be warned to remain at least 10 nmi from the site. It is not clear whether the estimates of the zones of effect to two decimal points appropriately reflect the degree of significance of the data and calculations. Also, as noted earlier and below, the rationale for some of these determinations are not completely clear, and may be questionable. It is not clear, for example, why testing apparently would be suspended if a non-military vessel approached within 5 nmi of the detonation site, while detonations would not be suspended unless marine mammals are detected within 3 nmi of the detonation site. C14

Pages 4-7 to 4-9 (Analytical Approach): As we understand it, the analytical approach summarized here and described in Appendix C concludes that, while feeding, breeding, or other C15

behaviors could be disrupted by sounds generated by the explosions at distances from 10 to more than 100 nmi, such disturbance is not considered harassment because it is nearly instantaneous and would occur no more than four times at weekly intervals. Although the Commission agrees that short-term disturbance is unlikely to have biologically significant effects, and that it would be difficult to reliably estimate the species and number of marine mammals whose behavior might be disrupted, it nevertheless believes that the conclusion that such disturbance does not constitute harassment is inconsistent with the Marine Mammal Protection Act's definition of harassment and the provisions of the Act governing incidental take authorizations. We therefore suggest that the references to harassment here and elsewhere in the environmental impact statement be revised to reflect fully the definitions of Level A and Level B harassment enacted as part of the 1994 amendments to the Act. If the species and number of marine mammals whose behavior could be temporarily disrupted by the detonations cannot be estimated reliably, we suggest that the environmental impact statement note that available data are insufficient to reliably make such estimates and that, because there is no reason to believe that the length and frequency of disruptions could have biologically significant effects, no effort was made to estimate the species and number of marine mammals that potentially could be taken by Level B harassment. C15

Page 4-13, par. 4: Among other things, this paragraph indicates that --

> The range [of onset of extensive lung hemorrhage] varies depending on mammal weight, with the smallest mammals having the greatest potential hazard range. The range predicted for a small marine mammal (a calf dolphin) is 1.35 km (0.73 nmi) from the detonation point (Figure 4.3). *For purposes of impact analysis, it was assumed that 100% of the marine mammals within this radius would be killed.*

As we read it, Figure 4.3 indicates that 1% mortality would be expected at the range where onset of extensive lung hemorrhage is estimated to occur. If our reading is correct, the second of the previously referenced sentences might usefully be changed to read something like "[t]he range that onset of extensive lung C16

hemorrhage is predicted to occur and to kill 1% of small marine mammals (*e.g.*, a dolphin calf) is 1.35 km (0.73 nmi) from the detonation point (Figure 4.3)." C16

On a related point, it is not clear whether these estimates of "effects" distances are significant to two decimal points as indicated.

Page 4-13, last par.: The first two sentences in this paragraph state that --

> Two criteria for non-lethal injury discussed in Appendix D are **onset of slight lung hemorrhage and 50% probability of eardrum rupture.** These are injuries from which animals would be expected to recover on their own.

The rationale for using 50% probability of eardrum rupture as a criterion for non-lethal injury is not clear. It appears to be based on data from terrestrial mammals, rather than marine mammals. Further, there is no indication as to why there is a 50% probability that the eardrums of different marine mammal species would rupture at the calculated distance or that the ruptures would heal without causing problems. A better explanation of and justification for using this criterion should be provided. C17

Page 4-20, par. 1: Among other things, this paragraph indicates that "[t]he proportion of the minimum population affected is much less than 0.01 for most species, and the highest values are only 0.01751 (pilot whale at Norfolk) and 0.01099 (dwarf/pygmy sperm whale at Pascagoula)." It seems unlikely that the latter two values are significant to five decimal points as indicated. If the figures are not significant to the indicated levels, they should be rounded to the appropriate level of significance. C18

Page 4-20, par. 2: The last sentence in this paragraph should be revised as follows: "[e]ndangered ~~and~~, threatened, **and depleted** marine mammals are automatically strategic stocks even if annual mortality does not exceed PBR." C19

Pages 4-20 to 4-22 (Harassment) and 4-22 and 4-23 (Behavioral Responses): These and related sections of the draft environmental impact assessment appear to be based upon one C20

assumption that is not correct, and one assumption that may not be correct -- *i.e.*, (1) that disruption of behavior does not constitute harassment unless it somehow results in injury; and (2) that disruption of feeding, breeding, or other behavior cannot result in injury.

With regard to the last point, it should be recognized that the differentiation between Level A and Level B harassment provided in the 1994 amendments to the Marine Mammal Protection Act was related to the addition of new section 104(c)(3)(C), which directed the Secretaries of Commerce and the Interior to issue a general authorization for scientific research involving Level B harassment only. Although not reflected clearly in the definitions of Level A and Level B harassment, the intent apparently was to provide a general authorization for research unlikely to have biologically significant effects on natural behavior, and thus eliminate the sometimes time consuming procedure for obtaining research permits authorizing such taking. C20

Page 4-25, par. 4: This paragraph states that --

> At distances well beyond the harassment range, marine mammals may hear the detonations and may (or may not) respond. It is unlikely that an individual animal would experience more than a single, momentary disturbance. No significant or lasting impact on movements, migration patterns, breathing, nursing, breeding, feeding, or other normal behaviors would be expected.

As noted earlier, any disruption of behavior would constitute harassment as defined in the Marine Mammal Protection Act, whether or not it has significant or lasting impacts on movements, migration patterns, etc. Thus, while the Commission shares the view that four detonations, at weekly intervals, are unlikely to have biologically significant effects on behavior, the absence of biologically significant effects cannot be interpreted as the absence of harassment. Thus, this and another parts of the environmental impact statement should be revised to more accurately reflect the relevant provisions of the Marine Mammal Protection Act. C21

Page 5-4 (Weather Limitations) and Page 5-5 (Figure 5.1): The section describing weather limitations states that --

> To maximize detection of marine mammals and turtles, mitigation efforts would be conducted in sea states no greater than No. 3 based on the following scale:....3 = whitecaps on 33% - 50% of surface; 0.6 to 0.9 m (2 to 3 ft) waves....

The legend to the figure states that "[e]ffective viewing range from WINSTON S. CHURCHILL is 3 nmi. Maximum range is 5 nmi ...."

It would seem that the detection of marine mammals and turtles would be maximized when the sea is flat calm, with no waves or ripples (sea state No. 0). Thus, the referenced sentence on page 5-4 presumably would be more accurate if it were revised to read something like "[t]o maximize the capability of detecting marine mammals and turtles, while minimizing the number of days that tests may be suspended by sighting conditions, tests would be conducted in sea states no greater than No. 3 based on the following sea state scale...." Also, it would be useful to indicate how sea state and other variables (*e.g.*, group size) were factored into the estimates of effective and maximum viewing ranges from the ship as indicated in the legend to Figure 5.1. For example, what is the likelihood that an observer on the ship, using 25 powered binoculars, will be able to detect an individual dolphin or small group of dolphins inside or near the boundary of the 3.7 km safety range in sea state No. 3. C22

Pages 5-4 to 5-8 (Mitigation Components/Teams): The Commission believes that the mitigation program described in this section is likely to minimize, to the extent practicable, the number of marine mammals that could be killed or injured incidental to the shock trial. However, it is not clear precisely what is envisioned with regard to the pre-detonation passive acoustic monitoring. For example, there is no indication of where, what, or how many sonabuoys would be deployed, at what distances vocalizations by the different species are expected to be detectable, or how and how accurately locations are expected to be determined. Also, if it is not already contemplated, consideration should be given to the possibility that comparison of the nature and frequency of vocalizations, before and after detonations, could provide a measure of behavioral disruption, C23

which in turn could help interpretation of changes in vocalizations patterns detected during operation of the LFA sonar as well as the shock trial. C23

On a related point, the discussion of acoustic monitoring on page 5-8 focuses on detecting calls produced by mysticetes and sperm whales. Among other things, it states that "[t]hese cetacean species [sperm whales and mysticetes] are more difficult to visually detect at the surface, either because they tend to be solitary (mysticetes) or because they are deep divers (sperm whales)." In fact, it seems likely that individual dolphins would be more difficult to detect at the surface, particularly in sea states greater than one. C24

Page 5-13: The third sentence on this page states that "[a]t all sites [i.e., Norfolk, Mayport, and Pascagoula], cold core rings would also be avoided since marine mammal sightings are generally higher near them (Davis et al, 1999)." The referenced paper by Davis et al deals with cetacean habitats in the northern Gulf of Mexico. Data from other sources (e.g., the CETAP studies done by Winn et al) indicate that marine mammal sightings in the Atlantic may be higher in the vicinity of warm core rings spun off from the Gulf Stream. Therefore, if it has not already been done, consideration should be given to avoiding both warm and cold core rings. C25

Pages 5-14 and 5-16 (Monitoring 40 Minutes Prior to Detonation): The first sentence in this section states that "[f]orty minutes prior to each detonation, the aerial monitoring team would begin monitoring the Safety Range and Buffer Zone directly **preceding** the WINSTON S. CHURCHILL, as illustrated in Figure 5.6" [emphasis added]. It is not clear whether consideration has been given to the possibility that the flight plan illustrated in the figure would not allow detection of animals that could move into the safety range or buffer zone from the back or sides of the vessel if the vessel is moving slowly. C26

Page 5-19 (Post-Detonation MART Action Plan): The fifth sentence in this paragraph states that "large marine mammals (< 5m or 15 ft) that are dead would be pulled alongside the MART vessel and necropsied as possible (weather permitting)." It is not evident whether consideration was given to towing large animals to shore to do necropsies and, if so, why this possibility was ruled out. C27

Page 5-22 (Marine Mammal Stranding Network Protocol): The first sentence in this section states that "[d]ead marine mammals that cannot be recovered by the MART would be tagged." Where, how, and with what animals would be tagged should be indicated. C28

Page 11-3 (Marine Mammal Protection Act): The first sentence in the second paragraph of this section would be more accurate if it were revised to read as follows - "Section 101(a)(5) of the Marine Mammal Protection Act directs the ~~Secretary of the Department of Commerce~~ **Secretaries of Commerce and the Interior** 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~~ **other than** commercial fishing) within a specified geographical region if certain findings are made and regulations are issued." C29

Pages B-3 through B-35: This section provides a thorough and well referenced summary of available information concerning the distributions and densities of the various marine mammal species known to occur in and near the three possible test areas. As in Table 3.3, the middle set of columns in Table B.3 presumably should be titled "Pascagoula" , rather than "Mayport." Also, while not relevant to the impact assessment, you might consider including in this section data from the regional stranding networks indicating the species and numbers of marine mammals that have been found stranded in areas adjacent to the three test areas at different times of the year over the last ten to fifteen years. These data should be available from the National Marine Fisheries Service and would provide the basis for determining if there are increases in strandings that might be associated with the shock trial. C30

Page C-5 (Table C.1): As noted earlier, the Commission believes it is contrary to the intent and provisions of the Marine Mammal Protection Act to use the sound level at which temporary hearing threshold shifts are expected to begin as the basis for estimating the distances at which harassment could occur. Also, the Commission questions whether the estimates of marine mammal densities, effective strip widths for aerial and shipboard surveys, and a number of the other estimates provided later in this Appendix are significant to the number of decimal points indicated. C31

Page D-4, par. 1: The last sentence in this paragraph states that "[t]he brief 'sting' tactile perception effects are not used for DEIS (harassment) calculations because more conservative (harassment) criteria based on auditory effects are developed in Appendix E." As noted earlier, the Commission believes that defining harassment in terms of temporary hearing threshold shift is inconsistent with the definition of harassment in the Marine Mammal Protection Act. C32

Page D-9, sen. 1: This sentence states that "[f]igure D.2 presents a comparison between the Yelverton (1981) (No Injury) regression curve for impulse vs. body mass and a plot of the predicted impulses for onset of slight lung hemorrhage for the test conditions in **Table D.1.**" The test data plotted in Figure D.2 appear to indicate that the onset of slight lung hemorrhage occurs at impulse values less than those predicted by the Yelverton equation. Likewise, the test data for 1% mortality plotted in Figure D.3 appear below the line predicted by the Yelverton equation. Thus, it appears that the estimates of the distances at which no injury and 1% mortality are predicted may not be as conservative as indicated. An explanation of these possible discrepancies should be provided in the final environmental impact statement. C33

Pages D-12 through D-16 (Auditory System Injury): As noted earlier, it is not clear why both onset of lung injury and 50% rupture of the tympanic membrane are discussed as conservative predictors of severe injury. C34

Pages D-17 and D-18 (Marine Mammal Tactile Perception): Although interesting, the Commission finds this discussion largely irrelevant to the Marine Mammal Protection Act's definition of Level B harassment. C35

Pages E-1 through E-35 (Appendix E): This section provides a thorough summary and analysis of the best available data concerning the effects of sound on hearing in humans, other terrestrial mammals, and marine mammals. It provides solid support for the estimates of the types and levels of sound that reasonably can be expected to cause temporary hearing threshold shifts in various species of marine mammals and the distances from the detonation site where marine mammals may be expected to be exposed to impulse sounds that could cause temporary hearing threshold shifts. It also provides a reasonable basis for concluding that, because it is temporary, temporary hearing C36

threshold shifts do not constitute injury as envisioned in the Marine Mammal Protection Act's definition of Level A harassment, provided it does not make the affected animals vulnerable to predation or otherwise affect survival or productivity. C36

Pages G-1 through G-65 (Appendix G): This section provides an exemplary summary of available information concerning endangered, threatened, and candidate species that could be affected by the proposed action. With one exception, it also provides a clear and well-reasoned assessment of the likely direct and indirect effects of the proposed action on marine mammals. The exception is the assessment of what constitutes Level B harassment as defined in the 1994 amendments to the Marine Mammal Protection Act. That is, while it recognizes that the sounds produced by detonation of explosive charges could cause behavioral disruptions at distances beyond those where temporary hearing thresholds shifts could occur, it concludes that such disruptions would not constitute Level B harassment because they would have no significant or lasting impacts on movements, migration patterns, breathing, nursing, breeding, feeding, or other normal behavior (see, for example, the first paragraph on page G-29). C37

The Marine Mammal Protection Act defines Level B harassment as "any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or a marine mammal stock in the wild by causing disruption of behavioral patterns including, but not limited to, migration, breeding, nursing, breathing, feeding, or sheltering." Thus, it is clear that any behavioral disruption would technically constitute harassment, whether or not it affects survival or productivity. As noted earlier, the assessment of possible impacts should be revised to reflect this definition of harassment and the related provisions of the Act.

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I hope that these comments and suggestions are helpful. If you have questions about any of them, please let me know.

Sincerely,

John R. Twiss, Jr.
Executive Director

cc: Ms. Donna S. Wieting

NAVY RESPONSES

C. Marine Mammal Commission (John R. Twiss, Jr.)

C1. Response: Comment noted.

C2. Response: This general comment addresses the definition of Level B harassment and is restated throughout the specific comments (C4, C13, C15. C20, C21, C31, C32 and C37). The differences between the approach used in the DEIS and the one suggested by the Marine Mammal Commission (MMC) are not substantial. That is, both approaches come to the same conclusion about the number of animals affected and the kinds of effects that those animals would experience. The principal difference is in the classification or naming of some impacts in legal terms – with implications for the subsequent use of those terms in the request for "incidental takes." The root of the difference lies in the interpretation and application of the definition of Level B harassment in the Marine Mammal Protection Act (MMPA). Despite this difference in terminology, both the approach suggested by the MMC and that used in the DEIS would produce the same number of animals in each "take" category – i.e., Level A mortality and injury and Level B behavioral disturbance.

The term "harassment" was defined as Level B harassment for the purposes of the DEIS in Section 4.1.1(e). This usage follows from the SEAWOLF EIS in which the National Marine Fisheries Service (NMFS) requested that the Navy estimate impacts in three specific categories – mortality, injury, and harassment. As this usage causes confusion despite the explicit definition, the use of the term "harassment" has been reviewed and, where appropriate, it has been replaced in the FEIS with a more specific term that describes either the category of legal harassment intended – e.g., Level B harassment – or the impact under consideration – e.g., hearing-based behaviors.

The comments combine two assertions about the interpretation of the Level B definition and the justification for exclusion from enumeration of possible Level B harassments. The comments state in effect that (1) any and all potential behavioral disturbances, however slight, reach the status of Level B harassment and should be declared as such, but (2) behavioral disturbances other than those caused by TTS are less significant or important in the shock trial scenario, and therefore, need not be enumerated. Correspondingly, the FEIS takes the following positions. (1) Any and all possible behavioral disturbances should be considered as potential Level B harassment, but only important (or significant) disturbances that are known to exist in the subject species reach the status of Level B harassment and should be declared and enumerated as such. Additionally, (2) TTS reaches the status of Level B harassment, but other possible behavioral disruptions in the shock trial scenario are either of less importance – as suggested by the MMC – or may possibly be important, but are unknown to exist in the species under consideration. Further, adequate determination of such unknown behaviors for shock-trial-like acoustic emissions at the distances involved for the species under consideration is neither scientifically, practically, nor ethically possible.

Regarding the first assertion above, the unqualified, all-inclusive interpretation of the MMPA's Level B definition is not necessarily the meaning or intent of the law. The terms used within the definition are themselves ambiguous – i.e., neither "behavior" nor "disruption," its criterion degree or duration are defined. Since arbitrary extreme definitions of behavior, disturbance, and disruption could allow inclusion or exclusion of almost any given biological effect as Level B harassment, it is clear that the wording of the MMPA alone cannot provide a complete or reliable guide to regulatory practice.

Recognizing that ambiguity in the definition of Level B harassment, regulatory agents, public and private scientists, as well as interested public commentators have debated Level B harassment over several years in several forums. Not all aspects of the issue are resolved, but it has been concluded that incidental minor behavioral disruption does not constitute Level B harassment as intended by the MMPA. This conclusion was expressed in those forums and in a number of recent rulings of the regulatory agency – most notably, in the Final Rule for the SEAWOLF shock test (63 FR 66069, December 1, 1998), the conclusions of the recent NMFS Acoustic Criteria Workshop of September 1998 (with government and private experts) and acoustic and regulatory experts that were consulted during the preparation of this DEIS. In view of these findings and actions as well as the ambiguity of open-ended definitions, the FEIS takes the position that minor disturbance should neither be considered Level B harassment, declared as such, nor enumerated.

Regarding the second assertion, comment C2 makes statements about duration and frequency of behaviors, biological significance with an implicit definition, and a suggestion for justifying non-enumeration of behavioral disruptions other than those caused by TTS. The statement and suggestion are based on summary statements in Section 4.1.1 (and possibly Appendix G) of the DEIS which do not, in every instance, completely reflect the analysis performed. That detailed analysis as well as the summary have been restated more concisely and completely in the FEIS. To wit: beyond behavioral disruptions caused by TTS, the analysis considered disruptive responses that were impossible (escape from a shot-in-progress), disruptive responses that were very unlikely (conditioned responses to pre-shot stimuli), brief disruptive responses that were likely (orienting responses), and disruptive responses whose probabilities of occurrence are unknown (startle, panic and post-shot departure) in the relevant species. To these potential disruptions already descibed in the DEIS, have been added post-shot sensitization to other environmental stimuli, the probability of which is also unknown. Impossible and very unlikely responses are not considered further. Possible responses with unknown (and unknowable probabilities) are not considered further since any predictions of their existence and estimates of their duration would be only conjecture and speculation; studies with apparent relevance are reviewed in Section 4.1.1 of the FEIS.

The suggestion to group all such responses together for the single reason given does not reflect either the analysis just described or current knowledge.

The DEIS does not formally invoke the concept of biological significance or its implied definition as justification for exclusion from enumeration as suggested in this comment, since they have not yet been formally expressed in law or guidelines. Rather, biological significance is used only implicitly for exclusion of both classification and enumeration in the case of orienting responses that are "...negligible in terms of disrupting ongoing behaviors" [DEIS 4.1.1 (f)].

C3. Response: Comment noted.

C4. Response: Regarding the harassment issue in general, see response to comment C2. The sentence referred to has been reworded and does not mention harassment.

C5. Response: The table has been modified as suggested.

C6. Response: The text has been changed to explain the rationale. The U.S. Navy ship shock trial program historically has maintained a 5-nmi exclusion zone for non-military vessels. This exclusion zone is an electronic emissions control zone that virtually eliminates the possibility of an inadvertent detonation caused by radio/radar induced electrical current in the explosive firing circuit. As the charge-handling vessel has severely restricted maneuvering capability once the explosive charge is deployed and under tow some 2000-ft astern, the exclusion zone also provides an area of safe maneuvering.

C7. Response: See response to comment C17. Further rationale supporting the injury criteria has been inserted in Section 4.1.1 (not considered appropriate in the Executive Summary)

C8. Response: Live fire testing is required by statute, and is also Navy policy. The text has been modified to clarify this point.

C9. Response: See response to comment set E (Department of the Interior). Updated information on the Destin Dome Unit has been incorporated in the FEIS. If the Pascagoula test area is selected, the Navy would consult with MMS and Chevron to avoid problems.

C10. Response: The number of significant figures (decimal places) has been reevaluated throughout the FEIS and changed where appropriate. In the literature, marine mammal and turtle densities are typically reported to two or three decimal places. Following the example of the GulfCet II report, the FEIS reports densities to three decimal places. In theory, impact ranges can be calculated with great precision (i.e., to many decimal places), but due to the number of variables involved, two decimal places is considered reasonable. Accordingly, incidental take estimates and associated probabilities, which are a function of densities and impact ranges, have been rounded to two decimal places.

C11. Response: Humpback whale stranding data (including the cited paper) were reviewed, but due to the water depth these animals were considered less likely to occur in the test area than sperm or fin whales. The text has been modified to discuss humpback whales further.

C12. Response: Column headings in Table 3.3 have been corrected.

C13. Response: Regarding the MMC's interpretation of Level B harassment, see response C2. The sentence in question has been deleted and related material reworded.

C14. Response: The number of significant decimal places has been reevaluated throughout the FEIS (see response C10). As noted in response C6, the larger size of the ship exclusion zone is not necessary to protect ships, but to provide operational security and protect the test from electronic interference and noise. A footnote has been added to explain the rationale.

C15. Response: See response C2 regarding the interpretation of Level B harassment and the suggestion regarding insufficient data.

C16. Response: The sentence has been reworded as recommended. The number of significant decimal places has been reevaluated throughout the FEIS and changed where appropriate.

C17. Response: Additional rationale and justification for the use of lung injury and eardrum rupture as injury criteria has been provided in Section 4.1.1 of the FEIS. Terrestrial mammal and marine mammal auditory systems have similarities in structure and function (Ketten, 1995, 1998). There are no detailed experimental results from marine mammals upon which to base a quantitative analysis of the potential effects of a 10,000-lb charge detonation on marine mammal auditory systems. Ketten (1995, 1998) addresses these very same issues. By using the results from controlled underwater explosion experiments on small terrestrial mammals (dogs and sheep), reasonable assumptions can be made concerning potential auditory system impacts to small marine mammals. Under identical assumed conditions, the EIS and Ketten (1995, 1998) are consistent in the assumed overall potential impacts to marine mammals (see Figure D-9). Under the conditions of the proposed shock trial, the EIS impact analysis yields larger (more conservative) ranges for specific injury impacts than under the conditions described by Ketten (see FEIS Figure D-10).

50% eardrum rupture was considered as a criterion for non-lethal injury because it is a standard, statistically meaningful measure that has been estimated in a variety of mammals (Ketten, 1995, 1998). Further, it provides an indirect way to estimate the range for permanent threshold shift (PTS), an auditory impact that has never been studied in marine mammals (in terrestrial mammals, 50% incidence of TM rupture is associated with 30% incidence of PTS). Estimated ranges for eardrum rupture probabilities less than 50% would be highly variable. Instead of estimating an outer bound for eardrum rupture or calculating a gradient or probability curve, the EIS simply counts 100% of the animals in this range as "injured" even though the incidence of eardrum rupture would be less than 50% at this range and the incidence of PTS would be less than 30%. No assumptions are made as to the potential long-term effects of this type of injury. It is assumed that since the data are from small terrestrial animals, the predictions would be applicable primarily to smaller marine mammals. Larger animals could be less vulnerable to this type of injury. Animals at depths other than where the range is maximal would also be less vulnerable to eardrum rupture.

Ultimately, onset of slight lung injury, rather than 50% eardrum rupture, was chosen as the injury criterion for impact analysis. The slight lung injury criterion was more conservative (i.e., had a greater range) in this case.

C18. Response: The number of significant figures (decimal places) has been reevaluated throughout the FEIS and changed where appropriate. See response C10.

C19. Response: Sentence has been reworded as suggested.

C20. Response: Regarding harassment, see response C2. Neither assumption cited in this comment – (1) that disruption of behavior does not constitute harassment unless it somehow results in injury; or (2) that disruption of feeding, breeding, or other behavior cannot result in injury) – is made in the DEIS. To the contrary, TTS which is taken to be non-injurious, and therefore not Level A harassment – as the MMC agreed in comment C36 – causes behavioral disruption, and thus is considered Level B harassment. Further, responses to sub-TTS level exposures in shock tests, none of which are inherently injurious, were all considered as being potential Level B harassments before being discounted on grounds other than their non-injurious nature – e.g., low or unknown probability, brief duration, etc. [see Section 4.1.1(e) & (f)]. Still further, if the assumption were made that injury was a prerequisite to behavioral disruption being classified as harassment, then by definition, all Level B harassment would be Level A harassment as well.

Similarly, no assumptions are made about behavioral disruption causing or not causing injury. However, the DEIS does use two related assumptions: (1) the definition of Level B harassment addresses only the direct effects of the acts described – it makes no mention of "injuries" that might be caused by hypothetical secondary agents or actions as adjunct criteria for Level B harassment; and (2) even though disturbed behavior could result in injury from a secondary agent or action, neither the likelihood of such occurrence nor the number of animals affected could be predicted with any reliability in advance – any such predictions would be only conjecture..

C21. Response: Regarding harassment, see response C2. Also, the summary statement cited in this comment has been revised to more accurately reflect the discussion of behavioral responses presented in Section 4.1.1(f).

C22. Response: The suggested sentence has been incorporated into the FEIS. The maximum viewing range from the ship refers to the predicted distance that can be effectively searched using 25 power binoculars (from Barlow and Lee, 1994). The effective viewing range is that range that needs to be searched based on the calculated Safety Range and Buffer Zone. Sea state and other variables, such as group size were not factored into these estimates. However, detection probabilities estimated in Appendix C were estimated from data sets (e.g., GulfCet) that encompass the range of sea states and other variables likely to be encountered during the shock trial. Also see response to K6, International Fund for Animal Welfare.

C23. Response: Information has been added to Section 5.5.3 of the FEIS on the capabilities of the passive acoustic monitoring system, including the number and configuration of buoys to be deployed, distances at which vocalizations will be heard and how the sonobuoys, and therefore, detections, will be tracked. However, comparing vocalizations before and after the detonations will likely not be possible. If there are any vocalizations detectable within 2.25 nmi of the detonation point, then the detonation would not occur. In order for a detonation to occur, there must be no pre-detonation vocalizations and therefore nothing to compare post-detonation vocalizations to. There are also operational restrictions that occur after the detonation that would disallow recording of vocalizations.

C24. Response: Although individual dolphins are more difficult than large whales to detect at the surface, most of the small dolphins that are expected in the area (including pantropical, spinner and striped dolphins) are highly social and nearly always seen in large groups. Bottlenose and Atlantic spotted dolphins may be seen in somewhat smaller groups and have occasionally been sighted as solitary animals. The average group sizes reported in Table C.3 reflect this. Additional data from surveys flown in this area also suggest the social nature of most small odontocete species. Combining the 1995 and 1997 surveys in support of the SEAWOLF Shock Trial (Department of the Navy, 1995, 1998b, as cited in Appendix B) and the 1999 surveys in support of the Churchill Shock trial, there were a total of 314 sightings. Seventeen percent (n=54) of these sightings were of solitary animals. This may be indicative of the relative rareness of solitary animals, but also illustrates that solitary animals can be sighted and identified during survey conditions similar to those under which the shock trial will be conducted.

C25. Response: Based on literature reviewed in response to this comment, edges of warm core rings may have higher mammal densities and should be avoided, but the interior of such features typically has low productivity and low mammal densities. Discussion of warm core rings has been added to Section 3.0. Section 5.0 clarifies that edges of warm core rings and interfaces between warm and cold rings would be avoided in site selection.

C26. Response: Other flight patterns were considered, but this was determined to be the most effective overall. Observers on both the aircraft and the WINSTON S. CHURCHILL would be searching the Safety Range and Buffer Zone behind as well as in front of the vessel. Observers onboard the Churchill would have Bigeyes binoculars and would be positioned to maintain a search pattern that includes 360° around the ship. Observers onboard the aircraft would also be able to search behind and abeam of the ship even when they are flying transects in front of the ship.

C27. Response: Towing a large whale to shore for an onshore necropsy was not considered due to the length of time the tow would take. The MART vessel would likely only be able maintain a maximum speed of five knots while towing a large whale. Therefore it would take between 9 and 20 hours to tow the animal into shore. During the tow, the essential tissues (heart, lung, brain) would more than likely decompose beyond usefulness as far as determining if blast injury caused the death. The MART vessel would have a platform from

which the veterinarian and technician would be able to perform a partial necropsy on large whales, weather permitting.

C28. Response: Information has been added to Sections 5.7.1 and 5.7.2. Two types of tags may be used on dead marine mammals that are found in the test area prior to the first detonation or those that are found in the test area after a detonation has occurred but that cannot be collected due to size or inclement weather. Flagging tape would be tied around the peduncle and lower jaw, and information related to the animal (date of discovery, location, identification number) would be written on the tape in indelible ink. Tags would also be inserted in the blubber. Tagging of all dead marine mammals would be coordinated with the NMFS to assure that stranding networks are aware of the tag circumstances. Sea turtles would be marked with flipper tags obtained from and coordinated thru the Archie Carr Center for Sea Turtle Research.

C29. Response: Text has been changed as suggested..

C30. Response: Table B.3 headings have been corrected. The Navy has obtained historical data, which were examined to help determine which species could occur at each test area (since some species are rarely sighted at sea). Strandings data have not been tabulated in the FEIS since they area not related to the impact assessment, but they may be useful in the future as a baseline in the event that strandings occur during the shock trial period.

C31. Response: Regarding rounding, the Navy has reevaluated the number of significant decimal places throughout the FEIS and changed where appropriate. Mammal and turtle densities are reported to three decimal places following the example of the GulfCet II report (Mullin and Hoggard, 2000). Effective strip widths are from the same source and are stated as reported by the authors. Regarding the harassment issue, see response C2. Also, as a point of clarification, the DEIS does not use the distance at which TTS is expected to begin as the basis for estimating the distance at which harassment "could" occur. As previously stated, all potential behavioral disruptions that "could" occur at longer distances (lower levels) were considered as potential Level B harassments before being eliminated for various reasons, some of which are pertinent specifically to the shock-test scenario. In general, the DEIS considers TTS as one of many potential Level B harassments. With single acoustic events that are isolated in time, TTS happens to be the only one of those potential Level B harassments that has at once, sufficient predictability, likelihood and impact to be considered harassment.

C32. Response: Regarding the harassment issue, see response C2. The sentence in question has been deleted in the clarification of terminology.

C33. Response: Figures D-2, D-3 and D-4 have been modified to correctly show the relationship of predicted injury levels with injury levels resulting from explosion tests with small terrestrial mammals. The methodology employed in the DEIS is believed to overestimate injury severity at a given range from the explosion.

C34. Response: See response C17.

C35. Response: The Tactile Perception text has been revised and no longer refers to "harassment."

C36. Response: The assertion of the comment's last sentence that TTS is not injurious due solely to its temporary nature, and the implication that TTS could constitute Level A harassment if it resulted in vulnerability to predation or otherwise affected survival and productivity, are unfounded. The temporary nature of TTS is only one aspect of the rationale that depends just as substantially on the scientific evidence that tissue is neither destroyed nor lost in TTS, as well as the view of TTS as not injurious in the more developed area of human damage risk criteria. These issues are described in Appendix E of the FEIS. The definitions of Level A and Level B harassment address only the direct effects of the acts described and it is those direct effects that are enumerated in the FEIS. That is, the definitions make no mention of "injuries" that might be caused by hypothetical secondary agents or actions – see C20, second paragraph above.

C37. Response: Regarding harassment, see response C2. Further, modifying the definition of Level B harassment to say "any behavioral disruption" without reasonable qualification would, given evermore sensitive technology, lead to an ever-expanding range of effect that would eventually include every animal that barely perceives the sound in the oceans. Such arbitrary and unbounded interpretations of the MMPA almost certainly go far beyond the intended scope of the law and in so doing, dilute its usefulness as the basis for regulation.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702
(727) 570-5317, FAX 570-5300

D

January 20, 2000 F/SER4:MT:rr

Marconi Systems Technologies
2611 Jefferson Davis Highway
Suite 5000
ATTN: DDG 81 Shock Team
Arlington, Virginia 22202

Dear Sir:

The National Marine Fisheries Service (NMFS) has reviewed the December 1999 Draft Environmental Impact Statement (DEIS) for the shock trial of the Winston S. Churchill, as proposed by the U.S. Navy. The following comments are related specifically to potential impacts to Essential Fish Habitat (EFH) associated with each project alternative. Issues related to the Endangered Species Act and/or Marine Mammal Protection Act are the purview of our Protected Resources Division and will be addressed separately.

The DEIS provides adequate information to assess the project's environmental impact and addresses potential EFH impacts related to each project alternative. The three potential sites chosen include the Naval Station Mayport, Florida; Naval Station Norfolk, Virginia; and Naval Station Pascagoula, Mississippi. The preferred alternative is to conduct a shock trial at an offshore location between May 1 and September 30, 2001 at one of the three sites. Several mitigative measures would be taken to reduce potential impacts to Federally managed species such as postponing detonation if large schools of fish or Sargassum rafts are present within the Safety Range.

Based upon the information provided in the DEIS, the U.S. Navy has determined that the preferred alternative would not have an adverse effect on EFH at the Mayport, Norfolk, or Pascagoula test areas. Impacts to the water column habitat would be localized and transient, with no significant adverse effect on EFH for any pelagic species. Minor disturbance of soft bottom areas beneath the charge may occur, but no adverse effects on soft bottom benthic habitats are expected due to the water depth (minimum of 600 feet). Hard bottom habitats, such as artificial reefs and coral areas, have been avoided through an exclusionary mapping process and no adverse effects are anticipated.

Since sensitive marine habitats have been avoided and the proposed action would be occurring in deep water, the NMFS anticipates that EFH and associated trust resources would not be significantly impacted by the proposed work. Because the DEIS adequately describes the proposed project and reasonably expected impacts to EFH and associated marine fishery resources, the NMFS has no comments or recommendation regarding site selection. D1

Sincerely,

Andreas Mager, Jr.
Assistant Regional Administrator
Habitat Conservation Division

NAVY RESPONSES

D. National Marine Fisheries Service, Southeast Regional Office (Andreas Mager, Jr.)

D1. Response: Comment noted.

United States Department of the Interior

E

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

January 13, 2000

ER-99/1077

LCDR, Jeff Riedel
U. S. Navy
Program Executive Office for
Theater Surface Combatants
2531 Jefferson Davis Highway
Arlington, VA 22242-5165

Dear Sir:

The Department of the Interior has reviewed the draft Environmental Impact Statement (DEIS) for the WINSTON S. CHURCHILL (DDG81) Shock Trial, as requested. We have no comments to offer. E1

Thank you for the opportunity to review and comment on the draft EIS.

Sincerely,

James H. Lee
Regional Environmental Officer

CC: Marconi Systems Technologies
2611 Jefferson Davis Highway
Suite 5000
Arlington, VA 22202

ATTN: DDG 81 Shock Team

United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

January 18, 2000

ER-99/1077

LCDR Jeff Riedel
U. S. Navy
Program Executive Office for
Theater Surface Combatants
2531 Jefferson Davis Highway
Arlington, VA 22242-5165

Dear Sir:

This is a follow-up letter to the one we sent to you January 13, 2000, regarding the draft EIS for the WINSTON S. CHURCHILL (DOG81) Shock Trial. Since our first letter, we received comments from the Minerals Management Service (MMS) for input into our letter to you. These comments are as follows:

Sect 3.3.5 on page 3-50 "Active Petroleum Lease Blocks, Pipelines, and Platforms" – The paragraph does make mention Navy plans to coordinate with MMS to determine whether any new platform, rigs, or activities are planned in the active blocks. The northwestern most portion of the Pascagoula test area overlaps with part of the Destin Dome 56 Unit Development and Production Plan of Chevron Oil Company for which an Environmental Impact Statement is currently being prepared. The final EIS is due for completion in late Spring of 2000 and a decision on the plan is scheduled for late Summer of 2000. Activity on the unit could be taking place during some phases of the shock test if it is held in the Pascagoula test area. Some mention should have been made of this proposed activity, and coordination with Chevron and it's contractors. E2

Sect 6.1.4 on page 6-5 "Other Activities – Pascagoula", subsection (d) Petroleum Industry – This section only addresses plans for an upcoming lease sale (Proposed Sale 181) in the area, but does not mention the possible approval of the Destin Dome 56 Unit Development and Production Plan mentioned above. The Destin Dome plan is of more immediate concern to this Agency, and is more likely to result in activities which would have to be coordinated with MMS and Chevron. Details on the plan and the approval process should be obtained from the Gulf of Mexico Regional Office in New Orleans and added to the section. E3

In the same section, in the paragraph titled "Potential for Cumulative Impacts" mention is made of a programmatic environmental assessment currently being prepared by MMS. It is too early in the evaluation process to make any conclusions as to the findings of the document so the statement E4

should only advise that the document is being prepared. In addition, the paragraph appears to be oriented towards indicating that geophysical activities are a more important noise sources than the shock trial. That is not the function of the cumulative analysis. This section should point out that the shock trial will impose additional noise related impacts to those already being experienced. Finally, it is perhaps premature to decide that "the potential for significant cumulative impacts in combination with other noise sources is considered minimal." MMS is still unsure of the findings of the analysis being prepared. That the conclusion will be that no significant impacts will occur is premature at this time, and should not be used as a basis for the last sentence in this paragraph. E4

If there are questions related to these MMS comments, please contact Archie Melancon, MMS, at 703/787-1547.

Sincerely,

James H. Lee
Regional Environmental Officer

CC: Marconi Systems Technologies
2611 Jefferson Davis Highway
Suite 5000
Arlington, VA 22202

ATTN: DDG 81 Shock Team

NAVY RESPONSES

E. U.S. Department of the Interior (James H. Lee)

E1. Response: Lack of comment noted (first letter dated January 13, 2000).

E2. Response: The Pascagoula test area does not overlap with the Destin Dome 56 Unit (see Figure I-1). This conclusion has been verified for the FEIS. However, some portions of the Destin Dome blocks would be within 10 nmi (the radius of the ship warning zone) if a test site were selected in the northwestern corner of the Pascagoula test area. If the Pascagoula test area is selected for the shock trial, the Navy would contact the Minerals Management Service (MMS) and Chevron to determine whether any petroleum industry activities are planned during the period of the shock trial and to coordinate activities. Mention of the Destin Dome gas development project has been added to sections 3.3.5 and 4.1.4(c) of the FEIS.

E3. Response: Information regarding the Destin Dome gas development project has been obtained from the MMS and added to section 6.1.4(d) of the FEIS.

E4. Response: The wording of section 6.1.4(d) of the FEIS has been rewritten to address this comment.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

F

JAN 21 2000

Marconi Systems Technologies
2611 Jefferson Davis Highway
Suite 5000
Arlington, Virginia 22202
Attn: DDG 81 Shock Team

Subject: Draft Environmental Impact Statement for the Shock Trial of the Winston S. Churchill (DDG-81)

Dear Sir:

Pursuant to Section 309 of the Clean Air Act and Section 102 (2)(C) of the National Environmental Policy Act, EPA, Region 4 has reviewed the subject document, an evaluation of the environmental consequences of shock trial testing at one of three proposed offshore locations, viz., Norfolk, Virginia, Mayport, Florida, or Pascagoula, Mississippi. Specifically, shock testing is a progression in which a ship and ever larger explosive charges are successively brought closer together and the latter detonated. Experience has shown the Navy that this is the best method of fully assessing survivability of the ship and its systems. Genuine explosions are required for this assessment since computer simulations are not currently adequate to provide sufficient information about actual equipment effects.

The shock trial would be conducted at one detonation per week for three weeks. This sequencing allows time to perform interim detailed inspection of the blast effects on the ship's systems. A fourth detonation is only an option if the first three tests fail to provide technically acceptable data. Favorable weather conditions for the offshore (deep water) test sites are most likely to occur during the months of May through September.

The analysis of the ramifications of this action together with the background information provided in the EIS appear adequate to make a general determination as to the proposal's impacts. We understand from previous tests that mitigation measures to protect marine mammals and turtles proved satisfactory in comparable situations in the Pacific. Similar techniques should be used in this test. The nature of the testing makes it impossible to avoid some risk to avian/marine species likely to be present within the test area; nonetheless, all reasonable efforts should be made to minimize losses. Post-monitoring results should be made available for review and analysis to involved natural resource agencies to determine how successful these measures were. This assessment will be essential in ascertaining both short- and long-term impacts to biota in test areas since in the foreseeable future the Navy will be conducting similar trails on all its major new assets.

After deliberation, a rating of EC-1 was assigned. That is, irrespective of the planned mitigation, we have a degree of environmental concern regarding the proposal. However, the document contained sufficient information for reasoned decision-making now. With implementation of prudent safety precautions, it appears that any of the above sites would meet the Navy's needs. This notwithstanding, if potential hazard(s) to marine mammals/sea turtles are factored into the risk profile, NAS Norfolk fares poorly in comparison. Either of the remaining two sites (Pascagoula and Mayport) should be able to meet the needs of all parties at acceptable costs. F1

If we can be of further assistance in this matter, Dr. Gerald Miller (404-562-9626) will serve as initial point of contact.

Sincerely yours,

Heinz Mueller

Heinz J. Mueller, Chief
Office of Environmental Assessment

NAVY RESPONSES

F. U.S. Environmental Protection Agency (Heinz J. Mueller)

F1. Response: Comment noted.

STATE AGENCIES

G

STATE OF FLORIDA

DEPARTMENT OF COMMUNITY AFFAIRS

"Dedicated to making Florida a better place to call home"

JEB BUSH
Governor

STEVEN M. SEIBERT
Secretary

February 17, 2000

Marconi Systems Technologies
2611 Jefferson Davis Highway
Suite 5000
Arlington, Virginia 22202

Attn: DDG 81 Shock Team

RE: Department of the Navy - Draft Environmental Impact Statement for the Shock Trial of the Winston S. Churchill (DDG 81) - Of Interest to the State of Florida
SAI: FL199912160948C

Dear Sir or Madam:

The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Gubernatorial Executive Order 95-359, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated a review of the above-referenced project.

The Florida Fish and Wildlife Conservation Commission (FWC) offers comments regarding potential impacts to sea turtles. The FWC notes that, because of the potential presence of endangered and threatened sea turtles offshore Mayport, and because the densities of turtles offshore Norfolk are also expected to be high, the FWC recommends that the test detonations be performed at the Pascagoula site. Please refer to the enclosed FWC comments. G1

Based on the information contained in the draft environmental impact statement and the applicant's satisfactory compliance with all conditions stipulated by the FWC, as summarized and enclosed, the state has determined that the above-referenced project is consistent with the Florida Coastal Management Program. G2

2555 SHUMARD OAK BOULEVARD • TALLAHASSEE, FLORIDA 32399-2100
Phone: 850.488.8466/Suncom 278.8466 FAX: 850.921.0781/Suncom 291.0781
Internet address: http://www.dca.state.fl.us

FLORIDA KEYS
Area of Critical State Concern Field Office
2796 Overseas Highway, Suite 212
Marathon, Florida 33050-2227

Thank you for the opportunity to review the draft environmental impact statement. If you have any questions regarding this letter, please contact Ms. Cherie Trainor, Clearinghouse Coordinator, at (850) 414-5495.

Sincerely,

Ralph Cantral, Executive Director
Florida Coastal Management Program

RC/cc

Enclosures

cc: Bradley Hartman, Fish and Wildlife Conservation Commission

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

JAMES L. "JAMIE" ADAMS, JR. Bushnell
BARBARA C. BARSH Jacksonville
QUINTON L. HEDGEPETH, DDS Miami
H.A. "HERKY" HUFFMAN Deltona
DAVID K. MEEHAN St. Petersburg
JULIE K. MORRIS Sarasota
TONY MOSS Miami
EDWIN P. ROBERTS, DC Pensacola
JOHN D. ROOD Jacksonville

ALLAN L. EGBERT, Ph.D., Executive Director
VICTOR J. HELLER, Assistant Executive Director

OFFICE OF ENVIRONMENTAL SERVICES
BRADLEY J. HARTMAN, DIRECTOR
(850)488-6661 TDD (850)488-9542
FAX (850)922-5679

January 26, 2000

FEB 03 2000
State of Florida Clearinghouse

Ms. Cherie Trainor
Florida State Clearinghouse
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100

RE: SAI #9912160948C, Department of the Navy, Draft EIS for the Shock Trial of the Winston S. Churchill

Dear Ms. Trainor:

The Office of Environmental Services of the Florida Fish and Wildlife Conservation Commission has reviewed the referenced project, and offers the following comments.

The proposed project involves four detonations of 10,000 lbs. of explosives in proximity to the Winston S. Churchill, an ARLEIGH BURKE class destroyer, between May 1 and September 30. Three alternatives for offshore test sites are suggested: Norfolk (no less than 62.5 km off the Outer Banks of NC), Mayport (no less than 70 km off Volusia through Nassau Counties), and Pascagoula, MS (no less than 62.5 km off Pensacola).

The proposed test sites are not in state waters; however, we are concerned about the potential for detonations offshore Mayport to affect adult sea turtles that are nesting in high concentrations on the east coast of Florida, and post-hatchling turtles that are swimming toward the Gulf stream during hatching season (July 1 – October 31). It is true that loggerhead hatchlings seem to be associated with *Sargassum* mats; however, large numbers will be swimming around offshore seeking those mats, and will not be detectable by visual surveys. Also, there is some evidence that green turtle hatchlings may not be as strongly associated with algal rafts, but these hatchlings are still present in the Gulf Stream at this time of the year. Because of the potential presence of endangered and threatened sea turtles offshore Mayport, and because the densities of turtles offshore Norfolk are also expected to be high, we recommend that the test detonations be performed at the Pascagoula site. G3

620 South Meridian Street · Tallahassee · FL · 32399-1600
www.state.fl.us/fwc/

Please contact me or Ms. Karen Moody at (850) 922-4330 if you have questions about these comments.

Sincerely,

Bradley J. Hartman, Director
Office of Environmental Services

BJH/RNT
sai0948C
ENV 1-3-2, ENV 7-3

COUNTY: State

Message:

DATE: 12/16/1999
COMMENTS DUE-2 WKS: 12/31/1999
CLEARANCE DUE DATE: 01/24/2000
SAI#: FL9912160948C

STATE AGENCIES	WATER MANAGEMENT DISTRICTS	OPB POLICY UNITS
Community Affairs Environmental Protection Fish & Wildlife Conserv. Comm X Transportation	South Florida WMD St. Johns River WMD	Environmental Policy/C & ED RECEIVED ... 1999 ...te of Florida Clearingho...

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evalutation and is categorized as one of the following:

— Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.

X Direct Federal Activity (15 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.

— Outer Continental Shelf Exploration, Development or Production Activities (15 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.

— Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.

Project Description:

Department of the Navy - Draft Environmental Impactment Statement for the Shock Trial of the Winston S. Churchill (DDG 81) - Of Interest to the State of Florida.

To: Florida State Clearinghouse
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100
(850) 922-5438 (SC 292-5438)
(850) 414-0479 (FAX)

EO. 12372/NEPA
- [x] No Comment
- [ ] Comments Attached
- [ ] Not Applicable

Federal Consistency
- [x] No Comment/Consistent
- [ ] Consistent/Comments Attached
- [ ] Inconsistent/Comments Attached
- [ ] Not Applicable

G4

From:
Division/Bureau: FDOT
Reviewer: [signature]
Date: 12/21/99

DEC-28-1999 07:19 SFWMD-REG 561 682 6896 P.02/03

COUNTY: State

Message:

DATE: 12/16/1999
COMMENTS DUE-2 WKS: 12/31/1999
CLEARANCE DUE DATE: 01/24/2000
SAI#: FL9912160948C

STATE AGENCIES	WATER MANAGEMENT DISTRICTS	OPB POLICY UNITS
Community Affairs Environmental Protection Fish & Wildlife Conserv. Comm Transportation	X South Florida WMD St. Johns River WMD	Environmental Policy/C & ED RECEIVED DEC 27 1999 EXECUTIVE OFFICE

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evalutation and is categorized as one of the following:

— Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.

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— Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.

Project Description:

Department of the Navy - Draft Environmental Impactment Statement for the Shock Trial of the Winston S. Churchill (DDG 81) - Of Interest to the State of Florida.

To: Florida State Clearinghouse
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100
(850) 922-5438 (SC 292-5438)
(850) 414-0479 (FAX)

EO. 12372/NEPA
- [ ] No Comment
- [ ] Comments Attached
- [x] Not Applicable

Federal Consistency
- [ ] No Comment/Consistent
- [ ] Consistent/Comments Attached
- [ ] Inconsistent/Comments Attached
- [x] Not Applicable

G5

From:
Division/Bureau: ENVIRONMENTAL RESOURCE REGULATION
Reviewer: JIM GOLDEN
Date: 12/27/99

COUNTY: State Rec'd 1/99

Message: #1565 1/2/22

DATE: 12/16/1999
COMMENTS DUE-2 WKS: 12/31/1999
CLEARANCE DUE DATE: 01/24/2000
SAI#: FL9912160948C

STATE AGENCIES	WATER MANAGEMENT DISTRICTS	OPB POLICY UNITS
Community Affairs Environmental Protection Fish & Wildlife Conserv. Comm Transportation	South Florida WMD X St. Johns River WMD	Environmental Policy/C & ED

of Florida Clearinghouse

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evalutation and is categorized as one of the following:

— Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.

_X_ Direct Federal Activity (15 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.

— Outer Continental Shelf Exploration, Development or Production Activities (15 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.

— Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.

Project Description:

Department of the Navy - Draft Environmental Impactment Statement for the Shock Trial of the Winston S. Churchill (DDG 81) - Of Interest to the State of Florida.

To: **Florida State Clearinghouse**
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100
(850) 922-5438 (SC 292-5438)
(850) 414-0479 (FAX)

EO. 12372/NEPA

- ☐ No Comment
- ☐ Comments Attached
- ☐ Not Applicable

Federal Consistency

- ☒ No Comment/Consistent
- ☐ Consistent/Comments Attached
- ☐ Inconsistent/Comments Attached
- ☐ Not Applicable

G6

From:
Division/Bureau: SJRWMD/OPP
Reviewer: M Spontak 12/20/99
Date:

COUNTY: State

Message:

DATE: 12/16/1999
COMMENTS DUE-3 WKS: 01/07/2000
CLEARANCE DUE DATE: 01/24/2000
SAI#: FL9912160948C

STATE AGENCIES	WATER MANAGEMENT DISTRICTS	OPB POLICY UNITS
Community Affairs X Environmental Protection Fish & Wildlife Conserv. Comm Transportation	South Florida WMD St. Johns River WMD	Environmental Policy/C & ED

2 2 1999

JAN 21 2000

State of Florida Clearinghouse

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- ☐ Comments Attached
- ☐ Not Applicable

Federal Consistency

- ☑ No Comment/Consistent
- ☐ Consistent/Comments Attached
- ☐ Inconsistent/Comments Attached
- ☐ Not Applicable

G7

From:
Division/Bureau: FDEP/OLGA
Reviewer: Lindy Braz
Date: 01/18/00

NAVY RESPONSES

G. State of Florida Department of Community Affairs (Ralph Cantral)

G1. Response: See response #3 below (same comment but more detailed).

G2. Response: Comment noted.

G3. Response: Although large numbers of turtles are nesting on southeast Florida beaches during the shock trial period, surveys have shown that nearly all adult turtles during this time are found inshore of the Gulf Stream western wall (Fritts et al., 1983; Thompson et al., 1984; Thompson and Huang, 1993; see also FEIS Appendix B). Based on the previous NMFS requirements specified in the Biological Opinion for the SEAWOLF shock trial (Department of the Navy, 1998, Appendix G), the shock trial test site would be located at least 3.7 km (2 nmi) seaward of the western wall (see FEIS Section 5.0). Therefore, adult turtles are unlikely to be abundant. This conclusion is supported by results of aerial surveys of the Mayport test area in June and August 1999, when only a few turtles were seen. Densities were comparable to those reported for the Pascagoula test area during GulfCet II surveys (see FEIS Appendix B).

Although post-hatchling turtles are more likely to be encountered at Mayport than at Pascagoula, they are not believed to be at high risk for several reasons. First, because the shock trial site would be located seaward of the Gulf Stream western wall, hatchlings "swimming toward the Gulf Stream" from their nesting beaches would not pass through the shock trial site. Second, areas with large sargassum rafts and debris lines would be avoided during site selection and would result in postponement if present in the Safety Range prior to detonation (avoidance of debris lines has been added to Section 5.0). The strong association of loggerhead post-hatchlings with floating debris is supported by recent studies (Dr. Blair Witherington, Florida Department of Natural Resources, unpublished report). Third, at the sea surface (where post-hatchlings live due to their buoyancy and association with floating sargassum), animals must be relatively close to the detonation point to be injured. That is, injury ranges tend to be lowest at the surface (see Appendix D).

The comment also mentions green turtle hatchlings, which may be present in the Gulf Stream during this time of year (Carr, 1986; Hirth, 1997). While less is known about the distribution and movements of green turtle post-hatchlings, recent studies near the test area (Dr. Blair Witherington, Florida Department of Natural Resources, unpublished report) did not find any green turtle post-hatchlings in collections along the Gulf Stream western edge near the Mayport test area. The report concludes that green turtle hatchlings, unlike loggerheads, are not strongly associated with floating debris. Although this lack of association with debris eliminates one method of avoiding them, it also means that these turtles are likely to be more diffuse in their distribution than loggerhead hatchlings and therefore less likely to be killed in large numbers. Even if not strongly associated with sargassum and debris, post-hatchling green turtles are likely to be near the sea surface due to their buoyancy and, as noted previously, animals in near-surface waters are unlikely to be injured or killed unless they are relatively close to the detonation.

G4. Response: Lack of comment noted.

G5. Response: Lack of comment noted.

G6. Response: Lack of comment noted.

G7. Response: Lack of comment noted.

GEORGIA
Coastal Resources Division

H

January 25, 2000

Marconi Systems Technologies
2611 Jefferson Davis Highway
Suite 5000
Arlington, VA 22202
Attn: DDG 81 Shock Team

To Whom It May Concern:

Thank you for the opportunity to review and comment on the Draft Environmental Impact Statement (DEIS) that evaluates the environmental effects of shock testing the Winston S. Churchill off the U.S. East Coast. Comments regarding marine mammals and turtles are being deferred to our agency's Wildlife Resources Division, Nongame-Endangered Wildlife Program.

Overall we feel that with the proposed monitoring controls/precautions and preliminary site surveys in place, the shock testing should have minimal fisheries effects. Assuming that the severe impact from an explosion extends only 23m downward, this should place the bottom and associated dwellers well out of reach. H1

One concern, however, is the inability of site surveys to locate sub-surface spawners prior to testing, if testing occurs at the time of year for these aggregations. For example, groupers often occur well up into the water column over soft or hard bottom habitat. Red porgy (critically overfished) are believed to spawn over low relief areas, while red snapper appear to spawn over sandy bottoms. The lack of high relief is no guarantee that spawning does not occur in a particular area. With this in mind, tests should be timed to avoid spawning aggregations. If this is not possible, known or suspected spawning sites should be researched, identified, and avoided. Finally, the chosen site could be surveyed shortly before testing to ensure that an aggregation has not formed in the area and/or is susceptible to explosive effects. H2

Thank you again for the opportunity to review the DEIS. Should your agency require any additional information, please feel free to contact Henry Ansley, our Outer Continental Shelf Program Leader, or me.

Sincerely,

Susan Shipman

Susan Shipman, Chief
Marine Fisheries Section

cc: South Atlantic Fishery Management Council
Duane Harris
Stuart Stevens
Henry Ansley
Ron Michaels
Barb Zoodsma

Georgia Department of Natural Resources
Coastal Resources Division

NAVY RESPONSES

H. Georgia Coastal Resources Division (Susan Shipman)

H1. Response: Comment noted. The statement that severe effects would extend only 23 m downward is incorrect and is not found in the EIS. However, the conclusion that bottom-dwelling fishes are unlikely to be affected is correct. Information supporting this conclusion is provided in FEIS Appendix H.

H2. Response: More information on deepwater spawning aggregations has been added to sections 3.3.1 and 4.1.3(d) of the FEIS. The species mentioned in this comment, red porgy and red snapper, usually occur in water depths shallower than the test area. These species (and most other members of the snapper-grouper species complex) are unlikely to be affected given that the shock trial would be conducted in water depths greater than 183 m. There is one species that could be affected based upon its depth of occurrence and potential spawning behavior – the snowy grouper. It is possible that snowy grouper forms spawning aggregations in the water depths of the test area, though none are known to occur there. This species spawns from April to July and occurs in water depths ranging from about 60 to 300 m (Parker and Mays, 1998; Wyanski et al., 2000). However, snowy groupers are always associated with hard substrata, and known hard bottom areas and artificial reefs have been avoided through exclusionary mapping (see FEIS Section 2.0). In addition, calculations indicated that fish near the bottom in depths of 183 m or more are unlikely to be killed by the detonations [see FEIS Section 4.1.3(d)].

I

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

James S. Gilmore, III
Governor

John Paul Woodley, Jr.
Secretary of Natural Resources

Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 10009, Richmond, Virginia 23240
Fax (804) 698-4500 TDD (804) 698-4021
http://www.deq.state.va.us

Dennis H. Treacy
Director

(804) 698-4000
1-800-592-5482

January 20, 2000

Marconi Systems Technologies
2611 Jefferson Davis Highway, Suite 5000
Arlington, Virginia 22202
Attn: DDG 81 Shock Team

RE: Draft Environmental Impact Statement (DEIS) for Shock Trial of the WINSTON S. CHURCHILL (DDG 81), proposed by the Department of the Navy; DEQ 99-134F

Dear Sir/Madam:

The Commonwealth of Virginia has completed its review of the DEIS on the above referenced project. The Department of Environmental Quality is responsible for coordinating Virginia's review of federal environmental documents and responding to appropriate federal officials on behalf of the Commonwealth. The following agencies and planning district commission participated in this review:

Department of Environmental Quality
Department of Agriculture and Consumer Services
Virginia Marine Resources Commission
Virginia Institute of Marine Science
Hampton Roads Planning District Commission

The Chesapeake Bay Local Assistance Department, The Department of Historic Resources, the Department of Game and Inland Fisheries, and the City of Norfolk were also invited to comment.

An Agency of the Natural Resources Secretariat

The proposed project consists of conducting a shock trial of the WINSTON S. CHURCHILL at an offshore location between May 1 and September 30, 2001. The DEIS analyses three alternative test areas: Naval Station Mayport, Florida; Naval Station Norfolk, Virginia; and Naval Station Pascagoula, Mississippi. The DEIS also evaluates the "no action" alternative and an offshore location for conducting a shock trial. The purpose of the project is to generate data that can be used to assess the survivability of Flight IIA ships to underwater detonations.

Environmental Impacts and Mitigation

The Commonwealth of Virginia concurs with the findings and conclusions of the DEIS and supports the selection of the Mayport and Pascagoula sites. We agree that the offshore Norfolk site is more environmentally sensitive than the Mayport and Pascagoula site. Should the Norfolk site become the selected alternative, the Commonwealth must be involved in any site specific planning . All monitoring and mitigation measures recommended by the National Marine Fisheries Service for the protection of marine mammals, pelagic fish species, and sea turtles (included in the DEIS) must be strictly adhered to during the implementation of the project. I1

Pursuant to the Coastal Zone Management Act of 1972, as amended, the proposed project must be conducted in a manner that is consistent with the Virginia Coastal Resources Management Program (VCP). Therefore, the Navy must receive all applicable permits and approval listed under the Enforceable Programs of the VCP (attached). Please contact Silvia B. Gazzera of DEQ's Office of Environmental Impact Review at (804) 698-4488 for more information.

Thank you for the opportunity to review the DEIS.

Sincerely,

Michael P. Murphy, Director
Division of Environmental Enhancement

Enclosures
cc: Ellen Gilinsky, OWPP
Sheri Kattan, DEQ-TRO
Tom Barnard, VIMS
Tony Watkinson, VMRC
Arthur Collins, Hampton Roads PDC

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

James S. Gilmore, III
Governor

John Paul Woodley, Jr.
Secretary of Natural Resources

Street Address: 629 E. Main Street, Richmond, Virginia 23219
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Dennis H. Treacy
Director

(804) 698-4000
1-800-592-5482

Enforceable Regulatory Programs comprising Virginia's Coastal Resources Management Program

a. Fisheries Management - The program stresses the conservation and enhancement of finfish and shellfish resources and the promotion of commercial and recreational fisheries to maximize food production and recreational opportunities. This program is administered by the Marine Resources Commission (Virginia Code §28.2-200 to §28.2-713) and the Department of Game and Inland Fisheries (Virginia Code §29.1-100 to §29.1-570).

The State Tributyltin (TBT) Regulatory Program has been added to the Fisheries Management program. The General Assembly amended the Virginia Pesticide Use and Application Act as it related to the possession, sale, or use of marine antifoulant paints containing TBT. The use of TBT in boat paint constitutes a serious threat to important marine animal species. The TBT program monitors boating activities and boat painting activities to ensure compliance with TBT regulations promulgated pursuant to the amendment. The MRC, DGIF, and VDACS share enforcement responsibilities (Virginia Code §3.1-249.59 to §3.1-249.62).

b. Subaqueous Lands Management - The management program for subaqueous lands establishes conditions for granting or denying permits to use state-owned bottomlands based on considerations of potential effects on marine and fisheries resources, wetlands, adjacent or nearby properties, anticipated public and private benefits, and water quality standards established by the Department of Environmental Quality, Water Division. The program is administered by the Marine Resources Commission (Virginia Code §28.2-1200 to §28.2-1213).

c. Wetlands Management - The purpose of the wetlands management program is to preserve tidal wetlands, prevent their despoliation, and accommodate economic development in a manner consistent with wetlands preservation. This program is administered by the Marine Resources Commission (Virginia Code §62.1-1301 through §62.1-1320).

d. Dunes Management - Dune protection is carried out pursuant to The Coastal Primary Sand Dune Protection Act and is intended to prevent destruction or alteration of primary dunes. This program is administered by the Marine Resources Commission (Virginia Code §62.1-1400 through §62.1-1420).

An Agency of the Natural Resources Secretariat

e. Non-point Source Pollution Control - Virginia's Erosion and Sediment Control Law requires soil-disturbing projects to be designed to reduce soil erosion and to decrease inputs of chemical nutrients and sediments to the Chesapeake Bay, its tributaries, and other rivers and waters of the Commonwealth. This program is administered by the Department of Conservation and Recreation (Virginia Code §10.1-560 et.seq.).

f. Point Source Pollution Control - The point source program is administered by the State Water Control Board pursuant to Virginia Code §62.1-44.15. Point source pollution control is accomplished through the implementation of:

(i) The National Pollutant Discharge Elimination System (NPDES) permit program established pursuant to Section 402 of the federal Clean Water Act and administered in Virginia as the VPDES permit program.

(ii) Water Quality Certification pursuant to Section 401 of the Clean Water Act administered in Virginia through the Virginia Water Protection Permit which includes protection of wetlands --both tidal and non-tidal.

g. Shoreline Sanitation - The purpose of this program is to regulate the installation of septic tanks, set standards concerning soil types suitable for septic tanks, and specify minimum distances that tanks must be placed away from streams, rivers, and other waters of the Commonwealth. This program is administered by the Department of Health (Virginia Code §32.1-164 through §32.1-165).

h. Air Pollution Control - The program implements the federal Clean Air Act to provide a legally enforceable State Implementation Plan for the attainment and maintenance of the National Ambient Air Quality Standards. This program is administered by the State Air Pollution Control Board (Virginia Code §10-1.1300).

If you cannot meet the deadline, please notify SILVIA GAZZERA at 804/698-4488 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

REVIEW INSTRUCTIONS:

A. Please review the document carefully. If the proposal has been reviewed earlier (i.e. if the document is a federal Final EIS or a state supplement), please consider whether your earlier comments have been adequately addressed.

B. Prepare your agency's comments in a form which would be acceptable for responding directly to a project proponent agency.

C. Use your agency stationery or the space below for your comments. **IF YOU USE THE SPACE BELOW, THE FORM MUST BE SIGNED AND DATED.**

Please return your comments to:

DR. SILVIA B. GAZZERA
DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/698-4319

JAN 11 2000

Silvia B. Gazzera
Environmental Program Planner

COMMENTS

No comments from perspective of Virginia Water Protection Permit Program

I2

(signed) Ellen Gilinsky (date) 1/10/2000
(title) Va Water Protection Permit Program Manager
(agency) VA DEQ

PROJECT # 99-134F 8/98

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OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/698-4319

JAN 19 2000

Silvia B. Gazzera
Environmental Program Planner

COMMENTS

Concur with prefered alternative to utilize either the Manport or Pascagoula test sites. NMFS recommendations should be followed to avoid and minimize adverse impacts to marine mammals, sea turtles, and other aquatic life.

I3

(signed) (date) 1-14-00
(title) Environmental Engineer
(agency) DEQ - TRO

PROJECT # 99-134F 8/98

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C. Use your agency stationery or the space below for your comments. **IF YOU USE THE SPACE BELOW, THE FORM MUST BE SIGNED AND DATED.**

Please return your comments to:

DR. SILVIA B. GAZZERA
DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/698-4319

JAN 7 2000

Silvia B. Gazzera
Environmental Program Planner

COMMENTS

Based on information in our database, we do not anticipate this project will have any adverse impacts as it relates to VDACS' responsibilities for the preservation of agricultural lands and the protection of listed endangered or threatened plant and insect species.

Thank you for the opportunity to comment and if you have any questions or need additional information, please contact me at (804)786-3515.

I4

(signed) _____ (date) 1/5/2000

(title) Endangered Species Coordinator

(agency) Virginia Department of Agriculture and Consumer Services

PROJECT # 99-134F 8/98

If you cannot meet the deadline, please notify SILVIA GAZZERA at 804/698-4488 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

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Please return your comments to:

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DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/698-4319

JAN 14 2000

Silvia B. Gazzera
Environmental Program Planner

COMMENTS

No Comments

I5

(signed) Victoria Porterfield (date) 1-14-00

(title) Environmental Program Planner

(agency) DEQ-Waste

PROJECT # 99-134F 8/98

WILLIAM & MARY
VIMS
Virginia Institute of Marine Science
School of Marine Science

CCRM
Center for
Coastal Resources Management

JAN 1 2 ...

January 11, 2000

Dr. Sylvia B. Gazzera
Department of Environmental Quality
Office of Environmental Impact Review
629 East Main Street
Richmond, VA 23219

RE: DEIS Shock Trial of the Winston S. Churchill (DDG 81)

Dear Dr. Gazzera,

We have reviewed the subject document from a marine environmental perspective and have found it to be relatively clear and comprehensive. We concur with the findings and conclusions of the report, agreeing that offshore Norfolk is a much more environmentally sensitive area than the proposed alternative sites and should not be used for the proposed testing given the availability of the two lower latitude sites. We also suggest that the Commonwealth request it be involved in an additional, site specific planning and review effort should, for any reason, the Norfolk site become the primary site. I6

If I may answer any questions with regard to these comments, please do not hesitate to contact me.

Sincerely,

TABarnard Jr

Thomas A. Barnard, Jr.
Marine Scientist

PO Box 1346 • Route 1208 Greate Road • Gloucester Point, Virginia 23062-1346 USA
804/684-7380 • FAX 804/684-7179

VMRC HABITAT MGMT TEL:757-247-8062 Jan 19 00 11:01 No.004 P.02

If you cannot meet the deadline, please notify SILVIA GAZZERA at 804/698-4488 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

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B. Prepare your agency's comments in a form which would be acceptable for responding directly to a project proponent agency.

C. Use your agency stationery or the space below for your comments. **IF YOU USE THE SPACE BELOW, THE FORM MUST BE SIGNED AND DATED.**

Please return your comments to:

DR. SILVIA B. GAZZERA
DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/698-4319

Silvia Gazzera
Silvia B. Gazzera
Environmental Program Planner

COMMENTS

While the proposed test area lies outside the Jurisdictional boundaries of the Marine Resources Commission, precautions should be taken to minimize impacts to marine mammals, sea turtles, and ocean pelagic fish species. I7

(signed) Heather L. Wood 1/14/00 (date)

(title) Environmental Engineer

(agency) VA. Marine Resources Commission

PROJECT # 99-134F 8/98

JAN 12 2000

HAMPTON ROADS
PLANNING DISTRICT COMMISSION

ROBERT C. CLAUD, SR., CHAIRMAN • JACK D. EDWARDS, VICE-CHAIRMAN • MYLES E. STANDISH, TREASURER
ARTHUR L. COLLINS, EXECUTIVE DIRECTOR/SECRETARY

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GLOUCESTER COUNTY
Ross M. Hines, Board Member
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Joseph H. Spencer, II, Mayor
George E. Wallace, City Manager

ISLE OF WIGHT COUNTY
W. Douglas Caskey, County Administrator
Robert C. Claud, Sr., Board Member

JAMES CITY COUNTY
Jack D. Edwards, Chairman
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NEWPORT NEWS
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Joe S. Frank, Mayor
Edgar E. Maroney, City Manager

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Herbert M. Collins, Sr., Vice-Mayor
Paul D. Fraim, Mayor
Dean S. Hester, Council Member
Regina V.K. Williams, City Manager

POQUOSON
Charles W. Burgess, Jr., City Manager
Gordon C. Helsel, Jr., Mayor

PORTSMOUTH
Thomas Benn, III, Council Member
Ronald W. Massie, City Manager
P. Ward Robinett, Jr., Council Member

SOUTHAMPTON COUNTY
Michael W. Johnson, County Administrator
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SUFFOLK
Marian B. Rogers, Council Member
Myles E. Standish, City Manager

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Terry D. Lewis, County Administrator

VIRGINIA BEACH
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W. W. Harrison, Jr., Council Member
Harold Heischober, Council Member
Louis R. Jones, Council Member
Meyera E. Oberndorf, Mayor
Nancy K. Parker, Council Member
James K. Spore, City Manager

WILLIAMSBURG
Jackson C. Tuttle, II, City Manager
Jeanne Zeidler, Mayor

YORK COUNTY
Sheila S. Noll, Chairman
Daniel M. Stuck, County Administrator

January 10, 2000

Ms. Silvia B. Gazzera
EIR Program Planner
Department of Environmental Quality
Post Office Box 10009
Richmond, Virginia 23219

Re: Draft EIS for the Shock Trial
of the Winston S. Churchill
DEQ #99-134F (ENV:GEN)

Dear Ms. Gazzera:

Pursuant to your request of December 28, 1999, the staff of the Hampton Roads Planning District Commission has reviewed the Draft EIS for the Shock Trial of the Winston S. Churchill.

The document notes that the offshore area of southeastern Virginia was eliminated from the preferred alternative due to the magnitude of potential environmental impacts. Because it seems that our region is no longer in question, we currently have no comments on the project. I8

We appreciate the opportunity to review this project. If you have any questions, please do not hesitate to call.

Sincerely,

Arthur L. Collins
Executive Director/Secretary

HRV:fh

HEADQUARTERS • THE REGIONAL BUILDING • 723 WOODLAKE DRIVE • CHESAPEAKE, VIRGINIA 23320 • (757) 420-8300
PENINSULA OFFICE • HARBOUR CENTRE, 2 EATON STREET • SUITE 502 • HAMPTON, VIRGINIA 23669 • (757) 728-2067

NAVY RESPONSES

I. Virginia Department of Environmental Quality (Michael P. Murphy)

I1. Response: Comment noted.

I2. Response: Lack of comment noted.

I3. Response: Comment noted. The Navy must comply with NMFS protective measures specified in the incidental take authorization for marine mammals, as well as any requirements specified in the Biological Opinion for marine mammals and sea turtles.

I4. Response: Comment noted.

I5. Response: Lack of comment noted.

I6. Response: Comment noted.

I7. Response: Comment noted. Precautions to minimize impacts to marine mammals, turtles, and pelagic fishes are covered in Section 5.0 of the FEIS.

I8. Response: Lack of comment noted.

NON-GOVERNMENTAL ORGANIZATIONS

THE HUMANE SOCIETY OF THE UNITED STATES

J

OFFICERS
Joe Ramsey, Esq.
Chairman of the Board
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NGO in general consultative status with the Economic and Social Council of the United Nations

March 30, 2000

Marconi Systems Technologies
2611 Jefferson Davis Highway
Suite 5000
Arlington, VA 22202
Attn: DDG 81 Shock Team

To whom it may concern:

On behalf of the more than 7 million members and constituents of The Humane Society of the United States (HSUS), I am submitting these comments on the draft Environmental Impact Statement for the Shock Trial of the Winston S. Churchill (DDG 81) (DEIS).

Our comments are brief and general in nature. The DEIS has features (*e.g.*, discussions, conclusions, mitigations) that are similar to and in some cases the same as features found in a number of the U.S. Navy's recent Environmental Assessments (EA) and EISs written for a variety of activities having an acoustic impact on the marine environment. All of these environmental impact analyses have concluded that the activities would have a negligible effect on marine animals. However, recently conducted field research and several recent incidents correlated with Navy acoustic activities suggest that these optimistic conclusions are no longer supported empirically.

On March 15, 2000, 15 cetaceans[1] of four different species stranded on beaches in the Bahamas, after the Navy conducted some tests using a number of acoustic devices, including a "sonobuoy" using mid-range frequencies and moderate to high amplitudes (letter from J. Reynolds and N. Rose to R. Danzig, March 21, 2000; article in Washington Post dated March 22, 2000; email from K. Balcomb to M. Braynen and R. Gisiner, March 23, 2000). This kind of mass stranding, occurring in a short period, in a concentrated area, and involving multiple species of both odontocetes and mysticetes, has never before been reported in the Bahamas and may be a unique event regardless of location. In addition, research conducted under the auspices of the Office of Naval Research in 1997 and 1998, using the Low Frequency Active (LFA) sonar array, indicated that mysticetes exhibit detectable behavioral reactions to low frequency,

[1] A 16th animal was discovered on March 20 but had been seen stranded as early as March 17.

Promoting the protection of all animals
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continuous sounds of moderate amplitude (Clark and Tyack 1998).[2] Furthermore, in 1996, another cetacean mass stranding (of beaked whales) occurred in the Mediterranean following NATO exercises employing a low to mid-range frequency, high amplitude active sonar device (Frantzis 1998). These incidents and results, taken together with the results of other research exposing cetaceans to loud, low to mid-range frequency, continuous sounds (*e.g.*, Calambokidis *et al.* 1998) and other stranding incidents that may have been correlated with U.S. and foreign navy acoustic activities (*e.g.*, Simmonds and Lopez-Jurado 1991), paint a picture that warrants far greater caution than the Navy demonstrates in this or any other DEIS it has prepared. J1

The HSUS recognizes that the ship shock trials proposed for the Winston S. Churchill will produce an acoustic impact on the environment that differs from that produced by active sonar devices. Transient impulsive sounds such as those produced by the explosion of a 10,000 lb charge are shorter in duration and are thus potentially less harassing and injurious for animals outside of the physical blast zone (*i.e.*, the maximum range for injury or 1.22 nautical miles, according to the DEIS) than continuous sounds of similar frequency and amplitude (J. Goold, pers. comm.). We also recognize that a similar ship shock trial conducted in 1994 for the USS John Paul Jones resulted in no detectable deaths or injuries of marine mammals. However, the concern with loud, transient impulsive sounds is that the damage to animals outside the maximum mortality zone (0.73 nmi) may not be immediately detectable (and in fact, not all dead animals will be detected either). For example, a deafened whale may not exhibit any measurable changes in behavior, but could experience difficulty in locating food or in avoiding environmental hazards, resulting in death at a later date. There is evidence to suggest this may occur in mysticetes exposed to loud, transient impulsive sounds (*e.g.*, Todd *et al.* 1996). J2

Therefore, we continue to maintain our previous position (stated in comments submitted on other EAs and EISs) that the monitoring protocol that the Navy follows to detect marine mammals and sea turtles in the mitigation zones surrounding their acoustic activities, whether the sound is continuous or transient, is less effective than the Navy maintains. As a specific example, visual monitoring for sea turtles and deep-diving cetaceans up to two nautical miles from the explosion is simply ineffective. All marine biologists who do at-sea work with sea turtles and cetaceans know how difficult it is to detect the presence of all animals within a half-mile radius, let alone a two-mile radius. J3

In short, The HSUS wishes to express a general dissatisfaction with the discussion and proposed mitigations of the DEIS, especially in light of the recent events in the Bahamas. The Navy has been non-responsive to the growing body of research results and documented incidents that indicate that marine mammals, particularly cetaceans, are affected by its acoustic activities and J4

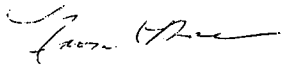
[2] Some of these data replicated results of earlier acoustic experimentation on mysticetes (*e.g.*, Malme *et al.* 1984).

may very well be mildly to extremely negatively impacted by these activities. The Navy continues to present virtually unmodified discussions in its EAs and EISs, in spite of a lack of empirical support for them and growing evidence that, in fact, argues for far more precautionary conclusions and mitigations. J4

The HSUS requests that the Navy withdraw this DEIS and make a programmatic and comprehensive attempt to re-evaluate its general approach toward all of its major acoustic activities in the marine environment. J5

Thank you for your attention to our views on this important matter.

Sincerely,



Naomi A. Rose, Ph.D.
Marine Mammal Scientist
Wildlife and Habitat Protection

Literature cited:

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cc: The Honorable Richard Danzig, Secretary of the Navy
The Honorable Penelope Dalton, National Marine Fisheries Service
The Honorable George Frampton, Council on Environmental Quality
The Honorable John Twiss, Marine Mammal Commission

The Honorable Barbara Boxer, Senate
The Honorable George Miller, House of Representatives

Mr. Joel Reynold, Esq., Natural Resources Defense Council

J. Humane Society of the United States (Naomi A. Rose, Ph.D.)

J1. Response: The Navy is concerned about the Bahamas mass strandings and is working with the National Marine Fisheries Service (NMFS) to determine the cause. No shock trial was occurring at the time of the mass strandings. The DDG 53 shock trial in 1994 occurred with no detectable marine mammal deaths or injuries (Department of the Navy, 1994). There is no empirical basis for concluding that shock trial poses an unusual or unanticipated risk to marine mammals. If investigations of the Bahamas strandings reveal any information that is pertinent to protecting marine mammals during a shock trial, the Navy would be obligated to reopen consultation with the NMFS under both Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) permit requirements.

J2. Response: The EIS acknowledges that animals beyond the mortality range may be killed, and that animals beyond the injury range may be injured. However, the probability of injury beyond the Safety Range of 2 nmi is quite low. The Safety Range is the maximum range that can feasibly be monitored. Calculations take into account the additional deaths and injuries by assuming 100% mortality and 100% injury within these respective ranges.

The shock trial would differ significantly from the events detailed by Todd et al. (1996), in which mysticetes suffered debilitating auditory injuries that ultimately resulted in death. As described in section D.4.3.1 of the DEIS, the injured mysticetes were seasonal residents probably exposed to multiple large detonations over a relatively short time period. The construction project used a 1 nmi radius safety zone for charges roughly the equivalent of the shock test charge. The construction project was located in a relatively shallow, rock-faced fjord. The shock trial will be conducted in deeper open-ocean waters with a 2 nmi radius safety zone. Also unlike the detonations reported by Todd et al. (1996), which occurred at a fixed location, during the shock trial site selection surveys would be used to find a site with low densities of marine mammals and turtles.

J3. Response: The Navy believes that mitigation effectiveness has been realistically estimated. The marine mammal and sea turtle mitigation/monitoring program was developed by marine biologists with expertise in designing cetacean and turtle surveys. Estimates of detection probability are based directly on visual surveys in which the probability of detection with distance from the trackline was estimated from the sightings data. The Navy does not maintain that all cetaceans and turtles within a certain distance of the trackline would be detected. However, the combination of aerial, shipboard, and passive acoustic monitoring offers a much higher probability of detecting mammals and turtles than would be the case in a typical mammal or turtle survey, which usually involves a single pass through a given area and where indeed "it is difficult to detect the presence of all animals within a half-mile radius." The monitoring program offers the highest probability of detection that can feasibly be achieved.

J4. Response: The EIS does not ignore or minimize potential negative impacts of shock trials on marine mammals and turtles. Potential impacts including death, injury, and auditory effects are acknowledged and summarized in Appendices D and E. The recognition that mammals and turtles could be killed or injured provides the motivation for the mitigation program, which is designed to protect these animals.

The Navy also disagrees with the assertion that "The Navy continues to present virtually unmodified discussions in its EAs and EISs...." The discussion of auditory impacts in Appendix E of this FEIS has been substantially updated since the SEAWOLF FEIS (Department of the Navy, 1998), which in turn represented a major improvement over the EA for the DDG 53 shock trial (Department of the Navy, 1993). These changes reflect the evolving state of knowledge in the field of auditory impacts on marine mammals.

J5. Response: The Navy disagrees with the recommendation to withdraw the EIS. The adequacy of the EIS is supported by comments from the U.S. Environmental Protection Agency (USEPA, comment set F) and the Marine Mammal Commission (comment set C). The USEPA concluded that the document "provides sufficient information for reasoned decision-making now." The Marine Mammal Commission indicated that the DEIS provides "a thorough and objective assessment of the species and numbers of marine mammals likely to be present in and near the three prospective test areas, and how the various species could be affected by the shock trial. Further, the Commission believes that, if the mitigation measures described in the DEIS are carried out, the number of marine mammals that could be killed or injured incidental to the trial will be minimized and documented to the extent practicable." All public comments identifying shortcomings and technical concerns with the DEIS have been addressed in the FEIS.

International Fund for Animal Welfare K

March 30, 2000

Marconi Systems Technologies
2611 Jefferson Davis Highway, Suite 5000
Arlington, VA 22202
ATTN: DDG 81 Shock Team

RE: RESPONSE TO U.S. NAVY WINSTON S. CHURCHILLL (DDG81) DEIS

www.ifaw.org

INTERNATIONAL HEADQUARTERS
411 Main Street
Yarmouth Port, MA 02675-0833
USA
Tel: 508 744 2000
Fax: 508 744 2009

OFFICES IN:
Australia
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Thank you for the opportunity to comment on the Draft Environmental Impact Statement (DEIS) for the proposed shock trials on the U.S. Navy Winston S. Churchill. The International Fund for Animal Welfare (IFAW) is a 501(c)(3) organization headquartered in Yarmouth Port, Massachusetts with over two million members worldwide. IFAW has a long history of involvement in the area of marine ecosystem research and advocacy, including marine acoustics. IFAW is extremely concerned about the effect of shock trials on marine mammals and sea turtles, and offers the following comments on the DEIS.

The need for shock trials is not adequately justified

The DEIS states that the proposed shock trials of the Winston S. Churchill are required by 10 U.S.C. Section 2366. This statute provides that survivability and lethality testing of certain munitions systems are required unless such testing would be "unreasonably expensive and impractical." 10 U.S.C. Section 2366(c)(1). This testing must occur "before proceeding beyond low-rate initial production." 10 U.S.C. 2366(b)(1). The Winston S. Churchill is the third ship in a new flight of 23 guided missile destroyers being acquired by the Navy. The DEIS asserts that the proposed shock trial provides the only means to assess the shock responses of the entire ship, and that the Winston S. Churchill will be representative of the remainder of the flight. The new flight of ships differs from the DDG 53 by the addition of a helicopter hangar, Vertical Launch System foundation changes, the raising of the AN/SPY-ID Radar arrays, and some electrical equipment changes. IFAW is unable to assess the need for the proposed shock trials because the Navy did not provide sufficient information regarding how the changes listed for the Winston S. Churchill substantially differ from the DDG 53 ships, which have already been successfully shock tested. IFAW requests that the Final EIS (FEIS) include a discussion regarding how these changes will affect the survivability of the DDG 81 ships in ways that are substantially different from the DDG 53 ships. IFAW requests the Navy provide substantive evidence in the FEIS that the proposed shock testing of the Winston S. Churchill as a lead ship for the DDG 81 ship line is necessary when compared to the DDG 53 ship line. K1

Alternatives

The DEIS evaluates two alternatives: the no action alternative; and shock testing in one of three locations. The DEIS dismisses the no action alternative by stating that the "maximum reasonable amount of computer modeling and component testing" has been done, and that shock trials are the only viable means of assessing the shock responses of the ship. As stated above, IFAW believes that the FEIS should provide an unassailable explanation as to why the shock trials for the DDG 53 are not sufficient for the DDG 81. K2

Predicted Impacts

The Endangered Species Act (ESA) provides that the term " 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in such conduct." "Harass" means "an intentional or negligent act or omission which creates the likelihood of injury to wildlife." The DEIS states that the "harassment zone" for odontocete cetaceans ranges from 24.6 km (13.3 nmi) to 32.8 km (17.7 nmi) from the detonation point. The harassment zone for mysticetes ranges from 22.8 km (12.3 nmi) to 42.6 km (23.0 nmi). Finally, the harassment zone for sea turtles is unknown. The Navy would effectively "take" each threatened and endangered marine mammal and sea turtle within this harassment zone. Therefore, the FEIS should disclose the harassment of any threatened or endangered species of marine mammals and/or sea turtles detected within the DEIS defined harassment zones as takes. K3

Pre-detonation Monitoring

In order to obtain a valid incidental take permit under the Endangered Species Act, the issuing authority (in this case, National Marine Fisheries Service) must consider whether the applicant has used the best available technology for minimizing or mitigating impacts. IFAW also notes that it is often difficult to identify particular species of marine mammals or sea turtles from aerial surveys. Therefore, in order to minimize impacts to the greatest extent possible, the FEIS should provide that the detection of *any* species of marine mammals and or sea turtles, or the indicators of their presence, such as sargassum floats and/or jellyfish, within the broadest harassment zone as defined by the DEIS for the test site, be just cause to halt the planned test for that day. K4

At the very least, the Navy should amend the FEIS to give more protection to endangered and threatened sea turtles. The DEIS states that any listed (endangered or threatened) *marine mammal* that is visually or acoustically detected within the Buffer Zone of the blast will be cause to postpone the blast. K5

The FEIS should add that any endangered or threatened *sea turtle* detected in the Buffer Zone should also be cause to postpone the blast. In addition, the DEIS states that if a northern right whale is detected within the Safety Range or Buffer Zone, the test will be postponed. Given the critical endangered status of the right whale, IFAW believes that it is crucial to postpone the blast if any right whales are seen in the Harassment Zone. K5

Moreover, the FEIS should accept visual detection of marine mammals and sea turtles, as well as their identifying indicators of sargassum floats and jellyfish, at sea conditions up to and including sea state two only. Given that visual detection of marine mammals, sea turtles, and identifying indicators might be severely limited in sea conditions of sea state three, IFAW believes that sea state conditions of three and higher should be cause to cancel the test planned for that day. K6

The FEIS should also clearly state that if any sonic buoy detection system or its components are in non-working order on the day of the planned test blast, the test should be cancelled for that day. Given the importance of the pre-detonation monitoring, the sonic detection buoy system must be in full working order on the day of the test, and in constant use up until the time of the blast. K7

Post-detonation monitoring

The post-blast mitigation tests are recognized as an essential component of shock test proceedings. However, the proposed surface visual and sonic detections of killed marine mammals and/or sea turtles is highly unlikely. Dead animals emit no sounds. The DEIS reference at section 5.6.3 states that "Any marine mammals or turtles killed by the blast would likely suffer lung rupture, which would cause them to float to the surface immediately due to air in the bloodstream." Buoyancy in relation to air within an animal is volume dependent, as well as pressure dependent. Relocation of air from the lungs into the bloodstream will not change the total volume of air within the animal. It merely moves from one area of the body to another. Greater depths result in greater pressures, resulting in less buoyancy. Without a gross increase of the volume of air within the body, there will be no increase in buoyancy by the air moving from the lungs into the bloodstream. We request that the U.S. Navy recognize and state clearly in the FEIS that most, if not all, of marine mammals and/or sea turtles killed during a shock test such as is proposed for the Winston S Churchill are most likely to sink and/or be consumed by other ocean species. Moreover, some animals that eventually rise to the surface may first move laterally out of the testing range. Therefore, these animals may not be detected by post-detonation monitoring. The FEIS should clearly state that detection of killed marine mammals and/or sea turtles after a shock test blast is very difficult with current methods of detection. The Navy should do subsurface (e.g., submarine) visual and sonar searches for any killed or injured marine mammals or sea turtles to obtain a more accurate estimate of the effects of such shock testing. K8

The DEIS admits that morbidity caused by the shock test may, in some animals, lead to mortality. Injuries that are recognized within this report as possible subsequent to shock test blasts include pulmonary and abdominal hemorrhages and/or auditory/sonic system damage would be considered takes under the Endangered Species Act. We therefore request that the U.S. Navy recognize the possibility that such takes that do not result in immediate death of the injured animal may lead to chronic debilitation and may allow for secondary infections. Debilitations and infections may be painful and may result in an increased likelihood of predation, stranding, and death. We request that the U.S. Navy clearly recognize the potential of creating injuries that result in debilitating and painful effects, both acute and chronic, for the individual animals involved. K9

Conclusion

The DEIS does not provide adequate safeguards and precautions to allow issuance of an incidental take permit under the Endangered Species Act. Due to the apparently minor design changes between the DDG 53 and DDG 81 ships, the DEIS does not provide legally sufficient justification for the need for the proposed shock trials. Given the gravity of the inadequacies in the current DEIS as described above, IFAW believes that the Navy is severely underestimating the mortality and morbidity associated with the shock trials. Finally, when and if the deficiencies in the DEIS are remedied, IFAW believes the true extent of the harm posed by the shock trials will be demonstrated and thus the ultimate result should be a denial of an incidental take permit. K10

Sincerely,

Fred O'Regan, CEO
International Fund for Animal Welfare
411 Main Street
Yarmouth Port, MA 02675

cc: Don Knowles, NMFS, Silver Spring, MD

NAVY RESPONSES

K. International Fund for Animal Welfare (Fred O'Regan)

K1. Response: Section 1.0 of the FEIS has been modified to explain how changes in the design of Flight IIA ships could affect survivability in ways that are substantially different from DDG 53 ships. The revised text explains why results from the DDG 53 shock trial are insufficient to adequately assess the survivability of Flight IIA ships and why a new shock trial is necessary.

K2. Response: See response K1.

K3. Response: Appendix G of the DEIS clearly stated the numbers of listed mammals and sea turtles that could be killed, injured, or harassed as a result of a shock trial.

K4. Response: There are two aspects to this comment. First is the suggestion that detection of any marine mammal or sea turtle should be basis for postponing a detonation because any sighting might be an endangered or threatened species. Since all of the sea turtles are endangered or threatened, this is already the case for them. The endangered marine mammal most likely to occur at Mayport or Pascagoula is the sperm whale. Other listed mammals potentially occurring there (though unlikely during the shock trial period) are all large mysticete whales. All of these are clearly distinguishable from the various dolphin species which make up most of the aerial sightings. Based on the Navy's aerial surveys in 1995 (Mayport and Norfolk), 1997 (Mayport), and 1999 (Mayport), most sightings by aerial observers identify the marine mammal to species or genus. Some pooled categories are used, such as "bottlenose or Atlantic spotted dolphin," and some sightings are noted as "unidentified dolphin." None of these instances would justify postponement on the basis that it "might be" an endangered or threatened species. Any unidentified sightings that could be a listed species (e.g., unidentified large whale, unidentified Balaenoptera) would be treated as such. Section 5.0 of the FEIS has been changed to note this.

The second aspect of this comment is the recommendation that detonation be postponed based on sightings in the broadest possible harassment zone (over 20 nmi in radius). This is not feasible or reasonable. Mitigation efforts are focused on the area of the Safety Range and Buffer Zone, which is where marine mammals and turtles would be at risk for death or injury. Broadening the aerial monitoring program would diminish the effectiveness of mitigation in the Safety Range and Buffer Zone, resulting in a higher probability of mammal and turtle death or injury. Introducing additional aircraft is not possible due to safety of flight constraints. Increasing the amount of area monitored by observers onboard vessels is not possible due to operational restrictions. Finally, mitigating the entire harassment zone in order to detect marine mammals or turtles is not reasonable, since animals in that zone would be exposed to only a very short duration impulsive noise once per week over the course of the shock trial.

K5. Response: Section 5.6.2(e) of the DEIS already stated that "detonation would also be postponed if a sea turtle or non-listed marine mammal detected within the Buffer Zone was moving toward and could enter the Safety Range prior to the detonation." This statement has been made more prominent in the FEIS. It is true that listed marine mammals are afforded additional protection (any sighting in the Buffer Zone would be cause for postponement, whether or not the animal is moving toward the Safety Range). This requirement was derived from the Biological Opinion for the SEAWOLF shock trial (Department of the Navy, 1998) and no such requirement was specified for sea turtles. The additional protection recognizes that the sperm whale, which is the only endangered marine mammal likely to occur at the Mayport and Pascagoula test areas during this season, is a deep diver which could move relatively quickly into the Safety Range and into depths where injury ranges are maximal.

Mitigation would not be focusing on the harassment zone outside of the Buffer Zone for reasons given above in response K4. If any right whales are seen in the vicinity of the test site, every possible precaution would be taken to ensure that none are injured or killed, as outlined in the FEIS. The chances of a right whale being in this area during this time of year are nearly zero, since data indicate that this population migrates to waters off Cape Cod, Stellwagen Bank and the Bay of Fundy in summer.

K6. Response: Sea state 3, as defined in the DEIS, is well within the limits set by NMFS for their own vessel cruises for estimating abundance and density.

K7. Response: Section 5.4 of the FEIS has been changed to note that there will be a working acoustic monitoring system on the day of a planned detonation or the test will not proceed on that day.

K8. Response: The word "immediately" has been removed from the quoted text of Section 5.6.3. The rate at which dead animals may return to the surface is dependent on many factors, including size and type of animal, fat stores, and depth and temperature of the water. The Navy agrees that, if animals are killed during the shock trial, some may not return to the surface immediately after the blast. The post-detonation mitigation effort, which would continue for seven days after the last shot, would provide ample time for submerged animals to resurface and be detected by either vessel or aerial monitoring. Further, as stated in the DEIS, the post-detonation mitigation would use a drogue or current meter to predict where submerged dead animals would be most likely to resurface.

Underwater visibility in the test area is expected to be poor since the test will be in the area of the Gulf Stream, eliminating the usefulness of underwater visual searches. Target strength of sea turtles and all but the largest marine mammals is not known, therefore sonar searches are of questionable use. Furthermore, the use of a sonar would introduce additional noise into the environment.

K9. Response: In estimating "takes," the EIS makes an allowance for serious injuries that result in delayed death. The maximum range for "onset of mortality" for a small animal is used as the 100% "lethal take" range for all animals. Animals located at both shallower and deeper depths than the critical depth (66 ft or 20 m) for the maximum range would be expected to have less severe injuries. Not all animals at this range would be small, and larger animals would be expected to have less severe (non-lethal) injuries. By considering all animals within this maximum range to be mortally injured, the EIS provides a reasonable and conservative estimate for the actual total number of animals that would be mortally injured on both immediate and delayed bases.

K10. Response: Specific comments have been addressed in the preceding responses. Additional explanation of the need for the shock trial has been added to the FEIS. The Navy believes that the FEIS accurately and reasonably estimates the potential for mortality and injury associated with the shock trial, and that the proposed mitigation minimizes that risk to the extent practicable. This conclusion is supported by comments from the Marine Mammal Commission (comment set C), which indicate that the DEIS provides "a thorough and objective assessment of the species and numbers of marine mammals likely to be present in and near the three prospective test areas, and how the various species could be affected by the shock trial. Further, the Commission believes that, if the mitigation measures described in the DEIS are carried out, the number of marine mammals that could be killed or injured incidental to the trial will be minimized and documented to the extent practicable."

NATURAL RESOURCES DEFENSE COUNCIL

L

By Certified Mail and Facsimile
Return Receipt Requested

March 31, 2000

Ms. Lyn Carroll
Marconi Systems Technologies
2611 Jefferson Davis Highway
Suite 5000
Arlington, VA 22202
FAX 703-602-6169

Re: Draft Environmental Impact Statement for the Shock Trial of the Winston S. Churchill (DDG 81)

Dear Ms. Carroll:

On behalf of the Natural Resources Defense Council ("NRDC") and our over 400,000 members nationwide, we write to express our concern about the U.S. Navy's upcoming shock trials of the Winston S. Churchill (DDG 81) and to join comments by the Humane Society of the United States and the International Fund for Animal Welfare on the Draft Environmental Impact Statement prepared for the shock trials by the Navy.[1] See Notice of Public Hearings and Extension of Public Comment Period, 65 Fed. Reg. 4236 (Jan. 26, 2000).

NRDC has been concerned about the adverse ecological effects of ship shock trials since 1994, when the Navy was prepared to embark upon a five-year series of detonations in an area just outside the Channel Islands National Marine Sanctuary. In that case, the U.S. District Court for the Central District of California found it a "near-certain likelihood" that the Navy, in failing to properly assess the risks of its activities in a rigorous and objective Environmental Impact Statement, had violated the National Environmental Protection Act. See Natural Resources Defense Council, Inc. v. United States Department of the Navy, 857 F. Supp. 734, 735 (C.D. Cal. 1994). While we applaud the steps that the Navy has taken since then to bring its shock trials into compliance with federal law, we continue to question the rigor and objectivity behind the Navy's risk assessment and alternatives analysis. We wholly agree with the Humane

[1] NRDC hereby incorporates these comments by reference. The comments that follow do not constitute a waiver of any factual or legal issue raised by any of these organizations or individuals and not specifically discussed herein.

6310 San Vicente Boulevard
Suite 250
Los Angeles, CA 90048
323 934-6900
Fax 323 934-1210
www.nrdc.org

71 Stevenson Street
Suite 1825
San Francisco, CA 94105
415 777-0220
Fax 415 495-5996

1200 New York Ave., N.W.
Suite 400
Washington, DC 20005
202 289-6868
Fax 202 289-1060

40 West 20th Street
New York, NY 10011
212 727-2700
Fax 212 727-1773

Society of the United States and the International Fund for Animal Welfare that the efficacy of the Navy's mitigation plan has been exaggerated, that the risks of animal morbidity and mortality resulting from the trials have been underestimated, and that the Navy's evaluation of its acoustic impacts on the marine environment neglects mounting evidence of harm. L1

For these reasons, we request that the Navy withdraw its Draft Environmental Impact Statement, pending further investigation and analysis. Thank you for considering these comments.

Very truly yours,

Joel Reynolds
Senior Attorney
Director, Marine Mammal Protection Program

NAVY RESPONSES

L. Natural Resources Defense Council (Joel Reynolds)

L1. Response: The three specific concerns expressed in this comment are addressed under responses to the Humane Society of the United States (comment set J) and the International Fund for Animal Welfare (comment set K). Specifically, the Navy maintains that (1) mitigation effectiveness has been realistically and conservatively estimated; (2) the risks of morbity and mortality have been realistically and conservatively estimated; and (3) there is no "mounting evidence of harm" that is relevant to the proposed shock trial. Therefore, the Navy does not agree that the DEIS should be withdrawn.

The adequacy of the EIS is supported by comments from the U.S. Environmental Protection Agency (USEPA, comment set F) and the Marine Mammal Commission (comment set C). The USEPA concluded that the document "provides sufficient information for reasoned decision-making now." The Marine Mammal Commission indicated that the DEIS provides "a thorough and objective assessment of the species and numbers of marine mammals likely to be present in and near the three prospective test areas, and how the various species could be affected by the shock trial. Further, the Commission believes that, if the mitigation measures described in the DEIS are carried out, the number of marine mammals that could be killed or injured incidental to the trial will be minimized and documented to the extent practicable."

INDIVIDUALS

M

P.O.B. 1583
Virginia Beach, Va. 23451
March 30, 2000

DDG 81 Shock Team
Marconi Systems Technologies
2611 Jefferson Davis Hwy, Suite 5000
Arlington, Va. 22202

Dear Team members

It is with thanksgiving for your extensive work, the 1½" thick Draft Environmental Impact Statement, and for the public hearing in Norfolk, Va. that I write. Having reviewed both, it is with horror and deep concern that I am moved to address some of the many issues, laws, events & lives involved in the proposed shock testing of the guided missle destroyer Winston S. Churchill.

Simply, there are three laws in conflict, two of which protect the marine mammals & endangered species that the "required" testing, shock testing, will injure & kill. **M1**

Why is not every sincere effort being made by the U.S. Navy and others involved to uphold the Endangered Species Protection Act & the Marine Mammal Protection Act, the spirit & letter of these Federal Laws ?? "Favorable weather" page E5-1 is a poor excuse to break Federal laws & a poor reason & so high risk for all including U.S. Navy public relations, U.S. Government, the marine life & environment, stranding teams, and cities & peoples, etc. Dead dolphins, sea turtles & others on summer populated beaches is bad news, bad cause & effect for everyone. The proposed testing time, May-Sept 2001, is the peak Virginia & North Carolina season of sea turtles & coastal dolphins (vs. the off-shore dolphin, little of whom is known) population. **M2**

"Favorable weather" & "availability of the ship" for the Navy is foul for all. Is the Churchill not "available" in March/April or late October-December ?? Please know: close & off-shore in late December through early March our Virginia waters host a juvenile humpback whale population. **M2**

During the March 13, 2000 Norfolk, Va. hearing testimony was given that was intended to assure the public, and possibly themselves - the Navy personnel, that all the precautions measures, etc. that were taken in a similar testing done off Santa Calif. that would also be taken in Va. Fla. or Miss. had been successful in that no marine mammal injuries or deaths were ~~"detected"~~ "detected". My false hope & assurance were soon injured & killed when the truth about "detected" was revealed. That California waters shock testing was far off shore, in swift currents & rushed & so very questionable "mitigation & monitoring", and a sparse Calif. coast stranding network. **M3**

Concerning "mitigation & monitoring" as proposed the "environmental buffer zone" is too small. Mortalities relative to lung & soft tissue damage seems to be mans limited research & thinking toward the ones that will be affected by such, the marine mammals & their whole biology. Such as for a humble new beginning the dolphins acoustics, hearing, communicating systems are fragile. One of many 10,000 pound bombs in their environment through their bodies is a deadly U.S. Navy proposal. Please reconsider & search more thoroughly dolphin biology, such as their translucently thin and hollow jaw bone through with sound vibrations are received. And "temporary hearing loss" if it is only "temporary," is how long? As sound, hearing & sonar is their primary sense for survival food, pod communication is "temporary" long enough not only for suffering but also for starvation, immune system break-down & eventual death. ??? (pages E-8 - E 14 note D.E.I.S.) **M4**

3

As for "monitoring" include please the truth that dolphins like humans do not float when they die. Floating requires gases build up & so time. Is but 3 hours of monitoring post each detonation sufficient & truthful ??

M5

Insufficient are the East Coast stranding networks that are being included. For example, the Va. Marine Science Museum's stranding center though professionally staffed and approx. 100 plus trained volunteers is ill equipped to cope with one injured dolphin much less many. There has been success with seals stabilized & quickly moved to Baltimore Aquarium with better facilities and also success with survival of stranded sea turtles including the endangered Kemp's Ridley. Please know that the V.M.S.M. stranding center, in its 10 years of devoted service, has not succeeded in rehabilitating even one of the many stranded dolphins & whales, cetaceans. The facilities are too limited. Also not yet considered is the response of the multitudes of volunteers being included if the Navy proceeds and more suffering and death unnecessarily darkens our doors & shores.

M6

Enclosed within are but two news articles witnessing the probabilities & possibilities if the U.S. Navy proceeds with this ill timed ill placed ill planned shock testing testing & testing of this kind & others, when will it stop ?

M7

There can be but 1 right choice — please — the "no action alternative"

Thank you
Pamela Sawyer

cc: President Wm Clinton
Sec. of U.S. Navy
Sec. of U.S. Coast Guard
Chief National Marine Fisheries Service
N.R.D.C.
I.W.C.
Humane Society of U.S.
Earthwatch

Navy tests suspected in whale deaths

BY JESSICA ROBERTSON
ASSOCIATED PRESS

FREEPORT, Bahamas — Eight whales beached and died soon after the U.S. Navy conducted anti-submarine exercises off the northern Bahamas, prompting an investigation and calls for an end to such exercises.

THE NAVY

The Navy said Tuesday that there was no evidence to link the whale deaths to last week's exercise testing sonar detection of submarines.

Navy Cmdr. Greg Smith said the sonar tests took place from about 1 to 5 p.m. March 15 off Abaco Island.

Marine biologist Ken Balcomb of the Earthwatch environmental group said beachings began that same day, and within two days, at least 14 whales had grounded themselves on Abaco, Grand Bahama, to the north, and Eleuthera to the south. Eight died, prompting investigations by Bahamian and U.S. scientists and authorities.

TIM AYLEN/Associated Press

Beachgoers on Grand Bahama try to touch a beached whale last week. Since March 15, eight whales have died after becoming beached.

"A whale beaching in the Bahamas is a once-in-a-decade occurrence," said Balcomb, an American who has been studying whales around Abaco island for nine years.

"We will be making recommendations to the Bahamian government that these sort of exercises be terminated," he said.

But Smith said the Navy plans to continue the tests.

Naomi Rose of the Washington-based Humane Society of the United States maintains that the signals could cause damage.

"These signals . . . could travel quite a distance and could even wrap around the island," said Rose, a marine mammal scientist. "One could argue that they fled the area where the sonar was being transmitted."

Another U.S. marine biologist in the Bahamas to investigate, Charles Potter of the Smithsonian Institute, said the number of whales beached is "extremely unusual." But he said the postmortem exams showed that the whales had suffered no physical damage, such as broken ear drums.

Michael Breynan, director of the Bahamian Fisheries Department, said he was working with U.S. scientists to try to determine the cause.

The US Navy Assault on Right Whales

by Dan Morast

One of the world's rarest species is the northern right whale. There are so few of them that scientists know almost every individual by name and family. The only known calving ground for the species is a small area in the warm, shallow, protected waters off the coast of north Florida and Georgia. The area is so vital to right whales that it has been legally designated as 'critical habitat,' an area essential for their survival. In many years, right whale deaths from ship strikes, entanglement in fishing gear, or natural mortality exceeds the number of babies born. Some scientists have predicted the species could be extinct in 30 years.

Each year, human activity or natural mortality result in the death of one or two right whales in the winter calving grounds. Suddenly, starting in January of 1996, right whales began dying in record numbers. In a short two-month period, at least five and likely seven right whale mortalities were recorded. What could account for such a dramatic and unprecedented number of deaths?

Whenever large numbers of animals die in a small area over a short period of time, scientists consider several possibilities: viral outbreaks, natural biotoxins, or human activity. There has been no evidence to implicate a viral or toxic basis for the deaths, but had there been a change in human activity that could be expected to affect right whales?

During the past year, the US Navy shifted its war game activities from Guantanamo Bay, Cuba, to the coast of north Florida and Georgia, and the sudden increase in deaths coincides with those new military exercises. These exercises include using explosives that range up to 500 pound bombs! In several instances, loud gunfire from naval vessels was reported in the same time frame as the appearance of dead right whales. In addition, while the Navy is aware that ship strikes are the number one killer of right whales, and that recommended speeds around right whale habitat is 5-6 knots, Navy ships routinely move through the area traveling at speeds of 20 knots!

The fact that the Navy often refused to tow whale carcasses ashore for scientific investigation, or delayed reporting the existence of dead whales, increases the difficulty of ascertaining cause of death. However, examination suggests that at least two calves may have died of blast trauma, and one adult was killed by a large vessel traveling at a high rate of speed.

The western North Atlantic population of right whales, with less than 300 animals remaining, may have only one chance to avoid extinction. The incidents reported here represent the death of 2% of the entire population in only a two-month period. The continued use of prime right whale reproductive habitat for Naval operations is simply NOT acceptable.

ACTION ALERT

We have dealt with the Navy on issues of whale protection in the past. In 1992, we observed humpback and fin whales in waters that the Navy was using for target practice. The Navy ignored our concerns until an issue of the *Whalewatch* featured their actions and asked our members to contact the Secretary of the Navy.

Soon after the Navy became aware of our current concern with right whale mortalities, we received a call inquiring about the timing of our next newsletter! Clearly, the Navy is more concerned and likely to respond to public pressure than science . . . and luckily we have a membership that rises to such challenges. We ask that you write to the Secretary of the Navy stressing the three objectives below:

John H. Dalton
Secretary of the Navy
Pentagon
Washington, DC 20350
(fax: 703/614-3477).

- The Navy should cease all operations that might negatively affect the right whales within 75 miles of designated right whale critical habitat.
- The Navy should re-initiate formal consultation about their activities with the National Marine Fisheries Service under Section 7 of the Endangered Species Act.
- The Navy should comply with the mandates of the Marine Mammal Protection Act.

NAVY RESPONSES

M. Pamela Snyder

M1. Response: The laws cited are not in conflict. The Marine Mammal Protection Act (MMPA) allows incidental "taking" of marine mammals under certain provisions in Section 105. While fulfilling its statutory mandate to conduct live fire testing, the Navy has also complied with the MMPA by applying for an incidental take authorization. Likewise, the Endangered Species Act (ESA) does not prohibit all "taking" of listed species. Rather, if the Navy believes that a proposed action "may affect" listed species, the agency must consult with the NMFS, which must determine whether the proposed action would jeopardize the continued existence of listed species or result in destruction or adverse modification of their critical habitat. The Navy has complied with the ESA by preparing a Biological Assessment and formally consulting with the NMFS. The shock trial would be conducted in accordance with any restrictions and/or protective measures specified by the NMFS in their incidental take authorization (under MMPA) and the Biological Opinion (under ESA). In addition to complying with the letter of these laws, the Navy has honored the spirit of the laws by developing a mitigation program designed to minimize impacts on mammals and turtles to the extent practicable.

M2. Response: Favorable weather is needed to conduct the shock trial safely and to monitor the Safety Zone for marine mammals and turtles. Monitoring would be less effective during winter months because higher sea states and poorer visibility make it difficult to see mammals and turtles. Because bad weather occurs more frequently during winter, post-detonation monitoring would be more frequently interrupted and therefore less effective in identifying injured or dead animals. Conducting the shock trial during winter would involve other tradeoffs, such as higher probabilities of encountering northern right whales (especially at Mayport) and other mysticetes (e.g., humpbacks at Norfolk as mentioned in this comment).

M3. Response: It is very difficult to "prove a negative" – i.e., that no animals were killed or injured by the DDG 53 shock trial. However, the Navy developed a mitigation and monitoring program for that shock trial in cooperation with the NMFS, and no deaths or injuries were detected. The program represented the agencies' best effort to prevent marine mammal deaths and injuries and to detect any such impacts during and after the shock trial. Although the shock trial was indeed conducted far from shore, the Navy does not agree with the assertion that the program was "rushed," or that Southern California stranding network is "sparse." Lessons learned during that program, as well as technological developments since then, have been incorporated in the current mitigation program to improve protection of mammals and turtles and increase the probability of detecting deaths and injuries.

M4. Response: The DEIS did consider fragile auditory systems in developing mortality and injury estimates and the size of the Safety Range. The DEIS incorporated the best available data to date on the effects of blasts on marine mammals, which indicates that soft tissue (in particular, the auditory system and the gas-containing structures of the respiratory and gastrointestinal tract) will show effects before bone. Other anatomical characteristics of marine mammals as contrasted with their terrestrial counterparts were taken into account in the analysis in Appendix D. Characteristics such as light, oil-filled bones and near loss of certain skeletal structures, have no direct effect in the lung injury model used. Because of the uncertainties in extrapolating from terrestrial to marine mammals, effect ranges in Appendix D have been calculated using conservative assumptions that should deliberately overestimate the risk of injury.

M5. Response: Post-detonation monitoring is not limited to 3 hours. On shot day, post-detonation vessel monitoring is for at least 3 hours, and continues for 48 hours following the first two shots and for 7 days following the last shot. Post-detonation aerial monitoring, which coordinates with the vessel monitoring, is for a minimum of 3 hours on the day of the detonation, and continues for at least 3 hours per day for two days after the first two shots and for seven days after the last shot. This is all detailed in Section 5.0 of the FEIS.

The rate at which dead animals may return to the surface is dependent on many factors, including size and type of animal, fat stores, and depth and temperature of the water. The Navy agrees that, if animals are killed during the shock trial, some may not return to the surface immediately after the blast. The post-detonation mitigation effort, which would continue for seven days after the last shot, would provide ample time for submerged animals to resurface and be detected by either vessel or aerial monitoring. Further, as stated in the DEIS, the post-detonation mitigation would employ the use of a drogue or current meter to predict where submerged dead animals would be most likely to resurface.

M6. Response: The Navy would be cooperating with the marine mammal and sea turtle stranding networks that are coordinated by the National Marine Fisheries Service (NMFS). The Navy does not expect to kill or injure large numbers of mammals and turtles and therefore does not expect the stranding networks to be overwhelmed. If there is a high occurrence of marine mammal and sea turtle strandings that can be directly attributed to the shock trial during or after the shock trial period, the Navy would work together with NMFS to determine the best course of action for support to the stranding networks.

M7. Response: Comment noted.

N

200 B 89th St.
Va. Beach, Va.
23451

DDG81 Shock Team
Marconi Systems Technologies
2611 Jefferson Davis Hwy, Suite 5000
Arlington, Va. 22202

To Whom it may concern,

On page 1-1 of the DEIS, "Its the Navy's policy to shock test each new class of ships or major upgrade (Flight IIA ships in this case)". Which is it? 10 USC 2366 or Navy Policy? **N1**

"Tissues would be sent to AFIP for analysis." (Page 5-22) I find this most disconcerting and believe analyses of tissues should be done free of any military connection. On March 15, in the Bahamas — an area where a whale beaching is a one in ten year occurence — 14 whales beached themselves (resulting in 8 deaths) the same day the Navy conducted anti-sub exercises in the area. On March 21, the Navy said there was no evidence linking the two, and would continue the exercise. I should think it would better serve the military P.R. to have an outside analysis of tissues done, giving the appearance of independence, instead of the cause investigating the affect. **N2**

Of the 3 sites, Norfolk has the fewest days of idal conditions, more commercial shipping than Mayport, + the highest risk of impact on marine mammals + turtles. Don't do it here. **N3**

Figures 6-3 + 5.2 in the DEIS - Naval Station Norfolk has been misplaced. This is actually Fort Story at Cape Henry in Va. Beach. This does not instill my confidence in other "facts" + "figures" in the DEIS. Thankyou, Tracy Snyder **N4**

NAVY RESPONSES

N. Tracy Snyder

N1. Response: Both the statute and Navy policy require the shock testing. The text has been reworded to avoid any confusion on this point.

N2. Response: The Armed Forces Institute of Pathology (AFIP) has the appropriate expertise (with blast effects) to analyze tissue samples and determine the cause of injuries. The AFIP is used by the National Marine Fisheries Service (NMFS) for analysis of stranded animal tissues and therefore is standard operating procedure.

N3. Response: Comment noted.

N4. Response: Thank you. This figure and all related maps have been corrected.

O

19 Little Bay Harbor
Ponte Vedra Beach, FL 32082
March 15, 2000

SUBJECT: Public Hearing on USS Winston Churchill Shock Trial.

My name is Robert P. Stoll and I live at the above address. I regret that I could not be present in person for this hearing, but I would like to have these written comments considered as part of the record.

I recently completed two 3-year terms as a director of the Florida Audubon Society. I am currently a director of the St. Johns County Audubon Society, a Charter Member of the Cousteau Society, a Principal Permit holder in the Florida Fish and Wildlife Conservation Commission's Sea Turtle Protection Program and an active member of the Sea Turtle Stranding and Salvage Network. I belong to a number of other national and state environmental organizations.

I retired from the Army in 1980 after 29 years of service. My first assignment after being commissioned as a 2nd Lieutenant in the Army was to Fort Sill in Oklahoma to be trained as an artillery forward observer. That was probably the least sought-after assignment in the entire army at the time because there was heavy fighting going on in Korea and the term "forward" derives from the fact that there are no friendly forces ahead of the forward observer in combat. My training at Fort Sill lasted for 4 months. During that time we were trained to do all sorts of stressful things, including calling for live artillery fire on our own positions, and adjusting artillery while under live machine gun fire. The training was conducted in the extensive artillery impact areas at Fort Sill. On several occasions during the many live fire training exercises I watched as large wildlife animals such as deer and wild pigs suddenly appeared from seemingly nowhere at exactly the wrong moment and were killed or severely wounded and then probably suffered a slow death. Later on, in Korea, I watched similar artillery fire intentionally placed on the Chinese and Korean enemy troops inflict the same lethal effect on them.

Unfortunately war is a horrible, gruesome experience for all concerned, often including innocent bystanders. I attribute the fact that I survived my tour as an artillery forward observer in combat mostly to the excellent, realistic training I had received. The fact that innocent wildlife was inadvertently killed in the course of my training is a sad and unfortunate by-product of a process that has little good to be said for it under any circumstances. In a sense, I feel that I owe my being alive to their having been killed. We can argue that tradeoff forever, but when it is your life, it gets very personal.

I believe the shock trials for the USS Winston Churchill fall somewhere into this same logic. The tests may well result in design verification or changes that will save the lives of present and future men and women who may come into harm's way. That some wildlife will die as a result of these tests is not what any of us would wish for, but, as I said, it gets very personal if it is your life that might be saved.

I carefully read the studies that were conducted prior to the proposed Sea Wolf shock trials several years ago. I was impressed with their detail, the reasoning, and the conclusions of those studies. While I have not read the studies for the proposed trials for the USS Winston Churchill, I am confident that they are also the best possible evaluation of a situation all of us would prefer not to have to face. I cannot accept the "not in my back yard" argument. These tests have to be done somewhere, and the Sea Wolf studies clearly showed that this area has the least possible deleterious effect on marine wildlife. I believe that the fishing industry does more harm to the marine wildlife in one day than all these tests put together will ever do. Nor can I accept the argument that these tests are good for the local economy. The issue here is clearly wildlife protection, not subsidies to local businessman at taxpayers' expense. O1

In a perfect world we would not have to debate this issue, but this *is* clearly not a perfect world. Under the circumstances I strongly support the proposed conduct of the USS Winston Churchill Shock Trial.

Robert P. Stoll

Robert P. Stoll, DDS, MS.

NAVY RESPONSES

O. Robert P. Stoll

O1. Comment noted.

ENVIRONMENTAL EFFECTS CONSULTANTS
GEORGE A. YOUNG, PH.D.
3611 Janet Road, Wheaton, MD 20906-4353
(301) 946-6490 Phone (301) 871-6741 Fax

P

January 18, 2000

Marconi Systems Technologies
2611 Jefferson Davis Highway, Suite 5000
Arlington, Virginia 22202
ATTN: DDG 81 Shock Team

Subj: Comments on the Draft Environmental Impact Statement for the Shock Trial of the WINSTON S. CHURCHILL (DDG 81)

The technical descriptions of explosion phenomenology, potential environmental effects, and mitigation procedures in the DEIS are exceptionally thorough. The writers have utilized the relevant literature in an objective manner and have presented convincing arguments concerning the minimal and transient nature of any adverse effects.

However, I believe the discussion of the consequences of the absence of testing on the ability of the Navy to conduct its primary mission can be expanded to strengthen the arguments in favor of ship-shock tests.

Combat experience has been limited in recent years, though ships have struck floating mines off the coast of Vietnam and during the Gulf War. The value of shock-hardening was demonstrated in both conflicts.

Almost every full-scale test uncovers problems that were not anticipated during the design phase. We do not want to discover flaws in ship design when in actual combat. It should be stressed that the future survival of ships and crews is more important than the possible minimal effects on marine life during controlled tests.

P1

Sincerely,

George A. Young

GEORGE A. YOUNG

NAVY RESPONSES

P. George A. Young, Ph.D. (Environmental Effects Consultants)

P1. Comment noted. Section 1.0 has been revised to provide additional information about the need for shock trials.