Endangered Species Act - Section 7 Consultation
Biological Opinion

Action Agency: United States Department of the Interior
Minerals Management Service

Activity: Gulf of Mexico Outer Continental Shelf Multi-Lease Sale
(185, 187, 190, 192, 194, 196, 198, 200, 201)
(F/SER/2002/00718)

Consultation Conducted By: NOAA Fisheries, Southeast Regional Office

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Approved By:
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Consultation History

April 17, 2002: A request for formal consultation was received by the National Marine Fisheries Service (NOAA Fisheries) from the Minerals Management Service (MMS) for Lease Sale 184..
July 15, 2002: NOAA Fisheries acknowledged that a complete application had been received and formal consultation had been initiated.
August 8, 2002: NOAA Fisheries and MMS held a conference call to discuss the Lease Sale 184 Biological Opinion, comments from the International Association of Geophysical Contractors (IAGC), and information needs for the present Biological Opinion (Opinion).
September 4-5, 2002: Meeting in St. Petersburg, Fl with NOAA Fisheries, the IAGC, and MMS. The IAGC presented data on 2-D and 3-D seismic surveys and their acoustic properties and expressed their viewpoints on a seismic survey observer program. MMS and NOAA Fisheries held a separate consultation meeting to discuss observers, needed scientific information, and the Marine Mammal Protection Act (MMPA) requirements for the lease multi-sale.
September 12, 2002: NOAA Fisheries requested additional information on the sources of sound emissions in the Gulf of Mexico resulting from oil and gas lease sale actions including vessel sources, drilling noise, and noise from the various different types of seismic surveys. Requested were the range of frequencies produced, the range of decibel (dB) levels at source, duration of sounds (over time), whether the sounds are impulsive or continuous, and the periodicity of the sounds. MMS indicated that this information was not available.
September 19, 2002: NOAA Fisheries requested any analyses for the probability of an oil spill greater than 1,000 barrels (bbl) coming into contact with known sperm whale habitat, particularly off the mouth of the Mississippi River. MMS did not provide this information.
September 27, 2002: NOAA Fisheries sent a draft of the Opinion to MMS. MMS-Gulf of Mexico Region (GOMR) indicated that they had no comments.
October 18, 2002: Comments on the draft Opinion were received from MMS headquarters, including comments they had received from the National Ocean Industries Association (NOIA), and the International Association of Geophysical Contractors (IAGC).

Abstract

To comply with the requirements of the Endangered Species Act of 1973, the National Marine Fisheries Service (NOAA Fisheries) has prepared a biological opinion (Opinion) on the effects of the action proposed by the Minerals Management Service. Activities associated with oil and gas leasing, exploration and development will result in the introduction of vessel traffic, drilling, construction, chemicals, and sound into the marine environment. The area under consideration in the biological opinion includes portions of the Central and Western Planning Areas of the Gulf of Mexico and the associated waterways and ports utilized by service and tanker vessels associated with these actions.

The potential effects of the proposed action were analyzed for the 12 endangered and threatened

species under NOAA Fisheries jurisdiction that may occur within the action area. The evidence available for this assessment of the effects of sound associated with the proposed action on listed marine species is limited to information on the physics of sound propagation in the ocean environment and current knowledge of how marine animals behaviorally respond to these sounds.

Based on information on the geographic distribution of the listed species, NOAA Fisheries concludes that the blue whale (*Balaenoptera musculus*), sei whale (*B. borealis*), fin whale (*B. physalus*), humpback whale (*Physeter macrocephalus*), and the northern right whale (*Eubalaena glacialis*) are not likely to be affected by the proposed actions. These species of cetaceans are not considered rare, but are believed to be only occasional transients in the action area.

Based on published and unpublished studies, sounds associated with oil and gas leasing, exploration and development may result in threshold shift (i.e., hearing loss) in sperm whales (*Physeter macrocephalus*). Any behavioral responses causing adverse effects to individuals and cow/calf pairs, reproduction, feeding, or temporary threshold shift (TTS) and permanent threshold shift (PTS) due to seismic activity may result in negative impacts to the population. Behavioral changes that have been observed in this species include no apparent reaction, responses to loud, approaching vessels and seismic surveys, cessation of vocalizations, avoidance, increased logging at the surface (lying still at the surface of the water, resting, with its tail hanging down) during seismic surveys, increased dive frequency near vessels, and distribution of sperm whales further away from seismic surveys when airguns are firing. Sperm whales in the vicinity of seismic surveys may be harassed by the frequency and intensity levels associated with these activities that may result in alteration of their natural behaviors (e.g., increased dive frequency possibly disrupting diving patterns, resting patterns necessary for hunting, and interference with passive detection of prey). Of particular concern may be the disruption of cow/calf pairs, diving energetics, and foraging success. Until more conclusive results on the effects of seismic activities on sperm whale behavior are obtained, NOAA Fisheries believes that precautionary measures to prevent harm to sperm whales should be taken to reduce the likelihood of any adverse effects to individuals or populations (USFWS and NMFS 1998) due to TTS or PTS, the associated behavioral effects associated with auditory damage, and the potential for harassment by noise. Sperm whales and other cetaceans should, at minimum, be protected from the risk of threshold shift and cow/calf disturbance should be minimized. Establishment and monitoring of impact zones and observations of sperm whale behavior near seismic vessels will minimize the risks (i.e., TTS, PTS, and associated alterations to behavior) from exposure to high intensity seismic pulses 180 dB re 1 µPa, and will assist in better understanding the degree of behavioral reactions to these activities.

The leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles may experience short-term behavioral avoidance or threshold shift as a result of airgun use, but the role of environmental sound in sea turtles' behavior and biology is less clear than for marine mammals. Leatherback sea turtles are most likely to experience the seismic pulses from deepwater seismic surveys due to their deep, pelagic habitat. All listed species including sea turtles are vulnerable to vessel strikes and sublethal effects of oil spills as a result of the proposed action.

NOAA Fisheries concludes that the proposed action is not likely to jeopardize the continued existence of any endangered or threatened species.

Biological Opinion

I. Description of Proposed Action

This Opinion analyzes the proposed 2003-2007 Central and Western Gulf of Mexico (GOM) Outer Continental Shelf (OCS) oil and gas lease sales (Figure 1). Offshore is defined here as the OCS portion of the Gulf of Mexico that begins 10 mi offshore Florida; 3 mi offshore Louisiana, Mississippi, and Alabama; and 10 mi offshore Texas; and it extends seaward to the limits of the Exclusive Economic Zone (EEZ). The proposed Central GOM lease sales are Sale 185 in 2003, Sale 190 in 2004, Sale 194 in 2005, Sale 198 in 2006, and Sale 201 in 2007. The proposed Western GOM lease sales are Sale 187 in 2003, Sale 192 in 2006, Sale 196 in 2005, and Sale 200 in 2007. Sale 184 occurred in August 2002. Sale 184 was the first lease sale scheduled in the OCS Oil and Gas Leasing Program for the Central and Western Planning Areas of the GOM. However, since the associated Central Planning Area (CPA) and Western Planning Area (WPA) GOM Multi-Lease Sale Environmental Impact Statement (EIS) was still in the draft stages, the MMS submitted updated information that was tiered off the existing Western Multi-Lease Sale EIS , and requested a separate formal consultation on Lease Sale 184 to maintain the scheduled lease sale on August 21, 2002.

The GOM WPA currently contains about 22 million unleased acres offshore Texas and deeper waters offshore of Louisiana. Blocks in the area range from 9 to 220 miles from shore in water depths from 8 to 3,000 m. The areas to be affected include all available unleased acreage except for certain areas within the boundary of the Flower Garden Banks National Marine Sanctuary, and blocks or portions of blocks within a 1.4-mile buffer zone along a recently settled boundary between the U.S. and Mexico. Coastal areas, ports, and waterways used by vessel traffic related to the proposed action are considered part of the action area.

The GOM CPA currently contains about 24 million unleased acres offshore of Alabama, Mississippi, Louisiana, and Texas. The areas to be affected include all available unleased acreage except for blocks beyond the U. S. EEZ, in the area known as the northern portion of the Eastern Gap, and blocks or portions of blocks within a 1.4-mile buffer zone along a continental shelf boundary between the U.S. and Mexico. The proposed action includes the preliminary activities associated with award of leases; with the exploration, development, and

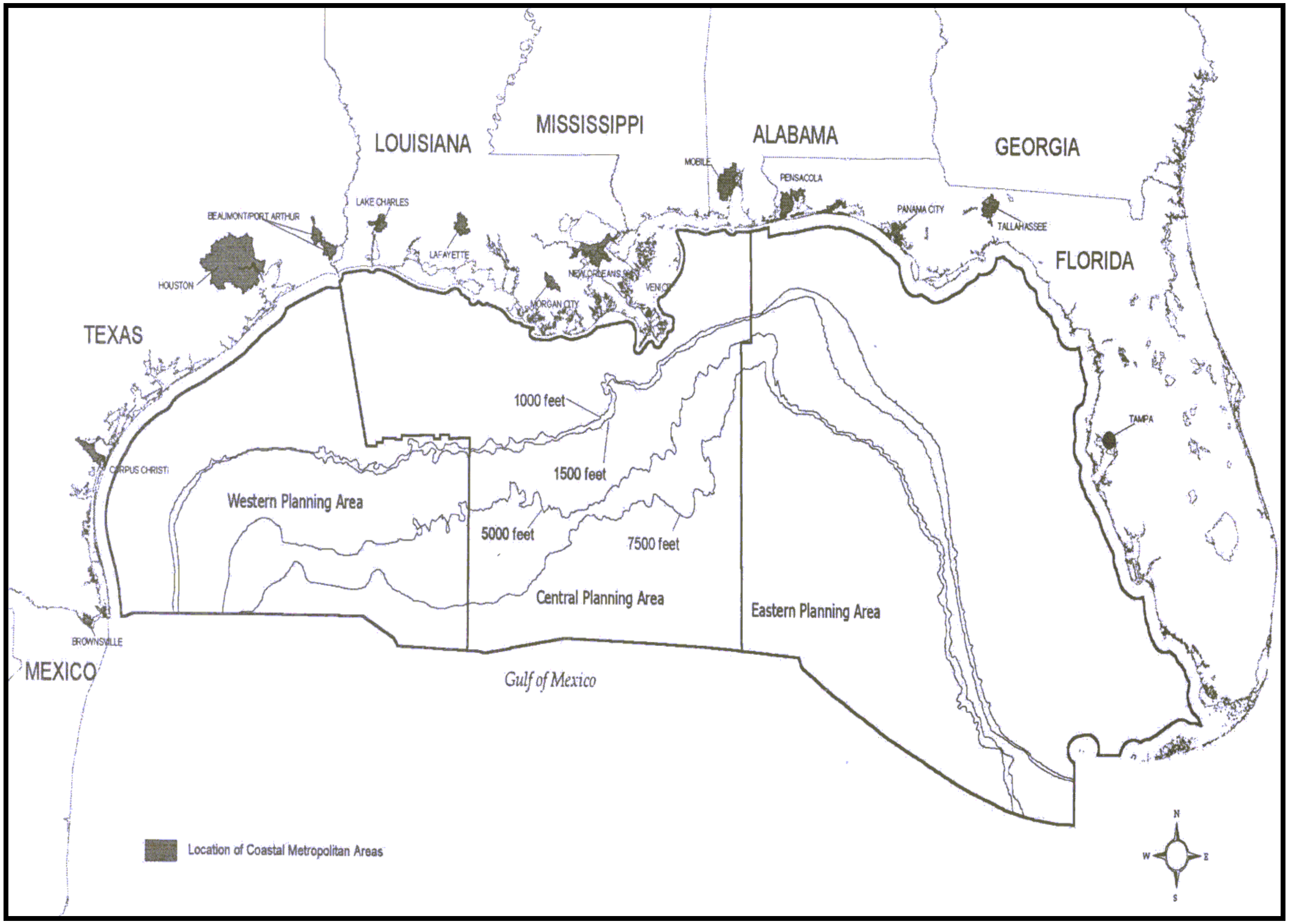

Figure 1. Gulf of Mexico Outer Continental Shelf Planning Areas.

production resulting from the proposed sale, and the effect of these activities on protected species under the jurisdiction of NOAA Fisheries. The MMS is presently preparing an EIS and will initiate consultation on the explosive removal of offshore structures; these actions will be considered under a separate consultation. The estimated amounts of resources projected to be developed as a result of this proposed sale range from 1.485 to 2.735 billion barrels of oil and 37.780 to 54.225 trillion cubic feet of natural gas.

Excluded from the proposed action are Blocks A-375 (East Flower Garden Bank) and A-398 (West Flower Garden Bank) in the High Island Area, East Addition, South Extension. The East and West Flower Garden Banks are designated as a National Marine Sanctuary. Also, in light of the President's June 1998 withdrawal of all National Marine Sanctuaries from oil and gas leasing, additional blocks or portions of these blocks (High Island, East Addition, South Extension, Block A-401; High Island, South Addition, Blocks A-366, A-383, A-399 and A-513; and Garden Banks 134 and 135), which lie partially within the Flower Garden Banks National Marine Sanctuary, are excluded from the proposed action. Mustang Island Area Blocks 793, 799, and 816 have been excluded from the proposed action for Navy personnel and equipment training. The MMS had deferred leasing of blocks beyond the EEZ in each of the Gulf of Mexico sales since Central Gulf Sale 169. In Central Gulf Sale 178 Part 2 and Western Gulf Sale 180, MMS offered blocks beyond the EEZ in the area known as the Western Gap. On June 9, 2000, following extensive negotiations, the Presidents of the U.S. and Mexico signed a treaty establishing the continental shelf boundary in the Western Gap. Also established is a 1.4-mi buffer zone on each side of the boundary in which the parties agreed to a 10-year moratorium on oil and gas exploitation commencing when the treaty entered into force. The U.S. Senate ratified the treaty on October 18, 2000, and the Mexican Senate gave its approval on November 28, 2000. The agreement is known as the Treaty Between the Government of the United States of America and the Government of the United Mexican States on the Delimitation of the Continental Shelf in the Western Gulf of Mexico Beyond 200 Nautical Miles. The provisions of the treaty entered into force upon exchange of the instruments of ratification of the treaty on January 17, 2001. The MMS proposes to offer the blocks in the area formerly known as the Western Gap but plans to defer leasing of blocks in the Eastern Gap.

The MMS assumes a 35-year life of the leases resulting from the proposed action. Exploratory activity takes place over a 25-year period, beginning in the year of the sale. Development activity takes place over a 29-year period, beginning with the installation of the first production platform and ending with the drilling of the last development wells. Production of oil and gas begins by the second year after a proposed action and continues through the 34th year.

MMS regulations explicitly prohibit the disposal of equipment, cables, chains, containers, or other materials into offshore waters. Portable equipment and other loose items weighing 18 kg or more must be marked in a durable manner with the owner's name prior to use or transport on offshore waters. Smaller objects must be stored in a marked container when not in use.
Under MMS operating regulations and lease agreements, all lessees must remove objects and obstructions upon termination of a lease. Lessees must ensure all objects related to their

activities are removed following termination of their lease.

MMS conducts onsite inspections to assure compliance with lease terms, Notices to Lessees (NTLs), and approved plans, and to ensure that safety and pollution-prevention requirements of regulations are met. These inspections involve items of safety and environmental concern. If an operator is found in violation of a safety or environmental requirement, a citation is issued requiring that it be remedied within 7 days.

Although the ESA defines prohibited takes of listed animals to include harassment, the ESA does not define harassment, nor has NOAA Fisheries defined this term through regulation. However, the MMPA of 1972, as amended, defines harassment as any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild, or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption to behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (16 USC 1362(18)(A)). NOAA is particularly concerned about disruptions to individuals or populations that may manifest as an animal that fails to feed successfully, breed successfully (which can result from feeding failure), or complete its life history because of changed in behavioral patterns.

The following section based on MMS' DEIS on the Multi-Lease Sale summarizes the actions and possible impacts to listed species in the action area associated with the lease sale.

Noise

Noise associated with OCS oil and gas development results from seismic surveys, the operation of fixed structures such as offshore platforms and drilling rigs, and helicopter and service-vessel traffic. Noise generated from these activities can be transmitted through both air and water, and may be extended or transient. Offshore drilling and production involves various activities that produce a composite underwater noise field. The intensity level and frequency of the noise emissions are highly variable, both between and among the various industry sources. Noise from proposed OCS activities may affect biological resources near the activities. Whether a sound is or is not detected by marine organisms will depend both on the acoustic properties of the source (spectral characteristics, intensity, and transmission patterns) and sensitivity of the hearing system in the marine organism. Extreme levels of noise can cause physical damage or death to an exposed animal; intense levels can damage hearing; loud or novel sounds may induce disruptive behavior or other responses of lesser importance. Loud, manmade underwater sounds are a recent and rapidly increasing perturbation of the marine acoustic environment (Jasny 1999).

A specific noise source in OCS operations originates from seismic activities. Airguns produce an intense, but highly localized, sound energy and represent a noise source of possible concern. The MMS has completed a draft programmatic EA on geophysical and geological permit activities in the Gulf of Mexico (MMS, Draft EA 2002). Two general types of seismic surveys are conducted in the Gulf of Mexico relative to oil and gas operations: 1) High-resolution site surveys collect data up to 1 km deep through bottom sediments and are used for initial site evaluation for potential structures as well as for exploration; these surveys involve a small vessel and perhaps a single airgun source and is also usually restricted to small areas, most often a single lease site; and 2) Seismic exploration and development surveys are often conducted over large survey areas (multiple leases and blocks) and obtain information on geological formations to several thousand meters below the ocean floor. For "2-D" exploration surveys, a single streamer (hydrophones) is towed behind the survey vessel, together with a single source (airguns) (Gulland and Walker 1998). Seismic vessels generally operate at low hull speeds (<10 kn) and follow a systematic pattern during a survey, typically a simple grid pattern for 2-D work with lines no closer than half a kilometer. In simplistic terms, "3-D" surveys collect a very large number of 2-D slices, perhaps with line separations of only 25-30 m. A 3-D survey may take months to complete and involves a precise definition of the survey area and transects, including multiple passes to cover a given survey area (Caldwell 2002). In 1984, industry operated the first twin streamers. By 1990, industry achieved a single vessel towing two airgun sources and six streamers. Industry continues to increase the capability of a single vessel, now using eight streamer/dual source configurations and multi-vessel operations (Gulland and Walker 1998).

For exploration surveys, 3-D methods represent a substantial improvement in resolution and useful information relative to 2-D methods. Many areas in the Gulf of Mexico previously surveyed using 2-D have been or will be surveyed using 3-D. It can be assumed that for new deepwater areas, 3-D surveys will be the preferred method for seismic exploration, until and if better technology evolves. A typical 3-D airgun array will involve 15-30 individual guns.

Information on drilling noise in the Gulf of Mexico is unavailable to date. From studies mostly in Alaskan waters, drilling operations often produce noise that includes strong tonal components at low frequencies, including infrasonic frequencies in at least some cases. Drillships are apparently noisier than semisubmersibles (Richardson et al. 1995).

Machinery noise generated during the operation of fixed structures can be continuous or transient, and variable in intensity. Underwater noise from fixed structures ranges from about 20 to 40 dB above background levels within a frequency spectrum of 30-300 Hz at a distance of 30 m from the source (Gales 1982). These levels vary with type of platform and water depth. Underwater noise from platforms standing on metal legs would be expected to be relatively weak because of the small surface area in contact with the water and the placement of machinery on decks well above the water.

Aircraft and vessel support may further ensonify broad areas. Noise generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al. 1995). Helicopters often radiate more sound forward than backward; thus, underwater noise is generally brief in duration, compared with the duration of audibility in the air. In addition to the altitude of the helicopter, water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area and an altitude of about 500 ft while between platforms.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al. 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. For a given vessel, relative noise also tends to increase with increased speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean (Jansy 1999). Given the amount of vessel traffic from all sources in the Gulf of Mexico, MMS believes that the contribution of noise from offshore service vessels is a minor component of the total ambient noise level (MMS, Draft EA 2002), but has not been well documented to date. In the immediate vicinity of a service vessel, noise could disturb marine mammals; however, this effect would be limited in area and duration.

Seismic surveys

Geophysical seismic surveys are performed to obtain information on surface and near-surface geology and on subsurface geologic formations. The MMS has completed a draft programmatic environmental assessment (EA) on geological and geophysical (G&G) permit activities in the Gulf of Mexico (MMS, Draft Ea 2002). The draft EA includes a description of the seismic surveying technologies and operations; this information was used in the preparation of the MMS EIS for this lease sale and is incorporated herein by reference and is summarized below.

High-resolution surveys are authorized under the terms of the lease sale. Most other seismic surveys are authorized under G&G permits. High-resolution seismic surveys collect data on surface geology used to identify potential shallow geologic hazards for engineering and site planning for bottom-founded structures. Deep-penetration, common-depth-point seismic surveys obtain data about geologic formations greater than 10,000 m below the seafloor. High-energy, marine seismic surveys include both two-dimensional (2-D) and three-dimensional (3-D) surveys. Data from 2-D/3-D surveys are used to map structure features of stratigraphically important horizons in order to identify potential hydrocarbon traps. They can also be used to identify and map habitats for chemosynthetic communities.

Typical seismic surveying operations tow an array of airguns (the seismic sound source) and a streamer (signal receiver cable) behind the vessel 5-10 m below the sea surface. The airgun array produces a burst of underwater sound by releasing compressed air into the water column, that creates an acoustical energy pulse. The release of compressed air every several seconds creates a regular series of strong acoustic impulses separated by silent periods lasting 7-16 seconds, depending on survey type and depth to the target formations. Airgun arrays are designed to focus the sound energy downward. Acoustic (sound) signals are reflected off the subsurface sedimentary layers and recorded near the water surface by hydrophones spaced within streamer cables. These streamer cables are often 3 mi or greater in length. Vessel speed is typically 4.5-6 knots (about 4-8 mph) with gear deployed.

The 3-D seismic surveying enables a more accurate assessment of potential hydrocarbon reservoirs to optimally locate exploration and development wells and minimize the number of wells required to develop a field. State-of-the-art interactive computer mapping systems can handle much denser data coverage than the older 2-D seismic surveys. Multiple-source and multiple-streamer technologies are used for 3-D seismic surveys. A typical 3D survey might employ a dual array of 18 guns per array. Each array might emit a 3,000-in^3 burst of compressed air at 2,000 pounds per square inch (psi), generating approximately 4,500 kilojoule (kJ) of acoustic energy for each burst. At 10 m from the source, the pressure experienced is approximately ambient pressure plus 1 atmosphere (atm). The streamer array might consist of 6-8 parallel cables, each 6,000-8,000 m long, spaced 75 m apart. A series of 3-D surveys collected over time (four-dimensional or 4-D seismic surveying) is used for reservoir monitoring and management (the movement of oil, gas, and water in reservoirs can be observed over time).

Prior to 1989, explosives (dynamite) were used in certain limited areas to generate seismic pulses. Explosives have been replaced by piston-type acoustic sources that generate superior acoustic signals and that do not cause the damaging environmental impacts associated with explosives. Rapid rise time (high velocity), high peak pressure, and rapid energy decrease characterize acoustical energy from explosives. Seismic airguns are considered nonexplosive and have long rise times to peak pressure (low velocity). It is assumed that no explosives will be used in future seismic surveys.

The number of pre-lease geophysical permits in the Gulf has been consistently high over the last five years. The MMS anticipates an increase in the number of permit applications Gulf-wide, due in part to an increase of high-resolution data applications, as well as additional applications for operations mostly located in mature areas on the shelf. In addition, extensive 2-D surveys with deep-penetration capabilities are being run in areas where limited or dated seismic coverage presently exist. State-of-the-art 3-D seismic data have enabled industry to identify, with greater precision, where the most promising deepwater prospects are located.

Postlease seismic surveying may include high-resolution, 2-D, 3-D, or 4-D surveying. In addition, multi-component data may be collected to improve lithology and reservoir prediction for oil and gas mineral reserves. High-resolution surveying is done on a site-specific or lease-specific basis or along a proposed pipeline route. These surveys are used to identify potential shallow, geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as hard-bottom areas, topographic features, or historical archaeological resources. New technology has allowed for 3-D acquisition and for deeper focusing of high-resolution data. Post-lease, high-resolution seismic surveying is assumed to be done once for each lease.

Deeper penetration seismic surveying (2-D, 3-D, or 4-D) may also be done post-lease for more accurate identification of potential reservoirs, increasing success rates for exploratory drilling and aiding in the identification of additional reservoirs in "known" fields. This 3-D technology can be used in developed areas to identify bypassed hydrocarbon-bearing zones in currently producing formations and new productive horizons near or below currently producing formations. It can also be used in developed areas for reservoir monitoring and field management. The 4-D seismic surveying is used for reservoir monitoring and management, as well as in identifying bypassed "pay zones." Through time-lapsed surveys, the movement of oil, gas, and water in reservoirs can be observed over time. Post-lease, deep seismic surveys may occur periodically throughout the productive life of a lease.

Development and production drilling

A production well is drilled to exploit the unique configuration of a discovered or known hydrocarbon field. Delineation or production wells can collectively be termed development wells. Development or production wells may be drilled from movable structures, such as jack-up rigs with fixed bottom-supported structures, vertically floating moored structures, floating production facilities (often called semisubmersibles), and drillships (dynamically positioned drilling vessels). The type of production structure installed at a site depends mainly on water depth. The number of wells per structure varies according to the type of production structure used, the prospect size, and the drilling/production strategy deployed for the drilling program and for resource conservation. Systems used to produce hydrocarbons can be fixed, floating, or sub-sea in deeper waters.

Production Platforms

Offshore platforms play a pivotal role in the development of offshore oil and gas resources. The purpose of a platform is to house production and drilling equipment and living quarters for personnel (on manned platforms). Structure installation and commissioning activities may take place over a period of a week to a month at the beginning of a platform's 20- to 40-year production life. Derrick barges may be used to upright and position structures. Moorings and anchors are usually attached to keep the structure on station. Commissioning activities involve all of the interconnecting and testing of the structure's modular components. Regulations and mitigating measures may help to protect sensitive areas (e.g., benthic, chemosynthetic communities) from potential impacts resulting from bottom disturbance during platform installation

A platform consists of two major components: an underwater jacket or tower and an above water deck. Other platform components are living quarters, control building, and production modules. Several types of production systems are used for offshore oil and gas development in the analysis area.

A fixed platform is the most commonly used type of production system in the U.S. Gulf of Mexico. A fixed platform is a large skeletal structure extending from the bottom of the ocean to above the water level. It consists of a metal jacket, that is attached to the ocean bottom with the piles, and a deck, that accommodates drilling and production equipment and living quarters. Fixed platforms are typically installed in water depths up to 1,500 ft.

A compliant tower is similar to a fixed platform; however, the underwater section is not a jacket but a narrow, flexible tower that, due to the flexibility of its structure, can move around in the horizontal dimension, thereby withstanding significant wave and wind impact. Compliant towers are typically installed in water depth from 1,000 to 2,000 ft.

Tension and mini-tension leg platforms do not have skeletal structures extending all the way to the ocean floor. Instead, they consist of floating structures, that are kept in place by steel tendons attached to the ocean floor. Tension leg platforms can be used in different depth ranges, up to 4,000 ft.

A spar platform (a floating caisson) consists of a large vertical hull, that is moored to the ocean floor with up to 20 lines. Above the hull sits the deck with production equipment and living quarters. At present, spar platforms are used in water depth up to 3,000 ft; however, present technology allows installations in waters as deep as 7,500 ft.

A floating production system consists of a semi-submersible unit that is kept stationary either by anchoring with wire ropes and chains or by the use of rotating thrusters, which self propel the semi-submersible unit. Floating production systems are suited for deepwater production in depths up to 7,500 ft.

A subs-ea system consists of a single sub-sea well or several wells producing either to a nearby platform or to a distant production facility through a pipeline and manifold systems. At present, subsea systems are used in water depths exceeding 5,000 ft.

A floating production, storage, and offloading (FPSO) system consists of a large vessel that houses production equipment. It collects oil from several sub-sea wells, stores it, and periodically offloads it to a shuttle tanker. The FPSO systems are particularly useful in development of remote oil fields where pipeline infrastructure is not available. To date, MMS has received no proposals for use of FPSO systems in the Gulf of Mexico.

Platforms are fabricated onshore and then towed to an offshore location for installation. Facilities where platforms are fabricated are called platform fabrication yards. Production operations at fabrication yards include the cutting and welding of steel components and the construction of living quarters and other structures, as well as the assembly of platform components. Fixed platform fabrication can be subdivided into two major tasks: jacket fabrication and deck fabrication.

There are presently 3,894 platform structures in the CPA and WPA (Table 1). Total OCS production structure installation Gulfwide has been estimated through the year 2042. The estimated number of platforms installed varies widely between water-depth subareas. In the WPA, production structure installation ranges from a low of 3-8 platforms in depths greater than 2,400 m to a high range of 428-628 in the shallowest water depth subarea (to a depth of 60 m). Projected CPA installations range from 9 to 23 in the deepwater (greater than 2,400 m) to a high of 1,810-2,441 structures in the shallowest water depth subarea (to a depth of 60 m). The total number of installations for the CPA ranges from 2,360 to 3,218 for all depth ranges.

Table 1. The number of platform types presently in the Central and Western Planning Areas of the Gulf of Mexico. Data is accurate up to May 2001 (MMS EIS, MMS 2002-015).

Platform Type	Central Planning Area	Western Planning Area	Total
Caisson	1,208	103	1,311
Compliant Towers	1	1	2
Fixed Leg	1,752	361	2,113
Mobile Production Units	1	0	1
Mini TLP's	2	0	2
Spars	1	1	2
Subsea Manifolds	2	2	4
Subsea Templates	8	0	8
Tension Leg	6	0	6
Well Protectors	383	62	445

Pipelines

Pipelines are the primary method used to transport a variety of liquid and gaseous products between OCS production sites and onshore facilities around the Gulf of Mexico. These products include unprocessed (bulk) oil and gas; mixtures of gas and condensate; mixtures of gas and oil; processed condensate, oil, or gas; produced water; methanol; and a variety of chemicals used by the OCS industry offshore. Pipelines in the Gulf are designated as either trunklines or gathering lines. Gathering lines are typically shorter segments of small-diameter pipelines that transport the well stream from one or more wells to a production facility or from a production facility to a central facility serving one or several leases, e.g., a trunkline or central storage or processing terminal. Trunklines are typically large-diameter pipelines that receive and mix similar production products and transport them from the production fields to shore. A trunkline may contain production from many discovery wells drilled on several hydrocarbon fields. The OCS-related pipelines near shore and onshore may merge with pipelines carrying materials produced in State territories for transport to processing facilities or to connections with pipelines located further inland. Most of the active length of OCS pipelines transport mostly gas (64%); the reminder transport predominately oil (25%).

Over the last 10 years, the average annual installation rate for OCS pipelines was 1,600 km and more than 200 pipelines and pipeline segments. Pipelines in the CPA accounted for 83 % of the length installed; pipelines in the WPA accounted for 17 percent. The installation rate for pipelines is expected to remain steady; this estimate includes consideration of expansion and replacement of the existing and aging pipeline infrastructure in the GOM.

It is expected that pipelines from most of the new offshore production facilities will connect to the existing pipeline infrastructure, that will result in few new pipeline landfalls. Production from a proposed action in the CPA and WPA will contribute 2 % and 1 %, respectively, to existing and future pipelines and pipeline landfalls. For the period 2003-2042, a range of 23-38 new landfalls is projected for the OCS Program. For each proposed action, 0-1 new landfalls are projected. The typical operational life of a pipeline has been estimated to be 20-40 years, but with current corrosion management, that lifetime has been significantly increased.

Removal of pipelines is expected to be rare and will generally involve short lengths. As of August 2001, less than 1 % of the total length of pipelines installed, or about 300 km, were removed. All pipelines removed were in the CPA, except for 1 km in the WPA. Most pipelines were in water depths of less than 66 ft (20 m); 6 pipelines were in water depths greater than 656 ft (200 m). Pipelines constructed in water depths <200 ft (60 m) are potential snags for anchors and trawls. Of the pipeline constructed in Federal waters, 58 % (49% of the WPA and 59% of the CPA) were constructed in water depths >200 ft. MMS regulations provide for the burial of any pipeline, regardless of size, if MMS determines that the pipeline may constitute a hazard to other uses of the OCS; in the Gulf of Mexico, MMS has determined that all pipelines installed in water depths <200 ft must be buried. The purpose of these requirements is to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, to reduce the risk of fishing gear becoming snagged, and to minimize interference with the operations of other users of the OCS. New installation methods have allowed the pipeline infrastructure to extend to deeper water. At present, the deepest pipeline in the Gulf is in 2,300 m water depth. More than 200 pipelines reach water depths of 300 m or more, and almost half of those reach water depths of 800 m or more.

Vessel traffic

Barges may be used offshore to transport oil and gas, supplies such as chemicals or drilling mud, or wastes between shore bases and offshore platforms. Barges are non-self-propelled vessels that must be accompanied by one or more tugs. Because of this, barge transport is usually constrained to shallow waters of the Gulf, close to the shoreline. Barging of OCS oil from platforms to shore terminals is an option used by the oil industry in lieu of transporting their product to shore via pipeline. A platform operator generally decides at the beginning of a development project whether the production will be barged or piped. Barging is used very infrequently as an interim transport system prior to the installation of a pipeline system.
As of August 2001, eight barge systems were operating in the Gulf, servicing 25 OCS platforms. These platforms were located in water depths less than 60 m with the exception of two platforms located in slightly deeper water. Five barge systems operate in the CPA, with one system handling a small amount of oil from the WPA, and three barge systems operate only in the WPA. About 1 % of the oil produced in less than 60 m is barged to shore. Eighty percent of barged oil is from leases east of the Mississippi River.

Other types of barging operations may occur in connection with OCS operations. Besides barging from platform to shore terminal, a few platform operators choose to barge their oil to other platforms where it is then offloaded to storage tanks and later piped to shore. Recently there has been some barging of oil from deepwater sites during extended well testing; this activity is likely to increase in the future. Storage and barging of the well stream from extended well tests is an alternative to flaring the gas and burning the liquids produced during well testing. No information is currently available on the number of barge trips associated with these other types of offshore oil barging operations.

Shuttle oil tanker transport of Gulf of Mexico OCS-produced oil has not occurred to date. Tankering is projected for some future OCS operations located in deepwater beyond the existing pipeline network. In early 1997, discussions between industry and MMS began concerning the feasibility of floating production, storage, and offloading (FPSO) systems and associated tanker transport of OCS-produced oil in the Gulf of Mexico. The FPSO's are floating production systems that store crude oil in tanks located in the hull of the vessel and periodically offload the crude to shuttle tankers or ocean-going barges for transport to shore. The FPSO's may be used to develop marginal oil fields or used in areas remote from the existing OCS pipeline infrastructure. Shuttles can have internal propulsion systems, or they may use other propulsion system configurations, such as an articulated tug barge (ATB). The ATB's involve the connectable/disconnectable integration of a tug-type vessel to a recess in the stern of a large-capacity barge. Shuttle tankers also vary in size. In the Gulf, the maximum size of shuttle tankers is limited primarily by the 34- to 47-ft water depths of U.S. Gulf Coast refinery ports. Due to these depth limitations, shuttle tankers are likely to be 500,000-550,000 bbl in cargo capacity.

Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore. A trip is considered the transportation from a service base to an offshore site and back, in other words a round trip. Based on MMS calculations, each vessel makes an average of three round trips per week for 40 weeks in support of drilling an exploration well and for 35 weeks in support of drilling a development well. A platform is estimated to require two vessel trips per week over its 20-year production life. All trips are assumed to originate from the service base. There are currently approximately 376 supply vessels operating in the Gulf of Mexico. Over the 40-year life of the proposed actions, supply vessels will retire and replacement vessels will be built. In general, the new type of vessels built will continue to be larger, deeper drafted, and more technologically advanced for deepwater activities.

Compared to shelf-bound service vessels, deepwater service vessels have improved hull designs (increased efficiency and speed), a passive computerized anti-roll system, drier and safer working decks, increased cargo capacity (water, cement, barite, drilling muds, etc.), increased deck cargo capability, increased cargo transfer rates to reduce the time and risk alongside structures (e.g., TLP), dual and independent propulsion systems, true dynamic positioning system, fuel and NOx efficient engines, and Safety of Life at Sea (SOLAS) capability (WorkBoat 1998). Service vessels primarily used in deepwater are offshore supply vessels (OSV), fast supply vessels, and anchor-handling towing supply/mooring vessels (AHTS) (WorkBoat 2000). Other deepwater specialty service vessels include well stimulation vessels. The OSV's and AHTS's carry the same type of cargo (freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, food, and miscellaneous supplies) but have different functions. The AHTS's also differ from the supply vessels by their deepwater mooring deployment and towing capabilities.

The proposed action in the WPA is estimated to generate 25,000-36,000 service-vessel trips or about 1,000 trips annually over the life of the lease. The projected number of service-vessel trips estimated for the OCS Program is 11,868,000-12,438,000 over the 2003-2042 period. This equates to an average rate of 296,700-310,950 trips annually.

Helicopters are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. In addition, equipment and supplies are sometimes transported. A trip is considered the transportation from a helicopter hub to an offshore site and back, in other words a round trip. Deepwater operations require helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating costs.

Helicopter trips projected for a proposed action in the CPA are 220,000-870,000 trips. This equates to an average annual rate of 5,500-21,750 trips. The proposed action in the WPA is projected to generate 110,000-410,000 helicopter trips or 3,000-10,000 trips annually.
The projected number of helicopter trips for the OCS Program is 32,615,000-55,439,000 trips over the 2003-2042 period. This equates to an average rate of 815,000-1,386,000 trips annually. To meet the demands of deepwater activities, the offshore helicopter industry is purchasing new helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating cost. The number of helicopters operating in the Gulf of Mexico is expected to decrease in the future, and helicopters that do operate are expected to be larger and faster.

Trash and debris

Oil and gas operations on the OCS generate waste materials made of paper, plastic, wood, glass, and metal. Most of this waste is associated with galley and offshore food service operations and with operational supplies such as shipping pallets, containers used for drilling muds and chemical additives (sacks, drums, and buckets), and protective coverings used on mud sacks and drilling pipes (shrink wrap and pipe-thread protectors). Some personal items, such as hardhats and personal flotation devices, are accidentally lost overboard from time to time. Generally, galley, operational, and household wastes are collected and stored on the lower deck near the loading dock in large receptacles resembling dumpsters. These large containers are generally covered with netting to avoid loss and are returned to shore by service vessels for disposal in approved landfills.

The MMS regulations, the EPA's National Pollutant Discharge Elimination System (NPDES) general permit, and the USCG regulations implementing MARPOL 73/78 Annex V prohibit the disposal of any trash and debris into the marine environment. Organic food waste is allowed to be ground up into small pieces and disposed of overboard from structures located more than 20 km from shore. Information provided by industry gives some indication of the amount of trash historically generated during the drilling of an average offshore well. Historically, a typical well drilled to about 4,300 m might require 9,300 mud sacks, 100 pails, 250 pallets, 225 shrink wrap applications, and two 55-gallon drums. Most drilling muds are now shipped pre-mixed in reusable bulk tanks. This change has resulted in a significant reduction in the amount of solid waste associated with drilling operations. Still, drilling operations require the most supplies, equipment, and personnel, and therefore, generate more solid waste than production operations. Over the last several years, companies have employed waste reduction and improved waste-handling practices to reduce the amount of trash offshore that could potentially be lost into the marine environment. Improved waste management practices, such as substituting paper cups and reusable ceramic cups and dishes for those made of Styrofoam, recycling offshore waste, and transporting and storing supplies and materials in bulk containers when feasible, are commonplace. Experimental technology, such as reinjection of waste materials reduced to slurry into downhole formations such as salt domes, is also under development.

Contaminants

The primary operational waste discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, produced water, deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced sand and well treatment, workover, and completion fluids. Minor additional discharges occur from numerous sources; these discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater.

The EPA, through general permits issued by the EPA Region that has jurisdictional oversight, regulates all waste streams generated from offshore oil and gas activities. The EPA published the most recent effluent guidelines for the oil and gas extraction point-source category in 1993 (58 FR 12454). The EPA Region 4 has jurisdiction over the eastern portion of the Gulf of Mexico OCS including all of the Eastern and Central Planning Areas off the coasts of Alabama and Mississippi. The EPA Region 6 has jurisdiction over the rest of the CPA and all of the WPA.

The largest discharges from drilling operations are drilling fluids (also known as drilling muds) and cuttings. Drilling fluids are used in rotary drilling to remove cuttings from beneath the bit, to control well pressure, to cool and lubricate the drill string, and to seal the well. Drill cuttings are the fragments of rock generated during drilling and carried to the surface with the drilling fluid. Three categories of drilling fluids or muds are used on the OCS: water based, oil based, and synthetic based. Water-based drilling fluids (WBF) have been used for decades to aid drilling on the continental shelf. The WBF may have diesel oil or mineral oil added to them for lubrication. Since 1992, synthetic-based drilling fluids (SBF), have been increasingly used, especially in deepwater, because they perform better, are less toxic than other fluids, and reduce drilling times, thus reducing the costs incurred from expensive drilling rigs. Most recently, internal olefins are the most prevalent base fluid for the SBF used in deepwater drilling in the Gulf of Mexico. However, some operators have used polyalpha olefins, esters, or their own proprietary blend as the base fluid.

The discharge of WBF and cuttings associated with WBF is allowed everywhere on the OCS under the general NPDES permits issued by Regions 4 and 6, as long as the discharge meets the toxicity guidelines. In deeper water, the upper portion of the well, 1,000-1,500 m, is drilled with WBF and the remainder is drilled with SBF. The upper sections are drilled with a large diameter bit; progressively smaller drill bits are used with increasing depth. Therefore, the volume of cuttings per interval (length of wellbore) in the upper section of the well is greater than the volume generated in the deeper sections.

Trace metals, including mercury, in drilling discharges are a concern because of the potential for some to bioaccumulate in marine organisms. For example, mercury is discharged during drilling as an impurity in barite (used in drilling fluid). Results of analysis conducted by Neff et al. (1989) looked at the accumulation of mercury and other metals in flounder, clams, and sand worms. Flounder did not accumulate any metals during exposure, and the soft-shell clams and sand worms had only slight increases of some metals. The authors noted that most of the accumulated metals were actually in the gut or gills as unassimilated barite particles. They concluded that metals associated with drilling fluid barite are virtually non-bioavailable to marine organisms. In addition, no operator can discharge drilling muds containing barite without a discharge permit from the EPA. The EPA requires concentrations of mercury to be less than or equal to 1 part per million in the barite used to make drilling muds.

Produced water is brought up from the hydrocarbon-bearing strata along with produced oil and gas. This waste stream can include formation water, injection water, and any chemicals (including well treatment, completion, and workover chemicals) added downhole or during the oil/water separation. Since the oil/water separation process does not completely separate the oil, some hydrocarbons remain with the produced water and often the water is treated to prevent the formation of sheen. The composition of the discharge can vary greatly in the amounts of organic and inorganic compounds. The EPA general permits allow the discharge of produced water on the OCS provided they meet discharge criteria. Oil and grease cannot exceed 42 milligrams per liter (mg/l) daily maximum or 29 mg/l monthly average. The Region 4 requires no discharge within 1,000 m of an area of biological concern. The discharge must also be tested for toxicity on a monthly basis.

Species affected

NOAA Fisheries believes that the sperm whale, leatherback, green, hawksbill, Kemp’s ridley, and loggerhead sea turtles are present in the action area and may be adversely affected by the proposed action. The effects of petroleum industry-associated noise on sea turtles are little understood, but may cause disturbance or physical harm. NOAA Fisheries believes sperm whales may be vulnerable to adverse affects resulting from anthropogenic noise resulting from the proposed action. Oil and chemical effects and increases in port traffic may effect proposed critical habitat for the Gulf sturgeon, but no critical habitat has been designated at this time.

II. Status of Listed Species and Critical Habitat

The following listed species under the jurisdiction of NOAA Fisheries are known to occur in the GOM and may be affected by the proposed action:

Endangered

Sperm Whale	*Physeter macrocephalus*
Leatherback turtle	*Dermochelys coriacea*
Green turtle	*Chelonia mydas*
Hawksbill turtle	*Eretmochelys imbricata*
Kemp's ridley turtle	*Lepidochelys kempii*

Threatened

Loggerhead turtle	*Caretta caretta*
Gulf sturgeon	*Acipenser oxyrinchus desotoi*

Endangered whales, including the blue whale (*Balaenoptera musculus*), sei whale (*B. borealis*), fin whale (*B. physalus*), humpback whale (*Physeter macrocephalus*), and the northern right whale (*Eubalaena glacialis*), have been observed occasionally in the GOM. Individuals observed have likely been inexperienced juveniles straying from the normal range of these stocks or occasional transients. Since NOAA Fisheries does not believe that there are resident stocks of these species in the GOM, the potential for interaction between any of the proposed project's activities and these whale species is extremely low. Based on the above, NOAA Fisheries has determined that these species are not likely to be adversely affected by the proposed action.

No critical habitat for listed species under the jurisdiction of NOAA Fisheries has been designated within the action area of the OCS Lease Multi-Sale in the Gulf of Mexico, although proposed critical habitat for the Gulf sturgeon is located in the action area (67 FR 39106).

III. Status of the Species

A. Sperm whale

a. *Species/critical habitat description*

Sperm whales are distributed in all of the world's seas and oceans. The sperm whale was listed as endangered under the ESA in 1973. For the purposes of management, the International Whaling Commission (IWC) defines four stocks: the North Pacific, the North Atlantic, the Northern Indian Ocean, and Southern Hemisphere. However, Dufault et al.'s (1999) review of the current knowledge of sperm whales indicates no clear picture of the worldwide stock structure of sperm whales. In general, females and immature sperm whales appear to be restricted in range, whereas males are found over a wider range and appear to make occasional movements across and between ocean basins (Dufault et al. 1999). Sperm whales are the most abundant large cetacean in the Gulf of Mexico, and represent the most important Gulf cetacean in terms of collective biomass. These whales were once hunted in Gulf waters.

There is no critical habitat designated for sperm whales.

b. *Life history*

Females and juveniles form pods that are restricted mainly to tropical and temperate latitudes (between 50 N and 50 S) while the solitary adult males can be found at higher latitudes (between 75 N and 75 S) (Reeves and Whitehead 1997). In the western North Atlantic they range from Greenland to the Gulf of Mexico and the Caribbean.

Evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce vocalizations (Norris and Harvey 1972, Cranford 1992). This suggests that vocalizations are extremely important to sperm whales. The function of vocalizations is relatively well-studied (Weilgart and Whitehead 1997, Goold and Jones 1995). Long series of monotonous, regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Sperm whales also utilize unique stereotyped click sequence "codas" (Mullins et al. 1988, Watkins 1977, Adler-Fenchel 1980, Watkins et al. 1985), according to Weilgart and Whitehead (1988) to possibly convey information about the age, sex, and reproductive status of the sender. Groups of closely related females and their offspring have group-specific dialects (Weilgart and Whitehead 1997).

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 in the Atlantic is closely correlated with the Gulf Stream edge. 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. It is not known whether Gulf sperm whales exhibit similar seasonal movement patterns. Their presence in the Gulf is year-round; however, due to the lack of males observed in the GOM and a lack of data on movements of the resident population, it is not known whether females leave the area to mate or whether males sporadically enter the area to mate with females, but it is highly likely that this group offshore of the Mississippi River delta remains in this area year-round and represents a resident population (Lang 2000). Davis et al. (2000, 2002) reported that low salinity, nutrient-rich water may occur over the continental slope near the mouth of the Mississippi or be entrained within the confluence of a cyclone-anticyclone eddy pair and transported over the narrow continental shelf south of the Mississippi River delta. This creates an area of high primary and secondary productivity in deep water that may explain the presence of the resident population of endangered sperm whales within 100 km of the Mississippi River delta (Townsend 1935, Berzin 1971, Davis and Fargion 1996, Davis et al. 2000, Weller et al. 2000) (Figure 2).

Deepwater is their typical habitat, but sperm whales also occur in coastal waters at times (Scott and Sadove 1997). When found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956), and with the movement of cyclonic eddies in the northern Gulf (Davis et al. 2000, 2002). Although sperm whales have been sighted throughout the GOM, sperm whales south of the Mississippi River Delta apparently concentrate their movements to stay in or near variable areas of upwelling, or cold-core rings (Würsig et al. 2000, Davis et al. 2002). Presumably this is due to the greater productivity inherent in such

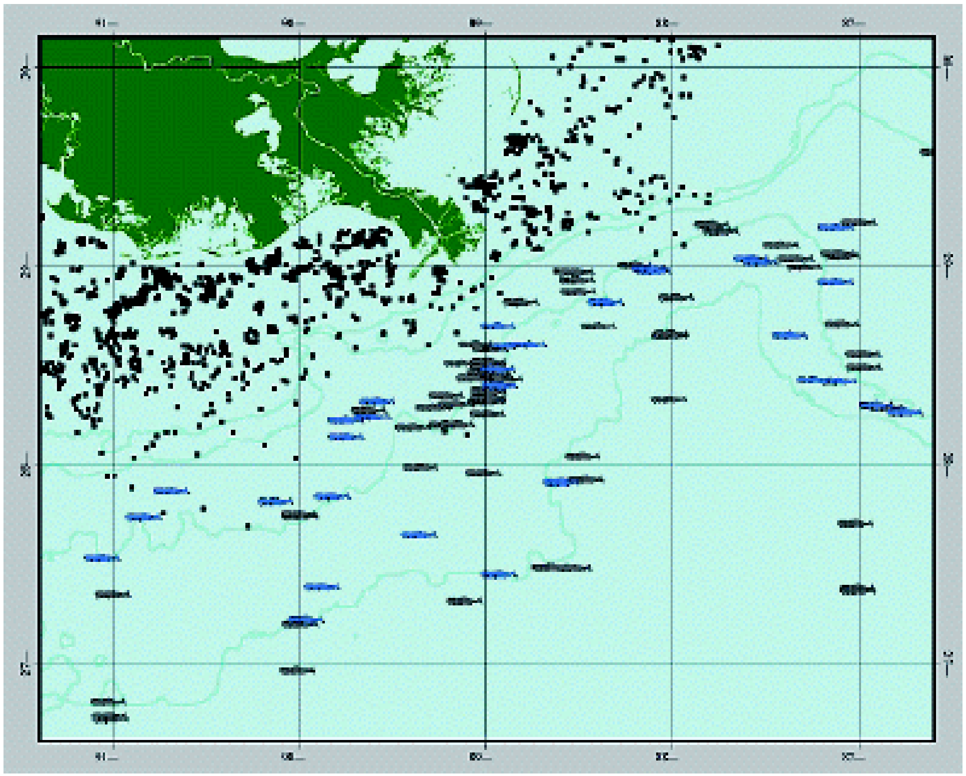

Figure 2. Each sperm whale symbol represents a sighting (one or more whales) from NMFS ship and aerial surveys between 1991 and 1999. Squares are oil and gas platforms. Sightings are raw data concentrated along repeated track lines and indicate persistence and some preference for depth, but this figure does not depict area wide distribution. (Prepared by Michelle Morin, MMS, survey data provided by NOAA Fisheries' Southeast Fisheries Science Center.)

areas, which would provide concentrated sources of forage species for these whales. The continental margin in the north-central Gulf is only 20 km wide at its narrowest point, and the ocean floor descends quickly along the continental slope, reaching a depth of 1,000 m within 40 km of the coast. This unique area of the Gulf of Mexico brings deepwater organisms within the influence of coastal fisheries, contaminants, and other human impacts on the entire northern Gulf. Low salinity, nutrient-rich water from the Mississippi River contributes to enhanced primary and secondary productivity in the north-central Gulf, and may explain the presence of sperm whales in the area (Davis et al. 2000). In fact, researchers with Texas A&M believe that the area should be considered as critical habitat for sperm whales (Davis 2000), as it is the only known calving area in the Gulf, for what is believed to be a resident population (Davis et al. 2002).

Sperm whales are noted for their ability to make prolonged, deep dives, and are likely the deepest and longest diving mammal. Typical foraging dives last 40 minutes and descend to about 400 m, followed by approximately 8 minutes of resting at the surface (Gordon 1987, Papastavrou et al. 1989). However, dives of over 2 hours and deeper than 3.3 km have been recorded (Clarke 1976, Watkins et al. 1985, Watkins et al. 1993) and individuals may spend extended periods of time at the surface to recover. Descent rates recorded from echo-sounders were approximately 1.7 m/sec and nearly vertical (Goold and Jones 1995). There are no data on diurnal differences in dive depths in sperm whales. Dive depth may be dependent upon temporal variations in prey abundance.

Cephalopods (i.e., squid, octopi, cuttlefishes, and nautilus) are the main dietary component of sperm whales. The ommastrephids, onychoteuthids, cranchids, and enoploteuthids are the cephalopod families that are numerically important in the diet of sperm whales in the Gulf of Mexico (Davis et al. 2002). Other populations are known to also take significant quantities of large demersal and mesopelagic sharks, skates, and bony fishes, especially mature males in higher latitudes (Clarke 1962, 1979). Postulated feeding and hunting methods include lying suspended and relatively motionless near the ocean floor and ambushing prey; attracting squid and other prey with bioluminescent mouths; or stunning prey with ultrasonic sounds (Norris and Mohl 1983, and Berzin 1971, as cited in Norris and Mohl 1983, Würsig et al. 2000). Sperm whales occasionally drown after becoming entangled in deep-sea cables that wrap around their lower jaw, and non-food objects have been found in their stomachs, suggesting these animals may at times cruise the ocean floor with open mouths (Würsig et al. 2000, Rice 1989).

c. *Population dynamics*

There is evidence based on year-round occurrence of strandings, opportunistic sightings, whaling catches, and recent sperm whale survey data that sperm whales in the Gulf of Mexico may be found throughout deep waters of the GOM (Schmidley 1981, Hansen et al. 1996, Davis et al. 2002). NOAA Fisheries treats sperm whales in the GOM as a distinct stock in the Marine Mammal Stock Assessment Report (Waring et al. 2000). Seasonal aerial surveys have confirmed that sperm whales are present in the northern Gulf of Mexico in all seasons. Sightings are more common during summer (Mullin et al. 1991, Mullin et al. 1994, Mullin and Hoggard 2000), but may be an artifact of movement patterns of sperm whales associated with reproductive behavior, hydrographic features, or other environmental and seasonal factors.

Female sperm whales attain sexual maturity at the mean age of 8 or 9 years and a length of about 9 m (Kasuya 1991, Würsig et al. 2000). 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 m, after a

15-16 month gestation period. Sperm whales exhibit alloparental (the assistance by individuals other than the parents in the care of offspring) guarding of young at the surface (Whitehead 1996), and alloparental nursing (Reeves and Whitehead 1997). Calves are nursed for 2-3 years (in some cases, up to 13 years); and the calving interval is estimated to be about 4 to 7 years (Kasuya 1991, Würsig et al. 2000).

Males have a prolonged puberty and attain sexual maturity at between age 12 and 20, and a body length of 12 m, but may require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991, Würsig et al. 2000). 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).

Recent density estimates of 2.36 whales per 1,000 km^2 have been calculated for the Northern GOM (Whitehead 2002). The age distribution of the sperm whale population is unknown, but they are believed to live at least 60 years. Potential sources of natural mortality in sperm whales include killer whales and the papilloma virus (Lambertsen et al. 1987). Little is known of recruitment and mortality rates; however, recent abundance estimates based on surveys indicate that the population appears to be stable; however, NOAA Fisheries believes there are insufficient data to determine population trends in the GOM for this species at this time (Waring et al. 2000).

d. ***Status and distribution***

Sperm whales are found throughout the world's oceans in deep waters between about 60° N and 60° S latitudes (Leatherwood and Reeves 1983, Rice 1989). The primary factor for the population decline that precipitated ESA listing was commercial whaling in the 18th, 19th, and 20th centuries for ambergris and spermaceti. The IWC estimates that nearly a quarter-million sperm whales were killed worldwide in whaling activities between 1800 and 1900. A commercial fishery for sperm whales operated in the Gulf of Mexico during the late 1700s to the early1900s, but the exact number of whales taken is not known (Townsend 1935). The over harvest of sperm whales resulted in their alarming decline in the last century. From 1910 to 1982, there were nearly 700,000 sperm whales killed worldwide from whaling activities (IWC Statistics 1959-1983). Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). Since the ban on nearly all hunting of sperm whales, there has been little evidence that direct effects of anthropogenic causes of mortality or injury are significantly affecting the recovery of sperm whale stocks (Perry et al. 1999, Waring et al. 1997), yet the effects of these activities on the behavior of sperm whales has just recently begun to be studied. Sperm whales are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. Presently, the global population of sperm whales is estimated to be at 32% of its pre-whaling number (Whitehead 2002).

Since sperm whales were listed under the ESA, concerns for the effects of anthropogenic activities on the physiology and behavior of marine mammals has received much attention. Sperm whales have been identified as species of concern in the Gulf of Mexico in relation to shipping, seismic surveys, and mineral production (Jansy 1999), although the studies of the effects of seismic pulses on sperm whales have been relatively few and have been largely inconclusive. However, many reported reactions to anthropogenic noise deserve special attention in assessing impacts to sperm whales and marine life in general. Sperm whale vocalization and audition are important for echolocation and feeding, social behavior and intragroup interactions, and to maintain social cohesion within the group. Anthropogenic sources from vessel noise, noise associated with oil production, seismic surveys, and other sources have the potential to impact sperm whales (e.g., behavioral alteration, communication, feeding ability, disruption of breeding and nursing, and avoidance of locales where audible sounds are being emitted). Andrew et al. (2002) reported that over a 33-year period, increases in shipping sound levels in the ocean may account for 10 dB increase in ambient noise between 20-80 Hz and between 200-300 Hz, and a 3 dB increase in noise at 100 Hz on the continental slope off Point Sur, California. Although comparable data are not available for shelf waters in the GOM, the amount of vessel traffic and industrial noise in the GOM may contribute to similar increases in ambient noise there. The effects of increased ambient noise on cetaceans (e.g., habitat use, behavior and physiological stress) is not well documented due to constraints on studying these animals; is likely species specific; and may also vary by life stage and gender. Digital recording tags (DTAGs) and passive acoustic studies have recently become very useful technologies for studying sperm whales and should provide some answers on the behavioral and physiological responses of sperm whales under various conditions.

Documented takes of sperm whales primarily involve offshore fisheries such as the offshore lobster pot fishery and pelagic driftnet and longline fisheries. Sperm whales have learned to depredate sablefish from longline gear in the Gulf of Alaska and toothfish from longline operations in the south Atlantic Ocean. No direct injury or mortality has been recorded during hauling operations, but lines have had to be cut when whales were caught on them (Ashford et al. 1996). 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 drift gillnet fishery for swordfish, and could likewise be taken in the shark drift gillnet fishery on occasions when they may occur more nearshore, although this likely does not occur often. Although no interaction between sperm whales and the longline fishery have been recorded in the U.S. Atlantic, as noted above, such interactions have been documented elsewhere. The Southeast U.S. Marine Mammal Stranding Network received reports of 16 sperm whales that stranded along the Gulf of Mexico coastline from 1987 to 2001 in areas ranging from Pinellas County, Florida to Matagorda County, Texas. One of these whales had deep, parallel cuts posterior to the dorsal ridge that were believed to be caused by the propeller of a large vessel; this trauma was assumed to be the proximate cause of the stranding.

B. Leatherback sea turtle

a. *Species/critical habitat description*

The leatherback sea turtle was listed as endangered on June 2, 1970 (35 FR 8491). Leatherback distribution and nesting grounds are found circumglobally, and are found in waters of the Atlantic, Pacific, and Indian Oceans, the Caribbean Sea, and the Gulf of Mexico (Ernst and Barbour 1972). Adult leatherbacks forage in temperate and subpolar regions from 71 N to 47 S latitude in all oceans and undergo extensive migrations between 90 N and 20 S, to and from the tropical nesting beaches. In the Atlantic Ocean, leatherbacks have been recorded as far north as Newfoundland, Canada, and Norway, and as far south as Uruguay, Argentina, and South Africa (see NMFS 2001). Female leatherbacks nest from the southeastern United States to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic. The most significant nesting beaches in the Atlantic, and perhaps in the world, are in French Guiana and Suriname (see NMFS 2001).

The leatherback is the largest and most pelagic of sea turtles. The average curved carapace length for adults is 155 cm and weights from worldwide populations range from 200-700 kg. Adults may attain weights up to and exceeding 1000 kg and reach lengths of 1.9 m. The leatherback forages widely throughout the water column from the surface to great depths throughout tropical and temperate oceans of the world. An adult leatherback was reported, by extrapolation of data, to achieve a maximum dive of 1300 m (Eckert et al. 1989). The distribution of leatherbacks appears to be dependent upon the distribution of their gelatinous prey (Leary 1957), consisting mostly of scyphomedusae (jellyfish) and pelagic tunicates. Leatherbacks typically lay a clutch of approximately 100 eggs within a nest cavity, that require approximately 60 days of incubation until pipping. Hatchlings average 61.3 mm long and 44.4 g in mass. Neonate leatherbacks are the most active sea turtle species, crawling immediately across the beach to the sea upon emergence, and swimming both day and night for at least six days after entering the surf (Wyneken and Salmon 1992).

Critical habitat for the leatherback includes the waters adjacent to Sandy Point, St. Croix, U.S.V.I. There is no critical habitat designation for the leatherback sea turtle in the Gulf of Mexico.

b. *Life history*

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). Adult leatherbacks forage in temperate and subpolar regions from 71 N to 47 S latitude in all oceans and undergo extensive migrations to and from tropical nesting beaches between 90 N and 20 S. Female leatherbacks nest from the southeastern United States to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic, with nesting occurring as early as late February or March. When they leave the nesting beaches, leatherbacks move offshore but eventually utilize both coastal and pelagic waters. Very little is known about the pelagic habits of the hatchlings and juveniles, and they have not been documented to be associated with the sargassum areas as are other species. Leatherbacks are deep divers, with estimated dives to depths in excess of 1000 m (Eckert et al. 1989), but they may come into shallow waters if there is an abundance of jellyfish nearshore.

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 of about 13-14 years for females, and an estimated minimum age at sexual maturity of 3-6 years, with 9 years reported as a likely minimum (Zug and Parham 1996) and 19 years as a likely maximum (NMFS 2001). They nest frequently (up to 7 nests per year) during a nesting season and nest about every 2-3 years. During each nesting females produce 100 eggs or more in each clutch and, thus, can produce 700 eggs or more per nesting season (Schultz 1975).

Leatherback sea turtles feed primarily on jellyfish as well as cnidarians and tunicates. They are also the most pelagic of the turtles, but have been known to enter coastal waters on a seasonal basis to feed in areas where jellyfish are concentrated.

c. *Population dynamics*

Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972). A population estimate of greater than or equal to 34,500 females (26,200-42,900) was made by Spotila et al. (1996), along with a claim that the species as a whole was declining and local populations were in danger of extinction (NMFS 2001). Genetic analyses of leatherbacks to date indicate that within the Atlantic basin significant genetic differences occur among St. Croix (U.S. Virgin Islands), and mainland Caribbean populations (Florida, Costa Rica, Suriname/French Guiana) and between Trinidad and the mainland Caribbean populations (Dutton et al. 1999), leading to the conclusion that there are at least three separate subpopulations of leatherbacks in the Atlantic.

The primary leatherback nesting beaches occur in French Guiana, Suriname, and Costa Rica in the western Atlantic, and in Mexico in the eastern Pacific. Recent declines have been seen in the number of leatherbacks nesting worldwide (NMFS and USFWS 1995). Adult mortality has increased significantly from interactions with fishery gear (Spotila et al. 1996). The Pacific population is in a critical state of decline, now estimated to number less than 3,000 total adult and subadult animals (Spotila et al. 2000). The status of the Atlantic population is less clear. In 1996, it was reported to be stable, at best (Spotila et al. 1996), but numbers in the western Atlantic at that time were reported to be on the order of 18,800 nesting females. The western Atlantic population currently numbers about 15,000 nesting females, whereas current estimates for the Caribbean (4,000) and the eastern Atlantic, off Africa (numbering 4,700), have remained consistent with numbers reported by Spotila et al. in 1996.

The nesting aggregation in French Guiana has been declining annually at about 15% since 1987. From 1979-1986, the number of nests was increasing at about 15% annually. The number of nests in Florida and the U.S. Caribbean has been increasing at about 10.3% and 7.5%, respectively, per year since the early 1980s but the magnitude of nesting is much smaller than that along the French Guiana coast (NMFS 2001). In 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 they are down.

d. *Status and distribution*

Leatherback sea turtles are susceptible to ingestion of marine debris (Balazs 1985, Fritts 1982, Lutcavage et al. 1997, Mrosovsky 1981, Shoop and Kenney 1992). NMFS (2001) notes that poaching of eggs and animals still occurs. In the U.S. Virgin Islands, four of five strandings in St. Croix were the result of poaching (Boulon 2000).

Of the Atlantic turtle species, leatherback turtles seem to be the most susceptible to entanglement in fishing gear with lines, such as lobster gear lines and longline gear rather than swallowing hooks. They are also just as susceptible to trawl capture as the other species. 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. It has been reported that 358 leatherbacks were incidentally caught by permitted activities, 2-45 observed takes occurred, an estimated 918 takes have occurred in the Atlantic pelagic longline fishery (NMFS 2001).

Leatherbacks may become entangled in longline gear (NMFS 2001, Part III, Chapter 7), buoy lines (Fletcher 2001), lobster pot lines (Prescott 1988), and trawl fisheries (Marcano and Alio 2000). During the period 1977-1987, 89% of the 57 stranded adult leatherbacks were the result of entanglement (Prescott 1988), and during the period 1990-1996, 58% of the 59 stranded adult leatherbacks showed signs of entanglement. Leatherback sea turtles also are vulnerable to capture in gillnets (Goff et al. 1994, Anon. 1996, Castroviejo et al. 1994, Chevalier et al. 1999, Lagueux 1998, Eckert and Lien 1999).

According to observer records, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992-1999, of which 88 were discarded dead (NMFS 2001). However, the U.S. fleet accounts for a small portion (5%-8%) of the hooks fished in the Atlantic Ocean compared to other nations, including Taipei, Brazil, Trinidad, Morocco, Cyprus, Venezuela, Korea, Mexico, Cuba, U.K., Bermuda, People's Republic of China, Grenada, Canada, Belize, France, and Ireland (Carocci and Majkowski 1998). Reports of incidental takes of turtles are incomplete for many of these nations (see NMFS 2001, Part II, Chapter 5, p. 162 for a complete description of take records). Adding up the under-represented observed takes per country per year of 23 actively fishing countries would likely result in estimates of thousands of sea turtles taken annually over different life stages.

C. Green sea turtle

a. *Species/critical habitat description*

Federal listing of the green sea turtle occurred on July 28, 1978 (43 FR 32808), with all populations listed as threatened except for the breeding populations of Florida and Pacific coast of Mexico, which are endangered. The complete nesting range of the green turtle within the NOAA Fisheries, Southeast Region includes sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina and at the U.S. Virgin Islands (U.S.V.I.) and Puerto Rico (NMFS and USFWS 1991a). Principal U.S. nesting areas for green turtles are in eastern Florida, predominantly Brevard through Broward counties (Ehrhart and Witherington 1992). Regular green turtle nesting also occurs on St Croix, U.S.V.I., and on Vieques, Culebra, Mona, and the main island of Puerto Rico (Mackay and Rebholz 1996).

Critical habitat for the green sea turtle has been designated for the waters surrounding Isla Culebra, Puerto Rico and its associated keys.

b. *Life history*

Green sea turtle mating occurs in the waters off the nesting beaches. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12-14 day intervals. Mean clutch size is highly variable among populations, but averages 110-115. Females usually have 2-4 or more years between breeding seasons, while males may mate every year (Balazs 1983). After hatching, green sea turtles go through a post-hatchling pelagic stage where they are associated with drift lines of algae and other debris.

Green turtle foraging areas in the southeast United States include any neritic waters having macroalgae or sea grasses near mainland coastlines, islands, reefs, or shelves, and any open-ocean surface waters, especially where advection from wind and currents concentrates pelagic organisms (Hirth 1997, NMFS and USFWS 1991a). Principal benthic foraging areas in the region include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984, Hildebrand 1982, Shaver 1994a, 1994b), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957, Carr 1984), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon System, Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward counties (Wershoven and Wershoven 1992, Guseman and Ehrhart 1992). Adults of both sexes are presumed to migrate between nesting and foraging habitats along corridors adjacent to coastlines and reefs. Age at sexual maturity is estimated to be between 20 to 50 years (Balazs 1982, Frazer and Ehrhart 1985).

Green sea turtles are primarily herbivorous, feeding on algae and sea grasses, but also occasionally consume jellyfish and sponges. The post-hatchling, pelagic-stage individuals are assumed to be omnivorous, but little data are available.

c. *Population dynamics*

The vast majority of green turtle nesting within the southeast United States occurs in Florida. In Florida from 1989-1999, green turtle abundance from nest counts ranged between 109-1,389 nesting females per year (Meylan et al. 1995 and Florida Marine Research Institute Statewide Nesting 2001 Database, unpublished data; estimates assume 4 nests per female per year, Johnson and Ehrhart 1994). High biennial variation and a predominant 2-year remigration interval (Witherington and Ehrhart 1989, Johnson and Ehrhart 1994) warrant combining even and odd years into 2-year cohorts. This gives an estimate of total nesting females that ranged between 705-1,509 during the period 1990-1999. It is important to note that because methodological limitations make the clutch frequency number (4 nests/female/year) an underestimate (by as great as 50%), a more conservative estimate is 470-1,509 nesting females in Florida between 1990 and 1999. In Florida during the period 1989-1999, numbers of green turtle nests by year show no trend. However, odd-even year cohorts of nests do show a significant increase during the period 1990-1999 (Florida Marine Research Institute, Index Nesting Beach Survey Database).

It is unclear how greatly green turtle nesting in the whole of Florida has been reduced from historical levels, although one account indicates that nesting in Florida's Dry Tortugas may now be only a small fraction of what it once was (Audubon 1926, Dodd 1981). Total nest counts and trends at index beach sites during the past decade suggest that green turtles that nest within the southeast United States are recovering and have only recently reached a level of approximately 1,000 nesting females. There are no reliable estimates of the number of green turtles inhabiting foraging areas within the southeast United States, and it is likely that green turtles foraging in the region come from multiple genetic stocks. These trends are also uncertain because of a lack of data. However, there is one sampling area in the region with a large time series of constant turtle-capture effort that may represent trends for a limited area within the region. This sampling area is at an intake canal for a power plant on the Atlantic coast of Florida where 2,578 green turtles have been captured during the period 1977-1999 (Florida Power and Light 2000a). At the power plant, the annual number of immature green turtle captures (minimum straight-line carapace length < 85 cm) has increased significantly during the 23-year period.

Status of immature green turtles foraging in the southeast United States might also be assessed from trends at nesting beaches where many of the turtles originated, principally, Florida, Yucatán, and Tortuguero. Trends at Florida beaches are presented above. Trends in nesting at Yucatán beaches cannot be assessed because of irregularity in beach survey methods over time. Trends at Tortuguero (20,000-50,000 nests/year) show a significant increase in nesting during the period 1971-1996 (Bjorndal et al. 1999).

d. *Status and distribution*

The principal cause of past declines and extirpations of green turtle assemblages has been the over-exploitation of green turtles for food and other products. Adult green turtles and immatures are still exploited heavily on foraging grounds off Nicaragua and to a lesser extent off Colombia, Mexico, Panama, Venezuela, and the Tortuguero nesting beach (Carr et al. 1978, Nietschmann 1982, Bass et al. 1998, Lagueux 1998).

Significant threats on green turtle nesting beaches in the region include beach armoring, erosion control, artificial lighting, and disturbance. Armoring of beaches (seawalls, revetments, rip-rap, sandbags, sand fences) in Florida, meant to protect developed property, is increasing and has been shown to discourage nesting even when armoring structures do not completely block access to nesting habitat (Mosier 1998). Hatchling sea turtles on land and in the water that are attracted to artificial light sources may suffer increased predation proportional to the increased time spent on the beach and in the predator-rich nearshore zone (Witherington and Martin 2000).

Green turtles depend on shallow foraging grounds with sufficient benthic vegetation. Direct destruction of foraging areas due to dredging, boat anchorage, deposition of spoil, and siltation (Coston-Clements and Hoss 1983, Williams 1988) may have considerable effects on the distribution of foraging green turtles. Eutrophication, heavy metals, radioactive elements, and hydrocarbons all may reduce the extent, quality, and productivity of foraging grounds (Frazier 1980).

Pollution also threatens the pelagic habitat of juvenile green turtles. Older juvenile green turtles have also been found dead after ingesting seaborne plastics (Balazs 1985). A major threat from manmade debris is the entanglement of turtles in discarded monofilament fishing line and abandoned netting (Balazs 1985).

The occurrence of green turtle fibropapillomatosis disease was originally reported in the 1930s, when it was thought to be rare (Smith and Coates 1938). Presently, this disease is cosmopolitan and has been found to affect large numbers of animals in some areas, including Hawaii and Florida (Herbst 1994, Jacobson 1990, Jacobson et al. 1991). The tumors are commonly found in the eyes, occluding sight, the turtles are often discovered entangled in debris, and are frequently infected secondarily.

Natural disturbances such as hurricanes can cause significant destruction of nests and topography of nesting beaches (Pritchard 1980, Ross and Barwani 1982, Witherington 1986). Predation on sea turtles by animals other than humans occurs principally during the egg and hatchling stage of development (Stancyk 1982). Mortality due to predation of early stages appears to be relatively high naturally, and the reproductive strategy of the animal is structured to compensate for this loss (Bjorndal 1980).

Green turtles are often captured and drowned in nets set to catch fishes. Gillnets, trawl nets, pound nets (Crouse 1982, Hillestad et al. 1982, National Research Council 1990) and abandoned nets of many types (Balazs 1985, Ehrhart et al. 1990) are known to catch and kill sea turtles. Green turtles also are taken by hook and line fishing. Collisions with power boats and encounters with suction dredges have killed green turtles along the U.S. coast and may be common elsewhere where boating and dredging activities are frequent (Florida Marine Research Institute, Sea Turtle Stranding and Salvage Network Database).

D. Hawksbill sea turtle

a. *Species/critical habitat description*

The hawksbill turtle was listed as endangered on June 2, 1970, and is considered Critically Endangered by the International Union for the Conservation of Nature (IUCN) based on global population declines of over 80% during the last three generations (105 years) (Meylan and Donnelly 1999). In the western Atlantic, the largest hawksbill nesting population occurs in the Yucatán Peninsula of Mexico (Garduño-Andrade et al. 1999) with other important but significantly smaller nesting aggregations found in Puerto Rico, the U.S. Virgin Islands, Antigua, Barbados, Costa Rica, Cuba, and Jamaica (Meylan 1999a). The species occurs in all ocean basins although it is relatively rare in the eastern Atlantic and eastern Pacific, and absent from the Mediterranean Sea. Hawksbills have been observed on the coral reefs south of Florida, but are also found in other habitats including inlets, bays, and coastal lagoons. A surprisingly large number of small hawksbills have also been encountered in Texas. The diet is highly specialized and consists primarily of sponges (Meylan 1988), although other food items have been documented to be important in some areas of the Caribbean (van Dam and Diez 1997, Mayor et al. 1998, Leon and Diez 2000). The lack of sponge-covered reefs and the cold winters in the northern Gulf likely prevent hawksbills from establishing a strong population in this area.

Critical habitat for the hawksbill turtle includes Mona and Monito Islands, Puerto Rico, and the waters surrounding these islands, out to 3 nautical miles. Mona Island receives protection as a Natural Reserve under the administration of the Puerto Rico Department of Natural Resources and Environment. The coral reef habitat and cliffs around Mona Island and nearby Monito Island are an important feeding ground for all sizes of post-pelagic hawksbills. Genetic research has shown that this feeding population is not primarily composed of hawksbills that nest on Mona, but instead includes animals from at least six different nesting aggregations, particularly the U.S. Virgin Islands and the Yucatán Peninsula (Mexico) (Bowen et al. 1996, Bass 1999). Genetic data indicate that some hawksbills hatched at Mona utilize feeding grounds in waters of other countries, including Cuba and Mexico. Hawksbills in Mona waters appear to have limited home ranges and may be resident for several years (van Dam and Diez 1998).

b. *Life history*

The life history of hawksbills consists of a pelagic stage that lasts from the time they leave the nesting beach as hatchlings until they are approximately 22-25 cm in straight carapace length (Meylan 1988), followed by residency in developmental habitats (foraging areas where immature individuals reside and grow) in coastal waters. Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs, although other hard-bottom communities and occasionally mangrove-fringed bays may be occupied. Hawksbills show fidelity to their foraging areas over periods of time as great as several years (van Dam and Diez 1998).

Hawksbills may undertake developmental migrations (migrations as immature turtles) and reproductive migrations that involve travel over hundreds or thousands of kilometers (Meylan 1999b). Reproductive females undertake periodic (usually non-annual) migrations to their natal beach to nest. Movements of reproductive males are less well known, but are presumed to involve migrations to the nesting beach or to courtship stations along the migratory corridor. Females nest an average of 3-5 times per season. Clutch size is up to 250 eggs (Hirth 1980). Reproductive females may exhibit a high degree of nesting fidelity to their natal beaches.

c. *Population dynamics*

Mona Island (Puerto Rico, 18º 05' N, 67º57 W) has 7.2 km of sandy beach that host the largest known hawksbill nesting aggregation in the Caribbean Basin, with over 500 nests recorded annually from 1998–2000 (Diez and van Dam in press, Diez 2000). The island has been surveyed for marine turtle nesting activity for more than 20 years; surveys since 1994 show an increasing trend. Increases are attributed to nest protection efforts in Mona and fishing reduction in the Caribbean. The U.S. Virgin Islands are also an important hawksbill nesting location. Buck Island Reef National Monument off St. Croix has been surveyed for nesting activity since 1987, where between 1987 and 1999, between 73 and 135 hawksbill nests had been recorded annually (Meylan and Donnelly 1999). This population, although small, is considered to be stable. Nesting beaches on Buck Island experience large-scale beach erosion and accretion as a result of hurricanes, and nests may be lost to erosion or burial. Predation of nests by mongoose is a serious problem and requires intensive trapping. Hawksbill nesting also occurs elsewhere on St. Croix, St. John and St. Thomas. Juvenile and adult hawksbills are common in the waters of the U.S. Virgin Islands. Immature hawksbills tagged at St. Thomas during long-term, in-water studies appeared to be resident for extended periods (Boulon 1994). Tag returns were recorded from St. Lucia, the British Virgin Islands, Puerto Rico, St. Martin, and the Dominican Republic (Boulon 1989, Meylan 1999b).

The Atlantic coast of Florida is the only area in the United States where hawksbills nest on a regular basis, but four is the maximum number of nests documented in any year during 1979-2000 (Florida Statewide Nesting Beach Survey database). Nesting occurs as far north as Volusia County, Florida, and south to the Florida Keys, including Boca Grande and the Marquesas. Soldier Key in Miami-Dade County has had more nests than any other location, and it is one of the few places in Florida mentioned in the historical literature as having been a nesting site for hawksbills (DeSola 1935). There is also a report of a nest in the late 1970s at nearby Cape Florida. It is likely that some hawksbill nesting in Florida goes undocumented due to the great similarity of the tracks of hawksbills and loggerheads. All documented records of hawksbill nesting from 1979 to 2000 took place between May and December except for one April nest in the Marquesas (Florida Statewide Nesting Survey database).

Twenty-four hawksbills were removed from the intake canal at the Florida Power and Light St. Lucie Plant in Juno Beach (St. Lucie County) during 1978-2000 (Florida Power and Light 2000a). The animals ranged in size from 34.0–83.4 cm straight carapace length and were captured in most months of the year. Immature hawksbills have been recorded on rare occasions in both the Indian River Lagoon (Indian River County) and Mosquito Lagoon (Brevard County). A 24.8 cm hawksbill was captured on the worm reefs 200 m off the coast in Indian River County.

Records of hawksbills north of Florida are relatively rare, although several occurrences have been documented (Parker 1996, Ruckdeschel et al. 2000, S. Epperly 1996., Schwartz 1976, Keinath and Musick 1991, Sea Turtle Stranding and Salvage Network database).

d. *Status and distribution*

Hawksbills are threatened by all the factors that threaten other marine turtles, including exploitation for meat, eggs, and the curio trade, loss or degradation of nesting and foraging habitats, increased human presence, nest depredation, oil pollution, incidental capture in fishing gear, ingestion of and entanglement in marine debris, and boat collisions (Lutcavage et al. 1997, Meylan and Ehrenfeld 2000). The primary cause of hawksbill decline has been attributed to centuries of exploitation for tortoiseshell, the beautifully patterned scales that cover the turtle's shell (Parsons 1972). International trade in tortoiseshell is now prohibited among all signatories of the Convention on International Trade in Endangered Species, but some illegal trade continues, as does trade between non-signatories.

E. Kemp's Ridley sea turtle

a. *Species/critical habitat description*

The Kemp’s ridley was listed as endangered on December 2, 1970. Internationally, the Kemp’s ridley is considered the most endangered sea turtle. Kemp’s ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico, Tamaulipas State. The species occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean. Occasional individuals reach European waters. Adults of this species are usually confined to the Gulf of Mexico, although adult-sized individuals sometimes are found on the Eastern Seaboard of the United States.

There is no designated critical habitat for the Kemp’s ridley sea turtle.

b. *Life history*

Remigration of females to the nesting beach varies from annually to every 4 years, with a mean of 2 years (TEWG 1998). Nesting occurs from April into July and is essentially limited to the beaches of the western Gulf of Mexico, near Rancho Nuevo in southern Tamaulipas, Mexico.

The mean clutch size for Kemp's ridleys is 100 eggs/nest, with an average of 2.5 nests/female/season.

Juvenile/subadult Kemp's ridleys have been found along the Eastern Seaboard of the United States and in the Gulf of Mexico. Atlantic juveniles/subadults travel northward with vernal warming to feed in the productive, coastal waters of Georgia through New England, returning southward with the onset of winter to escape the cold (Lutcavage and Musick 1985, Henwood and Ogren 1987, Ogren 1989). In the Gulf, juvenile/subadult ridleys occupy shallow, coastal regions. Ogren (1989) suggested that in the northern Gulf they move offshore to deeper, warmer water during winter. Studies suggest 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 1995). Little is known of the movements of the post-hatching, planktonic stage within the Gulf. Studies have shown the post-hatchling pelagic stage varies from 1-4 or more years, and the benthic immature stage lasts 7-9 years (Schmid and Witzell 1997). The TEWG (1998) estimates age at maturity to range from 7-15 years.

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). Pelagic stage, neonatal Kemp's ridleys presumably feed on the available sargassum and associated infauna or other epipelagic species found in the Gulf of Mexico.

c. *Population dynamics*

Kemp's ridleys have a very restricted distribution relative to other sea turtle species. Data suggests that adult Kemp's ridley turtles are 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, although adult-sized individuals sometimes are found on the Eastern Seaboard of the United States. The post-pelagic stages are commonly found dwelling over crab-rich sandy or muddy bottoms. Juveniles frequent bays, coastal lagoons, and river mouths.

Of the seven extant species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Most of the population of adult females nest on the Rancho Nuevo beaches (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 the population is now increasing. Nesting at Tamaulipas and Veracruz increased from a low of 702 nests in 1985, to 1,930 nests in 1995, to 6,277 nests in 2000. The population model used by the TEWG (1998) 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 used in their model are correct.

d. *Status and distribution*

The largest contributor to the decline of the ridley in the past was commercial and local exploitation, especially poaching of nests at the Rancho Nuevo site, as well as the Gulf of Mexico trawl fisheries. The advent of the Turtle Excluder Device (TED) regulations for trawlers and protections for the nesting beaches have allowed the species to begin to rebound. Many threats to the future of the species remain, including interactions with fishery gear, marine pollution, foraging habitat destruction, illegal poaching of nests, and the potential threats to nesting beaches from such sources as global climate change, development, and tourism pressures.

F. Loggerhead sea turtle

a. *Species/Critical habitat description*

The loggerhead sea turtle was listed as a threatened species on July 28, 1978 (43 FR 32800). This species inhabits the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans, and within the continental U.S. it nests from Louisiana to Virginia. The major nesting areas include coastal islands of Georgia, South Carolina, and North Carolina, and the Atlantic and Gulf coasts of Florida, with the bulk of the nesting occurring on the Atlantic coast of Florida. Developmental habitat for small juveniles are the pelagic waters of the North Atlantic and the Mediterranean Sea.

There is no critical habitat designated for the loggerhead sea turtle.

b. *Life history*

Loggerheads mate in late March through early June in the Southeastern U.S. Females emerge from the surf, excavate a nest cavity in the sand, and deposit a mean clutch size of 100-126 eggs. Individual females nest multiple times during a nesting season, with a mean of 4.1 nests/nesting individual (Murphy and Hopkins 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2-3 years, but can vary from 1-7 years (Dodd 1988). 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 or more, but there is some variation in habitat use by individuals at all life stages. Turtles in this early life history stage are called pelagic immatures. Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm straight-line carapace length they begin to recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico.

Benthic immature loggerheads, the life stage following the pelagic immature stage, have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico. Large benthic immature loggerheads (70-91 cm) represent a larger proportion of the strandings and in-water captures along the south and western coasts of Florida as compared with the rest of the coast. Benthic immature loggerheads foraging in northeastern U.S. waters are known to migrate southward in the fall as water temperatures cool (Epperly et al. 1995b, Keinath 1993, Morreale and Standora 1999, Shoop and Kenney 1992), and migrate northward in spring. Past literature gave an estimated age at maturity of 21-35 years (Frazer and Ehrhart 1985, Frazer et al. 1994) and the benthic immature stage as lasting at least 10-25 years. However, in 2001 NMFS SEFSC reviewed the literature and constructed growth curves from new data, estimating ages of maturity ranging from 20-38 years and benthic immature stage lengths from 14- 32 years.

Juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988). Sub-adult and adult loggerheads are primarily coastal and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

c. *Population dynamics*

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 do not nest in tropical areas of Central America, northern South America, and the Old World (Magnuson et al. 1990).

In the western Atlantic, most loggerhead sea turtles nest in the geographic area ranging from North Carolina to the Florida panhandle. There are five western Atlantic subpopulations, divided geographically as follows: (1) a northern nesting subpopulation, occurring from North Carolina to northeast Florida at about 29° N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez 1990) (approximately 1,000 nests in 1998) (TEWG 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (approximately 200 nests per year) (NMFS 2001). Natal homing of females to the nesting beach provides the barrier between these subpopulations, preventing recolonization with turtles from other nesting beaches.

Based on the available data, it is difficult to estimate the size of the loggerhead sea turtle population in the United States 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 United States from 1989-1998 represent the best data set available to index the population size of loggerhead sea turtles. However, an important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females but may not reflect overall population growth rates. Given this caveat, between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,014 to 92,182 annually, with a mean of 73,751. On average, 90.7% of these nests were from the south Florida subpopulation, 8.5% were from the northern subpopulation, and 0.8% were from the Florida Panhandle nest sites. There is limited nesting throughout the Gulf of Mexico west of Florida, but it is not known to which subpopulation these nesting females belong.

The number of nests in the northern subpopulation from 1989 to 1998 was 4,370 to 7,887, with a 10-year mean of 6,247 nests. With each female producing an average of 4.1 nests in a nesting season, the average number of nesting females per year in the northern subpopulation was 1,524. The total nesting and non-nesting adult female population is estimated as 3,810 adult females in the northern subpopulation (TEWG 1998, 2000). The northern subpopulation, based on number of nests, has been classified as stable or declining (TEWG 2000). Another consideration adding to the vulnerability of the northern subpopulation is that NOAA Fisheries scientists estimate that the northern subpopulation produces 65% males, while the south Florida subpopulation is estimated to produce 80% females (NMFS 2001).

The southeastern U.S. nesting aggregation is of great importance on a global scale and is second in size only to the nesting aggregation on islands in the Arabian Sea off Oman (Ross 1979, Ehrhart 1989, NMFS and USFWS 1991b). The global importance of the southeast U.S. nesting aggregation of loggerheads is especially important because the status of the Oman colony has not been evaluated recently, but it is located in an area of the world where it is highly vulnerable to disruptive events such as political upheavals, wars, catastrophic oil spills, and lack of strong protections (Meylan et al. 1995).

d. *Status and distribution*

Ongoing threats to the western Atlantic loggerhead populations include incidental takes from dredging, commercial trawling, longline fisheries, and gillnet fisheries; loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and disease.

Loggerhead sea turtles face numerous threats from natural causes. The five known subpopulations of loggerhead sea turtles in the northwest Atlantic that nest in the southeastern United States are subject to fluctuations in the number of young produced annually because of natural phenomena, such as hurricanes, as well as human-related activities. There is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November) and the 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. 1994). On Fisher Island near Miami, Florida, 69% of the eggs did not hatch after Hurricane Andrew, likely due to an inhibition of gas exchange between the eggshell and the submerged nest environment resulting from the storm surge. Nests from the northern subpopulation were destroyed by hurricanes that 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.

Sea turtle summary

Historically, intense harvest of eggs, loss of suitable nesting beaches and fishery related mortality have led to the rapid decline of sea turtle populations. NOAA Fisheries believes that all sea turtle species are highly migratory throughout the action area. Individual animals will make migrations into nearshore waters as well as other areas of the Gulf, Atlantic, and the Caribbean Sea. Therefore, the range-wide status of the five species of sea turtles described in Section III above most accurately reflects each species' status within the action area.

Anthropogenic sources continue to pose the greatest threat to sea turtles since their listing under the ESA. Ingestion of ocean debris and entanglement in nondegradable debris such as trash and discarded fishing gear continue to pose threats and lead to turtle deaths each year. Young turtles in their pelagic phase are dependent on ocean driftlines for food. Contact with oil and the ingestion of plastics and tar are known to kill young sea turtles (Carr 1987). Young turtles feeding in driftlines have been documented to ingest plastics, Styrofoam, balloons and tar, and mortalities have been attributed to ingestion of plastics and tar (Carr 1987, Witham 1978).

Sea turtles are adversely impacted both domestically and internationally by many factors including: trawl fisheries, gillnet fisheries, hook and line fisheries, pelagic longline fisheries, pound nets, fish traps, lobster pots, whelk pots, long haul seines and channel nets. Presently, NOAA Fisheries continues to modify TED design to reduce sea turtle mortality in trawl fisheries. Non-fishery impacts such as power plants, marine pollution, ingestion of marine debris, and direct harvest of eggs and adults in foreign countries, oil and gas exploration, development, and transportation, underwater explosions, dredging, offshore artificial lighting, marina and dock construction and operation; boat collisions, and poaching contribute to declines in sea turtle populations. On nesting beaches sea turtles are threatened with beach erosion; armoring; renourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment and furniture; exotic dune and beach vegetation; predation by species such as fire ants, raccoons (*Procyon lotor*), armadillos (Dasypus novemcinctus), opossums (*Didelphus virginiana*); and poaching.

Sea turtles entangled in fishing gear generally have a reduced ability to feed, dive, surface to breathe or perform any other behavior essential to survival (Balazs 1985). They may be more susceptible to boat strikes if forced to remain at the surface, and entangling lines can constrict blood flow resulting in necrosis. Greater numbers of sea turtles are killed in collisions with boats or are injured due to increased numbers of high-speed, high-powered boats. Coastal development and artificial lighting continue to threaten nesting beaches worldwide. Moreover, the effects of noise on sea turtles have been documented both in the laboratory and in field experiments.

G. Gulf sturgeon

a. *Species/critical habitat description*

NOAA Fisheries and the U.S. Fish and Wildlife Service listed the Gulf sturgeon, also known as the Gulf of Mexico sturgeon, as a threatened species on September 30, 1999 (56 CFR 49653). The Gulf sturgeon is a subspecies of the Atlantic sturgeon *(A. o. oxyrhynchus*). The Gulf sturgeon has a sub-cylindrical body embedded with bony plates (scutes), a greatly extended snout, ventral mouth with four anterior chin barbels, and a heterocercal tail (Valdykov 1955, Valdykov and Greeley 1963). Adults range from 1.8 to 2.4 m in length, with females attaining a greater length and mass than males.

Critical habitat was proposed June 6, 2002, in the *Federal Register* (67 FR 39105). The following are the Gulf of Mexico rivers and tributaries presently proposed as critical habitat for the Gulf sturgeon:

Pearl and Bogue Chitto rivers in Louisiana and Mississippi; Pascagoula, Leaf, Bowie (also referred to as Bouie), Big Black Creek, and Chickasawhay rivers in Mississippi; Escambia, Conecuh, and Sepulga rivers in Alabama and Florida; Yellow, Blackwater, and Shoal rivers in Alabama and Florida; Choctawhatchee and Pea rivers in Florida and Alabama; Apalachicola and Brothers rivers in Florida; and Suwannee and Withlacoochee rivers in Florida. The proposal also includes portions of the following estuarine and marine areas: Lake Pontchartrain (east of the Lake Pontchartrain Causeway), Lake Catherine, Little Lake, The Rigolets, Lake Borgne, Pascagoula Bay, and Mississippi Sound systems in Louisiana and Mississippi, and sections of the adjacent state waters within the Gulf of Mexico; Pensacola Bay system in Florida; Santa Rosa Sound in Florida; nearshore Gulf of Mexico in Florida; Choctawhatchee Bay system in Florida; Apalachicola Bay system in Florida; and Suwannee Sound and adjacent state waters within the Gulf of Mexico in Florida.

The proposed critical habitat for Gulf sturgeon is located in the action areas associated with the Central and Eastern Planning Areas of the GOM.

b. *Life history*

The Gulf sturgeon is anadromous, migrating into freshwater 8 to 9 months of the year. Adult fish tend to congregate in deeper waters of rivers with moderate currents and sand and rocky bottoms. Seagrass beds with mud and sand substrates appear to be important marine habitats (Mason and Clugston 1993). Individuals are long-lived, some reaching at least 42 years in age (Huff 1975). Age at sexual maturity for females range from 8 to 17 years, and for males from 7 to 21 years (Huff 1975).

Gulf sturgeon eggs are demersal (sink to the bottom) and adhesive (Vladykov 1963). Spawning occurs in freshwater over relatively hard and sediment-free substrates such as limestone outcrops and cut limestone banks, exposed limestone bedrock or other exposed rock, large gravel or cobble beds, soapstone or hard clay (Fox and Hightower 1998, Marchent and Shutters 1996, Sulak and Clugston 1999). Although fry and juveniles feed in the riverine environment, sub-adults and adults do not (Mason and Clugston 1993, Sulak and Clugston 1999). A full discussion of the life history of this subspecies may be found in the September 30, 1991, final rule listing the Gulf sturgeon as a threatened species (56 FR 49653), and the Recovery/ Management Plan approved by NOAA Fisheries and the U.S. Fish and Wildlife Service in September 1995.

c. *Population dynamics*

Gulf sturgeon occur in most major tributaries of the northeastern Gulf of Mexico, from the Mississippi River east to Florida's Suwannee River, and in the central and eastern Gulf waters as far south as Charlotte Harbor (Wooley and Crateau, 1985). In Florida, gulf sturgeon are still found in the Escambia, Yellow, Blackwater, Choctawhatchee, Apalachicola, Ochlockonee, and Suwannee rivers (Reynolds 1993). While little is known about the abundance of Gulf sturgeon throughout most of its range, population estimates have been calculated for the Apalachicola, Choctawhatchee, and Suwannee rivers. The FWS calculated an average (from 1984-1993) 115 individuals (> 45 cm TL) over-summering in the Apalachicola River below Jim Woodruff Lock and Dam (USFWS 1995). Preliminary estimates of the size of the Gulf sturgeon subpopulation in the Choctawhatchee River system are 2,000 to 3,000 fish over 61 cm TL. The Suwannee River Gulf sturgeon population (i.e., fish > 60 cm TL and older than age 2) has recently been calculated at approximately 7,650 individuals (Sulak and Clugston 1999). Although the size of the Suwannee River sturgeon population is considered stable, the population structure is highly dynamic as indicated by length frequency histograms (Sulak and Clugston 1999). Strong and weak year classes coupled with the regular removal of larger fish limits the growth of the Suwannee River population but stabilizes the average population size (Sulak and Clugston 1999).

d. *Status and distribution*

Historically, the Gulf sturgeon occurred from the Mississippi River to Tampa Bay. Its present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi east to the Suwannee River in Florida. Sporadic occurrences have been recorded as far west as the Rio Grande River between Texas and Mexico, and as far east and south as Florida Bay (Wooley and Crateau 1985, Reynolds 1993).

In the late 19th century and early 20th century, the Gulf sturgeon supported an important commercial fishery, providing eggs for caviar, flesh for smoked fish, and swim bladders for isinglass, a gelatin used in food products and glues (Carr 1983). Dams and sill construction after 1950 restricted access to historic spawning areas (Wooley and Crateau 1985), and overfishing resulted in the decline of the Gulf sturgeon throughout most of the 20th century. The decline was exacerbated by habitat loss associated with the construction of water control structures, such as dams and sills, mostly after 1950. In several rivers throughout its range, dams have severely restricted sturgeon access to historic migration routes and spawning areas. Dredging and other navigation maintenance, possibly including lowering of river elevations and elimination of deep holes and altered rock substrates, may have adversely affected Gulf sturgeon habitats (Wooley and Crateau 1985). Contaminants, both agricultural and industrial, may also be a factor in their decline. Organochlorines have been documented to cause reproductive failure in the Gulf sturgeon, reduced survival of young, or physiological alterations in other fish (White et al. 1983). In addition, Gulf sturgeon appear to be natal spawners with little, if any, spawning from other riverine populations.

Today, poor water quality due to pesticide runoff, heavy metals, and industrial contamination may be affecting sturgeon populations. Habitat loss continues to pose major threats to the recovery of the species.

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, its 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 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 are primarily fisheries and recovery activities associated with reducing fisheries impacts and minimizing adverse affects to sperm whales from seismic survey activities. Other environmental impacts include effects of discharges, dredging, military activities, and industrial cooling water intake.

A. Status of the species within the action area

a. *Sperm whale*

Sperm whale pods have been observed throughout the Gulf of Mexico from the upper continental slope near the 100 m isobath to the seaward extent of the U.S. EEZ and beyond, from sightings data collected from NOAA cruises from 1991 to 2000 (Roden and Mullin 2000, Baumgartner et al. 2001, Burks et al. 2001). Based on year-round occurrence of strandings, opportunistic sightings, and whaling catches, sperm whales in the Gulf of Mexico may constitute a distinct stock (Schmidley 1981). The Gulf of Mexico stock is comprised of mostly females and calves, although a few bulls have been sighted in the GOM. The presence of cow/calf pairs indicates that this is a biologically important nursing area for sperm whales. Based on seasonal aerial surveys, sperm whales are present in the northern GOM in all seasons, but sightings in the northern GOM are more common during the summer months (Mullin et al. 1991, Davis et al. 2000). Based on recent survey efforts, the boundaries of these areas of concentration in the Northern GOM appear to be approximately 86.5° W to 90.0° W, north of 27.0° N (Mullin 2002). Another area of concentrated sperm whale sightings is located off Southern Florida in an area approximately 86.5° W to 85.5° W, 24.0° N to 26.0° N (Mullin 2002).

The Gulf of Mexico sperm whale abundance has recently been estimated at 1,213 whales (CV = 0.35) (Mullin and Fulling, in prep.), calculated from an average of estimates from 1996-2001 surveys. The minimum population estimate (N_{min}) is 911 sperm whales. N_{min} is a component of the Potential Biological Removal level (PBR) calculation as required under the MMPA. The estimate of N_{min} is calculated as the lower limit of the two-tailed 60% confidence interval of the log-normal distributed abundance estimate (or the equivalent of the 20th percentile of the log-normal distributed abundance estimate (Anon 1994). The estimated PBR for the Gulf sperm whale stock is 1.8 sperm whales. PBR is an estimate of the number of animals which can be removed (in addition to natural mortality) annually from a marine mammal population or stock while maintaining that stock at the Optimum Sustainable Population level (OSP) or without causing the population or stock to slow its recovery to OSP by more than 10%. Sperm whale stock size is considered to be low relative to OSP; there is no trend in population size discernable from estimates of abundance over time (Waring et al. 2000). This population estimate is subject to final review and release in NOAA Fisheries' next Stock Assessment Report.

b. *Sea Turtles*

The five species of sea turtles that occur in the action area are all highly migratory. NOAA Fisheries believes that no individual members of any of the species are likely to be year-round residents of the action area. Individual animals will make migrations into nearshore waters as well as other areas of the North Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea. Therefore, the range-wide status of the five species of sea turtles, given in Section II above, most accurately reflects the species' status within the action area. More detailed descriptions of the species in the action area are given below.

Leatherback sea turtle

The leatherback is the most abundant sea turtle in waters over the northern Gulf of Mexico continental slope (Mullin and Hoggard 2000). Leatherbacks appear to spatially use both continental shelf and slope habitats in the Gulf (Fritts et al. 1983, Collard 1990, Davis and Fargion 1996). Recent surveys suggest that the region from the Mississippi Canyon to DeSoto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Mullin and Hoggard 2000). Temporal variability and abundance suggest that specific areas may be important to this species, either seasonally or for short periods of time. Leatherbacks have been frequently sighted in the GOM during both summer and winter (Mullin and Hoggard 2000).

Green Sea Turtle

The Florida breeding population of the green sea turtle is listed as endangered. Green sea turtles are found throughout the Gulf of Mexico. They occur in small numbers over seagrass beds along the south of Texas and the Florida Gulf coast. Reports of green turtles nesting along the Gulf coast are infrequent.

Hawksbill sea turtle

Long-term trends in hawksbill nesting in Florida are unknown, although there are a few historical reports of nesting in south Florida and the Keys (True 1884, Audubon 1926, DeSola 1935). No nesting trends were evident in Florida from 1979 to 2000; between 0 and 4 nests are recorded annually. The hawksbill has been recorded in all of the Gulf states. Nesting on Gulf beaches is extremely rare and one nest was documented at Padre Island in 1998 (Mays and Shaver 1998). Pelagic-size individuals and small juveniles are not uncommon and are believed to be animals dispersing from nesting beaches in the Yucatán Peninsula of Mexico and farther south in the Caribbean (Amos 1989). The majority of hawksbill sightings are reported from the sea turtle stranding network. Strandings from 1972–1989 were concentrated at Port Aransas, Mustang Island, and near the headquarters of the Padre Island National Seashore, Tx (Amos 1989). Live hawksbills are sometimes seen along the jetties at Aransas Pass Inlet. Other live sightings include a 24.7-cm juvenile captured in a net at Mansfield Channel in May 1991 (Shaver 1994b), and periodic sightings of immature animals in the Flower Gardens National Marine Sanctuary

Kemp's Ridley

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 1995).

Loggerhead sea turtle

Loggerhead nesting along the Gulf coast occurs primarily along the Florida Panhandle, although some nesting has been reported from Texas through Alabama as well (NMFS and USFWS 1991b). Loggerhead turtles have been primarily sighted in waters over the continental shelf, although many surface sightings of this species have also been made over the outer slope, beyond the 1,000 m isobath. Sightings of loggerheads in waters over the continental slope suggest that they may be in transit through these waters to distant foraging sites or while seeking warmer waters during the winter. Although loggerhead are widely distributed during both summer and winter, their abundance in surface waters over the slope was greater during winter than in summer (Mullin and Hoggard 2000).

c. *Gulf sturgeon*

The historic range of the Gulf sturgeon included nine major rivers and several smaller rivers from the Mississippi River, Louisiana, to the Suwannee River, Florida, and the marine waters of the Central and Eastern Gulf of Mexico, south to Tampa Bay (Wooley and Crateau 1985, USFWS 1995). Five genetically-based stocks have been identified by NOAA Fisheries and the USFWS: (1) Lake Pontchartrain and Pearl River, (2) Pascagoula River, (3) Escambia and Yellow rivers, (4) Chactawhatchee River, and (5) Apalachicola, Ochlockonee, and Suwannee rivers. Mitochondrial DNA analyses of individuals from sub-populations indicate that adults return to natal river areas for feeding as well as spawning (Stabile et al. 1996).

Subadult and adult Gulf sturgeon spend cool months (October or November through March or April) in estuarine areas, bays, or in the Gulf of Mexico (Odenkirk 1989, Clugston et al. 1995). Adult Gulf sturgeon likely overwinter in the Gulf of Mexico. Habitats used by Gulf sturgeon in the vicinity of the Mississippi Sound barrier islands tend to have a sand substrate and an average depth of 1.9 to 5.9 m (6.2 to 19.4 ft). Estuary and bay unvegetated “mud” habitats having a preponderance of natural silts and clays supporting Gulf sturgeon prey and the Gulf sturgeon found in these areas are assumed to be utilizing these habitats for foraging.

Sulak and Clugston (1999) describe two hypotheses regarding where adult Gulf sturgeon may overwinter in the Gulf of Mexico to find abundant prey. The first hypothesis is that Gulf sturgeon spread along the coast in nearshore waters in depths less than 10 m (33 ft). The alternative hypothesis is that they migrate far offshore to the broad sedimentary plateau in deep water 40 to 100 m (131 to 328 ft) west of the Florida Middle Grounds. Available data support the first hypothesis. Evaluation of tagging data has identified several nearshore Gulf of Mexico feeding migrations, but no offshore Gulf of Mexico feeding migrations. Telemetry data document Gulf sturgeon from the Pearl River and Pascagoula River subpopulations migrate from their natal bay systems to Mississippi Sound and move along the barrier islands on both the barrier island passes (Ross et al. 2001a, Rogillio et al. in prep.). Gulf sturgeon from the Choctawhatchee River, Yellow River, and Apalachicola River have been documented migrating in the nearshore Gulf of Mexico waters between Pensacola and Apalachicola bay units (Fox et al. in press, Paruka 2002). Telemetry data from the Gulf of Mexico mainly show sturgeon in depths of 6 m (19.8 ft) or less (Ross et al. 2001a, Rogillio et al. in prep., Fox et al. in press).

The release of chemicals and other biological pollutants may destroy or adversely modify biologically important habitat for the Gulf sturgeon. The release of chemical or biological pollutants may alter water quality and sediment quality by affecting the following factors: temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability.

B. Factors affecting species' environments within the action area.

Federal Actions

In recent years, NOAA Fisheries has undertaken several ESA section 7 consultations to address the effects of federally-permitted fisheries and other Federal actions on threatened and endangered species. Each of those consultations sought to develop ways of reducing the probability of adverse effects of the action on listed species. Similarly, recovery actions undertaken under the ESA are addressing the problem of take of whales, sea turtles, and Gulf sturgeon in the fishing and shipping industries and other activities such as Army Corps of Engineers (COE) dredging operations. The following summary of anticipated sources of incidental take listed species in the GOM includes only those Federal actions which have undergone formal section 7 consultation.

Vessel-related Operations and Exercises

Potential adverse effects from federal vessel operations in the action area of this consultation include operations of the U.S. Navy (USN) and the U.S. Coast Guard (USCG), which maintain the largest federal vessel fleets, the Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), and the Army Corps of Engineers (ACOE). NOAA Fisheries has conducted formal consultations with the USCG, the USN (described below) and is currently in early phases of consultation with other federal agencies on their vessel operations (e.g., NOAA research vessels). In addition to operation of ACOE vessels, NOAA Fisheries 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, NOAA Fisheries has and will continue to establish conservation measures for all these agency vessel operations to avoid adverse effects on listed species. At the present time, however, these actions represent potential for some level of interaction. The Opinions for the USCG (September 15, 1995, July 22, 1996, and June 8, 1998) and the USN (May 15, 1997) provide further detail on the scope of vessel operations for these agencies and conservation measures being implemented as standard operating procedures.

Since the USN consultation only covered operations out of Mayport, Florida, potential still remains for USN vessels to adversely affect large whales and sea turtles when they are operating in other areas within the range of these species. Similarly, operations of vessels by other Federal agencies within the action area (NOAA, EPA, ACOE) may adversely 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.

Dredging

The construction and maintenance of Federal navigation channels has also been identified as a source of sea turtle and Gulf sturgeon mortality. Hopper dredges move relatively rapidly (compared to sea turtle swimming speeds) and can entrain and kill these species, presumably as the drag arm of the moving dredge overtakes the slower moving animal. A regional biological opinion (RBO) with the COE has been completed for the southeast Atlantic waters and the Gulf of Mexico. Consultation on a new RBO for the COE's Gulf of Mexico hopper dredging operations has recently been completed as well.

COE and Minerals Management Service (MMS) rig removal activities also adversely affect sea turtles. For the COE activities, an incidental take (by injury or mortality) of 1 documented Kemp's ridley, green, hawksbill, leatherback, or loggerhead turtle is anticipated under a rig removal consultation for the New Orleans District (NMFS 1998). MMS activities are anticipated to result in annual incidental take (by injury or mortality) of 30 sea turtles, including no more than 5 Kemp's ridley, green, hawksbill, or leatherback turtles and no more than 10 loggerhead turtles, due to MMS' OCS oil and gas exploration, development, production, and abandonment activities. NOAA Fisheries recently issued an Opinion on MMS' Lease Sale 184 OCS oil and gas leasing actions in which measures were recommended to reduce the affects of seismic survey activities on sperm whales.

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 the ESA section 7 process. Gillnet, longline, trawl gear, and pot fisheries have all been documented as interacting with sea turtles. 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 NOAA Fisheries has determined are likely to adversely affect threatened and endangered species: American lobster, monkfish, dogfish, southeastern shrimp trawl fishery, northeast multispecies, Atlantic pelagic swordfish/tuna/shark, and summer flounder/scup/black sea bass fisheries.

The environmental baseline for the June 14, 2001, HMS Opinion also considered the impacts from the North Carolina offshore spring monkfish gillnet fishery and the inshore fall southern flounder gillnet fishery, both of which were responsible for large numbers of sea turtle mortalities in 1999 and 2000, especially loggerhead sea turtles. However, during the 2001 season NOAA Fisheries implemented an observer program that observed 100% of the effort in the monkfish fishery, and then in 2002 a rule was enacted creating a seasonal monkfish gillnet closure along the Atlantic coast based upon sea surface temperature data and turtle migration patterns. In 2001 NOAA Fisheries also issued an ESA section 10 permit to the State of North Carolina with mitigative measures for the southern flounder fishery. Subsequently, the sea turtle mortalities in these fisheries were drastically reduced. In 2002 NOAA Fisheries implemented a final rule restricting large-mesh gillnetting for the southern flounder fishery in Pamlico Sound, North Carolina concurrently with a 3-year ESA section 10 permit with mitigative measures. The reduction of turtle mortalities in these fisheries reduces the negative effects these fisheries have on the environmental baseline.

NOAA Fisheries has implemented a reasonable and prudent alternative (RPA) in the HMS fishery which would allow the continuation of the pelagic longline fishery without jeopardizing the continued existence of loggerhead and leatherback sea turtles. The provisions of this RPA include the closure of the Grand Banks region off the northeast United States and gear restrictions that are expected to reduce the bycatch of loggerheads by as much as 76% and leatherbacks by as much as 65%. Further, NOAA Fisheries is implementing a major research project to develop measures aimed at further reducing longline bycatch. The implementation of this RPA reduces the negative effects that the HMS fishery has on the environmental baseline. The conclusions of the June 14, 2001, HMS Opinion and the subsequent implementation of the RPA are hereby incorporated into the environmental baseline section of this Opinion.

The Southeast U.S. Shrimp Fishery is known be a significant source of sea turtle mortality. Shrimp trawlers in the southeastern U.S. are required to use TEDs, which reduce hard shelled sea turtle capture rates by 97%. Even so, NOAA Fisheries 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.

ESA permits

Regulations developed under the ESA allow for the taking of ESA-listed species for the purposes of scientific research. In addition, the ESA allows for the taking of listed species by states through cooperative agreements developed under section 6 of the ESA. Prior to issuance of these authorizations for taking, the proposal must be reviewed for compliance with section 7 of the ESA.

Sea turtles

Sea turtles are the focus of research activities authorized by permit or through a section 6 agreement under the ESA. There are currently 14 active scientific research permits directed toward sea turtles that may be found in the action area of this Opinion. Authorized activities range from photographing, weighing and tagging sea turtles incidentally taken in fisheries to blood sampling, tissue sampling (biopsy) and performing laparoscopy on intentionally captured turtles. The number of authorized takes varies widely depending on the research and species involved but may involve the taking of hundreds of turtles annually. Before any permit is issued, the proposal must be reviewed under the permit regulations (i.e., must show a benefit to the species). In addition, since issuance of the permit is a federal activity, these must also be reviewed for compliance with section 7(a)(2) to ensure that the action (issuance of the permit) does not result in jeopardy to the species. However, despite these safeguards, there is growing concern that research activities may result in cumulative effects that negatively affect sea turtle populations or subpopulations. Closer monitoring of all activities involving sea turtles may help to provide insight on the effects of research activities on sea turtles.

Sperm whales

There are presently five active research permits for sperm whales in the Gulf of Mexico. This research entails surveys, photo identification, tagging, biopsy sampling, and playback experiments to the whales. Most of the research activities involve incidental harassment to sperm whales and none have resulted in direct injury or mortality.

Gulf sturgeon

Many section 7 consultations for Federal actions affecting the Gulf sturgeon and its habitat have been undertaken with the COE, other Department of Defense (DOD) agencies, the U.S.C.G., the National Park Service, the Federal Highway Administration, the MMS, the Federal Energy Regulatory Commission, and others. Since listing, NOAA Fisheries has conducted 70 informal and four formal consultations involving Gulf sturgeon. The informal consultations, all of which concluded with a finding that the Federal action would not affect or would not likely adversely affect the Gulf sturgeon, addressed a wide range of actions including navigation, beach nourishment, Gulf of Mexico fishery management planning, oil and gas leases, power plants, bridges, pipelines, breakwaters, rip-rap, levees and other flood-protection structures, piers, bulkheads, jetties, military actions, and in-stream gravel mining. The formal consultations, which followed a finding that the Federal action may affect Gulf sturgeon, have dealt exclusively with navigation projects, oil and gas leases, pipelines, review of water quality standards, and disaster recovery activities, and have resulted in biological opinions. Also, the Gulf sturgeon was addressed in several biological opinions that were triggered by may-affect determinations for other listed species. To date, none of the Services' opinions has concluded that a proposed Federal action would jeopardize the continued existence of the Gulf sturgeon.

NOAA Fisheries' biological opinions for the Gulf sturgeon have concluded "no jeopardy" for the Gulf sturgeon, but included discretionary conservation recommendations to the action agency. These biological opinions for the Gulf sturgeon also have included non-discretionary reasonable and prudent measures, with implementing terms and conditions, which are designed to minimize the proposed action's incidental take of Gulf sturgeon. The conservation recommendations and reasonable and prudent measures provided in previous Gulf sturgeon biological opinions have included enforcement of marine debris and trash regulations; avoidance of dredging and disposal in deeper portions of the channel; monitoring and reporting of "take" events during project construction; operation of equipment so as to avoid or minimize take; monitoring of post-project habitat conditions; monitoring of project-area Gulf sturgeon subpopulations; limiting of dredging to the minimum dimensions necessary; limiting of the depth of dredged material placed in disposal areas; arrangement of the sequence of areas for dredging to minimize potential harm; screening of intake structures; avoidance of riverine dredging during spawning months; limiting of tow times of trawl nets for hurricane debris cleanup; addition of specific measures for species protection to oil spill contingency plans; and funding of research useful for Gulf sturgeon conservation.

Military activities

The air space over the Gulf of Mexico is used extensively by the Department of Defense (DOD) for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf. The Western Gulf has four warning areas that are used for military operations. The areas total approximately 21 million acres or 58 % of the area of the WPA. In addition, six blocks in the Western Gulf are used by the Navy for mine warfare testing and training. Mustang Island Area Blocks 793, 799, and 816 have been excluded from proposed action. Mustang Island Area Blocks 59, 147, 228, 602, 775, 790, 191, 798, 821, and 822; and Mustang Island Area, East Addition, Blocks 732, 733, and 734 will carry multi-use mitigation stipulations, if leased. The CPA has five designated military warning areas that are used for military operations. These areas total approximately 11.3 million ac. Portions of the Eglin Water Test Areas (EWTA) comprise an additional 0.5 million ac in the CPA. The total 11.8 million ac is about 25 % of the area of the CPA.

Additional 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 1997). 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 1996). The USN Mine Warfare Center in Corpus Christi, Texas may take, annually, up to 5 loggerheads and 2 leatherbacks, hawksbills, greens, or Kemp's ridleys, in combination, during training activities in the western Gulf of Mexico. U.S. Air Force operations in the Eglin Gulf Test Range in the eastern Gulf of Mexico may also kill or injure sea turtles. Air-to-surface gunnery testing is estimated to kill a maximum of 3 loggerheads, 2 leatherbacks, and 1 green, hawksbill or Kemp's ridley. Search and rescue training operations are expected to have a low level of impacts, taking 2 turtles over a 20 year period. NOAA Fisheries has reinitiated the 1980s biological opinion on USN Atlantic Fleet Weapons Training Facility at Vieques, Puerto Rico. 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 overall USCG or USN activities in the Gulf of Mexico has not been conducted.

Private Actions

Commercial traffic and recreational pursuits can have an adverse effect on sea turtles and cetaceans through propeller and boat strike damage. Private vessels participate in high speed marine events concentrated in the southeastern United States and are a particular threat to sea turtles, and occasionally to marine mammals as well. The magnitude of the impacts resulting from marine events is not currently known. NOAA Fisheries and the USCG are in early consultation on these events, but a thorough analysis has not been completed.

Maritime traffic

Tanker imports and exports of crude and petroleum products into the Gulf of Mexico are projected to increase. In 2000, approximately 2.08 billion barrels of oil (BBO) of crude oil (38 % of U.S. total) and 1.09 BBO of petroleum products (13 % of U.S. total) moved through analysis area ports. By the year 2020, these volumes are projected to grow to 2.79 BBO of crude oil and 1.77 BBO of petroleum products. Crude oil will continue to be tankard into the Gulf of Mexico for refining from Alaska, California, and the Atlantic.

Commercial fishing

Various fishing methods used in state fisheries, including trawling, pot fisheries, fly nets, and gillnets are known to cause interactions with sea turtles. Florida has banned all but very small nets in state waters, as has 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.

The state fishery for menhaden in state waters of Louisiana and Texas is managed by the Gulf States Marine Fisheries Council and is not federally regulated for sea turtle take. The fishery has been classified as a class-II fishery for marine mammal interactions and is required by the Marine Mammal Protection Act of 1972 to report all interactions with marine mammals. However, no such reporting exists for sea turtle takes in the fishery. Condrey and Rester (1996) reported a hawksbill take in the fishery and other takes have been reported in the fishery between 1992 and 1999 (DeSilva 1999).

Oil and gas activities

State oil and gas activities occur in Texas, Louisiana, and Alabama. The Texas coast is the largest along the Gulf of Mexico, spanning 400 mi and encompassing 12 counties. Texas also has the largest legal area of land extending Gulfward. Initially all coastal states owned 3 mi of land into the Gulf of Mexico; however, with the enactment of the Submerged Lands Act and its interpretation by the Supreme Court in 1960, Texas land extends 3 marine leagues (10.4 mi). The State of Texas has authority over and owns the water, beds, and shores of the Gulf of Mexico equaling nearly 2.5 million acres. In recent years, oil and gas production in the State of Texas has been declining. From 1978 to 1998 annual crude oil production fell from 1,040,966 Mbbl (million barrels) to 457,499 Mbbl. However, in that same timeframe, the number of producing oil wells rose from 166,65 to 170,288. Natural gas production has shown a similar trend over the same period. From 1978 to 1998, Texas natural gas production fell from 7,077.1 tcf to 5,772.1 tcf (trillion cubic feet) and the number of producing gas wells rose from 33,157 to 58,436. Texas offshore oil and gas production for the year 2000 was 41,106 tcf of natural gas and 520,352 bbl of oil. Texas offshore oil and gas production for the year 2001 (as of May 2001) is 18,057 tcf of natural gas and 210,783 bbl of oil (Texas Railroad Commission 2001).

In Louisiana, the Office of Mineral Resources holds regularly scheduled lease sales on the second Wednesday of every month. The first oil production in commercial quantities occurred in 1901 and it marked the beginning of the industry in the State. The first over-water drilling in America occurred in 1910 in Caddo Lake near Shreveport. The State began its offshore history in 1947. The territorial waters of Louisiana extend Gulfward for 3 mi and its shoreline extends nearly 350 mi. When including the oil and gas production in the Gulf of Mexico, Louisiana becomes the second leading natural gas producer in the country and the third leading crude oil producer. There are thousands of miles of pipelines in the State carrying crude oil from the Gulf of Mexico to refineries in Louisiana and other states, as well as carrying natural gas throughout the United States (Louisiana Mid-Continent Oil and Gas Association 2001). In 1999, Louisiana offshore production totaled 12.8 MMbbl of crude oil from about 554 offshore oil wells and 147.5 tcf of natural gas from about 177 natural gas wells.

Alabama does not hold regularly scheduled lease sales due to the limited amount of tracts available. The last lease sale was held in 1997. The territorial waters of Alabama extend Gulfward for 3 nmi and its shoreline extends nearly 52 mi. The first wells drilled for oil in the southeastern United States were drilled in Lawrence County in 1865, just six years after the first oil well was drilled in the United States. Alabama owns oil, gas, and mineral interests on small upland tracts, submerged river bottoms, estuaries, bays, and in the 3-mi area offshore. The Alabama State Oil and Gas Board was created after the oil discovery in 1944. As of August 2001, a total of 69 test wells have been drilled in Alabama coastal waters. Forty of these wells were permitted to test the Norphlet Formation below a depth of 20,000 ft. The two earliest wells were drilled to test undifferentiated rocks of Cretaceous age and 27 wells have targeted shallow Miocene gas reservoirs generally at depths of less than 3,500 ft. Operators have experienced a high success rate in drilling wells in Alabama coastal waters. A total of 28 of the

40 Norphlet Formation wells drilled to date have tested gas, and 23 of the 27 Miocene wells drilled have tested gas. Sixteen gas fields have been established in the offshore region of the State, with 7 fields being productive from the Norphlet Formation and 9 fields being productive from sands of Miocene age (Alabama State Oil and Gas Board 2001). Indigenous crude oil production totals 29,000 bbl per day, ranking Alabama 16th out of the 32 producing states and Federal offshore areas. Production of gas from the State's coastal waters flows through 44 fixed structures and platforms and now exceeds 220 Bcf annually. Production capabilities for individual wells range from a few million to more than 110 million cubic feet of gas per day (Alabama State Oil and Gas Board 2001).

In 1994 the State of Mississippi passed legislation allowing companies to enjoy substantial tax breaks based on the types of discovery involved and the methods they use. Those tax breaks range from a five-year exemption from the State's 6 percent severance tax for new discoveries to a 50 percent reduction in the tax for using 3-D technology to locate new oil and gas fields, or using enhanced recovery methods. As a result of the incentive program, 84 new oil pools have received the exemption, 108 inactive wells have been brought back into production, 13 development wells have been drilled in existing fields, 34 enhanced wells have received exemption, and 14 have received exemptions for using 3-D technology (Sheffield 2000).
The State of Florida has experienced very limited drilling in coastal waters. At present, a moratorium has stopped drilling activity in Florida State waters, and the State has no plans for lease sales in the future. Presently, no drilling rigs are operating within the State.

Electrical power generation

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; NOAA Fisheries estimates the survival rate at 98.5% or greater. Other power plants in Florida, Texas and North Carolina have also reported low levels of sea turtle entrainment, but formal consultation on these plants' operations has not been completed.

C. Other Potential Sources of Impacts in the Environmental Baseline

A number of activities that may indirectly affect listed species include discharges from wastewater systems, dredging, ocean dumping and disposal, and aquaculture. The impacts from these activities are difficult to measure. However, conservation actions are being implemented to monitor or study impacts from these sources.

NOAA Fisheries and the USN 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.

Natural seeps

Naturally occurring hydrocarbon seepage has long been identified as a significant source of hydrocarbons. Tarballs coming from natural seeps were used by early indigenous man living along the Gulf Coast to construct hunting tools. Given that the Gulf is a prolific petroleum-producing province, its seafloor is pocketed with areas from which oil and gas seeps. Accurately calculating the volume of oil naturally seeping is problematic. Often the volume measured floating on the surface of the water or beached has been used as the best indicator of the volume originally seeped.

D. Conservation and Recovery Actions Shaping the Environmental Baseline

Marine mammals

In response to a Biological Opinion issued by NOAA Fisheries on July 15, 2002, regarding MMS' OCS Lease Sale 184, MMS issued a Notice To Lessees (NTL) regarding minimizing the acoustic disturbance to marine mammals. The MMS issued the NTL (30 CFR 250.103, August 22, 2002) to explain how to implement seismic survey mitigation measures. This NTL implements stipulation 5 (d) of the Final Notice of Sale for OCS Lease Sale 184. MMS implemented these mitigations throughout the entire GOM for seismic activities under their jurisdiction for all seismic operations in waters greater than 200m (656 ft) in depth. These measures now apply to all on-lease seismic surveys conducted under MMS regulation 30 CFR 250.201 and all off-lease seismic surveys conducted under 30 CFR 251. The implementation of the stipulations contained within the NTL will greatly reduce the potential for any serious adverse impacts to sperm whales and other marine mammals in the Gulf of Mexico from seismic airgun use. The NTL (NTL No. 2002-G07) is available on the MMS website at:

http://www.gomr.mms.gov/homepg/regulate/regs/ntls/ntl_lst2.html

The NTL implemented throughout the GOM contains the following four main mitigation measures. The following text is excerpted from the NTL.

1. <u>Ramp-up Procedures</u>

Ramp-up means the gradual increase in emitted sound levels from an airgun array by systematically turning on the full complement of an array's airguns over a defined period of time (i.e., at a rate of 6 dB re 1 mPa per 5 minute interval). The intent of ramp-up is to warn animals of pending seismic operations and to allow sufficient time for those animals to leave the immediate vicinity. Under normal conditions, animals sensitive to these activities are expected to move out of the area. For all seismic surveys, use the ramp-up procedures described below to allow sea turtles and sperm whales to depart the exclusion zone before seismic surveying begins.

Measures to conduct ramp-up procedures during all seismic survey operations are as follows:

a. Visually monitor the exclusion zone and adjacent waters for the absence of sperm whales for at least 30 minutes before initiating ramp-up procedures. Exclusion zone means the area at and below the sea surface within a radius of 500 m surrounding the center of an airgun array and the area within the immediate vicinity of the survey vessel. If no sperm whales are detected, you may initiate ramp-up procedures. You must not initiate ramp-up procedures at night or when you cannot visually monitor the exclusion zone for sperm whales if your minimum source sound level output drops below 160 dB re 1 µPa (see measure 5).

b. Initiate ramp-up procedures by firing a single airgun. The preferred airgun to begin with should be the smallest airgun, in terms of energy output (dB) and volume (cubic inches).

c. Continue ramp-up by activating additional airguns at a rate of 6 dB re 1 µPa per 5 minute interval until the airgun array is operating at the desired survey intensity.

d. Immediately shut down all airguns ceasing seismic operations at any time a sperm whale is detected entering or within the exclusion zone. You may recommence seismic operations and ramp-up of airguns only when the exclusion zone has been visually inspected for at least 30 minutes for the absence of sperm whales.

e. You may reduce the energy output of the airgun array to maintain a minimum source sound level output of 160 dB re 1 µPa for routine activities, such as making a turn between line transects, or for maintenance needs. This procedure may be followed during periods of impaired visibility (e.g., darkness, fog, high sea states, etc.) and does not require a 30-minute visual clearance of the exclusion zone before the airgun array is again ramped up to full output.

2. <u>Visual Observers</u>

Visual monitoring means the use of trained observers to scan the ocean surface visually for signs of marine mammal presence. These approved observers must have successfully completed a seismic survey observer-training program. An approved program is one that adheres to the criteria outlined in a Biological Opinion that includes: at least two observers be used on a vessel, and; at least one formally trained biologist or equivalently experienced individual with the expertise in marine and animal science and who has completed a seismic observer training program . The area to be scanned visually includes, but is not limited to, the exclusion zone. Visual monitoring of an exclusion zone and adjacent waters is intended to establish and, when visual conditions allow, maintain a zone around the sound source and seismic vessel that is clear of marine mammals, thereby reducing or eliminating the potential for injury to sperm whales. You must use trained visual observers on all seismic vessels in the Gulf of Mexico OCS who have successfully completed a seismic survey observer-training program.

Visual observers must monitor waters (with the assistance of binoculars) for sperm whales within and adjacent to the exclusion zone for 30 minutes prior to initiating the airgun ramp-up procedures. Observers must monitor the exclusion zone and adjacent waters during seismic operations, unless atmospheric conditions reduce visibility to zero or during hours of darkness (i.e., night). When sperm whales are observed entering or within the exclusion zone, observers must call for the shut down of the airgun array; seismic operators must shut down the array when instructed by an observer. You may reinitiate ramp-up and seismic survey activities only when the observer has: (a) determined that the sperm whale(s) has departed the exclusion zone, and (b) visually monitored the exclusion zone for at least 30 minutes since the last sperm whale sighting within the exclusion zone.

3. <u>Marine Mammal Reporting</u>

When sperm whales are sighted prior to or during a seismic survey operation, observers are to document the information listed below. You must report this information to MMS within 8 days of the sighting by email (protectedspecies@mms.gov). In the near future, MMS will establish an internet observer-reporting network that you may use as an alternative reporting procedure. Include the following observations in your report:

a. The date, time, and location (latitude/longitude) of each observation.

b. The number of sperm whales sighted.

c. Whether or not a sperm whale entered the exclusion zone warranting a shut-down.

d. How long the shut-down occurred (i.e., how long the sperm whale was in the exclusion zone).

e. The name and contact information for the person submitting the report.

MMS has agreed to compile this information and submit it to NOAA Fisheries in annual reports. The program was implemented in October 2002; no reports have been received and the program is too new to analyze its effectiveness.

Sea turtles

NOAA Fisheries implemented a series of regulations aimed at reducing the potential for incidental mortality of sea turtles in commercial fisheries. In particular, NOAA Fisheries 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, Va) since 1992. 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. TEDS are certified for use in the shrimp fishery based on a testing protocol in which 97% of small turtles escape through the TED opening. However, recent analyses by Epperly and Teas (1999) indicate that the minimum requirements for the escape opening dimensions are too small, and that as many as 47% of the loggerheads stranding annually along the Atlantic seaboard and GOM were too large to fit through existing openings. On October 2, 2001, NOAA Fisheries published a proposed rule to require larger escape openings in TEDs and is planning to issue a final rule in early 2003.

In 1993 (with a final rule implemented in 1995), NOAA Fisheries established a Leatherback Conservation Zone to restrict shrimp trawl activities from the coast of Cape Canaveral, Florida, to the North Carolina/Virginia border. This provides for short-term closures when high concentrations of normally pelagic-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 NOAA Fisheries-approved TEDs.

NOAA Fisheries is also working to develop a TED which can be effectively used in a type of trawl known as a fly net, 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 field testing on commercial vessels has not been performed.

In addition, NOAA Fisheries 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, NOAA Fisheries also conducts a number of workshops with longline fishermen to discuss bycatch issues including protected species, and to educate them regarding handling and release guidelines. NOAA Fisheries intends to continue these outreach efforts and hopes to reach all fishermen participating in the pelagic longline fishery over the next one to two years. There is also an extensive network of Sea Turtle Stranding and Salvage Network 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.

V. Effects of the Action

Despite the many regulations implemented to reduce the likelihood of environmental impacts of OCS oil and gas development activities, these activities have the potential to have numerous direct and indirect adverse effects on listed and protected species in the Gulf of Mexico. These effects are described in detail in the draft environmental impact statements prepared by MMS for this proposed action.

The projects or results of actions undertaken as part of the proposed action that may have adverse effects on listed species are:

- noise from exploration, construction, and production activities;
- well, pipeline, and platform construction;
- vessel traffic;
- brightly-lit platforms;
- OCS-related trash and debris; and
- contaminants.

A. Noise

Oil and gas exploration, development and production activities contribute numerous sources of additional noise into Gulf of Mexico waters (Table 2). Note that the physical characteristics of many of these sound sources have not been measured in the GOM (MMS DEIS 2002) or are presented as computer simulations.

Seismic surveys

Prior to 1989, explosives (dynamite) were used in certain limited areas to generate seismic pulses. Explosives have been replaced by piston-type acoustic sources that generate superior acoustic signals and that do not cause the damaging environmental impacts associated with explosives. Rapid rise time (high velocity), high peak pressure, and rapid energy decrease characterize acoustical energy from explosives. Seismic airguns are considered nonexplosive and have long rise times to peak pressure (low velocity). It is assumed that no explosives will be used, and all future seismic surveys will utilize airguns.

During GulfCet I and II surveys seismic exploration signals were detected 10% and 21% of the time respectively (Davis et al. 2000). There has been a sharp increase in seismic exploration in the GOM over the last several years. The deepwater Gulf is the premier source of gas production to offset declines from fields on the shelf. Modern 3D seismic surveys are the main survey used for these efforts and sometimes cover hundreds of blocks and involve several months of acquisition time (Petzet 1999). The OCS Deep Water Royalty Relief Act (DWRRA*)* provides economic incentives for operators to develop fields in water depths greater than 200 m. Immediately after the DWRRA was enacted, deepwater leasing activity exploded. There are about 3,500 active leases in water depths less than 305 m, about 160 active leases in 305-457 m water depth, about 1,620 active leases in 457-1524 m water depth, about 1,320 active leases in 1524-2286 m water depth, and about 820 active leases in water depths of 2286 and greater. MMS projects that a large increase in the number of lease blocks surveyed will occur over the next few years. In addition to those blocks that may remain actively explored by seismic surveys, the number of lease blocks surveyed annually by seismic vessels over the outer continental shelf is projected to be 2,938 blocks by the end of 2002, 3,337 blocks in 2003, 4,111 blocks in 2004, and 7,336 blocks in 2005. The number of deep water seismic surveys is expected to slowly decrease after 2005 to 3,845 seismic surveys by the year 2012 (MMS,

Table 2. The major sources of sound from oil and gas activities. Explosive removals of offshore structures are not included in the table, since they are not considered in this biological opinion. An * indicates values measured in the GOM. Values for other geographic areas are given when data for the GOM are not available.

Source Type	Frequency Range (Hz)	Source Level (zero to peak, dB re 1 µPA at 1 m from source)	Duration/Firing Rate	Reference
Continuous				
aircraft	45-7,070	131-765	continuous	Richardson et al. 1995
Survey Vessel	1-150	<170	continuous	IAGC*
Tug and Barge	unavailable	143-171	continuous	Richardson et al. 1995
Tanker	variable	166-186	continuous	Richardson et al. 1995
Service vessel	variable	159-181	continuous	Richardson et 1l. 1995
Drilling from Vessels	10-10,000	154-191	continuous	Richardson et al. 1995
Drilling from Platforms	5-1,200	119-127 (received level)	continuous	Richardson et al. 1995
Construction	10-1,000	low?	Intermittent/continuous	Richardson et al. 1995
Impulsive				
Acoustic Positioning Devices	50,000 - 100,000	< 190	unavailable	IAGC*
Echo Sounders	12,000 200,000	< 210 < 215	unavailable	IAGC*
Side Scan Sonar	50,000-500,000	220-230	0.01ms-0.1ms	Richardson et al. 1995
Acoustic Current Profilers	>1,000,000	unavailable	unavailable	IAGC*
Geohazard-2D	unavailable	229-233	2 days / 7-8 s	MMS, 2002
Geohazard-3D	unavailable	233	5 days / 7-8 s	MMS, 2002
Exploration-2D	3- over 1000	233-260 (est.)	days to months / 10-14 s	MMS, 2002, IAGC
Exploration 3-D	3-over 1000	233-260 (est.)	days to months / 10-14 s	MMS, 2002, IAGC*
Ocean bottom cable surveys	unavailable	233-260 (est.)	days to months / 10 s	MMS, 2002
Vertical Cable surveys	unavailable	233-260 (est.)	days to months / 10 s	MMS, 2002

Deepwater Gulf of Mexico 2002). About 18% to 47% of the lease blocks in the GOM are undergoing geological surveys in any given year.

Airgun arrays are towed 5-10 m below the surface of the water and release the compressed air every 10-15 seconds. Twelve to 70 airguns may be towed to study deep water structures. The peak levels of sound pulses produced by the airgun arrays are well above ambient and vessel sound levels at approximately 260 dB re 1 μPa (peak to peak)1 meter from the source, but short pulses limit the total energy released. The sound from the seismic sources is directed downward; however, some horizontal propagation that can be detected many kilometers away will occur (Malme et al. 1983). Depending on the type of seismic survey operation and type of air guns used, survey operations produce between 225 to 260 dB re 1 μPa at 1 m. McCauley (1994) reported that, dependent on the sound propagation characteristics of the area, intensity only decreases to 180 dB at 1 km and to approximately 150 dB within 10 km of the source. Typically, the more powerful airguns are used in deepwater seismic surveys. Furthermore, the frequency spectrum and intensity level is dependent upon the manufacturer and model of the airgun, as well as the type of array utilized during seismic surveys, and other environmental variables. However, some generalizations can be extrapolated from this information, and using these typical characteristics of seismic surveys in the Gulf of Mexico, the effects on threatened and endangered species can be analyzed.

The airgun is the preferred source for marine seismic surveys. Other sources, such as the Water-gun, Vaporchock or Maxipulse (chemical explosives) have been used in the past, but are now considered obsolete. In order to increase the total emitted energy, several airguns of differing sizes are mounted together in arrays. Such airgun arrays may consist of 10 to 30 airguns or more. For a typical 3-D survey, airguns are deployed in usually two arrays, towed from suspended floats behind the vessel at a distance of 100-200 m. Following behind the airgun arrays are anywhere from 6-12 streamer cables 3-8 km long and spread out over a breadth of 600-1,500 m (Figure 3). The survey vessel tows the array at 4-5 knots. While in tow the airguns on one array will fire simultaneously followed by the other array firing 13-14 seconds later. To complete a survey, the ship will continue down a track from 12-20 hours (100-166 km), depending on the size of the survey. At the end of a survey track, the ship will take 2-3 hours to turn around and continue down another track. The surveys occur both day and night and may require days, weeks, or months to complete.

A typical airgun array used in the Gulf of Mexico fires at approximately 240 dB re 1μPa at 1 m from the source with maximum estimated levels of 260 dB re 1 μPa $_{p\text{-}p}$ (Richardson et al. 1995). Individual guns within an array effectively work together with combined sound pressure levels coalesced into one pulse. The dB level of the pulse generated by several airguns is not additive; however, back calculations from far field measurements reveal a greater "estimated point source" created by the pulse, than would actually be measured from any one individual airgun. The array of airguns can then be considered a "point source", although this estimated dB level is never realized in near field measurements. The far field signature of an airgun array depends on the number of airguns, their positions, volumes, firing times, initial pressures, port areas, and port-closure pressures (Dragoset 1990, Caldwell and Dragoset 2000). However, the strength of an airgun array is roughly proportional to the number of airguns in the array; followed by a combination of factors including the total volume of the airguns in the array, port sizes, and tow depth. However, airgun specifications are not available from industry and is considered proprietary information, but based on recent information provided by the IAGC for 3-D seismic surveys in the GOM, when all the airguns in the array are treated as a single point source, the calculated source level (260 dB re 1 μPa $_{p\text{-}p}$) is greater than the point source from any one individual airgun (240 dB re 1 μPa $_{p\text{-}p}$). These theoretical point sources more accurately reflect the actual received levels from the full airgun array in the far-field (75 - 100m measured directly below the array) (Caldwell and Dragoset 2000), although the point source of 260 dB re 1 μPa is never actually realized from any one individual airgun. For example, calculations from far field measurements to estimate the point source for a full airgun array commonly used for 3-D seismic surveys in the Gulf of Mexico would result in point sources of approximately 260 dB re 1 μPa (Figure 4). Notably, near-field intensities will increasingly deviate from theoretical source levels as individual airguns have a greater interfering effect at distances nearer to an airgun array. In addition to the far field effects of received intensity levels, other properties of the received pulse at the location of whales will vary from the output signal. A recent study by Madsen et al. (2002) measured the received sound properties of airgun emissions to sperm whales. Both peak frequency and duration increased with distance. The peak signal increased from 50 Hz at the source to 200 Hz, and the signal had increased in duration by a factor of 40 approximately greater than 20 km from the source. The cause of this effect were attributed to multiple propagation paths in shallow water, due to bottom and surface reflection in waters ranging from 30 - 1,100 m depth, that resulted in different arrival times in deeper water causing the greater duration. Whether multiple propagation paths exist in the deep water of the GOM exists remains to be measured, and will likely vary with depth and topographic features in the area.

For deepwater surveys frequency spectra are generally concentrated in frequencies below 500 Hz, but contain sufficient energy above 500 Hz (Figure 5). MMS' Multi-Sale Draft Environmental Impact Statement (2002) indicates that although the output of airgun arrays is usually tuned to concentrate low frequency energy, a broad frequency spectrum is produced, with significant energy at higher frequencies (e.g., Goold and Fish 1998). In reference to low and high frequency sounds, low frequencies are referred to as 1 - 1,000 Hz, and frequencies greater than 1,000 Hz as high frequency sounds. These higher energies encompass the entire audio frequency range of 20 Hz to 20 kHz and extend well into the ultrasonic range up to 50 kHz. More detailed descriptions on the operation and specifications of airgun arrays can be found in Caldwell 2002, Caldwell and Dragoset 2000, and Ward et al. 1998.

Although the hearing ability of toothed whales (other than sperm whales) is believed to be poor at low frequencies, there is sufficient output of airgun arrays at frequencies of 200-500 Hz to make them audible at distances of 10-100 km (Harwood and Wilson 2001, Figure 6); however, due to lower source levels at the source for higher frequencies, the 180 dB re 1 μPa isopleth would occur at a lesser distance from the array than lower frequency outputs (Figure 7), and received frequency levels may increase with distance from the source (Madsen et al. 2002). These higher frequency components are weak compared to the low frequency energy (1 - 1,000 Hz), but the signals are strong when compared to the ambient noise levels (Richardson et al.

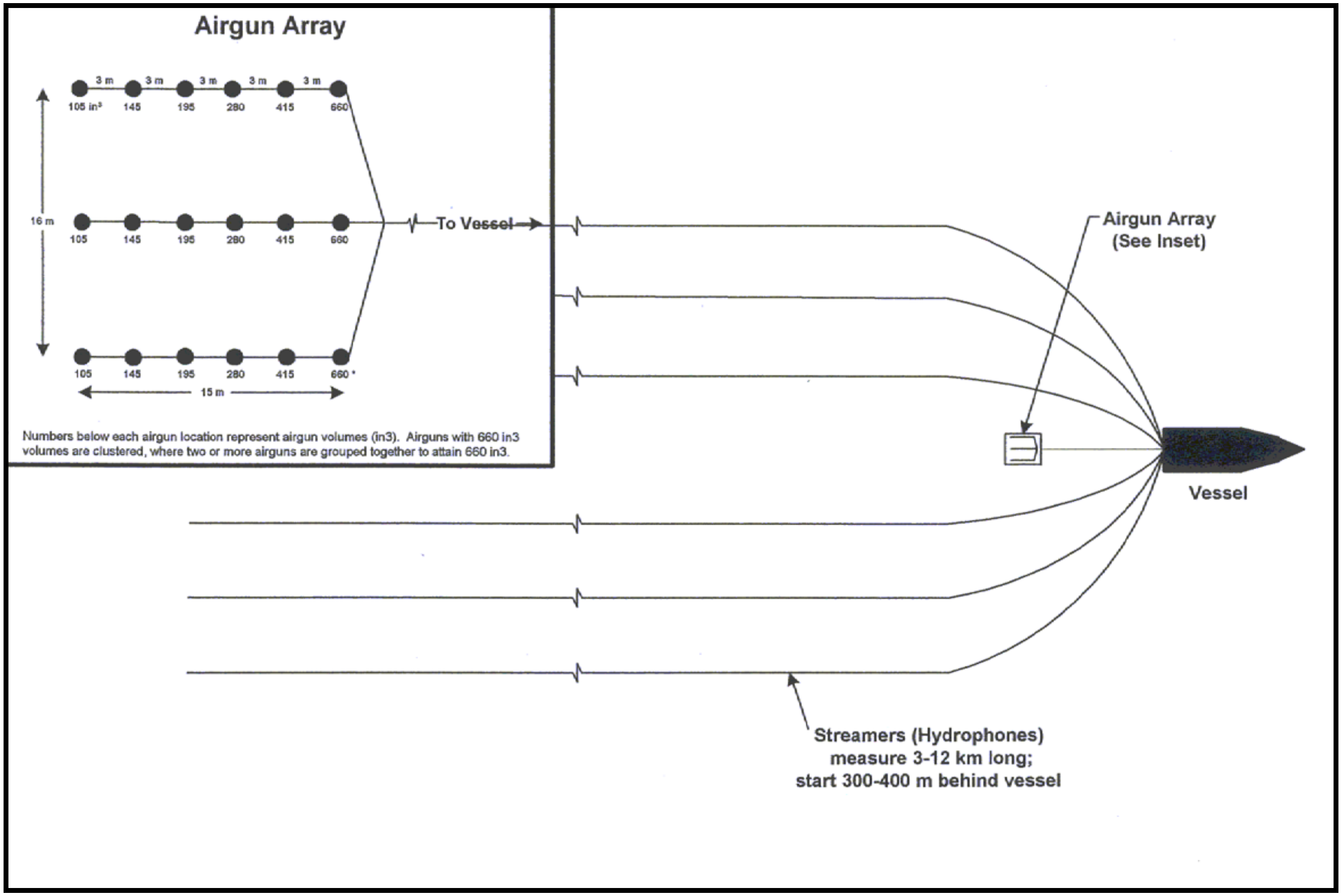

Figure 3. The typical seismic airgun array configuration for 3-D airgun array in the GOM..

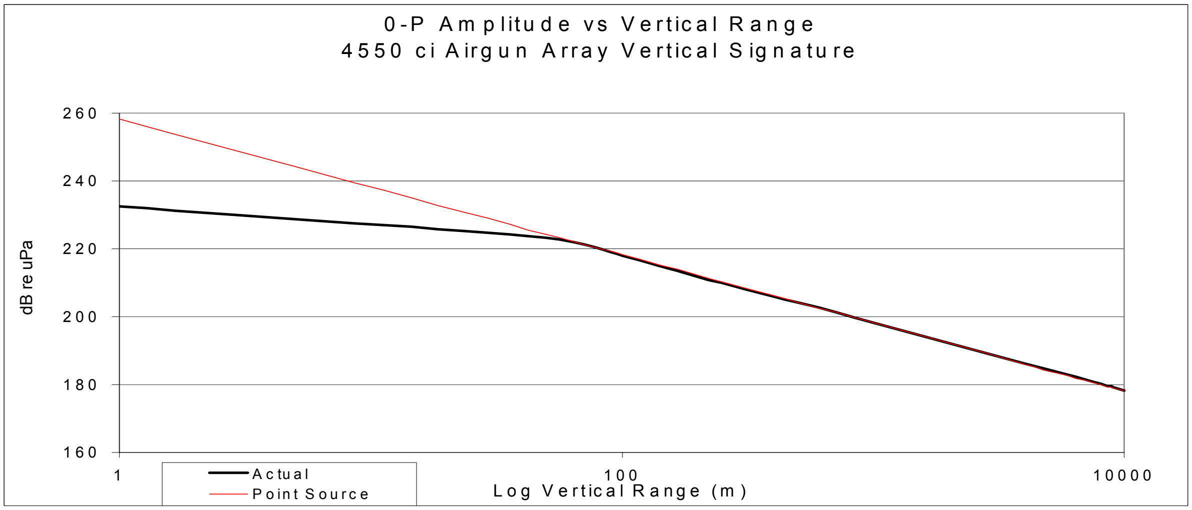

Figure 4. The estimated point source level for a typical 3-D airgun array. The red line is an extrapolation of pressure measured at some distance below the array to a point 1m from the center of the array. However, because of the area dimensions of the array, the point source is never realized. Approximately 100m below the array, the point source estimation becomes less accurate due to the interfering effects among individual airguns. This area directly below the array is called the near-field, outside this field is called the far-field. Graph courtesy of the IAGC.

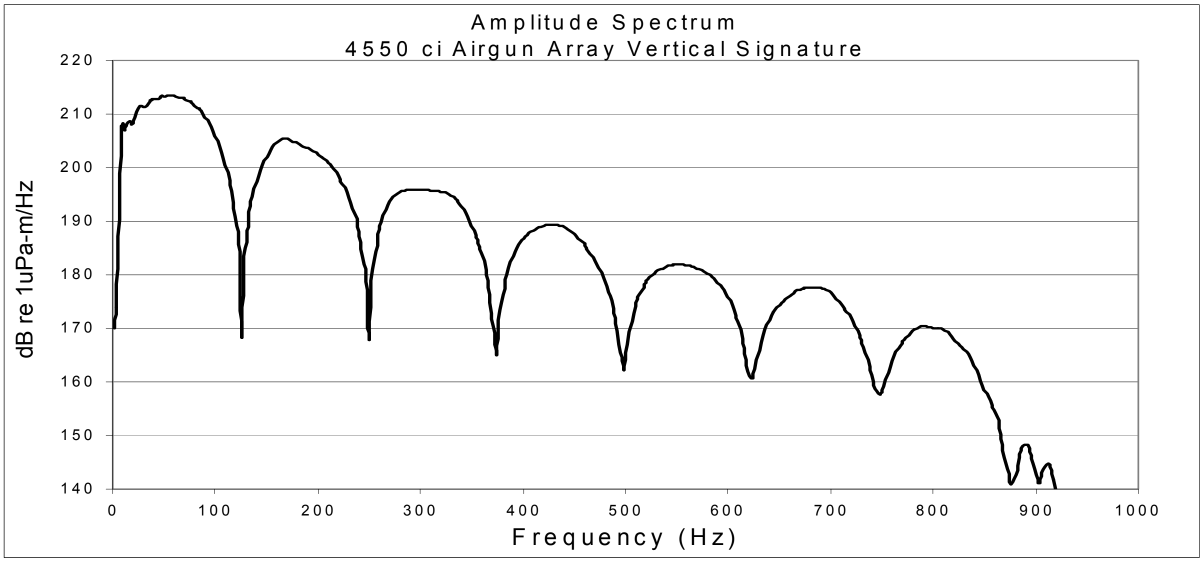

Figure 5. This signature is for a 4450 in^3 airgun array at 6m depth. It was generated using a seismic industry computer modelling program called Nucleus. The signature was modeled at a sampling of 0.5 ms and has a 3 Hz to 880 Hz bandpass filter applied to filter out frequencies outside this range. Frequencies above 880 Hz and the associated dB level for those frequencies are not represented on the graph. Decibel level is characteristic for all seismic surveys. Graph courtesy of the IAGC.

Source Level Vs. Frequency

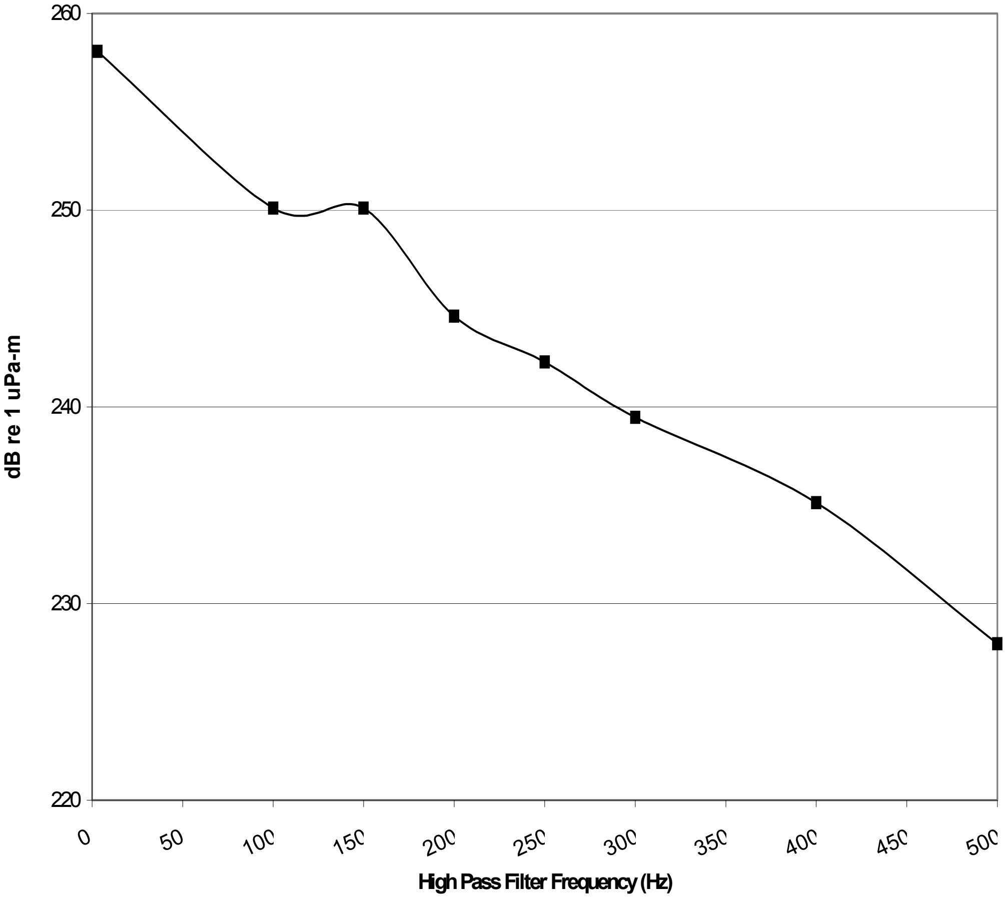

Figure 6. The above graph shows the zero-to-peak amplitude for the signature from the 4450 in^3 airgun array after application of various high pass filters. The filter removes all frequencies below the high-pass frequency. Frequencies above 500 Hz are not represented. The peak amplitude of the airgun signature is a function of frequency content. The graph shows that the amplitude of the signature decreases as the high pass frequency increases. Graph courtesy of the IAGC.

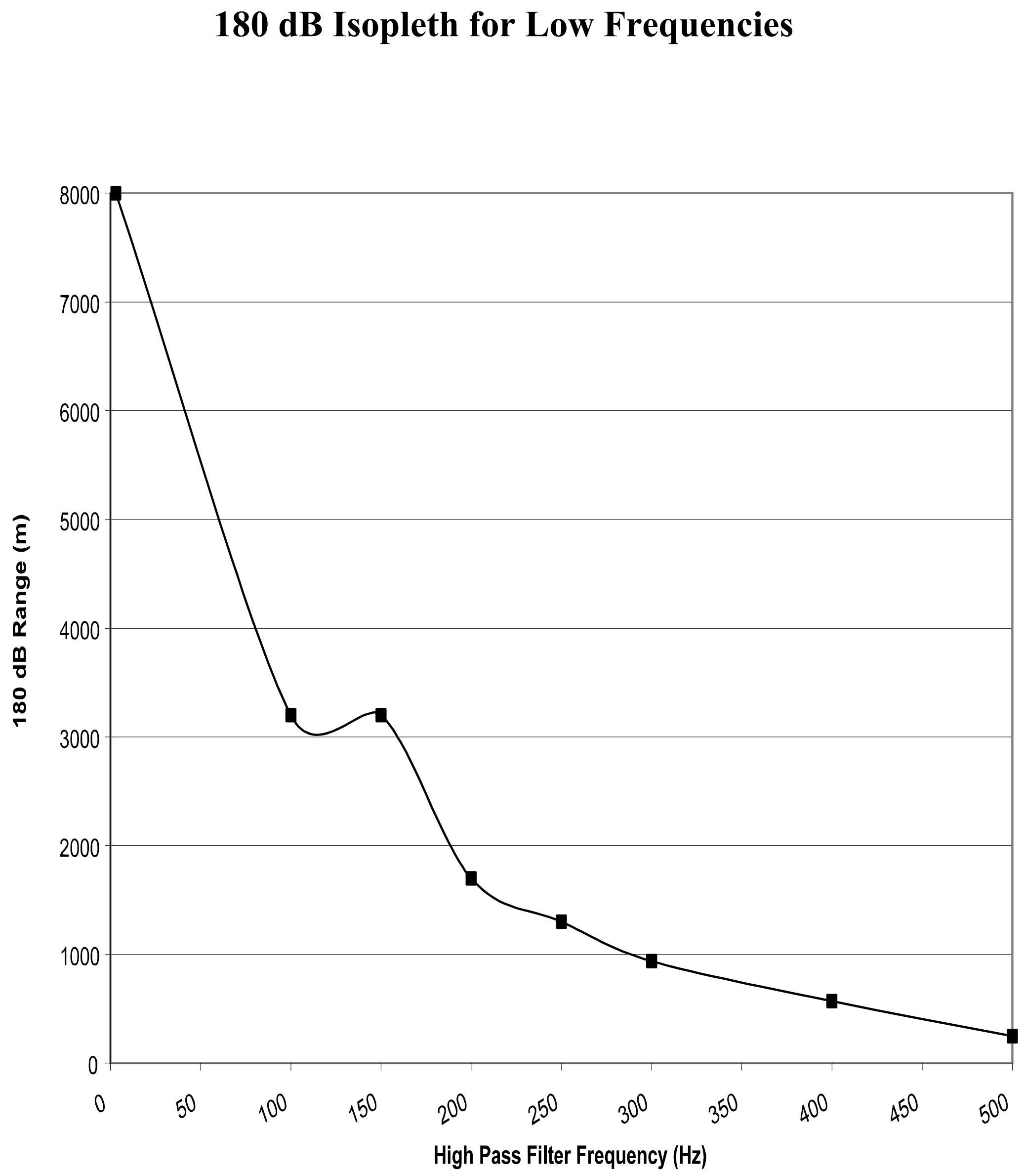

Figure 7. The 180 dB isopleth decreases with distance from the source at increasing frequency levels. Hypothetical propagation loss for a point source from a 3-D seismic survey when a 1/r spreading loss model is applied to the vertical signature. Frequencies above 500 Hz are not represented. The distance of the 180 dB isopleth will vary with physical propagation characteristics and the associated mathematical model. Graph courtesy of the IAGC.

Unlike surface seismic, borehole 1995). The high frequencies produced by seismic surveys are consistent with the recorded frequencies received by a hydrophone (Mate et al. 1994) of a seismic survey that may have possibly resulted in the displacement of sperm whales up to 60 km; however, it is very unlikely the highest frequency components would be audible to sperm whales at this distance due to frequency attenuation and spherical propagation losses, but audible at closer distances to the source. For example; a 50 kHz signal attenuation rate in seawater decays at approximately 15.5 dB/km. Although the airgun frequency content may encompass a wide range of frequencies, sound pressure levels at higher frequencies are limited, and increasing frequency levels will attenuate more rapidly at a given distance; however, attenuation rates among frequencies differ in shallow waters. It is likely that dolphins can hear the higher components of seismic pulses, though the thresholds are relatively poor at low frequencies. These higher frequency emissions may explain the recently reported behavioral reactions of dolphins, including avoidance and agonistic behaviors during airgun use (Stone 1997, 1998, 2000, 2001).

Unlike surface seismic, borehole seismic surveys are conducted with receivers deployed in a well-bore at pre-determined, discrete intervals. The receiver intervals are typically 50 to 75 feet during Vertical Seismic Profile (VSP) data acquisition and 500 feet for Velocity Survey data acquisition. The receiver or receiver array is deployed on a multi-conductor wireline cable located on a drilling rig rather than towed from a vessel as in surface (2-D and 3-D) surveys.

During the borehole seismic survey, the rig must remain idle or on stand-by for the duration of seismic data acquisition.

The source positioning for borehole seismic surveys ranges from: static - off the side of the rig suspended by a crane (Velocity Survey or Zero Offset VSP); static - offset from the rig deployed by a work boat (Offset VSP); and a moving source deployed from a work boat (normal incident, Walkaway, and 3-D VSP). Each method of source deployment yields different interpretative results, but all methods require a well-bore for receiver deployment. In addition to the source and receiver geometry, there are several key elements of borehole seismic survey data acquisition that are substantially different from surface seismic data acquisition:

- The source size is much smaller, usually 4-8 airguns
- The duration of the survey is substantially shorter, offshore borehole seismic operations usually average less than a day
- The airguns are fired 4-8 times every 16 seconds followed by 5 to 20 minutes of silence while the down-hole receiver is moved in the well-bore
- Borehole seismic surveys in Deep Water (≥200 m) require the drilling rig to suspend operations while the hydrophone is deployed in the well-bore.

Sperm whales

Sperm whales are sensitive to the acoustic environment and may respond to sound emissions in many ways. There is some evidence from sonars (Goold 1999, Watkins and Scheville1975, Watkins et al. 1985, 1993), pingers (Watkins and Scheville 1975), the Heard Island Feasability Test (Bowles et al. 1991, 1994), and the Acoustic Thermometry of Ocean Climate (ATOC) (Costa et al.1998) that indicates disruption of sperm whale vocalization and behavior. The effects of low frequency sound on sperm whale audition, vocalization, and behavior has been difficult to assess in field studies, but the GOM population has recently received greater attention in the Sperm Whale Seismic Study (SWSS) in 2002. Although the results of this study are not yet available, the present evidence suggests some behavioral disturbances may result as discussed below.

Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Scheville 1975, Watkins et al. 1985). Andre et al. (1997) reported that 10 kHz pulses (180 db re 1 µPa at the source) induced startle reactions in sperm whales, and Goold (1999) reported six sperm whales that were driven through a narrow channel using ship noise and echosounder/fishfinder emissions from a flotilla of 10 vessels. Bowles et al. (1991) reported that low frequency sounds (209-220 db re 1 Pa at 57 Hz) from the Heard Island Feasibility Test may have caused sperm whales to fall silent and/or to leave the test area. Watkins and Scheville (1975) showed that sperm whales interrupted click production in response to pinger (6 to 13 kHz) sounds. Watkins et al. (1985, 1993) also reported that sperm whales in the eastern Caribbean became silent, interrupted their activities and moved away from strong pulses from submarine sonar. Watkins et al. (1993) reported interruption of vocal activity and immediate submergence by two sperm whales exposed to high level submarine sonar pulses. They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). One contradictory observation reports no alteration in sperm whale vocal activity when exposed to levels of 173 dB re 1 µPa rms from 1 g TNT detonators (Madsen and Mohl 2000), but it was surmised that the detonations resembled the distant sounds of sperm whale clicks and may account for the apparent lack of response by the whales. If indeed sperm whales did perceive seismic pulses as resembling their own vocalizations, then masking and disturbance effects might be expected to be of concern for this species. Richardson et al. (1995) cite a personal communication with J. Gordon indicating that sperm whales in the Mediterranean Sea continued calling when exposed to frequent and strong military sonar signals, but also report that whalers rarely used sonar to follow these whales due to their tendency to scatter upon hearing the sound. Thus, although the behavioral reactions of sperm whales and other cetaceans are highly variable in response to anthropogenic sounds, there is strong evidence that many individuals are affected. The variability in responses may be the effects of individual variation in behavior, habituation to particular sounds, and behavior and/or sex dependent differences.

Temporary or permanent threshold shift could also result from exposure to loud received levels in the frequencies audible to sperm whales; however, sperm whales would need to be subject to relatively high sounds levels (compared to terrestrial mammals) to be affected. Finneran et al. (2002) have reported that in response to water guns, the odontocete *Delphinapterus leucas* (beluga or white whale), exhibited masked temporary threshold shifts (MTTS) of 7 and 6 dB at 0.4 and 30 kHz respectively, approximately 2 minutes following exposure to single impulses with peak pressures of 160 kPa, peak-to-peak pressures of 226 dB re 1 Pa, and total energy fluxes of 186 db re 1 Pa (Finneran et al. 2002). Thresholds returned to within 2 dB of the pre-exposure value within 4 minutes of exposure. This study indicates that toothed whales (including sperm whales) can experience temporary hearing loss from exposure to loud impulsive noise and frequency ranges produced by some airguns. Sperm whales in the GOM have the potential to be exposed to received sound intensity levels much greater than those tested in the beluga study mentioned above.

The available knowledge to date on the hearing capabilities of cetaceans and the mechanisms they use for receiving and interpreting sounds remains very limited due to the cryptic nature of some species and their rarity, the large size of many species, and the difficulties associated with performing field studies on these animals. Underwater hearing abilities have been studied experimentally in few odontocete species and in no mysticetes (baleen whales). Individuals have been studied in captivity and this imposes constraints upon the species and size of cetacean involved. Where experimental data do not exist, some inference of the sound frequencies that are important to cetaceans can be made from the characteristics of the sounds they produce, and from the structure of their hearing organs.

Vocalization

Most toothed whales produce loud bursts of echolocation clicks (at frequencies generally of 20-150 kHz); these function at close range, rarely beyond a kilometer or two. In the case of the largest of the toothed whales, the sperm whale, they may reach almost 50 km. Codas are short patterned series of clicks (Watkins and Schevill, 1977) produced mainly by female and immature sperm whales while socializing at the surface, and echolocation clicks are made by all animals. A recent study reported that during foraging dives, sperm whales clicked most of the time. During these dives, sperm whales clicked almost continuously, being silent for only 15.5% of the time between fluke-up and surfacing (Jaquet 2002). Sperm whales are very different both behaviorally and morphologically from other odontocetes and are known to use their vocalizations to communicate and echolocate over relatively long distances. It is generally believed that they have better sensitivity at lower frequencies than indicated by other odontocetes, and there is some evidence suggesting low frequency sensitivity.

Sperm whales produce loud broad-band clicks from about 0.1 to 20 kHz (Weilgart and Whitehead 1997, Goold and Jones 1995). Generally, most of the acoustic energy is present at frequencies below 4 kHz. In females the peak regions are typically near 1.2 and 3.0 kHz respectively, although diffuse energy up to and past 20 kHz has been noted. Clicks recorded off the coast of Norway in 1997 and 1998, an area thought to be utilized by adult foraging males, were measured for directionality and sound levels. The recorded sound levels for sperm whale clicks can exceed 220 dB (Møhl et al. 2000). The results of this study are 40 to 50 dB higher than the sound levels previously recognized for this species. Clicks are more often reported between 160-180 dB, so 220 dB likely reflects the upper limit of sound levels produced, or may reflect size and/or gender differences between individuals.

Vocalization data in marine mammals are frequently cited as indicating high tolerance for intense sounds. Sperm whales have been noted to produce sounds with source levels as high as 180 to 220 dB, but interpretation of these reports must be cautiously applied to threshold intensities in marine mammals. Although vocalizations are reasonable indicators for mid-range hearing characteristics because peak spectra of vocalizations are generally near the best frequency of hearing in each species, it is important to recall that recorded outputs from an animal may have little to do with ear tolerances (Ketten 2000). Animals, including humans, commonly produce sounds which would produce discomfort if they were received at the ear at levels equal to the emitted level. Mammal ears are commonly protected from self-generated sounds passively by intervening tissues (head shadow and impedance mismatches) as well as by active mechanisms (eardrum and ossicular tensors). Marine mammals have analogous structures, and they are likely to be functional. Arguments that marine mammals can tolerate higher intensities simply because of their size and tissue densities are also not persuasive (Ketten 2000). The large head size of a whale is not acoustically exceptional when the differences in pressure and sound speed in water vs. air are taken into account.

Coda clicks differ from echolocation clicks in that they are not directional and are about 20 dB (mean of 165±5 dB re 1 µPa) less than the highly directional echolocation clicks (mean of 178±4 dB re 1 µPa) (Madsen et al. 2002). In addition to prey detection and possible stunning of prey, echolocation clicks provide information about distance from the ocean floor and the frequency spectra may be depth dependent (Thode et al. 2002). Clicks are repeated at rates of 1-90 per second (Backus and Schevill 1966, Watkins and Schevill 1977, Watkins et al. 1985). Recent vocalizations measured from a sperm whale calf estimated to be less than two weeks in age (Ridgway and Carder 2001) resulted in two types of clicks: (a) 1 to 2 ms high-frequency, low amplitude clicks with peak frequencies at 5 kHz to 12 kH (amplitude under 140 dB re 1 Pa), and (b) 7 to 20 ms low-frequency, high amplitude clicks with peak frequencies at 500 Hz to 3 kHz (148 to 165 dB re 1 Pa). Low-frequency grunts were also recorded at frequencies below 3 kHz. Adult sperm whales produce clicks at a frequency between 100-30,000 Hz. Most animals have vocalizations that are tightly linked to their peak hearing sensitivities in order to maximize intra-specific communication, but they also have hearing beyond that peak range that is related to the detection of acoustic cues from predators, prey, or other significant environmental cues (Ketten 1998). Thus, sounds within this frequency range are presumably within the hearing sensitivity range of sperm whales.

Audition

Anatomically, acoustically, and functionally, cetacean inner ears divide into three formats: Type I ears (high frequency), found in the highest frequency animals, have a functional upper bound greater than 160 kHz; Type II ears (mid to high frequency) have a functional upper bound less than 160 kHz; and Type M ears (low frequency cetaceans), common to baleen whales, have sensitivities as low as 10 Hz.

The auditory sensitivities of porpoises, dolphins and smaller toothed whales examined are greatest at very high frequencies (Figure 8). The consensus of the data is that virtually all marine mammal species are potentially impacted by sound sources with a frequency of 300 Hz or higher (Ketten 1998). From those odontocete species that have been measured, auditory thresholds increase at lower frequencies (i.e., the frequencies must be louder to be audible). For example, auditory sensitivities for the species that have been measured can hear sounds as low as 40-50 dB at frequencies between 1 kHz and 100 kHz, but at approximately 100 Hz, the sound may be required to be 120 dB to be heard. However, low frequency hearing in odonotocetes has not been fully studied (Evans 1998), and auditory sensitivities for more species must be obtained. Sperm whale hearing of low frequency sounds is likely more sensitive than that of other odontocetes; however, there are not many measurements of sperm whale sensitivity available (Ridgway and Carder 2001). Low frequency sound may affect sperm whales because their wide-band clicks contain energy between 100 and 2,000 Hz (Watkins et al. 1985, Moore et al. 1993). When the frequency output of a typical 3D seismic airgun array is overlaid on the audiograms for other species of odontocetes that have been measured, we can obtain a general range of frequencies (Figure 8, Figure 9) that would be audible for some other odontocetes. Hearing ranges are both size and niche related (Ketten 1998). In general mammalian ears scale with body size (Manley 1972, Ketten 1992, 1994, 2000, West 1986). Smaller animals typically have good high frequency hearing while larger animals tend to have lower overall ranges (von Békesy 1960, Greenwood 1962, Manley 1972, West 1986). Based on ear structure, body size, and deep diving behavior, sperm whale sensitivity to lower frequencies is greater than those reported for other odontocetes (Madsen et al. 2002, Ketten 1995, Watkins et al. 1985, Moore et al. 1993), and thus sperm whales are more likely to be vulnerable to disturbance from seismic surveys (Gordon 2002, Gordon et al. 1998).

Masking

Significant auditory interference, or masking, generally occurs when the interfering noise is louder and of a similar frequency to the auditory signal received by the animal that is processing echolocation signals or other information from conspecifics. The maximum radius of influence of an introduced sound on marine mammals is the distance from the source at which the noise can barely be heard. Richardson et al. (1995) define masking as: obscuring of sounds of interest by interfering sounds, generally at similar frequencies. Depending upon ambient conditions and the sensitivity of the receptor, underwater sounds produced by seismic operations may be detectable some substantial distance away from the activity. Any sound that is detectable is theoretically capable of eliciting a disturbance reaction by a marine mammal or masking a signal of comparable frequency.

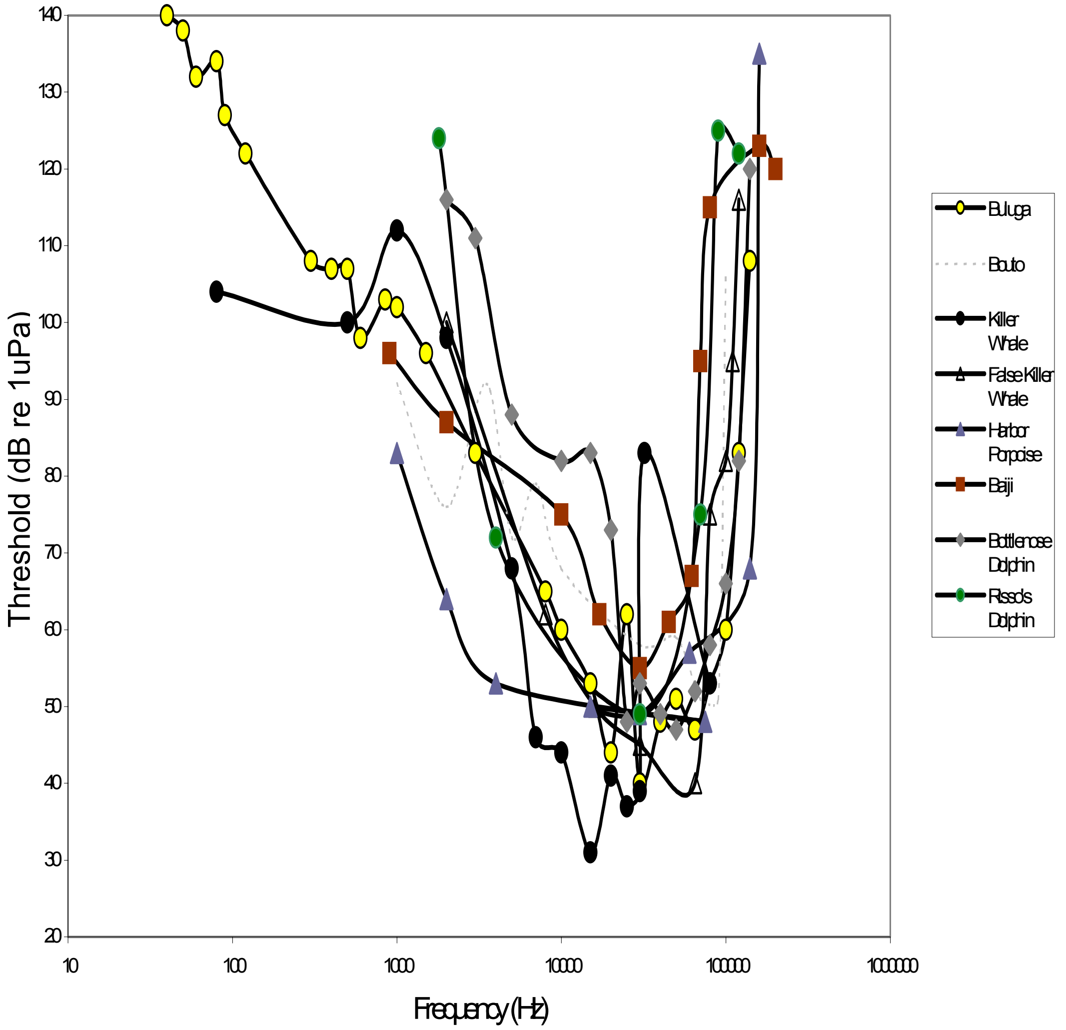

Figure 8. Audiograms for 8 species of odontocetes. Sensitivity is greatest at higher frequencies. As sensitivity decreases, dB level increases for those frequencies to be audible. Graph courtesy of Texas A&M University.

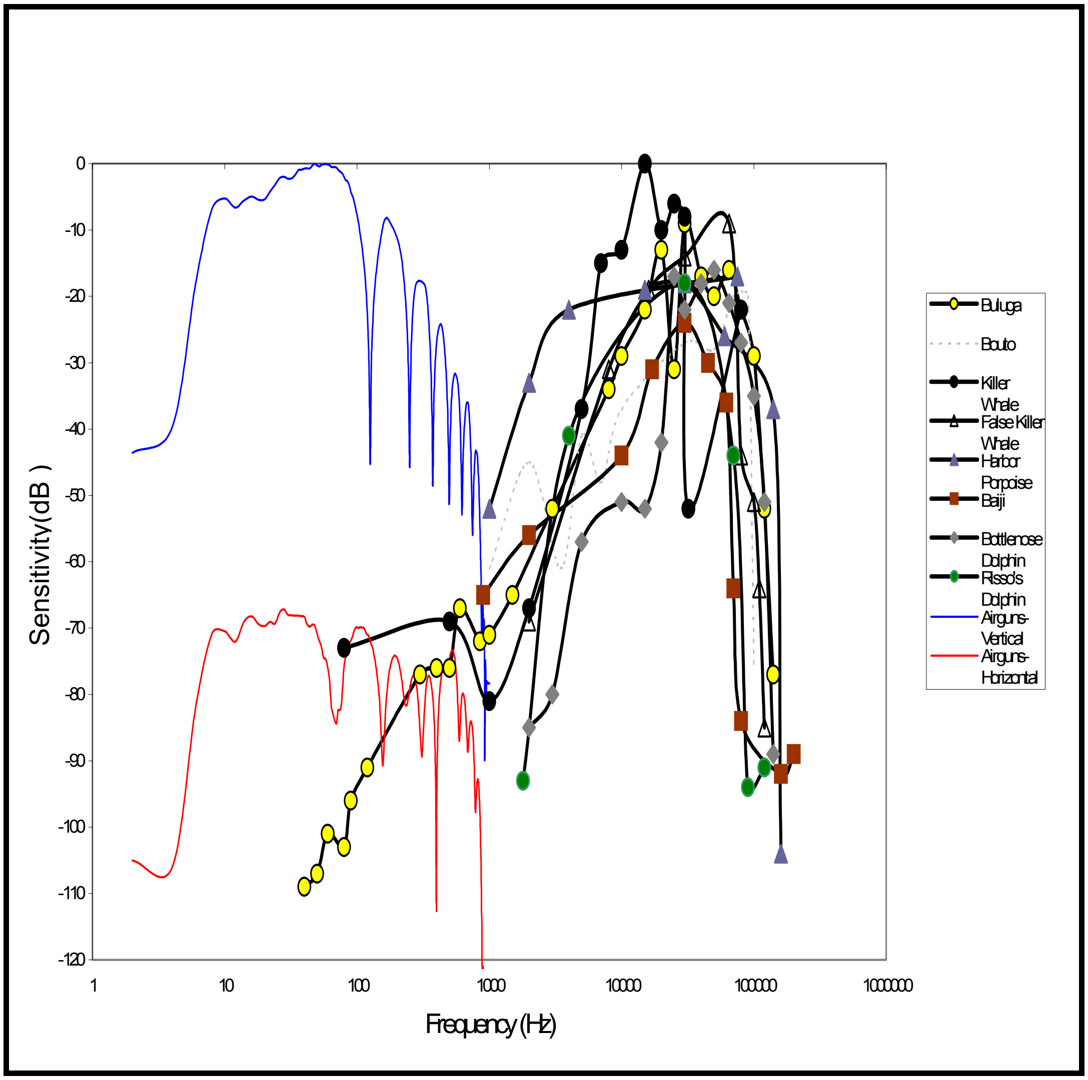

Figure 9. The vertical and horizontal output frequency spectra of a typical deepwater 3D airgun array overlaid on the hearing sensitivities of selected odontocetes. The measurements of output frequency spectra are limited between 3 and 880 Hz. Measurements were recorded with a band pass filter that does not represent higher frequency emissions below 3 Hz and above 880 Hz. Hearing thresholds have been normalized. The normalization is relative to the lowest hearing threshold for the killer whale (about 31 dB re 1 µPa at 15 kHz). Reproduction of audiogram data and airgun frequency spectra provided by the IAGC.

Although the frequencies produced by airguns are concentrated at lower frequencies, it is apparent from recent measurements (Goold and Fish 1998, Sodal 1999) that airguns produce a broad sound spectrum. This range is determined by either the hearing sensitivity of the animal, and/or the background noise level (Richardson et al. 1995). For example, communication signals in beluga are subject to masking by low frequency noises of icebreakers (Erbe 2000).

Large whale species are assumed to have good sensitivity to low and medium frequencies because their vocalizations are in this part of the sound spectrum. Masking for sperm whales is a possibility for some frequencies given some of the lower frequencies produced in their vocalizations that could affect communication between individuals, ability to receive information from their environment, or echolocation effectiveness. Sperm whales may rely on the detection of faint echos to locate prey. The ability to hear and respond to the calls of predatory killer whales, female pods, and calves also plays an important role of defense, reproduction, and nursing in the behavior of sperm whales. Sperm whale clicks can range to below 100 Hz, but most of the energy is concentrated at 2-4 kHz and 10-16 kHz, generally outside the most intense frequencies produced by seismic airguns in the Gulf, but higher frequencies are emitted from airguns at audible intensities above ambient noise levels.

Presently, research is being conducted to determine how the higher frequencies are generated during seismic surveys and the intensity levels at which they are emitted. It is probable that masking would be more likely to result from continuous noise rather than short pulses associated with seismic exploration (Richardson et al. 1995). Because airguns are typically fired at an interval of 13-14 seconds in deepwater surveys, the degree of any masking interference is likely very small. However, the probability that sperm whales will be affected by seismic activities will increase when multiple seismic surveys occur in adjacent survey areas, considering the low attenuation rates of sound in deepwater environments. In addition the possible considerations of multiple seismic surveys that are audible at any given location, the duration of the seismic pulse may increase with distance from the source due to the effects of multiple transmission paths, possibly increasing any disturbance affects that may occur by increasing the exposure time to the noise. This effect may be compounded from the occurrence of multiple seismic surveys. Similarly, if sperm whales perceive multiple seismic pulses as resembling their own vocalizations, then masking and disturbance affects might be expected to be more pronounced in this species if it occurs. However, the higher frequencies that have the potential to interfere with sperm whale reception of interspecific clicks would attenuate more rapidly than lower frequency sounds, thus greatly reducing decibel level and masking frequencies at greater distances. There is the possibility that the coda clicks of females that decrease in intensity over long distances may be masked to male receivers. Therefore, masking is theoretically possible; yet, it is unlikely to result from individual seismic surveys at closer distances, but may result due to possible increases in frequency over longer distances that could overlap with some frequencies produced by females. Without definitive studies some concerns still remain, particularly for those faint echoes from prey and passive sounds of lower intensity that may be important cues for sperm whales. In the absence of good field measurements from the seismic survey vessels in the Gulf of Mexico and information on the locations of seismic surveying, the possible affects from multiple seismic surveys cannot be fully analyzed at this time and deserve further study.

Avoidance

There is some observational evidence of variable responses by sperm whales to seismic pulses. Presently, the available information suggests that sperm whales have at least good hearing sensitivity in the mid to high range of hearing (Ketten 1994, Ridgway and Carder 2001)(see *Audition* section above), but their hearing ability at lower frequencies has not been tested and additional studies are needed. Evidence from the sounds produced by seismic surveys (towing of the array and airgun firing) and the observed disturbances to sperm whales indicate that they may be more vulnerable than other odontocetes to seismic surveys.

Sperm whale vocalizations consist of series of regularly spaced clicks. These are superficially similar to seismic pulses in that they are both powerful transients. It has been suggested that because they make these types of noises themselves, sperm whales may be less susceptible to damage by them, yet there is some evidence that disruption to normal behaviors (e.g., ceasing vocalizations, changes in dive frequency, and behavioral changes associated with temporary or permanent threshold shift) may possibly occur. Any alterations of normal behavior that result in avoidance of biologically important habitat, or alters feeding, breeding, or nursing will likely be biologically significant and are defined as takes under the ESA and the MMPA. The observed levels of disturbance associated with seismic surveys and the lack of available scientific information to refute these observations warrant NOAA Fisheries' determination that precautionary measures must be taken to reduce the potential for sperm whales to be adversely affected by the received level of sounds produced by airgun arrays within the 180 dB isolpeth.

As with other marine mammals, odontocetes exhibit disturbance reactions such as cessation of resting, feeding, or social interactions and/or changes in surfacing, respiration, or diving cycles, disruption of breeding or nursing, acoustic communication or feeding, and avoidance behavior in response to certain frequencies in the hearing range of the animal and to sound intensity. Rankin and Evans (1998) reported that seismic exploration in the Gulf of Mexico had negative impacts on aspects of communication and orientation behavior of sperm whales. There have been a number of reports that odontocetes are observed less frequently and cease vocalizing when seismic surveys are being conducted (e.g., Goold 1996). Based on such observations, inner ear anatomy, and the available evidence that sperm whales have greater auditory sensitivity to low frequency sounds than other odontocetes, it is reasonable to assume that some observable behavioral reactions such as increased dive frequency, shorter resting periods, or shorter dive times may possibly result from exposure to low frequency sounds, but the results of seismic surveys on sperm whales have been inconclusive.

Bowles et al. (1991, 1994) reported that sperm whales did not vocalize during periods when a seismic survey vessel was heard firing at a range of 370 km. This seismic survey vessel was using an array of 8 x 16l Bolt airguns with an estimated source level of 263 dB. At this range, the seismic pulses had a duration of 3 secs, ranged in frequency from 30-500 Hz, and had received levels of 120 dB re. 1 m Pa measured at a range of 1,070 km. Studies by Rankin and Evans (1998) indicate that seismic exploration in the Gulf of Mexico has negative impacts on aspects of sperm whale communication.

A cetacean population may be spread over a large area; some parts of that area may be more important than others because of the presence of an important food source, breeding area, or nursery area. If this happens to coincide with the zone of influence of a seismic survey then a disproportionate part of the population might be affected (Evans 1998). The area south of the Mississippi delta is a known nursery area in the Gulf for an apparently resident population, and is thought to be a biologically important area to sperm whales for hunting and raising calves. Research into the dynamics of the Gulf of Mexico population continues. The use of DTAGs in association with visual and acoustic observations from research vessels has recently provided an excellent means to assess possible effects of seismic exploration on sperm whales. In one DTAG deployment in the northern Gulf of Mexico on July 28, 2001, researchers documented that the tagged whale moved away from an operating seismic vessel once the seismic pulses were received at the tag at roughly 137 dB re 1µPa (Johnson and Miller 2002). Such avoidance reactions have been documented in the past, but their biological significance remains unclear.

In an opportunistic observation, the number of sperm whales has been reported to decrease in an area when airguns were used in the Gulf of Mexico (Mate et al. 1994) and sperm whales are also reported to have moved out of areas after the start of airgun seismic testing, indicating that the potential for acoustic harassment and disturbance from the dB levels and/or frequency ranges produced from seismic surveys may exist. Mate also reported that sperm whales sighted over a few days in a particular area began to leave and were possibly displaced up to 60 km when seismic activities occurred. This suggests that sperm whales may be harassed by seismic surveys, but might remove themselves from harmful exposure to airgun pulses. Sperm whale density had been reduced to approximately 1/3 of pre-survey levels after two days and they were completely absent from the area after five days. It should be noted that this report resulted from an opportunistic observation rather than a planned study, but it should serve to prompt further investigation to ensure that seismic surveys do not exclude sperm whales from their habitat. Sperm whales have also been reported to temporarily vacate the waters off Kaikoura, New Zealand after a seismic survey (IFAW 1996).

In contrast to these reports of sensitivity to seismic pulses, other observations suggest that sperm whales are not excluded from habitat by seismic surveys (e.g. Rankin and Evans 1998, Swift 1998). Swift (1998) used acoustic monitoring techniques to determine the relative abundance and distribution of sperm whales by detecting vocalizations. Acoustic detection rates were actually higher during the seismic surveying period than before and after the survey. Swift (1998) also found no significant difference in detection rates between 'guns on' and 'guns off' periods during the seismic survey itself, suggesting a lack of short-term responses as well. However, it should be noted that, using hydrophones, these researchers were able to detect sperm whales at ranges of 5 miles and this may have made changes in behavior and distributions at lesser ranges more difficult to detect. In an opportunistic observation, the IAGC (2002) has reported that a solitary sperm whale tracked in the western Gulf of Mexico did not exhibit any apparent displacement from seismic survey activities in the vicinity. Another recent study looked at male sperm whale click patterns and position relative to an airgun array with a nominal working pressure of 2000 psi and a source level of 261 dB (Madsen et al. 2002). The vessel towing the array was located greater than 20 km from the sperm whales in polar waters off northern Norway. The received intensity level that sperm whales experienced from the seismic vessel was measured at 146 dB re 1 μPa (p-p). The received levels from the distant seismic vessel did not elicit any apparent avoidance behavior by the males, nor did the pulse evoke any changes in the acoustic behavior during foraging (Madsen et al. 2000).

A summary of survey safety zones for cetaceans and common mitigation measures is presented in Tables 3 and 4.

Many countries have regulatory laws in place to protect marine mammals from seismic surveys (Pierson et al. 2001). Australia's Environment Protection and Biodiversity Conservation Act, which requires that air guns be shut down when a whale approaches within a three km radius, and not restart until the whale is gone, or has not been spotted for 30 minutes. The United Kingdom presently implements guidelines for minimizing acoustic disturbance of marine mammals from seismic surveys (JNCC 1998). Pierson et al. (2001) presents a compilation of mitigations that are implemented by various countries to reduce the affects of seismic exploration on marine mammals. From observer reports on seismic surveys, it has been reported that there is a tendency for cetaceans to increase swimming speed, breach, and jump. Nearly all species, including sperm whales, were found to be farther from the air guns when they were firing than when they were not (Stone 1997, 2000, 2001). Sperm whales were more likely to be logging at the surface during airgun use, and were observed to dive more frequently when the airguns were not firing. Logging is when a whale lies still at the surface of the water, resting with its tail hanging down. While floating motionless, part of the head, the dorsal fin or parts of the back are exposed at the surface. These reports note that although these trends in behavioral reactions are emerging, the sample sizes for sperm whales have been too small to determine whether these behavioral reactions are significant. However, these observations are consistent with observations of other large whale species in response to airguns for which there are good data, and may reflect the tendency for sperm whales to dive when airguns are not firing, and remain at the surface during airgun use. Most of the energy from airguns is directed downwards, resulting in a sound shadow in surface and near-surface waters where received sound levels are of much less intensity. During an experiment on seismic airgun effects with humpback whales in Australia, humpbacks were also observed more frequently at the surface, when airguns were firing (McCauley et al. 2000). The researchers suggested that the increased observations of humpbacks at the surface when the airguns were firing may have been indicative of humpbacks utilizing the sound shadow in surface waters.

More research is needed to study the variables that may affect sperm whale’s reactions to anthropogenic acoustic emissions and the conditions under which the responses are observed. Some of the factors that may affect the observable behavioral reaction of sperm whales to seismic pulses include habituation, sensitization, and threshold shift, the behavior of the whale at the time of disturbance (e.g., migrating, feeding, mating, nursing, and resting), sex, and distance and received level from the seismic source. Distance from airguns has been found to be an important factor affecting humpbacks (McCauley et al. 2000), gray, and bowhead whales (see Richardson et al. 1995 for summary on these species).

Table 3. Safety zone radii employed during recent seismic surveys (adapted from Pierson et al. 2001).

	Survey Impact Zone Radius		
Geographic Area	**Mysticetes**[1]	**Odontocetes**	**Pinnipeds**
Gulf of Mexico	No Mitigation	500 m [2] (1,0640 ft)	NA
United Kingdom 1995 to present	500 m [3] (1,0640 ft)	500 m [3] (1,640 ft)	500 m [3] (1,640 ft)
Alaska (Beaufort Sea) Northstar, 1997	1,020 m [4] (3,346 ft)	1,020 m [4] (3,346 ft)	260 m [5] (853 ft)
Southern California (Santa Barbara Channel) Santa Ynez Unit, 1995	450 m [4] (1,476 ft)	152 m [5] (500 ft)	152 m [5] (500 ft)
Washington/British Colum (Pudget Sound region), SHIPS, 1998bia	500 m [6] (1,640 ft)	200 m [7] (656 ft)	100 m [8] (328 ft)

Superscripts:
1. This category includes sperm whales for some surveys.
2. This category only includes sperm whales.
3. A distance at which cetaceans may be relatively reliably observed.
4. The distance at which the received level was estimated to be 180 dB re 1 µPa (rms) for the largest array used.
5. The distance at which the received level was estimated to be 190 dB re 1 µPa (rms) for the largest array used.
6. An additional 100 m was added to the distance at which the received level was estimated to be 180 dB re 1 µPa (rms).
7. This was twice the distance at which the received level was estimated to be 210 dB re 1 µPa (rms).
8. The distance at which the received level was estimated to be 210 dB re 1 µPa (rms).

Table 4. Mitigation and monitoring measures employed during recent seismic surveys (adapted from Pierson et al. 2001).

Survey mitigation or monitoring measure Geographic Region	Seasonal restrictions	Aerial restrictions	Ramp-Up	Safety Zones	Shipboard Observers	Acoustic Monitoring	Aerial Surveys
Gulf of Mexico	No	Yes	Yes	Yes	Yes	Optional	No
United Kingdom 1995 to present	Yes	Yes	Yes	Yes	Yes	Optional	No
Alaska (Beaufort Sea) Northstar, 1997	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Southern California (Santa Barbara Channel) Santa Ynez Unit, 1995	Yes	No	Yes	Yes	Yes	Yes	Yes
Washington/British Columbia (Puget Sound region) SHIPS, 1998	Yes	No	Yes	Yes	Yes	Optional	Optional

Habituation and sensitization

In addition to disturbance, habituation and sensitization also are important when discussing the potential reactions of whales to a noise stimulus. Habituation refers to the condition in which repeated experiences with a stimulus that has no important consequence for the animal leads to a gradual decrease in response. Sensitization refers to the situation in which the animal shows an increased behavioral response over time, to a stimulus associated with something that has an important consequence for the animal. Richardson et al. (1990) provided an example of bowheads becoming habituated to the noises from dredging and drilling operations. Conversely, Richardson et al. (1995) cited Walker (1949) as reporting that the responses of gray whale mother and calf pairs to a hovering helicopter seemed to increase the more the helicopter herded the mother and calf pairs into shallow water.

In toothed whales, one apparent example of habituation is the tolerance by white whales of the many boats that occur in certain estuaries versus the extreme sensitivity of this species to the first icebreaker approach of the year in a remote area of the high Arctic. Odontocetes may be attracted to fish killed by underwater explosions and may be highly motivated to remain in an area that would otherwise pose a risk. Also, in certain areas, wild dolphins have become unusually tolerant of humans, and may even actively approach them (Lockyer 1978, Conner and Smolker 1985, Shane et al. 1986).

In general, there is a tendency for the level of response to human-made noises to scale with the level of variability and unpredictability in the sound source (Richardson et al. 1995). Animals may show little to no response to a noise source with a relatively constant intensity level and constant frequency spectrum (e.g., a humming generator or operational drilling platform) but will react to a noise source that is rapidly changing in intensity or in frequency content (e.g., an exploration drilling platform, ice breaking activity). Of course, when whales are presented with very loud noises they will likely react regardless of whether they are intermittent or continuous.

The behavioral responses of marine mammals to noise are quite variable. A host of factors may affect an animal's response to a particular stimulus including: 1) its previous experience of the stimulus; 2) any associations the individual may have made with that signal; 3) the individual's auditory sensitivity; 4) its biological and social status; and 5) its behavioral state and activity at the time. Thus, by their very nature, behavioral responses are likely to be unpredictable. Habituation occurs when an animal's response to a stimulus wanes with time. This often results because the stimulus is no longer novel and no aversive events have become associated with it. Animals are most likely to habituate to sounds or activities that are predictable and unvarying. For example, sperm whales off Key West, Florida exhibit dramatic reactions to approaching research vessels, and the sperm whale group off the mouth of the Mississippi River is much more easily approached (Anonymous 2002). Although, this has not been yet been associated with habituation to vessel traffic or the high occurrence of seismic surveys in that region, it raises some important questions in regard to why these behavioral differences are observed for the same species.

The opposite process is sensitization, when experience of a signal leads to an increased response. Often, sensitization will occur when an animal learns to associate a sound with a harmful or unpleasant event. In such cases, animals might be expected to respond to signals when they are only just audible. The calls of predators are one example of signals in this class. For example, an animal that had been exposed to levels of sound at a level high enough to cause discomfort might show avoidance responses at a lower level on subsequent exposures, while other animals, which had only been exposed to lower levels, might become habituated (Gordon 1998). Thus, quite different response behaviors might become established in different individuals. Within a species, different classes of individuals might be expected to be differentially vulnerable and/or responsive. For example, a mother nursing a young calf might be more likely to show avoidance behavior than a male guarding a breeding territory. Also, the animal's behavioral state might make it more or less likely to exhibit disturbance behavior: animals that are resting or engaged in some non-essential activity would be expected to show greater behavioral change than animals highly motivated to perform an important activity, such as nursing, breeding, or feeding.

Mother/calf pairs

Mothers and their dependent calves are probably the elements of populations that are most vulnerable to disturbance. In some species of odontocetes, calves remain with their mothers for several years. Sperm whale calves cannot perform the long, deep dives required by adults to locate and hunt prey. Calves are routinely left alone at the surface while their mothers feed many thousands of meters below (Gordon 2002). Serious disturbance caused by avoidance of adults could lead to lost calves and possible increased mortality. Also, any serious interruptions to feeding behaviors by decreased foraging efficiency or changes in squid distribution by airgun emissions may have large affects on a lactating female and may affect a calf's nutritional status and health. The low reproductive rate of sperm whales means that populations will be slow to recover from any increased mortality or decreased fitness. Displacement by a continually operating seismic vessel in an important habitat type could have much more profound and serious effects on the population than is observed from individuals. Calves are small, comparatively weak, and possibly vulnerable to predation, exhaustion, and other stressors in the environment. If repeated displacement or disruption of animals in the nursery area near the Mississippi River Delta region of the Gulf of Mexico occurred, serious consequences at the population level that affect recruitment rates could result. Calves are dependent on the pod for nutrition and sheltering. The potential dislocation of these animals in a confined area would leave calves open to a number of dangers, including predation, interruption of feeding, and exhaustion. These potentially damaging or disturbing affects of seismic surveys cannot be considered in isolation since other anthropogenic stressors could synergistically increase the effects to an animal or population.

It is possible that seismic survey noise could cause some problems in the biologically sensitive area off the mouth of the Mississippi River and for other cow/calf pairs throughout the GOM. Seismic surveys, and those surveys in combination with other factors (e.g., vessel traffic and drilling and production activities), may have affects such as: excluding sperm whales from important areas at significant times; changes in prey distribution, disruption of biologically significant behaviors (e.g., feeding and nursing) and increased levels of stress. Potentially, very large numbers of animals could be affected in this way. The level of disturbance from seismic surveys may seem less severe than direct mortality of individuals, but disruptions on this scale could affect many more individuals and extend over significant periods of time.

Diving and feeding

Sperm whales spend a large amount of time below the surface while feeding. The sperm whale dive takes then down to a depth where they could be passed over by operating seismic vessels without visual detection. As airgun arrays are generally configured to produce a maximum, low frequency energy lobe directly downwards toward the seabed, sperm whales may enter a region of increased ensonification relative to more near-surface species (Figure 10). Foraging along the bottom may be a risk factor for disturbance because the requirement of such animals to dive to the bottom to feed significantly increases the energetic outlay for foraging. Because the whale forages on the bottom, it may be tied to localized food resources that it has learned to find and capture. Disturbances from seismic surveys may result in whales moving away from their

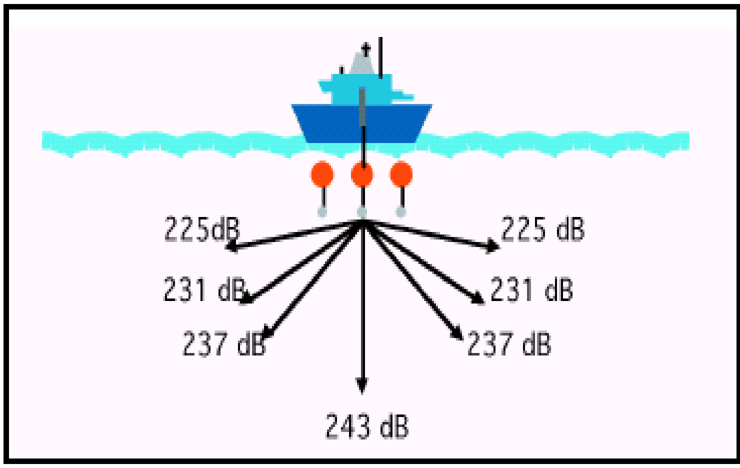

Figure 10. Spherical spreading of the signal beneath an airgun array. Sound is directed downwards directly beneath the array. Sound levels lateral to the array are of lesser intensity, yet strong compared to ambient noise levels. Sound levels represented will vary with airgun model and array configuration. Figure from Caldwell and Dragoset (2000).

preferred feeding area in order to avoid a loud noise source. Alterations to feeding behaviors may have a much greater impact on whales that tend to foraging in preferred areas than on sperm whales that feed on more widely dispersed squid in the middle of the water column (Johnson and Miller 2002).

A diving animal is committed to a strict energy budget, which ensures that the oxygen stores within its body are managed to allow the animal to dive to a certain depth for a particular length of time. These considerations may mean that a diving animal's options for avoiding loud noise sources are constrained and the consequences of their taking avoidance action may be greater than they would at first seem. From the perspective of an animal wishing to avoid loud noise sources, this is likely to mean that strategies involving energetically costly activities, such as rapid swimming, may be precluded, particularly towards the end of dives when oxygen stores will be minimal.

It is also likely that the natural response of an air-breathing diver to an unknown threat or alarming stimulus, will be to head to the surface where they will at least have access to air, but for deep divers this may take them closer to the noise source. There are indications that humpback whales (McCauley et al. 2000) and deep divers such as sperm and pilot whales surface (Stone 1998) in response to seismic air gun activity (Gordon 2002). Even modest reductions in the time available for recovery on the surface may be deleterious. For example, sperm whales which feed at great depths invest a significant proportion of each dive in traveling to and from these foraging areas. Thus, a reduction in dive length, caused perhaps by being forced to dive early before full recovery, would result in a proportionally larger decrease in time spent usefully feeding at depth.

Since sperm whales perform long, deep dives, it is very possible that individuals could be located in mid-water near an airgun array when it begins to fire. If it is out of the beam directly below the array it may actually hear the echo from the bottom as being louder than the sound arriving directly, and this has often been the case monitoring whales on the Atlantic Frontier in the UK. (Gordon 2002). Moving away from the loudest source of noise may then bring the whale towards the source rather than away from it. With these considerations of the energetic and behavioral limitations that deep diving behavior places on sperm whales, the significance of any potential alterations to their normal behavior becomes more apparent.

Generally of course, submerged whales are not visible at the surface, and divers such as sperm whales may dive up to two hours, but routinely perform dives of between 30-60 minutes. Ramp up or soft start procedures may allow for sperm whales to be sighted in the impact zone during the ramp up period, or "annoy" sperm whales into leaving an area before potentially harmful dB levels are received. It is not simply the level and frequency of noises that may cause disturbances, but sudden increases in noise, unusual noises and rapid movements of the noise source may all be particularly alarming to sperm whales. Based on evidence from responses to vessel noise, some marine mammals do not always move away from high intensity, lower frequency sound. This may be the case when behaviorally directed motivations outweigh any risks associated with that behavior (e.g., feeding, breeding, or nursing). A lack of response to these sounds may expose individuals to harmful sound levels that may result in temporary or permanent hearing loss.

Threshold shift

In terrestrial mammals (and presumably in marine mammals), received sound levels must far exceed the animal's hearing threshold (hearing sensitivity) for there to be any temporary threshold shift (TTS) and must be even higher for there to be risk of permanent threshold shift (PTS) (Richardson et al. 1995). Threshold shift has been reported for bottlenose dolphins and belugas to both tones and waterguns (Finneran et al. 2000, 2002). The more easily observed responses include changes in activity or aerial displays, movement away from the sound source, or complete avoidance of the area. The reaction threshold and degree of response are related to the activity of the animal at the time of the disturbance. Whales engaged in active behaviors such as feeding, socializing, or mating are less likely than resting animals to show overt behavioral reactions, unless the disturbance is directly threatening. The temporary or permanent loss of hearing range has a similar affect on behavior as masking in that the ability of a cetacean to navigate, communicate, and detect predators and prey may be altered. A marine mammal very close to one of the airgun arrays may be at risk of temporary or permanent hearing impairment. TTS is a theoretical possibility for animals within a few hundred meters (Richardson et al. 1995), and repeated exposure to sounds resulting in TTS are thought to cause PTS.

Sound pressure levels from an acoustic source that are of sufficient intensity, such as with large seismic airgun arrays, pose this risk. Richardson et al. (1995) hypothesized that marine mammals would have to be well within 100 m of an airgun array to be susceptible to immediate hearing damage based on measurements in the Beaufort Sea. In other areas cetaceans may be exposed to levels of 180 dB from airguns at distances of 1000 m (1 km) (McCauley 1994) or more. Although the main energy from airgun emissions is of lower frequency, there is sufficient energy at higher frequency levels to be audible to odontocetes, including sperm whales. Although sperm whales are presumed to have poorer hearing sensitivities at lower frequency levels (i.e., the sound needs to be louder to be heard), it is not certain whether the effects caused by the low frequency sound are reduced as a result (Finneran et al. 2000). There is sufficient intensity produced from airgun arrays to likely have some adverse effects, especially to animals beneath an array and at close distances. The field measurements of sound propagation for different types of seismic surveys in the GOM have not been well reported, and are likely different in the GOM than for other areas reported. Seismic signals in the deepwater Gulf of Mexico are carried much greater distances than in shallow water, but the attenuation of sound will vary with the physical characteristics of the survey area. There is some evidence of the sensitive hearing structures of sperm whales being damaged resulting in threshold shift.

Examination of two ship-struck sperm whales (a mother and male calf) off Gran Canaria revealed both had auditory damage (reported in Oman 1998). The whales were resting at the surface and made no apparent attempt to avoid the barge which struck them. Computerized tomography scans showed that ears from both animals had reduced auditory nerve volumes, and one animal had patches of dense tissue in the inner ear. These findings were consistent with auditory nerve degeneration and fibrous growth in response to inner ear damage (André et al. 1997). When sperm whales in the area were played back low frequency noise, they exhibited no behavioral response. In conjunction with scan results, this suggests that noise from shipping had impaired the hearing thresholds of sperm whales for low frequency sound, increasing the probability of collision with vessels in a high volume shipping lane (André et al. 1997). It is thought that the population of resident sperm whales in that area experience PTS, resulting in the whales being acoustically "blind" to approaching vessels resulting in many mortalities each year. Recent strandings of two beaked whales have been attributed to seismic surveys in the Gulf of California, indicating that auditory trauma may possibly result from seismic surveys and an associated risk of PTS and TTS, and a flight response resulting from exposure to the airgun noise for that species. The possibility of threshold shift in sperm whales has not received much attention in the GOM. However, based on current evidence, the risk of threshold shift exists from both continuous (e.g., propeller cavitation) and repeated exposure to non-continuous (e.g., repeated airguns firing) anthropogenic sound.

NOAA Fisheries believes that activities should avoid, to the greatest extent practicable, exposing mysticetes, elephant seals, and odontocetes, including sperm whales, to a sound pressure level of 180 dB re 1microPa-m (rms) or higher. For all other pinnipeds, activities should avoid, to the greatest extent practicable, exceeding a level of 190 dB re 1 µPa-m (RMS). These determinations are based on findings of the High-Energy Seismic Workshop held at Pepperdine University in 1997 as updated by the NOAA Fisheries' Acoustics Workshop held in Silver Spring, Md. in 1998. The 180 dB re-1µPa-m level is also an estimate by the U.S. Dept. of the Navy (2001) of the threshold of sound energy that may cause hearing damage in cetaceans, and NATO presently utilizes a conservative 160 dB safety zone for cetaceans (NATO 2001). It is unclear which measurements of a seismic pulse provide the most helpful indications of its potential impact on marine mammals (Gordon et al. 1998). Gordon et al. speculate that peak broadband pressure and pulse time and duration would be most relevant at short ranges (hearing damage range) while sound intensity in 1/3 octave bands is a more useful measurement at distance (behavioral affects). This is presently the best scientific information available.

We note, moreover, that the precautionary application of a 180 dB safety zone for protecting cetaceans does not necessarily mean that animals entering that zone will be adversely affected by alteration in hearing ability or behavior. It simply means that animals have the potential to incur a temporary elevation in hearing threshold (TTS) at the 180 dB sound pressure level or may experience permanent hearing (PTS) loss at these greater sound pressure levels which, in turn, could also result in behavioral alterations similar to masking. Threshold shift may alter an individuals ability to hear conspecifics, and detect prey, predators, or other important acoustic information in the environment. Observations of these impact zones would additionally help reduce any adverse behavioral effects that could result from exposure to such sound intensity levels.

Summary of potential impacts to sperm whales from seismic surveys

Sperm whales are clearly aware of their acoustical environment and can exhibit behavioral reactions including cessation of vocalizations, disruption of feeding and dive behaviors, and locomotive avoidance. Because they spend large amounts of time at depth and use low frequency sound, sperm whales are likely to be vulnerable to the effects of low frequency sound in the ocean (Croll et al. 1999). Based on the above analysis of effects, there is evidence that sperm whales may be affected by both the high and low frequency spectrum of sounds. Even though sperm whales are abundant on a world-wide scale (Reeves and Whitehead 1997), because their potential rate of reproduction is so low and because those found in the Gulf of Mexico are believed to be a small, resident population (N_{min}= 911), even small negative impacts of noise resulting from activities associated with the proposed action could contribute to population declines.

These impacts resulting from acoustic disturbances may frighten, annoy, or distract sperm whales and lead to physiological and behavioral disturbances. Response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al. 1995). Sounds can cause reactions that might include disruption of sperm whales' normal activities (behavioral and/or social disruption) and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al. 1995).

The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Energetic consequences would depend on prey availability. Of the animals responding to noise, females in late pregnancy or lactating would probably be most affected. Human-made noise may cause temporary or permanent hearing impairment in marine mammals if the noise is strong enough. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but this does not prove that the animals are unaffected by noise; for example, they may become stressed, making the individual(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation (MMS DEIS 2002). Aversive levels of noise might cause animals to become irritable, affecting feed intake, social interactions, or parenting; all of these effects may result in population declines over time and repeated exposure.

Any behavioral responses causing adverse effects to individuals and cow/calf pairs, reproduction, feeding, or TTS and PTS due to seismic activity may result in negative impacts to the population. Sperm whales in the vicinity of seismic surveys may be harassed by the frequency and intensity levels associated with these activities that may result in alteration of their natural behaviors (e.g., increased dive frequency possibly disrupting diving patterns, resting patterns necessary for hunting, and interference with passive detection of prey). Of particular concern may be the disruption of cow/calf pairs, diving energetics, and foraging success. All cetaceans including sperm whales should, at minimum, be protected from the risk of threshold shift and cow/calf disturbance should be minimized. Monitoring of impact zones and observations of sperm whale behavior near seismic vessels will minimize the risks (i.e., TTS, PTS, and associated alterations to behavior) from exposer to high intensity seismic pulses ≥180 dB re 1 μPa, and will assist in better understanding the degree of behavioral reactions to these activities.

In assessing the effects of airgun noise, zones of influence can be estimated based on horizontal distances from the sound source; however, as seismic exploration increasingly moves into deeper offshore waters the magnitude of the third dimension, depth, becomes more significant (Gordon et al. 1998). Sperm whales spend significant amounts of time underwater and at very substantial depths. Sperm whales regularly make dives in excess of 1,000 m (Watkins et al. 1993), and have been recorded down to 2,500 m (Norris and Harvey 1972). Diving takes them into regions in which received sound levels are higher than those measured or predicted close to the surface, including the zones beneath and at angles to air gun arrays in which most sound is focused (Figure 10). Since airgun arrays are towed a few meters beneath the surface of the water and the sound is directed downward, the received sound intensity in surface and near surface waters may be from 20 - 40 dB lower than levels received by submerged animals, and has been referred to as the sound shadow (also referred to as the shadow zone) earlier in this document. When calculating the impact zone to animals that are deep divers and spend a majority of their lives beneath the surface, received levels in the depths are more important than those found in surface waters. Calculations have been proposed that include subtracting 20 dB from the source levels prior to mathematically calculating impact zones. This method may be appropriate for more surface dwelling species that perform short, shallow dives, but is not effective for minimizing sound exposure to deep dwelling cetaceans such as the sperm whale, since this “array effect” only applies to surface waters.

New information is expected to be available soon from MMS in a programmatic Environmental Assessment on Geological and Geophysical Exploration in the GOM that can better predict frequency with decibel level produced by airgun arrays at given depths and angle from the source. Information from airgun models and array configurations in the GOM has been sparse, and has not allowed NOAA Fisheries to accurately calculate the zones of influence based on frequency and decibel level for different array configurations and survey types. Impact zones should be conservatively calculated based on spherical spreading models until better field measurements are reported. The Draft Environmental Assessment on Geological and Geophysical Exploration for Mineral Exploration on the Gulf of Mexico suggests that seismic surveys in Federal OCS waters of the GOM ≥ 200 m is likely to range from close to free-field (20log[R]), and a more conservative model for the possibility of sound channels in some locations should also be considered (15log[R]). Propagation characteristics are affected by water depth, temperature, salinity, depth of the sound source, and other parameters that will determine the appropriate model.

By means of a Gulf-wide Notice to Lessees for all seismic activities (30 CFR 250.103, August 22, 2002), MMS has implemented a 500 m impact zone to minimize any possible effects to sperm whales. For typical 2-D and 3-D towed array seismic surveys with estimated source levels of 257 dB re 1 µPa (-3 dB rms conversion), a 500 m impact zone for a 180 dB isopleth equates to an estimated source level of approximately 232 dB, not 260 dB for typical surveys in the GOM. At source levels of 257 dB (rms), the 20log[R] model and associated calculation above produce received levels of 203 dB re 1 µPa at 500 m from the source in subsurface waters (a conservative estimate) and 183 dB in surface waters due to the array effect. Presently, the impact zone of 500 m closely approximates the received dB levels in surface waters, but may not accurately reflect the 180 dB isopleth and associated impact zone beneath an array. These disparities between dB measurements for surface and sub-surface waters indicate the need for better data to effectively formulate models that can be used to better calculate an impact zone for sperm whales and other deep diving cetaceans. Field measurements of propagation characteristics of airgun pulses will assist in determining the model that "best fits" the airgun arrays and sound propagation characteristics in the deepwater GOM. NOAA Fisheries believes that ramp-up procedures and visual monitoring of an impact zone coupled with PAM systems will more effectively minimize possible adverse effects to sperm whales (NMFS 2002). Conservative estimates should be used to calculate impact zones for sperm whales without the array effect until more appropriate models can be formulated from field measurements that effectively minimize the risk of threshold shift to sperm whales.

Sea turtles

Sea turtle hearing sensitivity is not well studied, but a few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al. 1969, Lenhardt et al. 1983, Bartol et al. 1999). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al. 1983). Some possible reactions to low frequency noise include startle responses and rapid swimming (McCauley 2001), and swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions by utilizing the sound shadow (Lenhardt 1994).

There have been several controlled experiments that have documented that sea turtles can hear and behaviorally respond to environmental noise. A study with loggerhead sea turtles in water-filled tanks reported responses to low frequency sounds by rapid swimming movements indicating some behavioral response to vibration applied directly to the carapace, and some loggerheads exposed to low-frequency sounds responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt 1994). Loggerheads responded with rapid swimming movements induced by low frequency vibration delivered to the carapace, but no flipper or head movements were observed in response to airborne sound pressure (Lenhardt et al. 1996). The behavioral thresholds (the lowest intensity to elicit a behavioral response) were recorded at 430 Hz and 500 Hz for bone conducted sound and have been measured to have an effective hearing range between 250 and 700 Hz (Bartol et al. 1999). It was also noted that some air is maintained behind the eardrum in shallow water, and that the middle ear air bubble could serve as a sound pressure to displacement transformer allowing turtles to detect sound pressure beyond the near field (Lenhardt et al. 1996).

These experiments have demonstrated that sea turtles can detect and respond to frequencies consistent with measured cochlear potentials, and due to limitations of bone conducted sound, may only respond to a limited range of sound intensities. However, the question of the detection of sounds and the differences between functional responses that sounds may elicit in aquatic and terrestrial environments remain largely untested. Interestingly, although certain intensities may be required to elicit responses through bone conducted hearing, sounds between 100 and 800 Hz can be detected at lower energy levels and are likely purely auditory (Lenhardt 1994). Baker (2000) tested the behavioral responses of leatherback hatchlings to four sounds (surf sounds, highway traffic sounds, an organ tone [392 Hz] pulsing at one second intervals, and music). Leatherbacks exhibited significant orientation towards the surf sounds and music. Although a pure 392 Hz tone near the peak range of hearing in sea turtles did not elicit a response, the broader frequency spectrum of low frequency sounds of breaking waves and the sounds of music elicited significant, positive phonotaxis from leatherback hatchlings. These responses by leatherback hatchlings were elicited at a sound pressure level of 90 dB in air. The intensity of any given frequency will be greater for sea turtles in the marine environment than in air due to differences in the propagation of sound pressure levels between water and air, and reception differences of auditory membranes submerged in water. Generally, for a truly amphibious animal, underwater sound intensities would need to be approximately 59.7 dB greater to be numerically comparable to sound intensity levels in air (Ketten 2000). For example; humans begin to feel discomfort at approximately 120 dB in air. It has been inferred that marine vertebrates may begin to experience similar discomforts at 180 dB re 1 µPa in water. Sea turtles may also have difficulty detecting frequency and signal direction due to the increased speed of sound in water (1530 m/sec) than in air (340 m/sec). The speed of sound in seawater varies roughly between 1460 m/s and 1555 m/s, because it is dependent on temperature, salinity and pressure. Due to the faster propagation of sound in water, the time of arrival between the ears is greatly reduced which would make localizing a sound source more difficult. However, head movements by swimming or scanning back and forth, and at surface auditory reception may behaviorally compensate for the auditory limitations of sea turtles in water.

A recent study has investigated the effects of airguns on sea turtle behavior. McCauley et al. (2000) reported that green and loggerhead sea turtles show avoidance to 3D air-gun arrays at 2 km and at 1 km with received levels of 165 dB re 1 µPa and 175 db re 1 µpa respectively. Responses by sea turtles were consistent and showed that above an air-gun level of approximately 166 dB re 1 mPa mean squared pressure the turtles noticeably increased their swimming activity compared to non air-gun operation periods and above 175 dB re 1 mPa mean squared pressure their behavior became more erratic possibly indicating the turtles were in an agitated state. The increase in swimming behavior tracked the received air-gun level, in that the turtles spent increasingly more time swimming as the air-gun level increased. The authors cautioned that these observations are variable and thus far, are based on few observations. However, the authors indicate that these observations are consistent with avoidance to airguns around 175-176 dB re 1 mPa mean squared pressure (O'Hara 1990) and reinforce the view that at this level, active avoidance of the air-gun source would occur. The results of Moein et al. (1994) showed that the avoidance behavior first observed at the beginning of the trials was not statistically significant for loggerheads receiving repeated air-gun exposures several days after their first exposure. They concluded that this was due to either habituation or a temporary shift in the turtles hearing capability at received levels of approximately 172-175 dB re 1 μPa.

There is evidence suggesting that turtles may be able to hear low-frequency sounds, which is where most industrial noise energy is concentrated. It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al. 1983). Based on conclusions of Lenhardt et al. (1983) and O'Hara and Wilcox (1990), low-frequency sound transmissions could potentially cause increased surfacing behavior and deterrence from the area near the sound source. The potential for increased surfacing behavior could place both sea turtles and whales at greater risk of vessel collisions and potentially greater vulnerability to natural predators. The extent of the importance of audition in sea turtle behavior and the physiological effects and disruption to sea turtle behaviors by avoidance responses remains unclear. However, based on the above evidence, NOAA Fisheries believes it is reasonable to assume that sea turtles will detect noise associated with oil and gas exploration, development, and vessel traffic noise, and may possibly experience temporary, adverse effects. Important sea turtle habitats generally occur in shallower waters. The propagation of an air-gun array in such water depths may be vastly different than that for the array measured in 120 m water depth resulting in sea turtles having to be at closer distances to a seismic survey depending on depth, bottom topography, and sediment type. Since leatherback sea turtles are mostly pelagic, they may be at greater risk of disturbance than other sea turtle species from many of the seismic surveys being conducted in the deep waters of the Gulf of Mexico. Additional studies are needed to determine the duration of these possible disturbances to sea turtles.

Seismic effects on prey

Squid are a primary prey item of sperm whales in the GOM. Squid have shown a strong startle response to a nearby air-gun starting up by firing their ink sacs and/or jetting directly away from the air-gun source at a received level of 174 dB re 1 mPa mean squared pressure (McCauley et al. 2000). Throughout this study the squid (*Sepioteuthis australis*) showed avoidance of the air-gun by keeping close to the water surface at a position furthest away from the air-gun where due to the sound shadow and distance from the airguns, the received levels would be less intense. During two trials with squid and using a ramped approach air-gun signal (rather than a sudden nearby startup), a startle response was not seen but a noticeable increase in alarm responses was seen once the air-gun level exceeded 156- 161 dB re 1 μPa mean squared pressure. Although startle responses were not as consistent during the ramp-up trials, there was a general trend for the squid to increase their swimming speed on approach of the airgun but then to slow at the closest approach and to remain close to the water surface during the air-gun operations. Squid appeared to make use of the sound shadow measured near the water surface. Persistent alarm responses in the form of squid jetting away from the airgun source and corresponding with an air-gun shot were observed. It was demonstrated that as the air-gun threshold increased, so did the relative proportion of startle responses recorded, and that this type of response was consistent between trials. Captive squid showed strong startle responses to nearby air-gun start up and provided evidence that they would significantly alter their behavior at an estimated 2-5 km from an approaching large seismic source.

McCauley et al. (2000) showed that it is probable that seismic operations will impact squid at thresholds at 161-166 dB re 1 mPa mean squared pressure and may affect behavior at lower levels. Seismic activities in the Gulf operate at dB levels much greater than those shown to alarm squid in the McCauley study and are likely to result in changes in the distribution of squid in the vicinity of seismic operations within the 161dB isopleth surrounding an air-gun array. Changes in squid distribution could result in changes in sperm whale distribution relative to prey availability at these dB levels. Sperm whale distribution in the Gulf of Mexico has been associated with areas of high primary productivity and prey availability. There could be a lag time between changes in prey distribution and sperm whale distribution.

Gulf sturgeon

McCauley et al. (2000) reported that a general response of fishes exposed to air gun levels greater than 156-161 dB re 1 µpa was to swim to the bottom, but that no physiological stress could be attributed to the air gun startle responses. There have been no studies to date on the effects of noise on Gulf sturgeon, and it is unlikely that any sturgeon will be exposed to seismic activity associated with mineral exploration in the WPA or CPA of the Gulf of Mexico.

B. Drilling and oil platform activities

Information on drilling noise in the Gulf of Mexico has not been reported in the MMS Draft EIS 2002 (Table 1). The noises from operating platforms and drillships could produce sounds at intensities and frequencies that can be heard by turtles and sperm whales. Drillships are noisier than semisubmersibles (Richardson et al. 1995). Bowhead whales (*Balaena mysticetus*) avoid drillship noise with broad-band (20-1,000 Hz) received levels around 115 dB. Studies have also shown that bowhead whales (Schick and Urban 2000) and gray whales (Malme et al. 1983) may temporarily lose habitat from the presence of drillship noise.

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that can be detected by cetaceans. Some of these sounds could mask cetaceans' reception of sounds produced for echolocation and communication (MMS DEIS 2002). Below 1 kHz, where most OCS-industry noise energy is concentrated, sensitivity seems poor for many odontocetes, but sperm whales are considered more sensitive to low frequencies. Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al. 1995). Drillships produce higher levels of underwater noise than other types of platforms and are operating in sperm whale habitat in the deep water environments of the GOM. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al. 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al. 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al. 1995).

Underwater noise from fixed structures ranges from about 20-40 dB above ambient background levels within a frequency spectrum of 30-300 Hz at a distance of 30m from the source (Gales 1982). Mysticetes have more sensitive hearing at low frequencies that may explain the drastic behavioral effects to oil and gas exploration and development noise than have been reported for odontocetes. The potential direct and indirect impacts of sound on sperm whales includes physical auditory effects (temporary threshold shift), behavioral disruption, disruption of habitat utilization by displacement, and changes in the distribution of prey species. Based on the above information, NMFS believes that the low frequency noise created by drilling activities may also be detected by sperm whales and some harassment resulting in biological effects is possible given the limited information on the sounds created by drilling activities in the GOM. However, based on the information available from other regions (see Richardson et al. 1995 for summary), NOAA Fisheries does not believe any adverse effects will result from these activities at this time. However, because of the biological importance of the action area to Gulf sperm whales, any short- or long-term effects that appreciably alter their behavior, ability to hunt, or reduce their reproduction, numbers, or distribution in the action area would be biologically significant and will warrant a reassessment of these effects.

C. Vessel and helicopter traffic

Sperm whales

Helicopter activity will increase as a result of the proposed action. Since noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles and sperm whales there is the possibility of short-term disruption of movement patterns and behavior. For example, an approaching Bell 214ST helicopter became audible in air over four minutes before passing overhead, while it was detected underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m (Greene 1985). Helicopter activity projections are 220,000-870,000 trips over the life of the proposed action or 5,641-22,308 trips annually (MMS DEIS 2002). The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes (noted below) over noise-sensitive areas. Guidelines and regulations promulgated by NMFS under the authority of the Marine Mammal Protection Act do include provisions requiring helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic operating at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is expected that about 10 % of helicopter trips would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from, and interrupt cetaceans nearby (depending on the activity of the animals) (Richardson et al. 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they repeatedly disrupt vital functions, such as feeding and breeding.

Sperm whale responses to vessels may vary depending on the type of vessel involved. Sperm whales have been observed to reduce surface times with fewer blows per surface, exhibit shorter intervals between blows, and exhibit reduced frequency of dives with raised flukes, while other whales tolerate boat presence (Gordon et al. 1992). Many of the more prominent reactions observed by sperm whales appear to be associated with the level of noise produced by the vessels (Richardson et al. 1995). The variable reactions by individual sperm whales may indicate some habituation on the part of those individuals that do not exhibit any reactions or may be indicative of individual variation in the behavioral patterns that are also associated with other marine mammals. Sperm whale cow/calf pairs may be particularly vulnerable to disturbances by close vessel approaches. Sounds from approaching aircraft are detected in air far longer than in water. Gulf sturgeon are not expected to be impacted by noise associated with aircraft and vessel traffic associated with oil and gas activities in the WPA (see vessel collisions below).

An estimated 63,000-111,000 OCS-related, service-vessel trips are expected to occur over the life of the proposed action (MMS DEIS 2002). The rate of trips would be about 1,615-2,846 trips/yr. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans or mask their sound reception (MMS DEIS 2002). There is the possibility of short-term disruption of movement patterns and behavior. Long-term displacement of animals from an area is also a consideration. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals, but has not been frequent in the GOM. Limited observations on an NMFS cruise off the mouth of the Mississippi River in the summer of 2000 indicated that sperm whales appeared to avoid passing service vessels. As exploration and development of petroleum resources in oceanic waters of the northern Gulf increases, OCS vessel activity will increase in these waters, thereby increasing the risk of vessel strike to sperm whales and other deep-diving cetaceans (e.g., Kogia and beaked whales) (MMS DEIS 2002). In addition to increased vessel traffic, increases in seismic activity in the deepwater GOM (≥ 200 m) may increase the possibility of PTS or TTS resulting in sperm whales becoming “acoustically blind” to the low frequency sounds of approaching vessels. Deep-diving whales are more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives.

Sea turtles

MMS reported that transportation corridors for sea going vessels for the proposed action would be through areas where loggerhead turtles have been sighted; these vessels would transit at a speed of about 8-12 knots or less during actual construction on-site. There are no systematic studies published of the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. However, it is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause the animal to alter its normal behavior pattern. Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC 1990). Startle reactions may result in increased surfacing, possibly causing an increase in risk of vessel collision. Reactions to aircraft or vessels, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided due to noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. If sound affects any prey species, impacts to sea turtles would depend on the extent that prey availability might be altered.

Gulf sturgeon

Gulf sturgeon habitat in the action area of the Central Planning Area of the proposed action. Port traffic servicing both the Central and Western Planning Areas may route through Gulf sturgeon habitat. Approximately 40-150 vessel trips per month would occur as a result of a WPA proposed action. Because of the location of the deepwater portion of the WPA, service bases usage may be split between the deepwater ports of Texas (Freeport, Galveston, and Sabine Pass) and Louisiana (Lake Charles, Berwick, Port Fourchon, and Venice). This would result in 5-20 vessel trips/month going to Louisiana's deepwater ports and 5-20 vessel trips/month going to Texas's deepwater ports as a result of a proposed action (MMS EIS 1998). A vessel trip is defined as a round trip between service bases, including all transport between these destinations. About three quarters of the service vessel trips are projected for shallow water (< 200 m) and one quarter of the service vessel trips are projected for deepwater 200 m and greater (Childs 2002). Overall, for all service vessel trips in the CPA associated with oil and gas production, it is estimated that 1,000 trips will occur annually. In the CPA an estimated 2,000 to 3,000 service vessel trips will occur annually. This equates to approximately 296,700 to 310,950 trips occurring annually as a result of OCS service vessel trips. The major ports are:

-Cameron, Louisiana;
-Freeport, Texas (deepwater);
-Galveston, Texas (deepwater);
-Port O'Conner, Texas; and
-Sabine Pass, Texas (deepwater)

It is projected that the majority of service vessel trips as a result of the proposed action will be to the service bases listed above. The WPA EIS (1998) identified the following service bases in Louisiana, Mississippi, and Alabama that could service the deepwater portions of the WPA:

-Lake Charles, Louisiana;
-Berwick, Louisiana;
-Port Fourchon, Louisiana;

-Venice, Louisiana;
-Pascagoula, Mississippi; and
-Theodore and Mobile, Alabama

Vessel traffic associated with service and transport have the potential to affect Gulf sturgeon physiology and the associated habitats of this species. However, Venice is the easternmost service base identified in any WPA exploration or development plans received so far (Jeff Childs, pers. comm. July 8, 2002). It is unlikely that a proposed action will result in any trips east of the Mississippi River that would affect any proposed critical habitat of the Gulf sturgeon. However, vessel traffic associated with past MMS lease sale activities may still be using ports in Jackson, Ms., and in Mobile, Al. that could potentially affect Gulf sturgeon habitat. If Gulf sturgeon critical habitat is designated, MMS should reinitiate consultation with NOAA Fisheries at that time to re-assess any potential effects from lease sale actions.

D. Construction activities

Structure installation and pipeline placement can cause localized water quality degradation because of disturbed sediments which can impact wetlands, seagrass beds and live-bottom sea turtle habitats; however, these impacts are expected to be temporary. Structure installation, pipeline placement, dredging, blowouts, and water quality degradation can impact seagrass bed and live-bottom sea turtle habitats. The temporary loss of seagrass and high-salinity marsh would affect sea turtles indirectly by temporarily reducing the availability of forage species that rely on these sensitive habitats. Because of the temporary nature of these disturbances, little or no long-term damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom sea turtle and Gulf sturgeon habitat, sea grasses, and wetlands as a result of the proposed action.

Sperm whales

Noises associated with structure installation activities may be detected by all listed species, and they may temporarily avoid swimming through noisy areas, especially if the noises are highly variable and unpredictable. Drilling and production facilities produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles (MMS DEIS 2002). Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies (Richardson et al. 1995).

A total of 111-247 exploration wells and 178-352 development wells are projected to be drilled as a result of the proposed action. A total of 28-49 production structures are projected to be installed as a result of the proposed action. These wells and platforms could produce sounds at intensities and frequencies that could be heard by cetaceans. It is expected that noise from drilling activities would be relatively constant and last no longer than four months per well. The frequencies overlap with the range of vocalizations and hearing range of this species, but are generally of low intensity. Potential effects on Gulf of Mexico marine mammals include disturbance (subtle changes in behavior, interruption of previous activities, or short- or long-term displacement);

masking of calls from conspecifics, reverberations from own calls, and other natural sounds (e.g., surf, predators); stress (physiological); and hearing impairment (permanent or temporary) by airgun emissions, but would be unlikely due to the low intensity of these sounds produced. Construction activities that produce loud, prolonged noise may have the potential to adversely affect sperm whales, but no such noises have been identified as part of the action.

Sea turtles

It is reasonable to assume that any behavioral responses which may result from the detection of noises associated with structure installation and pipeline placement activities are not likely to result in a biological effect which would adversely affect any listed species. Based on information provided by the MMS, these noises are generally of low intensity when compared to other sound sources in the Gulf.

Gulf sturgeon

Pipeline placement in the WPA will make landfall on the Texas shoreline, but these construction activities associated with the WPA will not affect Gulf sturgeon habitat in the action area of the CPA.

E. Vessel strikes

The emergence of deepwater drilling has become the most important factor driving the boat supple industry in the Gulf of Mexico (MMS DEIS 2002). Increased ship traffic could increase the probability of collisions between ships and sperm whales or turtles, resulting in injury or death to some animals. In addition to the seismic survey vessels, service vessels are the main source of vessel traffic associated with OCS development. The highest risk of collision with marine mammals or sea turtles comes from service vessels. Seismic survey vessels pose a low risk since they generally move at slow towing speeds of 4.5 kts, and no impacts with any marine mammal or listed species have been reported.

Sperm whales

Adverse reactions by whales to vessel activity have been recorded (e.g., Gaskin 1972, Gambell 1968, Lockyer 1977, Whitehead and Waters 1990, Reeves 1992, Gordon et al. 1992). Sperm whales are also vulnerable to collisions with vessels. The USS ROSS, en route to gunnery exercises and while located in the Outer Range approximately 35 miles southwest of Vieques and about 8 miles south of Puerto Rico, collided with and killed a sperm whale on June 18, 2001. The reported vessel speed at the time of the collision was 27 knots (J. Wallmeyer 2001) in daylight and unrestricted visibility. After the impact, a pod of whales was seen nearby. In the Gulf of Mexico, the USS BULKLEY reported striking a whale of uncertain species at night on June 25, 2001, while undergoing sea trials out of Pascagoula, Mississippi. Due to the offshore distribution of sperm whales, interactions that do occur are less likely to be reported than those involving right, humpback, and fin whales occurring in nearshore areas. Although ship strikes with sperm whales do not appear to be a major threat in the Gulf of Mexico at this time, an increase in vessel traffic throughout known sperm whale habitat warrants concern.

Although sperm whales are only rarely known to be struck by vessels in the GOM, and their large size should make them easily detectable by an onboard observer, other large whales such as humpback and right whales (which generally are not present in the Gulf) have been struck by non-OCS vessels outside the proposed action area. Individuals experiencing PTS may not hear approaching vessels, and would be more likely to surface in its path, being acoustically "blind" to approaching ships. Presently, there is concern for PTS in sperm whales in the Canary Islands. It is believed that sperm whales in this area suffer PTS and are killed every year as a result of collisions with ships. Examination of the ear structures from stranded whales in this region have revealed ear damage indicative of hearing loss. The Whale Anti-Collision System (WACS) is presently being tested in a busy sea lane among the Canary Islands to reduce the number of vessel strikes there. Also, calves spend a great deal more time at the surface since they cannot make the long, deep dives as do foraging adults, and they may be more vulnerable to ship strikes than adults. Given the existing level of OCS-related vessel traffic in the Gulf, the absence of any reported collisions with listed sperm whales in the GOM, the rapid and powerful swimming capabilities of this species, their habit of spending little time at the surface, and the expectation that an onboard observer may spot a sperm whale and avoid a collision, it is not probable that adult sperm whales will be struck by an OCS-related vessel unless vessel traffic increases in areas of high sperm whale density. Increased seismic survey activity may increase surface times resulting in a greater probability for vessel/whale collisions; however, there is no evidence for this at this time.

Sea turtles

As stated above, increased ship traffic could increase the probability of collisions between ships and sea turtles. Although there have been thousands of vessel trips that have been made in support of offshore operations during the past 40 years of OCS oil and gas operations, there have been no reports of OCS-related vessels having struck sea turtles. However, collisions with small and/or submerging turtles may go undetected, even with an observer onboard. Sea turtles could, on occasion, be killed or injured by collisions with oil and gas service vessels (MMS Lease Sale 184 EA 2002).

In the wild, most adult sea turtles spend at least 3-6 % of their time at the surface for respiration. Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19-26 % of their time at the surface, engaged in surface basking, feeding, orientation, and mating (Lutcavage et al. 1997). Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. It is not known whether turtles exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Data show that vessel traffic is one cause of sea turtle mortality in the Gulf (Lutcavage et al. 1997). Stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993 about 9 % of living and dead stranded sea turtles had boat strike injuries (n=16, 102) (Lutcavage et al., 1997). Vessel-related injuries were noted in 13 % of stranded turtles examined from strandings in the Gulf of Mexico and on the Atlantic Coast during 1993 (Teas 1994), but this figure includes those that may have been struck by boats post-mortem. In Florida, where coastal boating is popular, the frequency of boat injuries between 1991 and 1993 was 18% of strandings (Lutcavage et al. 1997). Based on the above, the increase in ship traffic is not likely to result in a ship strike of a sperm whale; however, due to the difficulty of sighting sea turtles and their weaker swimming abilities, it is reasonable to assume that one turtle may be accidentally injured or killed by collision with a project related vessel annually over the projected 30-35 years of operations resulting from the proposed lease sales.

Gulf sturgeon

Gulf sturgeon are not likely to be injured or killed as a result of vessel traffic associated with the proposed action.

F. Brightly-lit platforms

Brightly-lit, offshore drilling platforms present a potential danger to sea turtle hatchlings (Owens 1983). Hatchlings are known to be attracted to light (Raymond 1984, Witherington and Martin 1996, Witherington 1997) and could be expected to orient toward lighted offshore platforms if they are close to shore (Chan and Liew 1988). If this occurs, hatchling predation would increase dramatically since large birds and predacious fish also congregate around the platforms (Owens 1983, Witherington and Martin 1996). Hatchlings may rely less on light cues offshore (Salmon and Wyneken 1990); however, it is not known whether lights on platforms located further offshore attract them. Furthermore, attraction to offshore locations would be less problematic than attraction to landside locations, as the issue is to ensure that hatchlings head to sea rather than remaining onshore where they are subject to a variety of mortality sources including auto traffic and dehydration. While some adverse effects may occur, NOAA Fisheries believes it is unlikely that they will appreciably reduce the reproduction, numbers, or distribution of sea turtles in the wild.

G. OCS-related trash and debris

Debris ingestion is an ongoing threat to sea turtles and marine mammals. Oil and gas operations on the OCS generate waste materials made of paper, plastic, wood, glass, and metal. Some personal items, such as hard hats and personal flotation devices, are accidentally lost overboard from time to time. The oil and gas industry is subject to regulations prohibiting the disposal of trash into the marine environment, although it is expected that items may go overboard accidentally.

Many types of plastic materials are used during drilling and production activities; the offshore oil and gas industry was shown to contribute 13 % of the debris found at Padre Island National Seashore (Miller et al. 1995). The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. Accidental release of debris from OCS activities is known to occur offshore, and such flotsam may injure or kill cetaceans (MMS DEIS 2002).

Sperm whales are known to ingest foreign objects, and it has been suggested that they may at times feed near the ocean bottom with open mouth, ingesting many of the items they encounter (Würsig et al. 2000). Laist (1996) summarized literature citing incidents of marine debris in cetaceans, and lists various types of fisheries gear, ropes, mylar balloons, cups, and newspapers as having been found in digestive tracts of stranded sperm whales. The NOAA Fisheries Southeast Region's stranding records include a juvenile sperm whale which stranded off Hatteras, North Carolina in 1999, with its esophagus and stomach chambers blocked with unidentified plastic, rope, plastic bags, and a small inflatable raft. In April 2002 the first record of plastic ingestion and marine debris by mysticetes was reported (Blanc 2002) from a stranded minke whale (*Balaenoptera acutorostrata*) on the beach of Lestre in Normandy, France. The stomach of the minke whale contained plastic bags and debris (food product packaging including plastic and aluminum, supermarket bags, and other plastic bags totaling about 800 g humid weight) which may have resulted in the mortality of this animal.

NOAA Fisheries believes that the amount of marine debris generated as a result of the proposed action is likely to be insignificant and is not likely to result in injury or death of sperm whales or Gulf sturgeon, but may result in mortality of a few individual sea turtles. The ingestion of marine debris is mostly documented from stranded animals, and the origin of the debris is often unknown. These mortalities are not likely to significantly affect population numbers, and cannot be attributed directly to OCS actions. Sea turtle ingestion of marine debris is discussed in the "threats to sea turtles" subheading in section IV. No documented cases of sperm whales interacting with pipelines while feeding or stranded animals having foreign debris in their stomachs have been documented in the Gulf of Mexico. There have not been any documented cases of Gulf sturgeon entangled in marine debris, or ingestion of flotsam associated with oil and gas activities.

H. Contaminants

The discharge of oil is not authorized for exploration and production of oil resources; however, natural seeps from the ocean floor and accidental spills do occur. Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by the U.S. Environmental Protection Agency's National Pollutant and Discharge Elimination System permits. Most of the routinely discharged chemicals are diluted and dispersed when released in offshore areas and are not expected to directly affect any listed species, but may indirectly affect species through bioaccumulation of trace metals. Accidental or intentional discharges of oil or chemicals have the potential to be released in large volumes that may have deleterious short-term effects (hours to days) within the immediate marine environment (MMS DEIS 2002). The severity of the effects of an oil spill on listed species is obviously related to the location of the spill, the type of oil, the level of contact with the oil that the whales, turtles or fish have, and the life stage of the animal encountering the oil. Chemical spills may accidentally occur from a wide variety of exploration and production activities (see Boehm et al. 2001 for a detailed description of chemicals used in deepwater oil and gas operations) and may have adverse effects on habitats and species. There is a medium risk of probability (on a scale of low to high) that an oil or chemical spill will deleteriously affect a protected species (Boehm et al. 2001).

There has not been a clear pattern of increases or decreases in the occurrence of oil spills or solid chemical spills over the past decade (MMS DEIS 2002). However, there has been a steady increase in the number of liquid chemical spills occurring between 1990-1998 (MMS DEIS 2002). A total of 32 accidental spills (65,577 gal) occurred in 1998, accounting for 26.7% of the total number of spill incidents in U.S. waters for that year. Boehm et al. (2001) suggested that the increase in liquid chemical spills may not be directly correlated to an increase in operations, but rather, in part reflected an improvement in reporting practices by offshore operators and chemical supply companies, suggesting that many spill events may still remain unreported. Oil spills can happen from a large variety of sources, including drilling rigs, drillships, tankers, barges, other vessels, pipelines, storage tanks and facilities, production wells, trucks, railcars, and other sources. A total of 500-1,600 bbl of oil is estimated to occur from spills <1,000 bbl as a result of the proposed action in the WPA. The chance of one spill occurring in the WPA between 500 and 1,000 bbl is 6%-12% and it is estimated that 1 spill >1000 bbl will occur in the WPA as part of the proposed action (MMS DEIS 2002).

Direct contact with oil can result in irritation and damage to skin and soft tissues of whales and dolphins, and similar effects to sea turtles. Inhalation of toxic vapors released by fresh crude oil spills and other volatile distillates may irritate respiratory membranes, congest lungs and cause pneumonia. Hydrocarbons absorbed in the blood stream may accumulate in the brain and liver and result in neurological disorders. Trained dolphins could detect, and appeared to avoid, dark oil slicks. However, bottlenose dolphins did not consistently avoid entering slick oil during the Mega Borg oil spill (Smultea and Würsig 1991, 1995).

The DEIS prepared for the proposed action (MMS 2000) recounts numerous studies of the effects of oil on sea turtles. Eggs, hatchlings and juvenile turtles are the most vulnerable to mortalities associated with oil spills. Fresh oil was found to be toxic to sea turtle nests, particularly during the last quarter of the incubation period (MMS 2000 Lease Sale 181 EIS). Based on direct observations, all of the major systems in sea turtles are adversely affected by short exposure to weathered oil (Vargo et al. 1986, Lutz and Lutcavage 1989). The long-term effects and the effects of chronic exposure are unknown. Oil adheres to the body surface of sea turtles, and has been observed on eyes, nares, mouth, and upper esophagus. Feeding along convergence lines could prolong sea turtles' contact with oil (Witherington 1994). Chronically ingested oil may accumulate in organs. Entrapment in tar and oil slicks may occur. Blood chemistry studies on sea turtles after oiling revealed decreases in hematocrit and hemoglobin concentrations (Lutcavage et al. 1995). This reduction in critical components of the oxygen transport system and associated high white blood cell counts suggests that sea turtles are significantly stressed by exposure to oil. A loggerhead sea turtle was sighted surfacing repeatedly in an oil slick in the

Gulf of Mexico for over an hour. In 1993, eggs, hatchlings, and juvenile sea turtle mortalities occurred after a freighter hit two barges transporting fuel from Mississippi and Louisiana to Tampa, Florida. Strandings of oiled turtles or turtles associated with tar are reported regularly to the Sea Turtle Stranding and Salvage Network database, particularly from south Florida and along Padre Island, Texas.

Known Gulf sturgeon habitat is in the action area and may be affected by actions associated with oil spills. Hydrocarbons may enter the Gulf sturgeon's system by ingestion of contaminated prey or entry through the gills. Internal or external contact with oil may interfere with gill epithelium function, disrupt liver function, or result in mortality of Gulf sturgeon. Fish eggs and larvae are killed when contacted by oil. However, it has been estimated that there is less than a 0.5% probability of an oil spill > 1,000 bbl occurring in the WPA and coming into contact with known Gulf sturgeon habitat within 10 days (MMS DEIS 2002), and the potential for an oil spill to adversely impact Gulf sturgeon is very low. However, if a spill does, serious adverse effects are likely to result. In the CPA there is a 2-5 % probability that an oil spill ≥ 1,000 bbl will come into contact with Gulf Sturgeon habitat within 10 days of the spill. The MMS has not calculated the probabilities of a major spill coming into contact with known sperm whale habitat off the Mississippi River delta (see Figure 2), but it may be assumed that this probability is high due to the relatively large area and occurrence of oil production activities in the vicinity. A summary of the probabilities of an oil spill ≥1,000 bbl occurring in the action area and contacting known sea turtle habitats under NOAA Fisheries' juristiction is presented in Table 5.

Texas and Louisiana populations of sea turtles are at the greatest risk of being affected by an oil spill resulting from the proposed action (Table 5). Chronic exposure of listed and protected whales, marine mammals, and sea turtles to the components of oil spills may result in contamination or reduction of prey. Additionally, physiological stress on these animals might result in reduced fitness and vulnerability to disease and parasites. However, annually, few deaths are likely due to the low likelihood that many listed or protected species may occur in the small areas contacted by oil spills, and dispersion and loss of oil is likely to be rapid if a spill occurs. Coastal oil-spill contingency plans should reduce the impact of spills, although some spill clean-up activities may affect sea turtles. (Note: Oil spill response and clean-up is federally managed by multi-agency Regional Response Teams, not MMS; therefore, oil spill response is not considered part of MMS' proposed action). Protection efforts generally attempt to prevent contact of oil on sensitive areas such as nesting beaches where turtles are particularly vulnerable.

Based on the above information, NOAA Fisheries believes that oil spills as a consequence of the proposed action will have adverse impacts on sperm whales and sea turtles. The effects on sperm whales are expected to be sublethal as are the majority of effects on sea turtles. Because of the probability of releases and some large spills, however, NOAA Fisheries does believe that the degree of oiling experienced by a few individual turtles may occassionally be acute and significant. NOAA Fisheries therefore believes that, over the projected 35-year lifetime of the proposed action, up to two sea turtles (in any combination of the five species found in the GOM) may be killed as a result of an oil spill resulting from activities associated with the proposed

Table 5. The probability of an oil spill >1,000 bbl coming into contact with sea turtle habitat within 10 days of a spill occurring in the CPA or WPA. Probabilities are summarized from MMS' map of affected areas (MMS DEIS 2002).

Sea Turtle Habitat	CPA Probability (%)	WPA Probability (%)
Texas coastal habitat	1	128
Texas mating habitat	< 0.5-1	64
Louisiana coastal habitat (West of Miss. R.)	262	2
Louisiana coastal habitat (East of Miss. R.)	35	<0.5
Louisiana mating habitat	< 0.5-1	< 0.5
Mississippi mating and coastal habitat	< 0.5	< 0.5
Alabama mating and coastal habitat	< 0.5	< 0.5
Florida Panhandle mating and coastal habitat	< 0.5	< 0.5
Southwest and South Florida mating and coastal habitat	< 0.5	< 0.5
Florida Tortugas mating and coastal habitat	< 0.5	< 0.5
Florida Keys mating and coastal habitat	< 0.5	< 0.5

action. Although populations of some of these species are small, the loss of this small number of individuals is not likely to appreciably reduce the species' ability to survive and recover in the wild through reduction in their numbers. NOAA Fisheries is unable to estimate the number of individuals that may experience sublethal effects. For adult, female sea turtles, the reproductive periodicity and the number of eggs produced during a breeding season are thought to be influenced by the animals' nutritional condition and general fitness, so impacts to an individual adult female's overall reproductive success are theoretically possible. Although there is great uncertainty about the nature and extent of sublethal effects from contact with spilled oil, NOAA Fisheries does not expect those effects to rise to the level where there would be a detectable effect on any population's reproduction. Sublethal effects are also likely as a result of bioaccumulation of oil-based toxins up the food chain; however, such effects are currently not quantifiable.

The routine discharges of drilling fluids may indirectly affect the prey of sperm whales and sea turtles, and these discharges contain heavy metals that affect water quality in the near-field of platforms. Trace metals, including mercury, in drilling discharges are a concern because of the potential for them to bioaccumulate in marine organisms. Mercury, particularly in the form of methylmercury, is extremely toxic to marine organisms, wildlife, and man. The main pathway for human exposure to methylmercury is through consumption of freshwater and marine fishery products. There is considerable concern throughout the US, including the Gulf of Mexico states, about mercury contamination of commercial and recreational freshwater and marine fishery products. The main source of mercury to the Gulf of Mexico is from wet and dry deposition from the atmosphere of inorganic mercury, from natural and anthropogenic, primarily combustion, sources. River inflows, particularly from the Mississippi River system, also contribute large amounts of mercury to the Gulf. Some of the inorganic mercury that enters the Gulf is reduced to elemental mercury by sunlight or microbial activity. The elemental mercury is volatile and evaporates rapidly to the atmosphere. Most of the mercury complexes with dissolved or particulate organic matter and may settle with it and accumulate in sediments. If the sediments or bottom water are hypoxic/anoxic, some of the inorganic mercury may be methylated by sulfate-reducing bacteria. Microbially-mediated mercury methylation also occurs in the oxygen-minimum layer of the ocean; this may be the major source of methylmercury in the muscle tissues of large pelagic fish such as swordfish and tuna. In the presence of elemental sulfur that may be abundant in anoxic sediments, some of the methylmercury may be methylated to form volatile dimethylmercury, which diffuses into the water column and into the atmosphere. Under slightly more oxidizing conditions than those required for methylation, methylmercury is demethylated by marine bacteria. Under more strongly reducing conditions in marine sediments, most of the inorganic mercury precipitates as highly insoluble mercuric sulfide. Because of these microbially-mediated reactions, methylmercury usually represents less than 1% of total mercury in marine sediments and hypoxic bottom water.

The quantitatively most important sources of mercury from offshore oil platforms are drilling fluids and produced water. Gulf of Mexico produced water rarely contains more than about 0.1 mg/L total mercury (about 10-fold higher than clean natural seawater). Barite is used as a weighting agent for mercury. The EPA limit on mercury in barite is 1 ppm. The average mercury in modern drilling mud barite is 0.5 ppm. Most drilling muds and cuttings contain < 0.1 ppm mercury. The mercury in produced water is diluted rapidly to background concentrations following discharge to the ocean. Nearly all the mercury in drilling muds is associated with the barite, which is added to the mud. Clays in drilling muds may contain traces of mercury. Most drilling muds discharged to US waters contain less than 1 ppm mercury. Sediments around offshore platforms in the Gulf also rarely contain more than about 1 ppm mercury. The background concentration of mercury in marine sediments from the Gulf of Mexico usually is less than 0.1 ppm. An exception was identified in the GOMEX program. Sediments collected within 50 m of a platform near the Flower Garden Banks (HI-A389) contained up to 3.5 ppm mercury. Drilling muds from this platform were shunted to within 10 m of the bottom to prevent possible harm to corals at the crest of the banks. The discharges occurred before imposition of limits on mercury in drilling mud barite. Fish and invertebrates collected near the platform contained slightly elevated concentrations of total mercury. Mercury concentrations often are higher in liver than in muscle of large, long-lived predatory fish, such as king mackerel and snapper. All other data for mercury in tissues of fish and shellfish from the Gulf of Mexico revealed that marine animals collected near offshore platforms do not contain significantly higher concentrations of mercury than the same or related species from elsewhere in the Gulf.

The mercury in drilling mud barite is sequestered in the solid barium sulfate in sulfide minerals, particularly sphelerite (ZnS). It is extremely insoluble and stable in this form, particularly in anoxic sediments. Very little mercury can be extracted from the barite, even under mildly acidic conditions, as might occur in the digestive tract of a marine animal. Because of its low bioavailability, mercury in barite is not readily available for methylation.

As platforms move into deeper waters, multiple wells will be associated with each structure and the resultant cumulative amount of contaminants allowed in discharges will be larger. However, the resulting introduction of contaminants into the Gulf of Mexico may affect sea turtles, and marine mammals, including listed sperm whales, through biomagnification in the food chain or a reduction in available prey. Chronic sublethal effects could cause declines in the health of listed species, or lowered reproductive fitness. In the WPA a total of 111-247 exploratory wells and 178-352 development wells will be drilled over the course of the lease that will discharge an estimated 1,000,000-2,300,000 bbl of water-based drilling fluids and between 160,000-330,000 bbl of associated cuttings. These routine discharges of drilling fluids contain mostly barium and trace amounts of chromium, copper, cadmium, mercury, lead, and zinc. Chronic levels of these metals are localized to within 150 m of drilling structures (Kennicutt 1995), significant levels of all these metals except chromium have been measured within 500 m of Gulf of Mexico drilling sites (Boothe and Presley 1989), and dilution to background levels occurs within 1,000 m of the discharge point. Most of these studies have focused on the effects of point discharges from individual platforms. The cumulative impacts of these discharges from existing wells, new wells, and accidental discharges remain to be fully assessed for larger geographic areas.

Marine mammals and sea turtles are unlikely to be directly effected by chemicals discharged in produced waters, drill muds, and drill cuttings, but are likely to accumulate heavy metals that will biomagnify through the food web. Heavy metals have been found in the tissues of both cetaceans and sea turtles; however, there is not sufficient data to determine the amount of accumulation or the effects of those concentrations on cetacean and sea turtle health, and no known deaths as a result of heavy metal toxicity have been documented. The range of the Gulf sturgeon is not within the vicinity of drilling operations in the WPA. Since the benthic prey of Gulf sturgeon are not migratory and do not exhibit large scale movements throughout the Gulf, the background levels of trace metals are not likely to affect the prey of Gulf sturgeon.

It is expected that cetaceans may have some interaction with these discharges. Direct effects to cetaceans are expected to be sublethal. It should be noted, however, that any pollution in the effluent could poison and kill or debilitate marine mammals and adversely affect the food chains and other key elements of the Gulf ecosystem (Tucker & Associates, Inc. 1990) including those for sea turtles. Because OCS discharges are diluted and dispersed in the offshore environment, impacts to cetaceans are expected to be negligible.

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 such as commercial fishing, recreational boating and fishing, and the transport of petroleum and other chemical products throughout the action area are expected to continue at the present levels of intensity in the near future as are their associated risks of injury or mortality to listed species posed by incidental capture by fishermen, accidental oil spills, vessel collisions, marine debris, chemical discharges, and man-made noises.

Coastal runoff and river discharges carry large volumes of petrochemical and other contaminants from agricultural activities, cities, and industries into the Gulf of Mexico. The coastal waters of the Gulf of Mexico have more sites with high contaminant concentrations than other areas of the coastal United States, due to the large number of waste discharge point sources (MMS DEIS 2002). The listed species analyzed in this Opinion may be exposed to and accumulate these contaminants during their life cycles.

Beachfront development, lighting, and beach erosion control are all ongoing activities along the action area of the Southeast U.S. coastline. 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 have or are adopting more stringent protective measures to protect hatchling sea turtles from the disorienting effects of beach lighting. Some of these measures were drafted in response to law suits brought against the counties by concerned citizens who charged the counties with failing to uphold the ESA by allowing unregulated beach lighting which results in takes of hatchlings.

State-regulated commercial and recreational boating and fishing activities in Gulf waters currently result in the incidental take of threatened and endangered species. 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. Any increase in recreational vessel activity in inshore and offshore waters of the Atlantic Ocean will likely increase the risk of turtles 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 NOAA Fisheries and the states on these issues should help decrease take of sea turtles caused by recreational activities. NOAA Fisheries will continue to work with states to develop ESA section 6 agreements and section 10 permits to enhance programs to quantify and mitigate these takes.

VII. Conclusion

After reviewing the current status of the endangered sperm whale, the green, leatherback, hawksbill, and Kemp's ridley sea turtles, and the threatened loggerhead sea turtle and Gulf sturgeon in the GOM, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is the biological opinion of NOAA Fisheries that the implementation of the proposed action, as described in the Proposed Action section of this Opinion, will adversely affect, but is not likely to jeopardize the continued existence of these species. No critical habitat has been designated for these species in the GOM.

VIII. Incidental Take Statement

Incidental Take Statement

Section 9 of the ESA and Federal regulations promulgated pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or to attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of a Federal agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary and must be undertaken by the MMS for the exemption in section 7(o)(2) to apply. MMS has a continuing duty to regulate the activity covered by this incidental take statement. If MMS 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, MMS must report the progress of the action and its impact on the species to NOAA Fisheries as specified in the incidental take statement.

Amount or Extent of Anticipated Take

NOAA Fisheries has determined that there is an expected impact to sea turtles in the action area as a result of OCS oil and gas leasing activities. Based on stranding records, incidental captures during recreational and commercial fishing vessels, scientific surveys, and historical data, the five species of sea turtles are known to occur in GOM waters in and around the action area. Current available information on the relationship between these species and OCS oil and gas activities indicates that sea turtles may be killed or injured by vessel strikes that may happen as a result of the proposed action. Therefore, pursuant to section 7(b)(4) of the ESA, NOAA Fisheries anticipates an incidental take as follows:

1 take (injury or mortality) per year of any sea turtle species by vessel impact over the 35-year life of the proposed action.

If the actual incidental take meets or exceeds this level, MMS must immediately reinitiate formal consultation.

NOAA Fisheries believes that an unspecified number of sea turtles will experience sublethal effects as the result of exposure to spilled oil, resulting from the proposed action. NOAA Fisheries believes that sea turtles of any of the five species present in the action area may be killed as a result of exposure to spilled oil. However, NOAA Fisheries is not including an incidental take statement for the incidental take of listed species due to oil exposure. Incidental take, as defined at 50 CFR 402.02, refers only to takings that result from an otherwise lawful activity. The Clean Water Act (33 USC 1251 *et seq*.) as amended by the Oil Pollution Act of 1990 (33 USC 2701 *et seq*.) prohibits discharges of harmful quantities of oil, as defined at 40 CFR 110.3, into waters of the United States. Therefore, even though this biological opinion has considered the effects on listed species by oil spills that may result from the proposed action, those takings that would result from an unlawful activity (i.e., oil spills) are not specified in this incidental take statement and have no protective coverage under section 7(o)(2) of the ESA.

An unspecified number of sperm whales within the action area may be adversely affected by seismic activities and increased vessel traffic, especially in the known nursery area of the Gulf of Mexico. Seismic activities have the potential to disrupt the normal behavior of marine mammals. Any vessel collisions with sperm whales are likely to severely harm or kill the animal. However, NOAA Fisheries is not including an incidental take statement for the incidental take of whale species because the take of marine mammals has not been authorized under section 101(a)(5)(E) of the Marine Mammal Protection Act (MMPA) and/or its 1994 amendments. The MMPA defines "take" to mean to harass, hunt, capture, kill, or attempt to harass, hunt, capture, or kill any marine mammal. Any activities that may adversely affect marine mammals are considered "harassment", and are prohibited under the Marine Mammal Protection Act (MMPA). "Harassment" is further defined under the "take" definition in the MMPA as: any act of pursuit, torment, or annoyance which:

(i) has the potential to injure a marine mammal or marine mammal stock in the wild; 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.

Following issuance of such regulations or authorizations and a finding of no significant impact in a take authorization under the MMPA, NOAA Fisheries will amend this Opinion to include incidental take of sperm whales. In the interim, NOAA Fisheries strongly recommends that MMS apply for any take authorizations in a timely manner, and continue to require implementation of the mitigation measures as stipulated in its August 22, 2002, NTL and summarized in the Environmental Baseline section of this Opinion. The MMS seismic NTL (No. 2002-G07) issued on August 22, 2002 is considered part of the proposed action for the effects of the lease sales analyzed in this Opinion. The mitigation measures in the NTL represent NOAA Fisheries' best judgement on avoiding serious injury to sperm whales and other marine mammals in the vicinity of seismic activities.

Effect of the Take

In the accompanying biological opinion, NOAA Fisheries determined that the aforementioned level of anticipated take (lethal, or non-lethal) is not likely to appreciably reduce either the survival or recovery of sperm whales, leatherback, green, hawksbill, Kemp's ridley, loggerhead sea turtles, or Gulf sturgeon in the wild by reducing their reproduction, numbers, or distribution. The proposed action, therefore, is not likely to result in jeopardy to any of the above mentioned species. The project area has no designated critical habitat for any of the listed species under NOAA Fisheries' jurisdiction, and therefore no adverse modification of critical habitat is expected from the proposed action.

Reasonable and Prudent Measures

NOAA Fisheries believes the following reasonable and prudent measures are necessary and appropriate to minimize the potential for incidental take of Kemp's ridley, green, loggerhead, leatherback, and hawksbill sea turtles:

1) MMS shall minimize the amount of flotsam and jetsam discharged into waters of the Gulf of Mexico as a result of the proposed action to the greatest extent practicable.

2) MMS shall implement measures to reduce any potential impacts to listed species by lease sale actions including, but not limited to, monitoring, reporting, and space, time, or activity restrictions to protect important habitats from the likelihood of chemical or oil spills.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, MMS 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 non-discretionary.

1. The MMS shall work with offshore oil and gas industry to:

a. Prepare a training video that educates offshore industry-related personnel on marine debris that may be generated by industry activities, their vectors of introduction into the marine environment, and measures that personnel are to undertake to eliminate jetsam and flotsam of industry-related trash in the Gulf. The MMS shall condition permits issued to oil companies to require offshore oil and gas industry-related personnel, including support services-related personnel (e.g., helicopter pilots, vessel captains and crews, and various contractors), to view the training video once each year. Lessees and operators will be responsible for certifying that personnel utilized offshore for their respective projects have viewed the training video on an annual basis.

b. Review existing practices, regulations, guidelines, and waste management plans to identify gaps that may result in the release of objects that might become flotsam and jetsam in the sea. MMS shall take actions to achieve zero loss of trash and debris to the sea. Any trash and debris lost overboard from facilities or vessels shall be recovered as safety permits. MMS shall document any trash and debris lost from facilities or support/service vessels that is not recovered. Information to document shall include a description of the trash or debris lost, date and location of loss, and source of the loss (platform, aircraft, or vessel). MMS shall submit this information in an annual report to NOAA Fisheries, Southeast Regional Office. Based on review of this information, MMS shall update guidelines accordingly, in the form of a Notice to Lessees and Operators, to eliminate sources of flotsam and jetsam from offshore oil and gas activities. MMS shall provide the NOAA Fisheries, Southeast Regional Administrator with a copy of these guidelines.

c. MMS shall condition permits issued to oil companies requiring them to post signs in prominent places on all offshore oil and gas industry-related vessels and surface facilities (e.g., fixed and floating platforms used as a result of the proposed action) detailing the reasons (legal and ecological) why release of debris must be eliminated.

2. MMS shall require that permit holders maintain helicopter traffic over the proposed action area at altitudes above 1,000 feet as practicable, to avoid disturbance to whales and sea turtles.

3. MMS shall condition permits issued to oil companies requiring them to have a training program to train vessel members to observe for sea turtles and sperm whales on support and supply ships while vessels are underway. These observers will be used to help avoid and monitor the take of listed species by support and supply vessel operations. These observers will make a report each trip containing the date and time of day, any sightings of listed species and proper identification if possible, and any incidences of behavioral reaction or injury to the animal.

4. Any takes of listed species shall be reported to the NOAA Fisheries Southeast Regional Office within no more than 48 hours of the incident resulting in the take. The MMS shall require lessees and operators to instruct offshore personnel to immediately report all sightings and locations of injured or dead endangered and threatened species (e.g., sea turtles and whales) to the MMS. The MMS-GOMR shall immediately coordinate with the appropriate salvage and stranding network coordinators to determine if recovery of the impacted animal is necessary, using qualified staff and the appropriate equipment. If oil and gas industry activity is responsible for the injured or dead animals (e.g., because of a vessel strike), the MMS shall require the responsible parties to assist the respective salvage and stranding network as appropriate. Any takes of sea turtles or cetaceans resulting in injury or mortality shall be immediately reported to MMS-GOMR and the NOAA Fisheries representative of the respective stranding networks. All live and dead protected species shall be reported to the following contacts.

Sea Turtle Stranding and Salvage Network: 305-361-4478
Marine Mammal Stranding Network 24-hour pager: 305-862-2850

5. MMS shall complete an annual report to be submitted to the NOAA Fisheries, Southeast Regional Office, Assistant Regional Administrator for Protected Resources, by January 30 of each year. This report will enumerate the number, amount, location, and types of oil or chemical spills resulting from the proposed action for the previous year, and takes of protected species (Section 9 and Federal regulations pursuant to section 4(d) of the ESA) resulting from the proposed action for the previous year. The report shall include the species or detailed description of the animal if positive identification "taken" is not possible, vessel identification, cause and/or circumstances surrounding the take, date, time, location, and name of the person filling out the report.

IX. 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.

In order for NOAA Fisheries to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NOAA Fisheries requests notification of the implementation of any conservation recommendations.

A. Recommendations for the Seismic Observer Plan

At MMS' discretion, these recommendations may be implemented as modifications of the mitigation measures contained in the August 22, 2002, NTL No. 2002-G07, as summarized in the Environmental Baseline section of this Opinion.

1. At least two observers should be used to monitor the impacted area for the presence of listed marine mammals. At least one formally trained biologist or equivalently experienced individual with the expertise in marine and animal science and who has completed a seismic observer training program should be monitoring the impact zone at all times during surveys and a minimum of 30 minutes prior to ramp-up and during ramp-up.

2. MMS should require that impact zones be calculated based upon an appropriate mathematical model for all marine mammal species inhabiting the GOM until a Take Authorization is obtained pursuant to the Marine Mammal Protection Act 16 USC 1361 *et seq*. Richardson et al. (1995) present an equation for spherical spreading to determine the distance (L_r) at which 180 dB levels or greater would be received within the range of a

sound source. The impact zone may be calculated by the logarithmic spherical spreading equation for deepwater propagation (see text for explanation of models);
$L_r = L_s - 20 \log R$ or $L_r = L_s - 15 \log R$ where:

L_r = the received level in dB re 1 μPa underwater

L_s = the source level at 1 m in the same units, and

R = the range in m

3. Seismic survey observer reports should be expanded to include sighting and behavioral information for all cetaceans. Reporting forms presently in use should be filled out completely for all protected species including sea turtles.

4 MMS should encourage the OCS oil and gas industry to research, develop, and deploy passive acoustic monitoring (PAM) technologies, night vision equipment, and other technologies to detect and monitor cetaceans during nighttime seismic operations in lieu of visual monitoring. The fact that sperm whales are vocal means that passive acoustic equipment and methods may offer an effective means of detecting and tracking sperm whales (p. D-9 MMS Draft Geological and Geophysical Exploration EA 2002, Whitehead and Gordon 1986, Gordon 1987, Leaper et al. 1992). PAM systems and procedures may be used in addition to visual observers; however, visual observers will be required when sperm whales are detected within the area of seismic activities. PAM systems that effectively detect sperm whales can be utilized for nighttime seismic surveys.

5. Modifications to the ramp-up procedures for seismic surveys:

a. When seismic surveys are conducted during poor visibility or nighttime operations, ramp-up procedures should always be utilized from shut-down. Airguns should not be firing when seismic surveys are not being conducted to limit the duration of acoustic input into the surrounding waters. Nighttime ramp-up should adhere to the same ramp-up procedures as stipulated for daytime operations. For seismic surveys passive monitoring equipment should be utilized to monitor for sperm whale presence in conjunction with visual verification whenever possible. Passive acoustic monitoring may be utilized in lieu of visual monitoring during nighttime surveys. Use of PAM systems should be encouraged during daytime seismic surveys as well, due to the lengthy dive times of sperm whales. Both visual or passive acoustic detection should warrant shut-down of the airgun array.

b. Presently, observers are required to monitor the impact zone a minimum of 30 minutes before ramp-up procedures are to commence during daylight hours (dawn to dusk). Also, ramp-up procedures are required to commence again following any shutdown of an airgun array due to cetacean presence in the impact zone or for shut-downs required for other purposes. Shut-downs should occur for detection of sperm whales by visual observers or by PAM detection. Due to the dive time of sperm whales, the duration of monitoring, and area monitored by observers, and the possible "down" time involved from shut-downs and ramp-up procedures in conducting surveys, NOAA Fisheries approves the following alternative. The ramp-up procedures may be waived following a shut-down of the array under the following conditions:

- Environmental conditions allow for monitoring of the entire impact zone.
- The observers (visual, or visual and PAM) monitor the impact zone for the duration of the shut-down period.
- The shut-down period does not exceed 20 minutes.

Observers should monitor the impact zone for a minimum of 30 minutes prior to ramp-up of an array, during ramp-up, during the seismic survey, and should continue monitoring of the impact zone for a minimum of 30 minutes following any shut-down to provide for the detection of any sperm whales that may be surfacing from dives or entering the impact zone. Ramp-up procedures should be required when any cetaceans are observed in the impact zone during the first 20 minutes following a shut-down. Shut-down periods exceeding 20 minutes should result in the commencement of normal ramp-up procedures. This alternative should only apply to daylight seismic surveys where visual verification of sperm whales and other cetaceans in the impact zone may be achieved. If passive acoustic monitoring technology is utilized for nighttime seismic surveys and no sperm whales are detected, shut-downs of airguns lasting less than 20 minutes may initiate firing if no vocalizations (clicks) are detected. For all airgun shut-downs (i.e., day or night) lasting more than 20 minutes or when a sperm whale or other cetacean is within or entering the impact zone, normal ramp-up procedures may commence when no animals are detected within the impact zone.

B. Programs and Research

1. MMS should sponsor programs that research, preserve, and restore the ecology of the Gulf of Mexico marine environment.

2. MMS should sponsor research on juvenile sea turtle habitat in the GOM, which may include the effects of oil and gas exploration, development, and production; including, but not limited to accumulation of debris and /or contaminants along driftlines, juvenile habitat, and breeding grounds.

3. MMS should continue to conduct surveys of the GOM to determine the seasonal distribution and relative abundance of sea turtles and cetaceans to ascertain the extent of impacts relative to OCS oil and gas activities.

4. On June 15-16, 1999, MMS hosted a Marine Protected Species Workshop in New Orleans, LA. MMS, in concert with appropriate agencies and with assistance in funding

by industry where possible, should continue efforts in supporting work to carry out the recommendations of the workshop panel. MMS should continue its support of research to determine effects of OCS related noise on sperm whales and sea turtles and present the results at the information transfer meetings.

5. MMS should support investigations into the effects of seismic noise on the distribution of cephalopods and fish (e.g., sperm whale prey items) near seismic vessels, including diel vertical migration, startle effects, and distribution.

6. MMS should work with NOAA Fisheries to determine the stock structure of cetaceans in the GOM, and the effects of oil and gas activities on behavior, breeding, feeding, and distribution. MMS should work with NOAA Fisheries in studying the effects of mercury and other contaminants on cetaceans, sea turtles, Gulf sturgeon, and their prey items in the GOM, and the amounts and sources of mercury from oil production discharges.

7. MMS should continue to partner with NOAA Fisheries to develop programs to minimize risks associated with oil and gas lease sale activities on the ecological health of the GOM ecosystem.

X. Reinitiation of Consultation

This concludes formal consultation on the GOM OCS Lease Multi-Sale (185, 187, 190, 192, 194, 196, 198, 200, 201) for 2003 to 2007. 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 the 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 (e.g., gulf sturgeon) that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, MMS must immediately request reinitiation of formal consultation.

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