U.S. DEPARTMENT OF THE INTERIOR

MINERALS MANAGEMENT SERVICE

Gulf of Mexico OCS Region

New Orleans, Louisiana

SITE-SPECIFIC ENVIRONMENTAL ASSESSMENT

INITIAL EXPLORATION PLAN

DESOTO CANYON BLOCKS
180 (OCS-G 23493)
224 (OCS-G 23497)

Ocean Energy, Inc.

January 2003

NOTED - SCHEXNAILDRE

U.S. DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE

Gulf of Mexico OCS Region

New Orleans, Louisiana

Date Received

November 8, 2002

Joint Initial Exploration Plan (N-7622)

SITE-SPECIFIC ENVIRONMENTAL ASSESSMENT DETERMINATION/ FINDING OF NO SIGNIFICANT IMPACT

Ocean Energy, Inc's Initial Exploration Plan to drill and temporarily abandon at the seafloor six exploratory wells has been received for the following blocks in DeSoto Canyon: Block 180 (OCS-G 23493) Wells B, C, and F; and Block 224 (OCS-G 23497) Wells A, D, and E. Our site-specific environmental assessment (SEA) on the subject action (N-7622) is complete and results in a Finding of No Significant Impact. Based on this SEA, we have concluded that the proposed action will not significantly affect the quality of the human environment (40 CFR 1508.27). Preparation of an environmental impact statement is not required. The following mitigations and a reminder of existing provisions are necessary to ensure environmental protection, consistent environmental policy, and safety as required by the National Environmental Policy Act, as amended, or are recommended measures needed for compliance with 40 CFR 1500.2(f) regarding the requirement for Federal agencies to avoid or minimize any possible adverse effects of their actions upon the quality of the human environment.

Mitigation

1. Please be advised that drilling permits cannot be issued for the proposed wells until concurrence with your coastal zone management consistency certification has been received by this office from the Alabama Department of Environmental Management or until concurrence with the certification has been conclusively presumed. (6.3)

2. Please be advised that drilling permits cannot be issued for the proposed wells until concurrence with your coastal zone management consistency certification has been received by this office from the Florida Department of Community Affairs or until concurrence with the certification has been conclusively presumed. The plan may require further evaluation based upon issues raised by the Florida Department of Community Affairs during its consistency review. (6.5)

Reminder of Existing Provisions

Ocean Energy, Inc. must comply with all requirements of U.S. Environmental Protection Agency (USEPA) Region 4's National Pollutant Discharge Elimination System permit. They must submit Discharge Monitoring Reports to USEPA's Region 4 as required.

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Date 1/15/03

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ABBREVIATIONS AND ACRONYMS

ADEM	Alabama Department of Environmental Management
API	American Petroleum Institute
BO	Biological Opinion
bopd	barrels of oil per day
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
CPA	Central Planning Area
CZM	Coastal Zone Management
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EFH	Essential Fish Habitat
EP	Exploration Plan
EPA	Eastern Planning Area
EWTA	Eglin Water Test Area
FDEP	Florida Department of Environmental Protection
FEL	from the east block line
FKNMS	Florida Keys National Marine Sanctuary
FMC	Fishery Management Council
FMG	Florida Middle Ground
FMP	Fishery Management Plan
FNL	from the north block line
FR	*Federal Register*
FSL	from the south block line
FWL	from the west block line
FWS	Fish and Wildlife Service
GOM	Gulf of Mexico
GOMR	Gulf of Mexico Region
LCE	Loop Current eddies
LDNR	Louisiana Department of Natural Resources
LTL	Letter to Lessees and Operators
MMC	Marine Mammal Commission
MMS	Minerals Management Service
MODU	Mobile Offshore Drilling Unit
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Science
NDBC	National Data Buoy Center
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NTL	Notice to Lessees and Operators
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OEI	Ocean Energy, Inc.
OPA	Oil Pollution Act
OSRA	Oil Spill Risk Analysis
OSRP	Oil-Spill Response Plan
PINC	Potential Incident of Noncompliance
ppt	parts per thousand
PSD	Prevention of Significant Deterioration
psu	practical salinity unit
RCRA	Resource Conservation and Recovery Act
SBF	synthetic-based fluids
SEA	Site-Specific Environment Assessment
SOPEP	Shipboard Oil Pollution Emergency Plan
SOV	spill occurrence variable
SST	sea-surface temperature
TRW	Topographic Rossby Waves
TV	transport variable
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USCG	U.S. Coast Guard
VOC	volatile organic compound
WBF	water-based fluids

INTRODUCTION

Ocean Energy, Inc. (OEI) has submitted to the Minerals Management Service (MMS) a Joint Initial Exploration Plan (EP) to drill and temporarily abandon at the seafloor six exploratory wells for the following blocks in DeSoto Canyon: Block 180 (OCS-G 23493) Wells B, C and F; and Block 224 (OCS-G 23497) Wells A, D, and E (Figures G-1 and G-2).

DeSoto Canyon Blocks 180 and 224 are located approximately 82 mi from the nearest Louisiana coastline, 102 mi from Alabama, and 108 mi from Florida. Water depths in these blocks of the proposed action range from 6,560 ft (2,000 m) in the northwest to 7,420 ft (2,262 m) in the southwest.

This Site-Specific Environmental Assessment (SEA) evaluates the potential effects associated with the proposed activities. This SEA uses information provided by the operator in the EP and available data or information from the Final Environmental Impact Statement (EIS) for the Eastern Planning Area (EPA) Lease Sale 181 (USDOI, MMS, 2001), the EPA Multisale Draft EIS (USDOI, MMS, 2002a), and the Central Planning Area (CPA) and Western Planning Area (WPA) Multisale Final EIS of the Gulf of Mexico (GOM) (USDOI, MMS, 2002b).

In accordance with the National Environmental Policy Act (NEPA), as amended, and the Council on Environmental Quality (CEQ) regulations, this SEA incorporates the tiering process outlined in 40 CFR 1502.20. Under this process, agencies are encouraged to tier environmental documents to eliminate repetitive discussions of the same issues. Some issues discussed in previous environmental documents may be briefly summarized and incorporated by reference. The significance of specific potential environmental consequences is evaluated to the criteria defined in 40 CFR 1508.27.

1. PROPOSED ACTION

1.1. Purpose and Need

1.1.1. Purpose of the Proposed Action

The purpose of the proposed action outlined by OEI in their EP is to evaluate the hydrocarbon potential in two OCS blocks located in DeSoto Canyon by drilling six exploratory wells over a 2-year period and to temporarily abandon them at the seafloor. The EP also indicates three well locations in each block. Exploration, discovery, and production of hydrocarbon resources would help satisfy the Nation's need for energy supplies and lessen dependence on foreign oil.

Under the Outer Continental Shelf Lands Act (OCSLA), as amended, the Department of the Interior (DOI) is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal OCS. The Secretary of the Interior oversees the OCS oil and gas program, and MMS is the agency charged with this oversight. The Secretary is required to balance orderly resource development with protection of the human, marine, and coastal environments while ensuring that the U.S. public receives an equitable return for resources discovered and produced on public lands.

1.1.2. Need for the Proposed Action

OEI, as the designated operator of DeSoto Canyon Blocks 180 and 224, has filed an EP with MMS, consistent with its obligation to file such plans before commencing exploration activity. The EP addresses a proposed action to explore different aspects of the geologic play. The geologic play comprises the gross geologic structure. The EP for the proposed action addresses a drilling program for the prospect that is appropriately evaluated. Listed below are some of the reasons that OEI has submitted this proposal to MMS:

- leaseholders have a legal right to pursue exploration for hydrocarbon resources;
- commercial quantities of hydrocarbons resources may be encountered;
- leaseholders are obligated via lease terms to diligently develop the resources; and
- limited lease term (10 years) and failure to develop the resources could lead to loss of sunk costs for lease acquisition and access to the lease.

1.2. MITIGATIONS

Mitigation–Coastal Zone Management Concurrence - Alabama

Drilling permits cannot be issued for the proposed wells until concurrence with OEI's coastal zone management consistency certification has been received by MMS from the Alabama Department of Environmental Management or until concurrence with the certification has been conclusively presumed.

Mitigation–Coastal Zone Management Concurrence – Florida

Drilling permits cannot be issued for the proposed wells until concurrence with OEI's coastal zone management consistency certification has been received by MMS from the Florida Department of Community Affairs or until concurrence with the certification has been conclusively presumed. The EP may require further evaluation based upon issues raised by the Florida Department of Community Affairs during its consistency review.

1.3. DESCRIPTION OF THE PROPOSED ACTION

1.3.1. Background

Leases OCS-G 23493 and OCS-G 23497 (Blocks 180 and 224, respectively) were acquired at Eastern GOM Lease Sale 181 held on December 5, 2001. All leases were issued with effective dates of March 1, 2002, and a primary term expiration date of February 29, 2012. According to 30 CFR 250.169(a), the term of the lease will be extended for a period of time equal to the period the GOM Region (GOMR) has directed a suspension of operations. The following is a summarized chronology of correspondence related to OEI's Joint Initial EP (N-7622) for DeSoto Canyon Blocks 180 and 224.

11/08/02 – Initial EP received.
11/22/02 – Request for additional information submitted
12/17/02 – EP deemed complete.

A site-specific 3D seismic hazards study for DeSoto Canyon Blocks 180 and 224 and a site-specific 3D seismic study review for the proposed drill site locations addressed in the subject plan were also received by MMS on November 6, 2002. The following is a summary breakdown of the wells in the exploration program of the proposed action:

DeSoto Canyon Block 180 (OCS-G 23493)

Activity	Well Surface Location	Water Depth
Drill two sidetracks and temporarily abandon Well B	7,425 ft FEL; 1,000 ft FNL	7,000 ft
Drill and temporarily abandon Well C	5,120 ft FEL; 4,915 ft FNL	6,762 ft
Drill and temporarily abandon Well F	1,820 ft FWL; 6,255 ft FNL	6,788 ft

DeSoto Canyon Block 224 (OCS-G 23497)

Activity	Well Surface Location	Water Depth
Drill and temporarily abandon Well A	1,505 ft FWL; 2,805 ft FNL	6,936 ft
Drill and temporarily abandon Well D	5,280 ft FWL; 80 ft FNL	6,927 ft
Drill and temporarily abandon Well E	3,470 ft FWL; 2,800 ft FNL	6,957 ft

1.3.2. Schedule of Activities

The exploration drilling program for the six wells in the proposed action is planned to begin on March 31, 2003, and end on April 12, 2005. The planned duration of the proposed action is 341 days (49 weeks) from beginning the first well to completing the last, assuming the exploration program goes to term. OEI estimates that operations to drill these wells should take approximately 50 days each. OEI provided the following schedule in the EP's:

DeSoto Canyon Block 180 (OCS-G 23493)

Activity	Estimated Start Date	Estimated Completion Date	Days Duration
Drill two sidetracks and temporarily abandon Well B	03/31/03	06/29/03	90
Drill and temporarily abandon Well C	01/01/04	02/20/04	50
Drill and temporarily abandon Well F	02/21/04	04/12/04	51

DeSoto Canyon Block 224 (OCS-G 23497)

Activity	Estimated Start Date	Estimated Completion Date	Days Duration
Drill and temporarily abandon Well A	06/30/03	08/19/03	50
Drill and temporarily abandon Well D	01/01/05	02/20/05	50
Drill and temporarily abandon Well E	02/21/05	04/12/05	50

1.3.3. Equipment and Support Systems

Offshore exploratory activities are carried out from mobile offshore drilling units (MODU's). The proposed action is in water depths usually termed ultra-deepwater (>5,000 ft). Those MODU's potentially suitable for the water depths for the OCS blocks that are part of the proposed action would be (1) a conventionally-moored semisubmersible (anchored to the sea bottom with a chain catenary or tensioned mooring lines), (2) a dynamically positioned (DP) semisubmersible, or (3) a DP drillship. The DP capability refers to the system of propeller jets that are used to keep the drilling rig on station by compensating for the motion of winds and currents. OEI proposes to use a DP semisubmersible similar to Transocean SedcoFoprex's semisubmersible, the *Cajun Express,* for drilling and temporarily abandoning six wells at the seafloor. When a rig is selected, the rig specifications to be used will be made a part of the appropriate Applications for Permit to Drill.

The *Cajun Express* is a DP semisubmersible built in 2000. It has a rated depth capability of 8,500 ft (2,591 m) and a rated drilling depth capability of 35,000 ft (10,668 m). It has a helipad and a crew capacity of 130. Based on the planned total depths of the wells in the exploration program and the water depths of the OCS blocks, the *Cajun Express* is completely suitable for the proposed action. An image and a list of specifications for the *Cajun Express* are posted on the Rigzone Website (http://www.rigzone.com).

OEI is responsible for not creating conditions that will pose unreasonable risk to the public health, life, property, aquatic life, wildlife recreation, navigation, commercial fishing, or other uses of the ocean. Safety features on the rig will include well control, pollution prevention, welding procedure, and blowout prevention equipment as described in 30 CFR 250, Subparts C, D, E, and G; and as further clarified by the MMS Notices to Lessees and Operators (NTL), and current policy making invoked by MMS, USEPA, and the U.S. Coast Guard (USCG). In addition, all appropriate life rafts, life jackets, and buoys, as prescribed by the USCG, will be maintained on the facility at all times.

In accordance with 30 CFR 250, Subpart O, OEI is to ensure well-control training is provided for lessee and contractor personnel engaged in oil and gas operations in the GOM OCS. Supervisory and certain designated personnel onboard the facility are to be familiar with the effluent limitations and guidelines for overboard discharges into the receiving waters, as outlined in the USEPA's Region 4 NPDES General Permit GMG 280000 and/or USEPA's Region 4 NPDES Individual Permit. Installation of curbs, gutters, drip pans, and drains on drilling deck areas are required to collect all fluid contaminants and runoff to determine suitability for discharge overboard. No disposal of equipment, cables, containers, or other materials into offshore waters is permitted.

The MMS will conduct onsite inspections of offshore facilities to confirm operators are complying with lease stipulations, operating regulations, approved plans, and other conditions; as well as to assure safety and pollution prevention requirements are being met. The National Potential Incident of Noncompliance (PINC) List serves as the baseline for these inspections. The MMS also inspects the equipment listed in the operator's approved Oil-Spill Response Plan that would be used for the containment and cleanup of hydrocarbon spills.

1.3.4. Onshore Support Facilities and Onshore/Offshore Personnel

As mentioned earlier, DeSoto Canyon Blocks 180 and 224 are located approximately 82 mi from the nearest Louisiana coastline, 102 mi from Alabama, and 108 mi from Florida. These leases are located approximately 152 mi from the onshore support base in Port Fourchon, Louisiana. OEI would use its existing onshore base facilities located in Port Fourchon as the loading point for tools, equipment, and machinery to be delivered to the drillship and for temporary storage for materials and equipment. Crew change activities would also be conducted from Port Fourchon, Louisiana. A vicinity map showing the location of DeSoto Canyon Blocks 180 and 224 relative to the shoreline and onshore bases is included as Figure G-1 in Appendix G.

No onshore expansion or construction is anticipated with respect to the proposed activities. The proposed activities do not mandate any immediate measures for land acquisitions or expansion of the existing onshore base facilities. Dredging and filling operations would not be required for the proposed activities nor would any new construction or expansion of onshore facilities be required as a consequence of the proposed action. The base has 24-hour service, a radio tower with a phone patch, dock space, equipment, supply storage space, and drinking and drill water.

1.3.5. Transportation Operations

Personal vehicles would be the main means of transportation to carry rig personnel from various locations to the Port Fourchon area. The crewboat would be used to carry smaller supplies such as groceries, whereas the supply boat would be used to carry casing and bulk supplies such as cement via the most direct route from Port Fourchon, Louisiana. The helicopter would be used to transport rig personnel and small supplies and would normally take the most direct route of travel between Port Fourchon, Louisiana, and DeSoto Canyon when air traffic and weather conditions permit.

The drilling schedule submitted by OEI shows 341 days (49 weeks) of actual drilling operation according to the beginning and ending dates for each well. Support vessels and travel frequency per week during the 12 months anticipated for the exploration, drilling, and completion activities are as follows:

Support Vessel	Drilling and Completion Trips per Week	Total Trips for 421 Weeks
Crewboat	3	147
Supply boat	3	147
Helicopter	9	441

Vessels currently under charter to OEI are expected to support the proposed operations. It is estimated that additional employees would be required for supply boat, crewboat, and standby operations. The vessel crews would not require local housing as they would usually live on their respective vessels while working in the area and would return to their residence upon completion of each tour of duty. Some deck hands may be hired from the local labor pool. Some of the service firm employees may be hired locally. Most of these employees would return to their places of residence on their days off.

1.3.6. H_2S Contingency Plan

In accordance with the regulations contained in 30 CFR 250.417, OEI requests that the Regional Supervisor classifies the proposed action in DeSoto Canyon Blocks 180 and 224 as H_2S absent. Based upon available geologic data in the Eastern GOM, MMS subsequently deemed this area an area where the absence of H_2S has been confirmed. As a result, a H_2S Contingency Plan is not required for the proposed action.

1.3.7. Subregional Oil-Spill Response Plan

The purpose of the Subregional Oil-Spill Response Plan (OSRP) is to assist the Spill Management Team (SMT) to prepare for and respond quickly and safely to a hydrocarbon discharge or threat of a hydrocarbon discharge. The specific objectives of the Subregional OSRP are to (1) define notification, activation, and mobilization procedures to be followed when a spill or threat of a spill occurs, and (2) describe positions on the SMT and define roles and responsibilities of team members, including organizational structure and lines of responsibility to be followed during a spill response. Although this plan contains procedures applicable to most foreseeable spill scenarios, actual conditions will dictate whether deviations from the plan are appropriate.

1.3.8. Discharges and Wastes Disposal

The proposed action would typically generate the following waste: (1) drilling fluids and cuttings discharge that occurs at the seafloor prior to installation of the marine riser, plugging and temporary abandonment, and also the discharge that occurs during drilling; (2) excess cementwastes from equipment washdown after cementing operation; (3) well treatment, completion, and/or workover fluids — waste of chemicals and additives used for completion and testing operation of the well; (4) deck drainage — waste resulting from rainfall, rigwash, deckwash, tank cleaning, and runoff from curbs and gutters; (5) uncontaminated seawater — seawater used for cooling the machinery onboard a rig; (6) desalinization unit water — water associated with the process of creating freshwater from seawater; (7) uncontaminated ballast water — seawater which is added or removed to maintain proper draft; (8) uncontaminated bilge water — which is collected in the bilges from machinery operation; (9) diatomaceous earth filter media — filter media used to filter completion fluids or seawater; (10) sanitary waste — human body waste discharge from toilets and urinals; (11) domestic waste — discharge from galleys, sinks, and showers; and (12) solid waste and trash — plastic, paper, aluminum, glass, food, and other refuse. The proposed EP submitted by OEI has indicated that all discharges and waste disposals associated with drilling would be in accordance with regulations implemented by MMS, USEPA, and USCG.

The MMS regulations ((NTL 98-27, 30 CFR 250.300(a), 30 CFR 250.300(b)(6), and 30 CFR 250.300(c)), the USEPA's NPDES general permit, and the USCG's regulations implementing MARPOL 73/78 Annex V prohibit the disposal of any solid waste, trash, and debris into the marine environment. Those wastes generated as a result of the proposed action would be transported to OEI's Port Fourchon shore base and then to Riverbirch Landfill in Avondale, Louisiana, for final disposal in accordance with all Federal, State, and local rules and regulations.

Certain wastes intrinsic to exploration for oil and gas have been exempted from Federal regulations as hazardous waste under Subtitle C of the Resource Conservation and Recovery Act (RCRA) of 1976. The discharge of these RCRA-exempt wastes (drilling fluids, cuttings, and well treatment fluids), deck drainage, sanitary and domestic waste, and miscellaneous waste (uncontaminated ballast water, uncontaminated bilge, desalinization water, uncontaminated seawater, diatomaceous earth filter, excess cement slurry, and muds, cuttings, and cement at the seafloor) into offshore waters is regulated by the USEPA under the authority of the Clean Water Act. No wastes generated during oil and gas operations can be discharged overboard unless they meet the standards required within an USEPA NPDES permit. These lease blocks are in an area covered by an NPDES general permit (GMG280000) issued by the USEPA's, Region 4 (final published in the *Federal Register* on October 16, 1998, Volume 63, Number 200, pp. 55718-55762, and final modification published in the *Federal Register* on March 14, 2001, Volume 66, Number 50, pp. 14988-14999). OEI plans to use water-based fluids (WBF) in most of its operation, although synthetic-based fluids (SBF) may be used in some cases. In the event OEI elects to use SBF for drilling and plans to discharge synthetic cuttings overboard, a USEPA Region 4's individual NPDES permit is required to discharge overboard cuttings wetted with SBF. OEI has stated in the EP that all offshore discharges associated with the proposed action will be in accordance with the NPDES General Permit No. GMG280000 and/or an Individual NPDES Permit. Included in the EP's Attachment 9 is a chart of the waste that may be generated as a result of the proposed action, along with the quantities and the methods of disposal.

2. ALTERNATIVES TO THE PROPOSED ACTION

OEI states that, in accordance with the requirements of 30 CFR 250, they considered the project alternatives and concluded there were none. OEI believes they tailored the proposed exploration activities in such a way to minimize environmental impacts, including use of a DP semisubmersible that would not involve any anchoring on the seafloor. The use of synthetic-based drilling fluids (Drilling Option A-1) would reduce drilling days, thereby reducing air emissions.

Other MMS considered alternatives, including approval of the proposal as originally submitted, are as follows:

Nonapproval of the Proposal–OEI would not be allowed to undertake the proposed activities. This alternative could prevent the exploration for much needed hydrocarbons and could result in the potential loss of royalty income for the citizens of the United States. Considering this aspect and that minimal impacts are anticipated, this alternative was not judged to be acceptable.

Approval with Existing and/or Added Mitigation–Measures that OEI proposes to implement to limit potential environmental effects are discussed in the EP. The OCS Operating Regulations, NTL's, and other regulations and laws were identified throughout this assessment as existing mitigation for potential environmental effects associated with the proposed EP. Additional mitigations recommended as a result of this SEA are identified in Appendix A.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1. PHYSICAL RESOURCES

3.1.1. Water Quality

Water quality, for the purpose of this SEA, is the ability of a waterbody to maintain the ecosystems it supports or influences. In the case of coastal and marine environments, the quality of the water is influenced by the rivers that drain into the area, the quantity and composition of wet and dry atmospheric deposition, and the influx of constituents from sediments. Besides the natural inputs, human activity can contribute to water quality through discharges, run-off, burning, dumping, air emissions, and spills. Also, mixing or circulation of the water can either improve the water through flushing or be the source of factors contributing to the decline of water quality.

Water quality is measured by testing factors that indicate the health of an ecosystem. The primary factors influencing coastal and marine environments are temperature, salinity, oxygen, nutrients, and turbidity or suspended sediment load. In addition, trace constituents such as metals and organic compounds can affect water quality. Pathogens and pH are important determinants of coastal water quality. Altering the ecosystem through changes in any of these parameters may result in the destruction of habitat, a specific species, or possibly mass mortality or the support of undesirable or exotic species. The effects can either be localized or widespread.

3.1.1.1. Offshore Water Quality

The water depth in the two contiguous blocks of the proposed action ranges from 2,000 to 2,262 m (6,560-7,420 ft). The water at depths greater than 1,400 m (4,593 ft) is relatively homogeneous with respect to temperature, salinity, and oxygen. Turbidity can be influenced by local conditions such as deepwater currents and may also be caused by seafloor activities near exploration infrastructure anchored to the seafloor. Temperature ranges from 4.0 to 4.5°C, salinity from 34.963 to 34.976 ppt (parts per thousand), and oxygen from 4.58 to 5.61 ml/l 0_2 (Nowlin, 1972).

The flushing time of the GOM is important (Pequegnat, 1983). In deep water, oxygen must come from the surface and be mixed into the deep water of the Gulf. Deep oceanic circulation patterns begin at the poles where cooler and denser water sinks and is circulated in large oceanic gyres.

Limited analyses of trace metals and hydrocarbons in the offshore water column and sediments exist. Hydrocarbon seeps are extensive through the continental slope and contribute hydrocarbons to the surface sediments and water column, especially in the Central GOM. In addition to hydrocarbon seeps, other fluids leak from the underlying sediments into the bottom water along the slope. These fluids have been identified to have three origins: (1) seawater trapped during the settling of sediments; (2) seawater containing salt dissolved from underlying diapirs; and (3) deep-seated formation waters. The first two fluids are the source of authigenic carbonate deposits while the third is rich in barium and is the source of barite deposits such as chimneys.

3.1.1.2. Coastal Water Quality

OEI has indicated that they would use Port Fourchon, Louisiana, as their service base. Port Fourchon lies 152 mi (245 km) northwest of the OCS blocks of the proposed action. Port Fourchon is located on the eastern side of the Terrebonne/Timbalier Bays estuarine system.

Estuaries are a transition zone between the freshwater of rivers and the higher salinity waters offshore. These bodies of water are influenced by freshwater drained from the continental mainland and sediment influx from rivers and the tidal actions of the oceans. Due to proximity to land and associated population centers, the water quality of estuaries is vulnerable to anthropogenic (manmade) sources of pollution. This includes permitted discharges, spills, nonpoint-source runoff, and atmospheric deposition of pollutants.

The Terrebonne/Timbalier Bays estuary is a major interdistributary basin within the Mississippi River deltaic plain. Occupying 680 mi^2 (1,760 km^2), it is bounded on the east by the natural levees of Bayou Lafourche and on the west by Bayou du Large drainage basin. The sources of freshwater inflow into this estuary include precipitation and freshwater from excess runoff from the Mississippi River to the east. Limited freshwater inflow also occurs from various smaller tributaries. The depth of open water areas within the estuary is relatively uniform and averages less than 2 m at mid-tide level. Salinity normally ranges between 5 and 20 ppt mid-estuary depending on freshwater inflow. The following conditions exist in Terrebonne/Timbalier Bays: (1) chlorophyll *a* concentrations and turbidity are high, (2) nuisance and toxic algal blooms occur episodically, (3) anoxic conditions are not observed, (4) nitrogen concentrations are medium, and (5) phosphorus is high (USEPA, 1999).

There are nutrient, oxygen, and water salinity/density gradients in most estuaries, depending on their submarine geomorphology, depth, freshwater input, tidal flushing, and season of the year. All GOM estuaries exhibit a similar geographical and vertical pattern in salinity. Higher salinity water is usually associated with the deeper portions of the estuary that open into the open Gulf. Higher salinity water forms a density gradient in the form of a denser "salt wedge" that moves up the estuary with tidal action. The mean tidal range along the upper Gulf Coast is on the order of 0.5 m. Near large energetic outlets, the tidal excursion can be large and may approach 15 km.

Density gradients can form effective transport mechanisms for planktonic organisms and dissolved and particulate matter. The salinity of water and associated water quality variables can influence the behavior of various pollutants by affecting the solubility of various compounds. These variables are discussed further in the Final EIS for Lease Sale 181 (USDOI, MMS, 2001) and in the EIS for the CPA and WPA multisale (USDOI, MMS, 2002b).

3.1.2. Air Quality

The area of the proposed action, including DeSoto Canyon Blocks 180 and 224, is located 82 mi from the Louisiana coastline, 102 mi from the Alabama coastline, 108 mi from the Florida coastline, and approximately 152 mi from the onshore support base in Port Fourchon, Louisiana. These operations will occur west of 87°30' W longitude and hence fall under MMS's jurisdiction for enforcement of the Clean Air Act. The air over the OCS water is not classified but it is presumed to be better than the National Ambient Air Quality Standards (NAAQS) attained onshore for all criteria pollutants.

The primary meteorological influences upon air quality and the dispersion of emissions are the wind speed and direction, the atmospheric stability class, and the mixing height. The mixing heights offshore are quite shallow, generally 900 m or less where there are no influences from land. The general wind flow for this area is driven by the clockwise circulation around the Bermuda High, resulting in a prevailing southeasterly to southerly flow. Superimposed upon this circulation are smaller scale effects such as the sea breeze effect, tropical cyclones, and mid-latitude frontal systems. Because of the various factors, the winds blow from all directions in the area of concern.

Plaquemines Parish, the nearest land, is in attainment for all NAAQS. The OCS blocks for the proposed action (DeSoto Canyon Blocks 180 and 224) are approximately 102 mi (164 km) due south of Baldwin County, Alabama. Baldwin County is in attainment with all NAAQS.

The two contiguous blocks of the proposed action are approximately 108 mi (174 km) from the Breton National Wilderness Area. The Breton National Wildlife Refuge and National Wilderness Area off the Mississippi coast is designated as a Prevention of Significant Deterioration (PSD) Class I air quality area. Class I areas are afforded the greatest degree of air quality protection and are protected by stringent air quality standards that allow for very little deterioration of their air quality. The PSD maximum allowable pollutant increase for Class I areas are as follows: 2.5 $\mu g/m^3$ annual increment for

NO_2; 25 μg/m^3 3-hr increment, 5 μg/m^3 24-hr increment, and 2 μg/m^3 annual increment for SO_2; and 8 μg/m^3 24-hr increment and 5 μg/m^3 annual increment for PM_{10}. The U.S. Fish and Wildlife Service (FWS) has responsibility for protecting wildlife, vegetation, visibility, and other sensitive resources in this Class I area. The FWS has expressed concern that the NO_2 and SO_2 increments for the Breton National Wilderness Area have been consumed.

3.2. BIOLOGICAL RESOURCES

3.2.1. Coastal Habitat

3.2.1.1. Coastal Barrier Beaches and Associated Dunes

Coastal barriers of the northern GOM are divided into three physiographic areas: the Chenier Plain, the Mississippi River Delta, and the distant offshore islands east of the Mississippi River, which include the Chandeleur and Dog Keys. The coastal barrier shores of the GOM discussed here are found between Isles Dernieres in Terrebonne Parish, Louisiana, and Cape San Blas in Gulf County, Florida. Barrier features that are found along this part of the coast are dominantly sand beaches. Sandy barrier beaches have several interrelated environments that are primarily composed of unconsolidated coarse sediments that have been transported and deposited by waves, currents, storm surges, and winds.

Beaches and dunes there consist of relatively low sand masses that can be divided into several interrelated environments. The beach consists of the foreshore and backshore. The unvegetated foreshore slopes up from the ocean to the beach berm crest. The backshore is found between the beach berm-crest and the dunes and may be sparsely vegetated. The beach-crest may occasionally be absent due to storm activity. The dune zone of a barrier landform can consist of a single, low dune ridge, several parallel dune ridges, or a number of curving dune lines that are stabilized by vegetation. Dune heights in coastal Louisiana range from 0.5 to 1.3 m above mean high tide levels. An analysis of 37 years of tide gauge data from Grand Isle, Louisiana, shows that the probability of storms overwashing sand dune ranges up to 16 percent.

The rate of coastal retreat for a deltaic coast largely depends upon the stage in the deltaic cycle. When a major distributary of the Mississippi River is abandoned, channelized, or leveed, as they have been by extensive recent navigation and flood control structures, the volume of sediment that is spread over the delta's wetlands is reduced. Subsidence is no longer offset by the addition of sediment, and as sea-level rises, the Mississippi River Delta is transformed into an eroding (transgressive) headland. The drowning delta plain may soon be reworked by wave energy into flanking arcs of barrier sand spits and barrier islands.

The beaches along the Chenier Plain are very narrow with a vegetated, low, single-dune berm separating them from the landward marshes. The barrier beaches of the Mississippi Delta are on barrier islands, which have the most rapid erosion rates in the western hemisphere. They are generally broader than those of the Chenier Plain with a slightly better developed, single dune ridge. The artificial dune ridge of Grand Isle is the largest dune ridge to be found in this area. Many washover sites are seen among the natural dunes. The beaches of these two areas consist of fine sands and muds that accumulated during the constructive delta building phases of the Mississippi River. Generally, beaches on the barrier islands east of the Mississippi River are much more stable. They are much broader with coarser, white quartz sands largely originating from the Florida Panhandle. Here the dunes are well developed with one to several dune lines that are typically vegetated.

For additional information, see the Final EIS for Lease Sale 181 (USDOI, MMS, 2001).

3.2.1.2. Wetlands

Within the shoreline areas proximal to the EPA sale area are coastal wetland habitats that include fresh, brackish, and saline marshes, and fresh and saline forests. These wetlands generally occur as narrow bands around waterways and as broad expanses. Sharply delineated botanical zones of either a single species or mixed communities of plants are found within wetlands. These zones are largely based upon elevations, chemical characteristics, and physical characteristics of a wetland's sediments. Coastal wetlands are generally characterized as being highly productive, efficient at recycling nutrients, and provide habitats for a broad variety of plants and animals, some of which have significant economic value.

Wetlands rely on overbank deposition of sediments from rivers in flood stage. Floods deposit layers of sediment, raising ground and waterbottom elevations to a level that supports emergent and other wetland vegetation. Wetlands provide habitat for a great number and wide diversity of invertebrates, fish, reptiles, birds, and mammals. The habitat diversity has made wetlands important nursery grounds for many fish and shellfish juveniles, which in turn support a thriving fishing industry. Louisiana's coastal wetlands support more than two-thirds of the wintering waterfowl population of the Mississippi Flyway, including 20-25 percent of North America's puddle duck population. Louisiana's coastal region also supports the largest fur harvest in North America (Olds, 1984).

The Louisiana coastal zone contains extensive expanses of wetlands, which are generally divided into an eastern deltaic region and the Chenier Plain to the west. Coastal marshes of Mississippi and Alabama largely occur as discontinuous bands around bays, sounds, and streams. Most wetlands in this area of the Gulf Coast were built in shallow-water areas that received flow from the Mississippi River and other rivers. The most extensive wetlands in this vicinity occur in the Eastern Pearl River and Pascagoula River deltas in Mississippi; the Mobile River and Tensaw River deltas in Alabama; and Grand Bay of Mississippi Sound, which straddles the Mississippi-Alabama border. Mississippi contains about 64,000 ac (25,920 ha) of vegetated, coastal wetlands (Coastal Preserves Program, 1999). According to Wallace (1996), Alabama has about 75,000 ac (30,375 ha) of forested wetlands, 4,400 ac (1,782 ha) of freshwater marsh, and 35,400 ac (14,337 ha) of estuarine marsh. In the Florida Panhandle, the greatest concentrations are associated with tidal portions of rivers that flow into the various bays of the area. Hardwood swamps represent the largest percentage of wetlands in the coastal counties of the Florida Panhandle. The wetlands of Mississippi, Alabama, and Florida are generally more stable than those in Louisiana, a reflection of more stable substrate, less disrupted sedimentation, and the occurrence of only minor canal dredging patterns in their wetlands.

The deterioration of coastal wetlands is an issue of Federal, State, and local concern. Several factors have been documented to cause wetland losses. Naturally occurring subsidence, erosion, and sea-level rise have caused wetland losses where sedimentation rates could not offset those factors. The Mississippi's deltaic plain is subject to very high subsidence rates as deltaic muds compact over time. Sea-level rise is a consequence of subsidence, and sea level rise has been estimated at 1 cm/yr (van Beek and Meyer-Arendt, 1982).

Human activities are the main contributors to wetland losses. These activities include farmland soil conservation efforts, dam and levee construction, canal building and dredging, and river channelization. These efforts have had the unintended consequence of reducing the sediment supply that is needed to keep a deltaic shoreline stable and "alive." The suspended-sediment load of the Mississippi River has been reduced by about 70 percent since 1850 (Kesel, 1988) from dams constructed during the 1950's and 1960's. In the wetlands of the Louisiana deltaic region, a landloss rate was calculated to be 69.2 km^2/yr during 1956 through 1978. A landloss rate for the same area was calculated to be 68.6 km^2/yr (Barras et al., 1990) during 1978 through 1990. Similar rates of loss are believed to continue today. In Mississippi, about 1,190 ha (2,940 ac) of vegetated coastal wetlands have been lost between 1973 and about 1997, indicating a loss rate of about 50 ha/yr (Coastal Preserves Program, 1999). Wetland-loss rates were not available for Alabama or Florida. Other factors with less measurable effects that contribute to wetland loss include residential and commercial development, and the construction of levees, bulkheads, jetties and other structures intended to reduce erosion. These structures can divert wave energy into sensitive wetlands to amplify erosive effects. Boat wakes also focus wave energy that can erode wetlands.

3.2.1.3. Seagrasses

Submerged seagrass beds grow in shallow, relatively clear and protected waters with predominantly sand bottoms. Their distribution depends on an interrelationship among a number of environmental factors that include temperature, water depth, turbidity, salinity, turbulence, and substrate suitability. Primarily because of low salinity, high turbidity and soft highly organic sediments, robust seagrass beds, and the accompanying high diversity of marine species are found among scattered and protected locations in the northern GOM.

Three million hectares (7,413,000 ac) of submerged seagrass beds are estimated to exist in exposed, shallow coastal waters of the northern GOM. An additional 166,000 ha (410,000 ac) are found in protected, natural embayments and are generally not considered exposed to OCS impacts. Approximately 98.5 percent of all coastal seagrasses in the northern GOM area are found off Florida. Texas and Louisiana contain approximately 0.5 percent of seagrass beds. Mississippi and Alabama have the remaining 1 percent of seagrass beds.

Most of Louisiana's seagrass beds occur in Chandeleur Sound. In Mississippi and Alabama, seagrasses occur within Mississippi Sound and lower Mobile Bay. In Florida, most of seagrasses occur in the Big Bend area offshore and in its bays and sounds.

Seagrasses provide important habitat for immature shrimp, black drum, spotted sea trout, juvenile southern flounder, and several other fish species; and they provide a food source for several species of wintering waterfowl.

The seagrass beds in the northern Gulf have generally diminished since 1940. Primary factors believed to be responsible include dredging, dredged material disposal, trawling, water quality degradation, eutrophication, hurricanes, slime mold infestation, flood protection levees that direct freshwater away from wetlands, saltwater, and infrequent freshwater diversions from the Mississippi River into coastal areas during flood stage.

For additional information, see the Final EIS for Lease Sale 181 (USDOI, MMS, 2001).

3.2.2. Offshore Habitat

3.2.2.1. Pelagic Environment: Plankton and Nekton

Zooplanktons are small animals that move with the water currents rather than swim independent of them. Taxa include copepods, other crustaceans, protozoans, hydromedusae, chaetognaths, salps, pteropods, and neustonic organisms. Nektons are pelagic organisms that control their own movement independent of water current speed and direction.

Nektons include pelagic fishes such as some sharks, toothed whales, sailfish, marlin, spearfish, swordfish, tuna, and flying fishes. Invertebrate nektons include squid, shrimp-like mysids, and deep-sea shrimp. Euphausiids are shrimp-like crustaceans that are herbivorous (when phytoplankton are abundant), omnivorous, or carnivorous. Pelagic shrimps are usually 1-10 cm in length.

3.2.2.2. Benthic Environment

3.2.2.2.1. Nonchemosynthetic Benthic Communities

The vast majority of the GOM has a soft, muddy bottom in which burrowing infauna are the most abundant invertebrates. The substrate is commonly soft hemipelagic clay. Major groups found throughout the Gulf include bacteria and other microbes, meiofauna (0.063-0.3 mm), macrofauna (> 0.3 mm), and megafauna (the largest animals). Nearly all macrofaunal species are infaunal invertebrates. Both meiofauna and macrofauna densities decrease with depth. DeSoto Canyon Blocks 180 and 224 are located in water depths between 6,560 and 7,420 ft (2,000-2,262 m), considered a part of the upper abyssal zone of the GOM. Hard-bottom areas that could support high-density coral or other attached communities do not occur in the vicinity of the proposed actions.

3.2.2.2.2. Chemosynthetic Communities

There are no known chemosynthetic communities in the two contiguous blocks or in the entire EPA sale area. The nearest location of an identified chemosynthetic community to DeSoto Canyon Block 180 is approximately 37 nmi (57 km) northwest in Viosca Knoll Block 826 (Figure III-6 in Final EIS for Lease Sale 181 (USDOI, MMS, 2001)).

Chemosynthetic communities are ecosystems where symbiotic bacteria use a carbon source independent of photosynthesis and the sun-dependent photosynthetic food chain that supports most all other life on earth. Hydrothermal chemosynthetic vent communities in the eastern Pacific tend to be smaller than those in the Gulf where hydrocarbons seep through the overlying sediment. Dense chemosynthetic invertebrate communities are usually found at depths of 400 m and greater, where the temperature and salinity of the water is mostly constant. For additional information about chemosynthetic communities, see the Final EIS for Lease Sale 181 (USDOI, MMS, 2001).

3.2.2.3. Sea Turtles

Five species of sea turtle are found in the waters of the GOM: Kemp's ridley, loggerhead, green, leatherback, and hawksbill. All are protected under the ESA. Sea turtles spend nearly all of their lives in the water. Females must emerge periodically from the ocean to nest on beaches. Sea turtles are long-lived, slow-reproducing animals. It is generally believed that all sea turtle species spend the first few years of their lives in pelagic waters, occurring in driftlines and convergence zones (in sargassum rafts) where they find refuge and food in items that accumulate in surface circulation features (Carr, 1986 and 1987).

Adult turtles in the Gulf are apparently less abundant in the deeper waters of the Gulf than they are in waters less than 27-50 m deep (NRC, 1990). More sea turtles are sighted in the northeastern Gulf than in the northwestern Gulf (Thompson, 1988). Sea turtle abundance in the Gulf appears to increase dramatically east of Mobile Bay (Davis et al., 2000). Factors such as water depth, bottom sediments, and prey availability may account for this. In the offshore Gulf, sea turtle distribution has been linked to zones of convergence.

For additional information and expanded discussion see the Final EIS for Lease Sale 181 (USDOI, MMS, 2001).

Green Turtle

The green turtle (*Chelonia mydas*) is the largest hard-shelled sea turtle; adults commonly reach 100 cm in carapace length and 150 kg in weight (USDOC, NMFS, 1990a). The green turtle has a global distribution in tropical and subtropical waters, and has a presence in all Gulf States. Areas in Texas and Florida figured heavily in the commercial fishery for green turtles at the end of the last century (Hildebrand, 1982).

There are historic and recent records of green turtle presence in southwest Florida (summary in Meylan et al., 1995). Nesting has been recorded at Eglin Air Force Base in Okaloosa County, in the Florida Panhandle (Meylan et al., 1995). Counts of the number of nests in Florida are increasing, but whether this upward trend is due to an increase in the number of nests or is a result of more thorough monitoring of the nesting beaches is uncertain (USDOC, NMFS, 1990a; Meylan et al., 1995). Reports of green turtle nesting in the northern Gulf are infrequent.

Green turtles primarily occur in coastal waters, where they forage on seagrasses, algae, and associated organisms (Carr and Caldwell, 1956; Hendrickson, 1980). Some green turtles may move through a series of "developmental" feeding habitats as they grow (Hirth, 1997). Adult green turtles in the Caribbean and GOM are herbivorous, feeding primarily on seagrasses and, to a lesser extent, on algae and sponges. Areas that are known as important feeding areas for green turtles in western Florida include the Homosassa River, Crystal River, and Cedar Key (USDOC, NMFS, 1990a).

Leatherback Turtle

The leatherback (*Dermochelys coriacea*) is the largest of the sea turtles, with an average curved carapace length for adult turtles of 159 cm and weight ranging from 200 to 700 kg (USDOC, NMFS, 1992). Leatherbacks have unique deep-diving abilities (Eckert et al., 1986), a specialized jellyfish diet (Brongersma, 1972), and unique physiological properties that distinguish them from other sea turtles (Lutcavage et al., 1990; Paladino et al., 1990). This species is the most pelagic and most wide-ranging of sea turtles, undertaking extensive migrations following depth contours for hundreds, even thousands, of kilometers (Morreale et al., 1996; Hughes et al., 1998). The leatherback's distribution is not entirely oceanic (>200 m). It is commonly found in relatively shallow continental shelf waters of the northern GOM (Leary, 1957; Fritts et al., 1983; Lohoefener et al., 1988 and 1990; Collard and Ogren, 1990; Davis et al., 2000). Based on a summary of several studies, Davis and Fargion (1996) concluded that primary habitat of the leatherback in the northwestern Gulf is oceanic. In contrast, the overall densities of leatherbacks in the Eastern Gulf on the shelf and on the slope were similar (Davis et al., 2000). It has been suggested that the region from Mississippi Canyon east to DeSoto Canyon appears to be an important habitat for leatherbacks (Davis and Fargion, 1996). Leatherback nesting is concentrated on coarse-grain beaches in the tropical latitudes (Pritchard, 1971).

The majority of sightings of leatherbacks during the GulfCet surveys occurred just north of DeSoto Canyon (Davis and Fargion, 1996; Davis et al., 2000). The nearly disjunct summer and winter distributions of leatherback sightings on the slope in the Eastern Gulf during GulfCet II indicate that specific areas may be important to this species either seasonally or for short periods of time. These specific locations are most probably correlated with oceanographic conditions and resulting concentrations of prey. Large numbers of leatherbacks in waters off the northeast U.S. have been associated with concentrations of jellyfish (Shoop and Kenney, 1992). Similar sightings with high jellyfish abundance have been made in the Gulf. There were 100 leatherbacks sighted just offshore Texas (Leary, 1957), while 7 were seen at a watermass boundary in the Eastern Gulf (Collard and Ogren, 1990).

Other clusters of leatherback sightings have been reported for the northern Gulf (Davis and Fargion, 1996; Lohoefener et al., 1990).

Hawksbill Turtle

The hawksbill (*Eretmochelys imbricata*) is a small to medium-sized sea turtle. Nesting females average about 87 cm in curved carapace length and can weigh up to 80 kg (USDOC, NMFS, 1993). The hawksbill occurs in tropical and subtropical seas of the Atlantic, Pacific, and Indian Oceans. This species feeds in the photic zone and prefers warm water temperatures.

The species is widely distributed in the Caribbean Sea and western Atlantic Ocean. Representatives of at least some life history stages occur in southern Florida and the northern GOM (especially Texas), in the Greater and Lesser Antilles, and along the Central American mainland south to Brazil (USDOC, NMFS, 1993). The hawksbill is the least commonly reported sea turtle in the Gulf (Hildebrand, 1982). Northerly currents may carry immature hawksbills away from their natal beaches in Mexico northward into Texas (Amos, 1989; Collard and Ogren, 1990). Texas and Florida are the only states where hawksbills are sighted with any regularity (USDOC, NMFS, 1993). The hawksbill turtle is a solitary nester. Within the continental U.S., nesting is restricted to the southeast coast of Florida and the Florida Keys. Nesting by hawksbills in Florida is considered rare; statewide, nesting has been reported as early as June 6 and as late as October 31 (Meylan et al., 1995). Hawksbill turtles are generally associated with coral reefs or other hard substrate areas, where they forage primarily on sponges (Carr and Stancyk, 1975; Meylan, 1988).

Kemp's Ridley Turtle

The Kemp's ridley (*Lepidochelys kempi*) is the smallest living sea turtle and the most imperiled. The weight of an adult is generally less than 45 kg and the straight carapace length is around 65 cm; adult Kemp's ridley shells are almost as wide as they are long (USDOI, FWS and USDOC, NMFS, 1992). The GOM's population of nesting females has dwindled from an estimated 47,000 in 1947 to a current nesting population of approximately 1,500 females (Byles et al., 1996). The recovery of the species has been frustrated primarily by incidental mortality in commercial shrimping that has prevented adequate recruitment into the breeding population (USDOI, FWS and USDOC, NMFS, 1992).

In the Gulf, Kemp's ridleys inhabit nearshore areas, being most abundant in coastal waters from Texas to west Florida (Ogren, 1989; Marquez, 1990 and 1994; Rudloe et al., 1991). Kemp's ridleys display strong seasonal fidelity to tidal passes and adjacent beachfront environs of the northern Gulf (Landry and Costa, 1999). There is little prolonged use of offshore habitats by this species. The adult Kemp's ridley turtle usually occurs only in the Gulf, but juveniles and immature individuals ranged between tropical and temperate coastal areas of the northwestern Atlantic (Marquez, 1990). Other spots of occurrence of juvenile and immature ridleys, quoted in stranding reports, are the west coast of Florida and the mouth of the Mississippi River (Ogren, 1989; Marquez, 1990). Juveniles, subadults, and adults are common off Big Gully, offshore east of Mobile Bay, Alabama, where they have been reported as captured in trawls since the mid-1970's (Carr, 1980; Ogren, 1989; Marquez, 1994). Some of the smallest Kemp's ridleys have been found off Wakulla and Franklin Counties, Florida (Ogren, 1989). Two sightings of Kemp's ridley were reported for the continental shelf in the Eastern Gulf during GulfCet II surveys (Davis et al., 2000).

Nesting in the U.S. occurs infrequently on Padre and Mustang Islands in south Texas from May to August (Thompson, 1988). The first confirmed nesting in the U.S. by a Kemp's ridley turtle that had previously nested in Mexico occurred in 1998 (Shaver and Caillouet, 1998). Kemp's ridleys that nest in south Texas today are likely a mixture of returnees from the experimental imprinting and head-starting project and others from the wild stock. Kemp's ridley turtles have occasionally nested in Florida.

Hatchlings appear to disperse offshore and are sometimes found in sargassum mats (Collard and Ogren, 1990). In the pelagic stage, the turtle is dependent on currents, fronts, and gyres to determine their distribution. The north and northeast portions of the Gulf are considered foraging habitat for juveniles, subadults, and post-nesting females (Ogren, 1989; Rudloe et al., 1991). The Kemp's ridley on the upper Texas and Louisiana coasts inhabits sandy and muddy bottoms, feeding on portunids and other crabs (Ogren, 1989; Shaver, 1991), and possibly on shrimp fishery bycatch (Landry and Costa, 1999). Other Kemp's ridley turtles head to the Cedar Key, Florida, area where they also prey on portunids. This is an area where seagrass communities are common, and also where ridleys penetrate bays and estuaries (Carr and Caldwell, 1956; Lutcavage and Musick, 1985; Landry, personal communication, 2000). Strandings of Kemp's ridleys on Texas beaches indicate that they are mostly from Mexico (Shaver, personal communication, 1998). In general, on a yearly basis, about 1 percent of strandings identified by the U.S. Sea Turtle Stranding Network are associated with petroleum (Teas and Martinez, 1992).

Loggerhead Turtle

The loggerhead sea turtle (*Caretta caretta*) occurs worldwide in habitats ranging from estuaries to the continental shelf (Dodd, 1988). The mean straight carapace length of adult southeastern U.S. loggerheads is approximately 92 cm; the corresponding mean body mass is approximately 113 kg (USDOC, NMFS, 1990b). The loggerhead is the most abundant species of sea turtle occurring in U.S. waters, throughout the inner continental shelf from Florida through Cape Cod, Massachusetts. The loggerhead is probably the most common sea turtle species in the northern Gulf (e.g., Fritts et al., 1983; Fuller and Tappan, 1986; Rosman et al., 1987; Lohoefener et al., 1990).

In the GOM, there are two loggerhead nesting subpopulations: the Florida Panhandle Nesting subpopulation (Eglin Air Force Base and the beaches near Panama City) and the Yucatán nesting subpopulation (northern and eastern Yucatán Peninsula, Mexico) (Byles et al., 1996). Little is known about seasonal movements of loggerheads in the Gulf (Byles et al., 1996). Recent surveys indicate that the Florida Panhandle accounts for approximately one-third of the nesting on the Florida Gulf Coast (Meylan et al., 1995). In the Florida Panhandle, Gulf, Franklin, and Bay Counties (Cape San Blas and St. Joseph Peninsula State Park in particular) have been found to have the highest levels of loggerhead nesting (Meylan et al., 1995). Loggerhead nesting has been reported on Gulf Shores and Dauphin Island, Alabama; Petit Bois, Horn, and East Ship Islands, offshore Mississippi; and the Chandeleur Islands, Louisiana (Fuller et al., 1987; Lohoefener et al., 1990; Patrick, personal communication, 1997a). It is unknown whether the nesting sea turtles in Alabama, Mississippi, and Louisiana are genetically distinct subpopulations or are genetically similar to the Florida Panhandle Subpopulation (Bowen et al., 1993).

GulfCet aerial surveys indicate that loggerheads are largely distributed in water depths less than 100 m (Shoop et al., 1981; Fritts et al., 1983) and deep waters (>1,000 m). Loggerhead distribution is not as nearshore dependent as that of Kemp's ridley and green sea turtles (Landry and Costa, 1999). Loggerhead abundance in slope waters of the Eastern Gulf increased significantly during winter (Davis et al., 2000).

Loggerheads have been found to be abundant in Florida waters (Fritts and Reynolds, 1981; Fritts et al., 1983; Davis et al., 2000). Census dives made near artificial reefs and a sunken offshore platform near Panama City, Florida, noted 17 sightings of sea turtles; all turtles sighted were loggerheads, usually resting in a shallow pit in the sand (Rosman et al., 1987). In the Central Gulf, loggerheads are very abundant just offshore Breton and Chandeleur Islands (Lohoefener et al., 1990).

Juvenile and subadult loggerheads are omnivorous, foraging on pelagic crabs, molluscs, jellyfish, and vegetation captured at or near the surface (Dodd, 1988; Plotkin et al., 1993). Adult loggerheads are generalist carnivores that forage on nearshore benthic invertebrates (Dodd, 1988). The banks off the central Louisiana coast and near the Mississippi Delta are also important marine turtle feeding areas (Hildebrand, 1982).

3.2.3. Coastal and Marine Birds

3.2.3.1. Nonendangered and Nonthreatened Species

The offshore waters, coastal beaches, and contiguous wetlands of the northeastern GOM are populated by both resident and migratory species of coastal and marine birds. This analysis assumes six major groups in the area of concern: seabirds, shorebirds, marsh and wading birds, waterfowl, diving birds, and raptors. Many species are mostly pelagic, and therefore rarely sighted nearshore. Fidelity to nesting sites varies from year to year along the Gulf Coast (Martin and Lester, 1991). Birds may abandon sites along the northern Gulf Coast because of altered habitat and excessive human disturbance.

Seabirds

Seabirds are a diverse group of birds that spend much of their lives on or over saltwater (Table 3-1). Species diversity and overall abundance is highest in the spring and summer and lowest in the fall and winter. Four ecological categories of seabirds have been documented in the deepwater areas of the Gulf: summer migrants (e.g., shearwaters, storm petrels, and boobies); summer residents that breed in the Gulf (e.g., sooty, least, and sandwich tern, and frigatebird); winter residents (e.g., gannets, gulls, and jaegers); and permanent resident species (e.g., laughing gulls and royal and bridled terns) (Hess and Ribic, 2000;

USDOI, MMS, 2001a). Collectively, they live far from land most of the year, roosting on the water surface, except at breeding time when they return to nesting areas along coastlines (Terres, 1991). Seabirds typically aggregate in social groups called colonies; the degree of colony formation varies between species (Parnell et al., 1988). They also tend to associate with various oceanic conditions including specific sea-surface temperatures, salinities, areas of high planktonic productivity, or current activity. Seabirds obtain their food from the sea with a variety of behaviors including piracy, scavenging, dipping, plunging, and surface seizing.

Table 3-1

Common Seabirds in the Northern Gulf of Mexico

Common Name	Scientific Name	Occurrence*	Feeding Behavior and Diet
Wilson's storm-petrel	*Oceanites oceanicus*	Summer resident	Picks crustaceans, fish, and squid from the sea surface
Magnificent frigatebird	*Fregata magnificens*	Summer resident	Dives to pluck jellyfish, fish, and crustaceans from the sea surface
Northern gannet	*Morus bassanus*	Wintering resident	Fish and squid
Masked booby	*Sula dactylatra*	Wintering resident	Plunge dives for flying fishes and small squid
Brown booby	*Sula leucogaster*	Wintering resident	Prefers to perch; comes ashore at night to roost
Cory's shearwater	*Calonectris diomedea*	Summer resident	Feeds at the water surface at night on crustaceans and large squid
Greater shearwater	*Puffinus gravis*	Summer resident	Dives to catch fish
Adubon shearwater	*Puffinus lherminieri*	Summer resident	Dives to catch fish, squid, and other organisms

*All major seabirds are distributed Gulfwide.

Shorebirds

Shorebirds are those members of the order Charadriiformes generally restricted to coastline margins (beaches, mudflats, etc.). GOM shorebirds comprise five taxonomic families: Jacanidae (jacanas), Haematopodidae (oystercatchers), Recurvirostridae (stilts and avocets), Charadriidae (plovers), and Scolopacidae (sandpipers, snipes, and allies) (Hayman et al., 1986). An important characteristic of almost all shorebird species is their strongly developed migratory behavior, with some shorebirds migrating from nesting places in the far north to the southern part of South America (Terres, 1991). Both spring and fall migrations take place in a series of "hops" to staging areas where birds spend time feeding heavily to store up fat for the sustained flight to the next staging area; many coastal habitats along the GOM are critical for such purposes. Along the Gulf Coast, observers have recorded 44 species of shorebirds. Six species nest in the area; the remaining species are wintering residents and/or "staging" transients (Pashley, 1991). Although variations occur between species, most shorebirds begin breeding at 1-2 years of age and generally lay 3-4 eggs per year. They feed on a variety of marine and freshwater invertebrates and fish, and small amounts of plant life.

Marsh and Wading Birds

The term "wading birds" is a general term for birds that live in warm shallow water (Table 3-2). They have long legs that allow them to forage by wading into shallow water, while they use their long bills and usually long necks to probe under water or to make long swift strokes to seize fish, frogs, aquatic insects, crustaceans, and other prey (Terres, 1991). These families have representatives in the northern Gulf: Ardeidae (herons, bitterns, and egrets), Ciconiidae (storks), Threskiornithidae (ibises and spoonbills), and Gruidae (cranes). Seventeen species of wading birds in the Order Ciconiiformes currently nest in the U.S., and all except the wood stork nest in the northern Gulf coastal region (Martin, 1991). Louisiana supports the majority of nesting wading birds. Great egrets are the most widespread nesting species in the Gulf region; they often occupy urban canals (Martin, 1991).

"Marsh birds" is a collective term referring to birds that have adapted to living in marshes and shallow water. Members of the Rallidae family (rails, moorhens, and gallinules) are elusive and rarely seen within the low vegetation of fresh and saline marshes, swamps, and rice fields (Bent, 1926; National Geographic Society, 1983; Ripley and Beehler, 1985).

Table 3-2

Common Wading Birds in the Northern Gulf of Mexico

Common Name	Scientific Name	Occurrence*	Feeding Behavior and Diet
American bittern	*Botaurus lentiginosus*	*	Amphibians, small fish, small snakes, crayfish, small rodents, and water bugs
Least bittern	*Ixobrychus exilus*	Summer resident	NA[1]
Great blue heron	*Ardea herodias*	*	Various aquatic animals
Great egret	*Casmerodias albus*	*	Fish, frogs, snakes, crayfish, and large insects
Snowy egret	*Egretta thula*	*	Arthropods, fish
Little blue heron	*Egretta caerulea*	*	Small vertebrates, crustaceans, and large insects
Tricolored heron	*Egretta tricolor*	*	NA[1]
Reddish egret	*Egretta rufescens*	Pan-Gulf except for central and eastern FL Panhandle	NA[1]
Cattle egret	*Bulbulcus ibis*	*	NA[1]
Green-backed heron	*Butorides striatus*	Permanent resident in central LA and eastward; summer resident, TX and western LA	NA[1]
Black-crowned night heron	*Nycticorax nicticorax*	*	NA[1]
Yellow-crowned night heron	*Nyctanassa biolacea*	Permanent resident TX, eastern LA, MS, AL, and eastern FL Panhandle	Aquatic organisms, especially crustaceans
White ibis	*Eudocimus albus*	*	NA[1]
Glossy ibis	*Plegadis falconellus*	*	Snakes, crayfish, and crabs
White-faced ibis	*Plegadis chini*	Permanent resident in TX and western and central LA; Summer resident in eastern LA	NA[1]
Roseate spoonbill	*Ajaia ajaja*	Permanent resident; Summer resident in LA	NA[1]

*All wading birds are permanent residents throughout the Gulf Coast unless otherwise indicated.
[1]Not available.

Waterfowl

Waterfowl belong to the taxonomic order Anseriformes and include swans, geese, and ducks. A total of 27 species are regularly reported along the north-central and western Gulf Coast (Table 3-3). Among these are 1 swan, 4 geese, 7 surface-feeding (dabbling) ducks and teal, 4 diving ducks (pochards), and 11 others (including the wood duck, whistling duck, sea ducks, ruddy duck, and mergansers) (Clapp et al., 1982; National Geographic Society, 1983; Madge and Burn, 1988). Many species usually migrate from wintering grounds along the Gulf Coast to summer nesting grounds in the northern U.S. Waterfowl migration pathways have traditionally been divided into four parallel north-south paths, or "flyways" (not mutually exclusive), across the North American continent. The Gulf Coast serves as the southern terminus of the Mississippi (Louisiana, Mississippi, and Alabama) flyway. Waterfowl are social and have a diverse array of feeding adaptations related to their habitat (Johnsgard, 1975).

Table 3-3

Common Waterfowl in the Northern Gulf of Mexico

Common Name	Scientific Name	Occurrence*	Feeding Behavior and Diet
Wood duck	*Aix sponsa*	Year-round	Dabbler; eats plants, invertebrates, tadpoles, and salamanders
Canvasback duck	*Aythya valisineria*	Year-round	Diver; feeds on molluscs and aquatic plants
Redhead duck	*Aythya americana*	*	Diver; mostly herbivorous
Ring-necked duck	*Aythya collaris*	*	Diver
Fulvous whistling duck	*Dendrocygna bicolor*	Nests in TX, LA	Feeds nocturnally on plant seeds on shore
Lesser scaup	*Aythya affinis*	High abundance	Diver; feeds on plants and animals
Greater scaup	*Aythya maarila*	*	Feeds on plants, insects, and invertebrates in nesting season; diet at sea in winter is mostly molluscs and plants
Black scoter	*Melanitta nigra*	Low abundance	Diver; feeds mostly on mollusks
White-winged scoter	*Melanitta fusca*	TX, LA, AL; low abundance	Diver; feeds mostly on shellfish
Surf scoter	*Melanitta perspicilla*	Low abundance	Diver; feeds mostly on mollusks and crustaceans
Common goldeneye	*Bucephala clangula*	*	Diver; needs on mollusks, crustaceans, insects, and aquatic plants
Bufflehead	*Bucephala albeola*	*	Diver; in fresh water, eats aquatic adult and larval insects, snails, small fish, and aquatic plant seeds; in salt water, eats crustaceans, shellfish, and snails
Common merganser	*Mergus merganser*	*	Diver; feeds on molluscs, crustaceans, aquatic insects, and some plants
Red-breasted merganser	*Mergus serrator*	*	Eats mostly fish
Hooded merganser	*Lophodytes cucullatus*	*	Diver; thin serrated bill is adapted to taking fish; also feeds on crustaceans, aquatic insects, other animals, and plants
Tundra swan	*Cygnus columbianus*	Winters on Atlantic Coast, minor presence in Gulf	NA[1]
Greater white-fronted goose	*Answer albifrons*	TX, LA, AL	Feeds on plants and insects
Snow goose	*Chen caerulescens*	TX, LA, MS, AL	Dabbler, grazer, herbivore
Canada goose	*Branta canadensis*	*	Dabbler; herbivore
Brant (goose)	*Branta bernicla*	FL	Herbivore
Mallard (duck)	*Anas platyrhynchos*	*	Dabbler; usually a herbivore; female supplements diet with invertebrate protein source when producing eggs
Mottled duck	*Anas fulvigula*	TX, LA year-round	Dabbler; invertebrates and some plant material
American widgeon (duck)	*Anas americana*	*	Dabbler; may feed on widgeon grass (*Ruppia maritima*)
Northern pintail (duck)	*Anas acuta*	Abundant in TX	Dabbler mostly herbivorous
Northern Shoveler (duck)	*Anas clypeata*	*	Dabbler; strains food through combs of teeth that are found inside the bill on each side
Blue-winged teal (duck)	*Anas discors*	*	Dabbler; mostly herbivorous
Cinnamon Teal (duck)	*Anas cyanoptera*	TX, west LA	Dabbler; eats invertebrates, plant seeds, and algae; sometimes skims water surface with bill
Gadwall (duck)	*Anas strepera*	*	Dabbler; mostly herbivorous
Ruddy duck	*Oxyura jamaicensis*	*	Diver; mostly herbivorous

*All waterfowl are wintering residents throughout the Gulf Coast unless otherwise indicated.
[1]Not available.

Raptors

The American peregrine falcon was removed from the endangered species list on August 20, 1999. Although the final determination to delist removes the American peregrine falcon from ESA protection, the species is still protected under the Migratory Bird Treaty Act. The FWS will continue to monitor the falcon's status for 13 years to ensure that recovery is established.

Diving Birds

There are three main groups of diving birds, respectively: cormorants and anhingas, loons, and grebes (Table 3-4).

Table 3-4

Common Diving Birds in the Northern Gulf of Mexico

Common Name	Scientific Name	Occurrence*	Feeding Behavior and Diet
Common loon	*Gavia immer*	Wintering resident	Dives from surface for fish, arthropods, snails, leeches, frogs, and salamanders
Horned grebe	*Podiceps auritus*	Wintering resident	Fish and some arthropods
Eared grebe	*Podiceps nigricollis*	TX, LA, MS, AL	Arthropods
Pied-billed grebe	*Podilymbus podiceps*	Permanent resident	Arthropods, small fish
Anhinga	*Anhinga anhinga*	Permanent resident	Swims underwater for fish, frogs, snakes, and leeches
Olivaceous cormorant	*Phalacrocorax olivaceus*	*	NA[1]
Double-crested cormorant	*Phylacrocorax auritus*	Permanent resident	NA[1]

*All of these diving birds are distributed Gulfwide except where otherwise indicated.
[1]Not available.

3.2.3.2. Endangered and Threatened Species

The following coastal and marine bird species that inhabit or frequent the northern GOM coastal areas are recognized by FWS as either endangered or threatened: piping plover, roseate tern, bald eagle, and brown pelican.

Piping Plover

The piping plover (*Charadrius melodus*) is a migratory shorebird that is endemic to North America. The piping plover breeds on the northern Great Plains, in the Great Lakes, and along the Atlantic Coast (Newfoundland to North Carolina); and winters on the Atlantic and Gulf Coast from North Carolina to Mexico and in the Bahamas West Indies. Habitat includes coastal sand flats and mud flats in proximity to large inlets or passes, which may attract the largest concentrations of piping plovers (Nicholls and Baldassarre, 1990). Hypothetically, piping plovers may have a preferred prey base there and/or the substrate coloration provides protection from aerial predators due to chromatic matching camouflage. Nesting habitat in the north includes open flats along the Missouri River and the Great Lakes. This species remains in a precarious state given its low population numbers, sparse distribution, and continued threats to habitat throughout its range.

Roseate Tern

The roseate tern (*Sterna dougalli*) is listed as threatened in Alabama and Florida. However, in the Florida Panhandle region it has only been sighted five times and is a migratory stray (USDOI, FWS, 1989). A northeastern Atlantic breeding population is east and north of Raritan Bay, New Jersey, and a Caribbean breeding population is found only as far north as south Florida (USDOI, FWS, 1989). The roseate tern is exclusively marine.

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is the only species of sea eagle that regularly occurs on the North American continent (USDOI, FWS, 1984). Its range extends from central Alaska and Canada to northern Mexico. The bulk of the bald eagle's diet is fish, though bald eagles will opportunistically take birds, reptiles, and mammals (USDOI, FWS, 1984). The historical nesting range of the bald eagle within the southeast United States comprised the entire coastal plain including shores of major rivers and lakes. An otherwise suitable site may not be used if there is excessive human activity in the area. The current range is limited, with most breeding pairs occurring in peninsular Florida and Louisiana, and some in South Carolina, Alabama, and east Texas. Sporadic breeding takes place in the rest of the southeastern states and in the panhandle of Florida. One hundred twenty nests have been found in Louisiana; only 3 nests occurred within 5 mi of the coast (Patrick, written communication, 1997). The bald eagle was listed as endangered in 1967 in response to the declines due to DDT and other organochlorines that affected the species' reproduction (USDOI, FWS, 1984). In July 1995, the FWS reclassified the bald eagle from endangered to threatened in the lower 48 states (*Federal Register*, 1995).

Brown Pelican

The brown pelican (*Pelicanus occidentalis*) is one of two pelican species in North America. It feeds entirely upon fishes captured by plunge diving in coastal waters. Organochlorine pesticide pollution contributed to the endangerment of the brown pelican. In recent years, there has been a marked increase in populations of the brown pelican along its entire former range. The populations of the brown pelican in Alabama, Florida, Georgia, North and South Carolina, and points northward along the Atlantic Coast were removed from the endangered species list in 1985; however, within the remainder of the range, which includes coastal areas of Louisiana and Mississippi, where populations are not secure, the brown pelican remains listed as endangered (*Federal Register*, 1985). The brown pelican is not federally listed in Florida but is listed by the State as a species of special concern.

3.2.4. Beach Mice

Hall (1981) recognizes 16 subspecies of field mouse (*Peromyscus polionotus*), 8 of which are collectively known as beach mice. The Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice and the Florida salt marsh vole are designated as protected species under the Endangered Species Act (ESA) of 1973. Beach mice occupy restricted habitat behind coastal foredunes of Florida and Alabama (Ehrhart, 1978; USDOI, FWS, 1987). Beach mice populations have fallen to levels approaching extinction. For example, in the late 1980's, estimates of total remaining beach mice were less than 900 for the Alabama beach mouse subspecies; about 500 for the Choctawhatchee beach mouse subspecies; and about 80 for the Perdido Key beach mouse subspecies. In addition, the entire current population estimates for St. Andrew beach mice is 350. About 71 mice are on East Crooked Island, Tyndall Air Force Base, Bay County, Florida, and about 276 are on St. Joseph Peninsula State Park, Gulf County, Florida (Lynn, 2002; Moyers et al., 1999). Continued monitoring of populations of all subspecies along the Gulf Coast between 1985 and the present indicates that approximately 52 km (32.3 mi) of coastal dune habitat are now occupied by the four listed subspecies (1/3 of historic range).

Beach mice are endangered primarily because of the loss of coastal habitat. Development of beachfront real estate along coastal areas and catastrophic alteration by hurricanes are the primary contributors to loss of habitat. Other factors include military activities, coastal erosion, and weather. A 1979 survey (Humphrey and Barbour, 1981) indicated that the beach mice had been driven out of seven of nine previously known habitat areas, although this loss was mitigated somewhat by the discovery of a new population on Shell Island. Additional discussion can be found in the Final EIS for Lease Sale 181 (USDOI, MMS, 2001; Section III.C.7).

3.2.5. Marine Mammals

Twenty-nine species of marine mammals are known to occur in the GOM (Davis et al., 2000). The Gulf's marine mammals are represented by members of the taxonomic order Cetacea, which is divided into the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales, dolphins, and their allies), as well as the order Sirenia, which include the manatee and dugong. Within the GOM, there are 28 species of cetaceans (7 mysticete and 21 odontocete species) and 1 sirenian species, the manatee (Jefferson et al., 1992).

3.2.5.1. Nonthreatened and Nonendangered Species

Two of the seven species of mysticetes known to occur in the Gulf are not presently listed as threatened or endangered. With the exception of the sperm whale, none of the odontocetes known to occur in the Gulf are currently listed as endangered or threatened.

Cetaceans – Mysticetes

Bryde's Whale

The Bryde's whale (*Balaenoptera edeni*) is the second smallest of the balaenopterid whales; it is generally confined to tropical and subtropical waters (i.e., between lat. 40°N. and lat. 40°S.) (Cummings, 1985). Unlike some baleen whales, it does not have a well-defined breeding season in most areas; thus, calving may occur throughout the year. The Bryde's whale feeds on small pelagic fishes and invertebrates (Leatherwood and Reeves, 1983; Cummings, 1985; Jefferson et al., 1993).

There are more records of Bryde's whale than of any other baleen whale species in the northern GOM. With few exceptions, Bryde's whale in the northern Gulf has been sighted along a narrow corridor near the 100-m (328-ft) isobath (Davis and Fargion, 1996; Davis et al., 2000). Most sightings have been made in the DeSoto Canyon region and off western Florida, though there have been some in the west-central portion of the northeastern Gulf. Group sizes range from one to seven animals. Abundance estimates are 29 and 25 individuals from ship and aerial surveys of the EPA slope, respectively, and 22 individuals for the oceanic northern Gulf (Davis et al., 2000). These data suggest that the northern Gulf may represent at least a portion of the range of a dispersed, resident population of Bryde's whale (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

Minke Whale

The minke whale (*Balaenoptera acutorostrata*) is a small rorqual that is widely distributed in tropical, temperate, and polar waters. Minke whales may be found offshore but appear to prefer coastal waters. Their diet consists of invertebrates and fishes (Leatherwood and Reeves, 1983; Stewart and Leatherwood, 1985; Jefferson et al., 1993; Würsig et al., 2000).

At least three geographically isolated populations are recognized: North Pacific, North Atlantic, and Southern Hemisphere. The North Atlantic population migrates southward during winter months to the Florida Keys and the Caribbean Sea. There are 10 reliable records of minke whales in the GOM and all are the result of strandings (Jefferson and Schiro, 1997). Most records from the Gulf have come from the Florida Keys, although strandings in western and northern Florida, Louisiana, and Texas have been reported (Jefferson and Schiro, 1997). Sightings data suggest that minke whales either migrate into Gulf waters in small numbers during the winter or, more likely, that sighted individuals represent strays from low-latitude breeding grounds in the western North Atlantic (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

Cetaceans – Odontocetes

Pygmy and Dwarf Sperm Whales

The pygmy sperm whale (*Kogia breviceps*) and its congener, the dwarf sperm whale (*K. sima*), are medium-sized toothed whales that feed on cephalopods and, less often, on deep-sea fishes and shrimps (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Caldwell and Caldwell, 1989). They inhabit oceanic waters in tropical to warm temperate zones and appear to be most common in waters over the continental slope and along the shelf edge (Jefferson and Schiro, 1997). Little is known of their natural history, although a recent study of *Kogia* in South Africa has determined that these two species attain sexual maturity much earlier and live fewer years than other similarly sized toothed whales (Plön and Bernard, 1999).

Kogia have been sighted throughout the Gulf in waters that vary broadly in depth and seafloor topographies (Mullin et al., 1991; Davis et al., 1998 and 2000). The GulfCet I study reported these animals in waters with a mean bottom depth of 929 m (Davis et al., 1998). *Kogia* have been sighted over the continental shelf, but there is insufficient evidence that they regularly inhabit continental shelf waters. Data also indicate that *Kogia* may associate with frontal regions along the shelf break and upper continental slope, areas with high epipelagic zooplankton biomass (Baumgartner, 1995). During the

GulfCet II study, *Kogia* were widely distributed in the oceanic northern Gulf, including slope waters of the eastern Gulf. *Kogia* frequently strand on the coastline of the northern Gulf, more often in the eastern Gulf (Jefferson and Schiro, 1997).

Because dwarf and pygmy sperm whales are difficult to distinguish from one another, sightings of either species are often categorized as *Kogia* sp. The difficulty in sighting pygmy and dwarf sperm whales is exacerbated by their avoidance reaction towards ships, and change in behavior towards approaching survey aircraft (Würsig et al., 1998). Therefore, combined estimated abundance are 66 and 188 individuals from ship and aerial surveys of the slope of the eastern Gulf, respectively, and 733 individuals for the oceanic northern Gulf (Davis et al., 2000).

Beaked Whales

Two genera and four species of beaked whales occur in the GOM. These encompass (1) three species of the genus Mesoplodon (Sowerby's beaked whale [*M. bidens*], Blainville's beaked whale [*M. densirostris*], and Gervais' beaked whale [*M. europaeus*], and (2) one species of the genus Ziphius (Cuvier's beaked whale [*Ziphius cavirostris*]). Morphological similarities among species in the genus Mesoplodon make identification of free-ranging animals difficult. Generally, beaked whales appear to prefer oceanic waters, although little is known of their respective life histories. Stomach content analyses suggest that these whales feed primarily on deepwater cephalopods, although they also consume some mesopelagic fishes and deepwater benthic invertebrates (Leatherwood and Reeves, 1983; Heyning, 1989; Mead, 1989; Jefferson et al., 1993).

In the northern Gulf, beaked whales are broadly distributed in waters greater than 1,000 m over lower slope and abyssal landscapes (Davis et al., 1998 and 2000). Group sizes of beaked whales observed in the northern Gulf comprise 1-4 individuals per group (Mullin et al., 1991; Davis and Fargion, 1996; Davis et al., 2000). Abundance estimates of mesoplodonts (Gervais', Blainville's, and Sowerby's beaked whales) are 0 and 59 individuals from ship and aerial surveys over the slope of the eastern Gulf, respectively, and 150 individuals for the oceanic northern Gulf (Davis et al., 2000). These estimates may include an unknown number of Cuvier's beaked whales. The species-specific abundance of Gervais', Blainville's, or Sowerby's beaked whale was not estimated due to the difficulty of identifying these species at sea. Abundance estimates for Cuvier's beaked whales are 0 and 22 individuals from ship and aerial surveys of the slope of the eastern Gulf, respectively, and 159 individuals for the oceanic northern Gulf (Davis et al., 2000).

Sightings data indicate that Cuvier's beaked whale is probably the most common beaked whale in the Gulf (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000). The Gervais' beaked whale is probably the most common mesoplodont in the northern Gulf, as suggested by stranding records (Jefferson and Schiro, 1997). There are only three confirmed records of Blainville's beaked whale, plus one questionable record (Jefferson and Schiro, 1997). Additionally, one beaked whale sighted during GulfCet II was determined to be a Blainville's beaked whale (Davis et al., 2000). Sowerby's beaked whale is represented in the Gulf by only a single record, a stranding in Florida; this record is considered extralimital since this species normally occurs much farther north in the North Atlantic (Jefferson and Schiro, 1997).

Dolphins

All remaining species of nonendangered and nonthreatened cetaceans found in the Gulf are members of the taxonomically diverse family Delphinidae. Most delphinids, with exceptions of the bottlenose dolphin and the Atlantic spotted dolphin, inhabit oceanic waters of the Gulf.

Atlantic Spotted Dolphin

The Atlantic spotted dolphin (*Stenella frontalis*) is endemic to the Atlantic Ocean within tropical to temperate zones. Surveys in the northern Gulf documented the Atlantic spotted dolphin primarily over the continental shelf and shelf edge in waters that were less than 250 m in depth, although some individuals were sighted along the slope in waters of up to approximately 600 m (1,969 ft) (Davis et al., 1998). Mills and Rademacher (1996) found the principal depth range of the Atlantic spotted dolphin to be much shallower at 15-100 m water depth. Griffin and Griffin (1999) found Atlantic spotted dolphins on the eastern Gulf continental shelf in waters greater than 20 m (30 km) from the coast. A satellite-tagged Atlantic spotted dolphin was found to prefer shallow water habitat and make short dives (Davis et al., 1996). Atlantic spotted dolphins are sighted more frequently in areas east of the Mississippi River (Mills and Rademacher, 1996). Perrin et al. (1994a) relate accounts of brief aggregations of smaller groups of Atlantic spotted dolphins (forming a larger group) off the coast of northern Florida. Abundance estimates are 1,827 and 1,096 individuals from ship and aerial surveys, respectively, of the shelf of the eastern Gulf (Davis et al., 2000). Abundance estimates are 1,055 and 1,800 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf, and 528 individuals for the oceanic northern Gulf (Davis et al., 2000). They are known to feed on a wide variety of fishes, cephalopods, and benthic invertebrates (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Perrin et al., 1994a). This species has been seen feeding in a coordinated manner on clupeid fishes in the northern Gulf, and in one instance, offshore the Florida Panhandle (Fertl and Würsig, 1995).

Bottlenose Dolphin

The bottlenose dolphin (*Tursiops truncatus*) is a common inhabitant of the continental shelf and upper slope waters of the northern Gulf. Sightings of this species in the northern Gulf are rare beyond approximately the 1,200-m (3,937 ft) isobath (Mullin et al., 1994b; Jefferson and Schiro, 1997; Davis et al., 2000). There appears to be two ecotypes of bottlenose dolphins, a coastal form and an offshore form (Hersh and Duffield, 1990; Mead and Potter, 1990). The coastal or inshore stock(s) is genetically isolated from the offshore stock (Curry and Smith, 1997). Genetic data also support the concept of relatively discrete bay, sound, and estuary stocks (Waring et al., 1999). In the northern GOM, bottlenose dolphins appear to have an almost bimodal distribution: a shallow water (16-67 m) and a shelf break (about 250 m) region. These regions may represent the individual depth preferences of the coastal and offshore forms (Baumgartner, 1995). Little is known of the behavior or ranging patterns of offshore bottlenose dolphins. Recently, two bottlenose dolphins that had stranded in Florida were fitted with satellite transmitters; these animals exhibited much more mobility than has been previously documented for this species (Wells et al., 1999a). The range previously reported for the offshore stock of bottlenose dolphins inhabiting the waters off the southeastern United States is larger than previously thought and underscore the difficulties of defining pelagic stocks. Abundance estimates are 1,056 and 1,824 individuals from ship and aerial surveys, respectively, of the shelf in the eastern Gulf (Davis et al., 2000). Abundance estimates are 1,025 and 3,959 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf, and 3,040 individuals for the oceanic northern Gulf. Abundance estimates for various Gulf bays, sounds, and estuaries are found listed in Waring et al. (1999). Bottlenose dolphins are opportunistic feeders, taking a wide variety of fishes, cephalopods, and shrimp (Davis and Fargion, 1996; Jefferson and Schiro, 1997; Wells and Scott, 1999).

Clymene Dolphin

The Clymene dolphin (*Stenella clymene*) is endemic to the Atlantic Ocean and found only in tropical and subtropical waters (Perrin and Mead, 1994). Data suggest that Clymene dolphins are widespread within deeper Gulf waters (i.e., shelf edge and slope) (Davis et al., 2000; Würsig et al., 2000). The Clymene dolphin represents a significant component of the northern GOM cetacean assemblage (Mullin et al., 1994c). The few records of the Clymene dolphin in the northern Gulf in the past, however, were probably a result of this species' recently clarified taxonomic status and the tendency for observers to confuse it with other species (Jefferson and Schiro, 1997). Clymene dolphins have been sighted in water depths of 612-1,979 m (Davis et al., 1998). The Clymene dolphin was shown to have a relationship with the depth of the 15°C isotherm, demonstrating a preference for waters where this isotherm shoals (most probably relating to productivity) (Baumgartner, 1995). Abundance estimates are 0 and 2,292 from ship and aerial surveys, respectively, of the continental slope of the eastern Gulf and 10,093 for the oceanic northern Gulf (Davis et al., 2000). This species appears to feed on fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994a), although knowledge of feeding habits is limited to stomach contents (small fish and squid) of two individuals (Perrin et al., 1981). The Clymene dolphin was observed employing a coordinated feeding strategy on schooling fish in the northern Gulf (Fertl et al., 1997).

False Killer Whale

The false killer whale (*Pseudorca crassidens*) occurs in oceanic waters of tropical and warm temperate zones (Odell and McClune, 1999). Most sightings have been made in waters exceeding 200 m, although there have been sightings from over the continental shelf (Davis and Fargion, 1996). Although sample sizes are small, most false killer whale sightings have been east of the Mississippi River (Mullin and Hansen, 1999). Abundance estimates are 311 and 150 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 817 individuals for the oceanic northern Gulf (Davis et al., 2000). False killer whales primarily eat fish and cephalopods, but they have been known to attack other toothed whales (Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Fraser's Dolphin

The Fraser's dolphin (*Lagenodelphis hosei*) has a pantropical distribution (Perrin et al., 1994c) in oceanic waters and in areas where deep water approaches the coast. Fraser's dolphins feed on fishes, cephalopods, and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Jefferson and Schiro, 1997). This species was previously known to occur in the northern Gulf based on a mass stranding in the Florida Keys in 1981 (Hersh and Odell, 1986). From 1992 to 1996, there were at least three strandings in Florida and Texas (Würsig et al., 2000). GulfCet ship-based surveys led to sightings of two large herds (greater than 100 individuals) and first-time recordings of sounds produced by these animals (Leatherwood et al., 1993). Fraser's dolphins have been sighted in the western and eastern Gulf at depths of around 1,000 m (3,281 ft) (Leatherwood et al., 1993; Davis and Fargion, 1996; Jefferson and Schiro, 1997; Davis et al., 2000).

Killer Whale

The killer whale (*Orcinus orca*) is a cosmopolitan species that occurs in all oceans and seas (Dahlheim and Heyning, 1999). Generally, they appear to inhabit coastal, cold temperate and subpolar zones. Most killer whale sightings in the northern Gulf have been in waters greater than 200 m deep, although there are sightings made from over the continental shelf (Davis and Fargion, 1996). Killer whales are found almost exclusively in a broad area of the north-central Gulf (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997; Mullin and Hansen, 1999). There was a sighting in May 1998 of killer whales in DeSoto Canyon (Ortega, personal communication, 1998). Abundance estimates were 0 for both ship and aerial surveys for the slope of the eastern Gulf and 68 individuals for the oceanic northern Gulf (Davis et al., 2000). Thirty-two individual killer whales have been photo-identified in the Gulf; some individuals have a wide temporal and spatial distribution (some with a linear distance between sightings of more than 1,100 km) (O'Sullivan and Mullin, 1997). It is not known whether killer whales in the northern Gulf remain within the Gulf or range more widely (Würsig et al., 2000). Worldwide, killer whales feed on marine mammals, marine birds, sea turtles, cartilaginous and bony fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). An attack by killer whales on a group of pantropical spotted dolphins was observed during one of the GulfCet surveys (O'Sullivan and Mullin, 1997).

Melon-headed Whale

The melon-headed whale (*Peponocephala electra*) is a deepwater, pantropical species (Perryman et al., 1994) that feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994c; Jefferson and Schiro, 1997). Sightings of this species in the northern Gulf have been primarily in continental slope waters west of the Mississippi River (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000; Mullin and Hansen, 1999). The first two records of this species' occurrence in the Gulf are recent strandings: one in Texas in 1990 and the other in Louisiana in 1991 (Barron and Jefferson, 1993). GulfCet surveys resulted in many sightings of melon-headed whales, suggesting that this species is a regular inhabitant of the GOM (e.g., Mullin et al., 1994b). The abundance for the oceanic northern Gulf is estimated to be 1,734 individuals (Davis et al., 2000).

Pantropical Spotted Dolphin

The pantropical spotted dolphin (*Stenella attenuata*) is distributed in tropical and subtropical marine waters of the world (Perrin and Hohn, 1994). It is the most common cetacean in the oceanic northern Gulf (Mullin et al., 1994a; Davis and Fargion, 1996; Davis et al., 2000). Pantropical spotted dolphins are typically found in waters deeper than 1,200 m deep (Mullin et al., 1994a; Davis et al., 1998 and 2000) but have been sighted over the continental shelf (Mullin et al., 1994a). Baumgartner (1995) did not find that pantropical spotted dolphins had a preference for any one habitat type; he suggested that this species might use prey species in each distinct habitat (e.g., within the Loop Current, inside a cold-core eddy, or along the continental slope). This ability may contribute to this species' success and abundance in the northern Gulf. Abundance estimates are 7,432 and 13,649 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 46,625 individuals for the oceanic northern Gulf (Davis et al., 2000). It feeds on epipelagic fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Pygmy Killer Whale

The pygmy killer whale (*Feresa attenuata*) occurs in tropical and subtropical waters throughout the world (Ross and Leatherwood, 1994), although little is known of its biology or ecology. Its diet includes cephalopods and fishes, though reports of attacks on other dolphins have been reported (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The pygmy killer whale does not appear to be common in the Gulf; most records are of strandings (Jefferson and Schiro, 1997). Sightings of this species have been at depths of 500-1,000 m (1,641-3,281 ft) (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000). Abundance estimates are 0 and 218 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 175 individuals for the oceanic northern Gulf (Davis et al., 2000).

Risso's Dolphin

The Risso's dolphin (*Grampus griseus*) is a pantropical species that inhabits deep oceanic and continental slope waters of tropical and warm temperate zones (Kruse et al., 1999). Risso's dolphins in the northern Gulf have been frequently sighted along the shelf edge, along the upper slope, and most commonly, over or near the 200-m water isobath just south of the Mississippi River in recent years (Würsig et al., 2000). There is a strong correlation between Risso's dolphin distribution and the steeper portions of the upper continental slope, which is most likely the result of cephalopod distribution along the continental slope (Baumgartner, 1997; Davis et al., 2000). Risso's dolphins have been sighted over the continental shelf at water depths less than 200 m (Mullin et al., 1994a; Davis et al., 1998). Abundance estimates are 679 and 1,317 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 3,040 individuals for the oceanic northern Gulf (Davis et al., 2000). Risso's dolphins feed primarily on squid and secondarily on fishes and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Baumgartner, 1997; Würsig et al., 2000).

Rough-toothed Dolphin

The rough-toothed dolphin (*Steno bredanensis*) occurs in tropical to warm temperate marine waters globally (Miyazaki and Perrin, 1994). Sightings in the northern Gulf occur primarily over the deeper waters (950-1,100 m) off the continental shelf (Mullin et al., 1994a; Davis et al., 1998). Most sightings of the rough-toothed dolphin have been west of the Mississippi River (Mullin and Hansen, 1999); however, a mass stranding of 62 rough-toothed dolphins occurred near Cape San Blas, Florida, on December 14, 1997. Four of the stranded dolphins were rehabilitated and released; three carried satellite-linked transmitters (Wells et al., 1999b). Water depth at tracking locations of these individuals averaged 195 m. Data from the tracked individuals, in addition to sightings at Santa Rosa Beach on December 28-29, 1998 (Rhinehart et al., 1999), suggest a regular occurrence of this species in the northern Gulf. Abundance estimates are 16 and 165 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 453 individuals for the oceanic northern Gulf (Davis et al., 2000). This species feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Short-finned Pilot Whale

The short-finned pilot whale (*Globicephala macrorhynchus*) is found in warm temperate to tropical marine waters of the world, generally in deep offshore areas (Bernard and Reilly, 1999). Based on historical records (mostly strandings), the short-finned pilot whale would be considered one of the most common offshore cetaceans in the northern Gulf (Jefferson and Schiro, 1997). The short-finned pilot whale has only occasionally been sighted during recent surveys in the northern Gulf. One potential explanation for the preponderance of pilot whales in the older records were misidentifications of other "blackfish" (e.g., false killer, killer, pygmy killer, and melon-headed whales) (Jefferson and Schiro, 1997). In the northern Gulf, it is most commonly sighted along the continental slope at depths of 250-2,000 m (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000). Short-finned pilot whales have been sighted almost exclusively west of the Mississippi River (Mullin and Hansen, 1999). There was one sighting of short-finned pilot whales in the slope in the eastern Gulf during GulfCet II, in the extreme western part of the study area (Davis et al., 2000). Abundance estimates are 0 and 160 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 1,471 individuals for the oceanic northern Gulf (Davis et al., 2000). Squid are the predominant prey, with fishes being consumed occasionally.

Spinner Dolphin

The spinner dolphin (*Stenella longirostris*) occurs worldwide in tropical oceanic waters (Perrin and Gilpatrick, 1994; Jefferson and Schiro, 1997). In the northern Gulf, most sightings of spinner dolphins have been east of the Mississippi River at depths of 500-1,800 m (1,641-5,906 ft) (Jefferson and Schiro, 1997; Mullin and Hansen, 1999; Davis et al., 2000). The distribution of spinner dolphins was shown to be related with the depth of the 15°C isotherm, thereby demonstrating a preference for waters where this isotherm shoals (most probably relating to productivity) (Baumgartner, 1995). Abundance estimates were 5,319 and 8,670 individuals from ship and aerial surveys, respectively, over the slope in the eastern Gulf and 11,251 individuals in the oceanic northern Gulf (Davis et al., 2000). Spinner dolphins appear to feed on fishes and cephalopods (Würsig et al., 2000).

Striped Dolphin

The striped dolphin (*Stenella coeruleoalba*) occurs in tropical and subtropical oceanic waters (Perrin et al., 1994b). Sightings in the northern Gulf occur primarily over the deeper waters beyond the continental shelf (Jefferson and Schiro, 1997; Davis et al., 2000; Würsig et al., 2000). The striped dolphin appears to prefer waters where the 15°C isotherm shoals (most probably relating to productivity) (Baumgartner, 1995). Abundance estimates are 416 and 2,198 individuals from ship and aerial surveys, respectively, over the slope of the eastern Gulf and 4,381 individuals for the oceanic northern Gulf (Davis et al., 2000). Striped dolphins feed primarily on small mid-water squid and fishes (especially lanternfish).

3.2.5.2. Threatened and Endangered Species

Five mysticete (or baleen) whales (the northern right, blue, fin, sei, and humpback), one odontocete (or toothed) whale (the sperm whale), and one sirenian (the West Indian manatee) occur in the GOM and are listed as endangered. The sperm whale is common in oceanic waters of the northern Gulf and is a resident species, while the baleen whales are considered rare or extralimital (Würsig et al., 2000). The West Indian manatee (*Trichechus manatus*) inhabits only coastal marine, brackish, and freshwater areas.

Cetaceans – Mysticetes

Blue Whale

The blue whale (*Balaenoptera musculus*) is the largest animal known. It feeds almost exclusively on concentrations of zooplankton (Yochem and Leatherwood, 1985; Jefferson et al., 1993). The blue whale occurs in all major oceans of the world; some blue whales are resident, some are migratory (Jefferson et al., 1993; USDOC, NMFS, 1998). Migrants move to feeding grounds in polar waters during spring and summer, after wintering in subtropical and tropical waters (Yochem and Leatherwood, 1985). Records of the blue whale in the northern Gulf consist of two strandings on the Texas coast (Lowery, 1974). The blue whale is probably not a regular inhabitant of the GOM (Jefferson and Schiro, 1997).

Fin Whale

The fin whale (*Balaenoptera physalus*) is an oceanic species that occurs worldwide in marine waters and is most commonly sighted where deep water approaches the coast (Jefferson et al., 1993). Fin whales feed on concentrations of zooplankton, fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The fin whale makes seasonal migrations between temperate waters, where it mates and calves, and polar feeding grounds that are occupied during summer months. Their presence in the northern Gulf is considered rare (Würsig et al., 2000). Sightings in the northern Gulf have typically been made in oceanic waters, chiefly in the north-central region of the Gulf (Mullin et al., 1991). There are seven reliable reports of fin whales in the northern Gulf, indicating that fin whales are not abundant in the GOM (Jefferson and Schiro, 1997). Sparse sighting data on this species suggest that individuals in the northern Gulf may be extralimital strays from their western Atlantic population (Jefferson and Schiro, 1997; Würsig et al., 2000).

Humpback Whale

The humpback whale (*Megaptera novaeangliae*) occurs in all oceans, feeding in higher latitudes during spring, summer, and autumn, and migrating to a winter range over shallow tropical banks, where they calve and presumably conceive (Jefferson et al., 1993). Humpback whales feed on concentrations of zooplankton and fishes using a variety of techniques that concentrate prey for easier feeding (Winn and Reichley, 1985; Jefferson et al., 1993). There have been occasional reports of humpback whales in the northern Gulf: a confirmed sighting of a humpback whale in 1980 in the coastal waters off Pensacola (Weller et al., 1996); two questionable records of humpback whale sightings from 1952 and 1957 off the coast of Alabama (Weller et al., 1996); a stranding east of Destin, Florida, in mid-April 1998 (Mullin, personal communication, 1998); and a confirmed sighting of six humpback whales in May 1998 in DeSoto Canyon (Ortega, personal communication, 1998). Humpback whales sighted in the GOM may be extralimital strays during their breeding season or during their migrations (Würsig et al., 2000). The time of the year (winter and spring) and the small size of the animals involved in many sightings suggest the likelihood that these records are of inexperienced yearlings on their first return migration northward (Weller et al., 1996).

Northern Right Whale

The northern right whale (*Eubalaena glacialis*) inhabits primarily temperate and subpolar waters. Northern right whales range from wintering and calving grounds in coastal waters of the southeastern United States to summer feeding, nursery, and mating grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf. Five major congregation areas have been identified for the western North Atlantic right whale (southeastern United States coastal waters, Great South Channel, Cape Cod Bay, Bay of Fundy, and Scotian Shelf). The distribution of approximately 85 percent of the winter population and 33 percent of the summer population is unknown. During the winter, a portion of the population moves from the summer foraging grounds to the calving/breeding grounds off Florida, Georgia, and South Carolina. Right whales forage primarily on subsurface concentrations of zooplankton such as calanoid copepods by skim feeding with their mouths agape (Watkins and Schevill, 1976; Leatherwood and Reeves, 1983; Jefferson et al., 1993).

The northern right whale is one of the world's most endangered whales. The coastal nature and slow swimming speed of the northern right whale makes it especially vulnerable to human activities (USDOC, NMFS, 1991a). Based on a census of individual whales identified using photo-identification techniques, the western North Atlantic population size was estimated to be 295 individuals in 1992 (Waring et al., 1999). Confirmed historical records of northern right whales in the GOM consist of a single stranding in Texas (Schmidly et al., 1972) and a sighting off Sarasota County, Florida (Moore and Clark, 1963; Schmidly, 1981). The northern right whale is not considered a resident (year-round or seasonal) of the GOM; existing records probably represent extralimital strays from the wintering grounds of this species off the southeastern United States from Georgia to northeastern Florida (Jefferson and Schiro, 1997).

Sei Whale

The sei whale (*Balaenoptera borealis*) is an oceanic species that is not often seen close to shore (Jefferson et al., 1993). They occur in marine waters from the tropics to polar regions but are more common in mid-latitude temperate zones (Jefferson et al., 1993). Sei whales feed on concentrations of zooplankton, small fishes, and cephalopods (Gambell, 1985; Jefferson et al., 1993). The sei whale is represented in the northern Gulf by only four reliable records (Jefferson and Schiro, 1997). One stranding was reported for the Florida Panhandle and three strandings were in eastern Louisiana (Jefferson and Schiro, 1997). This species occurrence in the northern Gulf is considered most likely to be accidental.

Cetaceans – Odontocetes

Sperm Whale

The sperm whale (*Physeter macrocephalus*) inhabits marine waters from the tropics to the pack-ice edges of both hemispheres, although generally only large males venture to the extreme northern and southern portions of their range (Jefferson et al., 1993). In general, sperm whales seem to prefer certain areas within each major ocean basin, which historically have been termed "grounds" (Rice, 1989). As deep divers, sperm whales generally inhabit oceanic waters, but they do come close to shore where submarine canyons or other geophysical features bring deep water near the coast (Jefferson et al., 1993). Sperm whales prey on cephalopods, demersal fishes, and benthic invertebrates (Rice, 1989; Jefferson et al., 1993).

The sperm whale is the only great whale that is considered to be common in the northern Gulf (Fritts et al., 1983; Mullin et al., 1991; Davis and Fargion, 1996; Jefferson and Schiro, 1997). Sighting data suggest a northern Gulfwide distribution over slope waters. Congregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River delta in waters that are 500-2,000 m (1,641-6,562 ft) in depth (Mullin et al., 1994a; Davis and Fargion, 1996; Davis et al., 2000). Sperm whale sightings in the northern Gulf chiefly occur in waters with a mean seafloor depth of 1,105 m (Davis et al., 1998). Mesoscale biological and physical patterns in the environment are important in regulating sperm whale habitat use (Griffin, 1999). Baumgartner (1995) noted that sperm whales avoided warm features characterized by a depressed 15°C isotherm and warm water at 100-m water depth; the highest sighting rates occurred in cooler water masses characterized by intermediate to cool temperatures at 100 m and a moderately shallow 15°C isotherm. Sperm whales were found in waters with the steepest sea surface temperature gradient; they may forage along thermal fronts associated with eddies (Davis et al., 1998). The GulfCet II study found that most sperm whales were concentrated along the slope in or near cyclones (Davis et al., 2000). Low-salinity, nutrient-rich water from the Mississippi River may contribute to enhanced primary and secondary productivity in the north-central Gulf, and thus provides resources that support the year-round presence of sperm whales south of the delta.

Consistent sightings in the region indicate that there is a resident population of sperm whales in the northern Gulf consisting of adult females, calves, and immature individuals (Mullin et al., 1994b; Davis and Fargion, 1996; Sparks et al., 1996; Jefferson and Schiro, 1997; Davis et al., 2000). Sperm whales have also been observed during cruises in 2000, 2001, and 2002 in the DeSoto Canyon. Biopsies have confirmed some of these animals as large males. There is evidence of movement back and forth between the Mississippi Canyon group and the DeSoto Canyon whales (Lang, personal communication, 2002). Minimum population estimates of sperm whales in the entire Gulf totaled 411 individuals, as cited in the National Marine Fisheries Serice (NOAA Fisheries) stock assessment report for 1996 (Waring et al., 1997). Subsequent abundance estimates of sperm whales in the "oceanic northern GOM" survey area totaled 387 individuals (Davis et al., 2000). Sperm whales in the Gulf are currently considered a separate stock from those in the Atlantic and Caribbean (Waring et al., 1997).

Cetacean Distribution in the Northern Gulf of Mexico

Factors influencing the spatial and temporal distribution and abundance of cetaceans may be environmental, biotic, or anthropogenic. Environmental factors encompass physiochemical, climatological, or geomorphological parameters. Biotic factors include the distribution and abundance of prey, inter- and intra-specific competition, reproduction, natural mortality, catastrophic events (e.g., die offs), and predation (Davis et al., 1998). Anthropogenic factors include historical hunting pressure (on some populations or species), pollution, habitat loss and degradation, vessel traffic, recreational and commercial fishing, oil and gas development and production, seismic exploration, and other manmade sources of noise in the sea.

Within the northern Gulf, many of the environmental and biotic factors influencing the distribution of cetaceans are affected by various hydrological circulation patterns. River discharge, wind stress, and the Loop Current generally drive these patterns. The major river system in this area is the Mississippi-Atchafalaya. Most of the river discharge into the northern Gulf is transported west and along the coast. Circulation on the continental shelf is largely wind-driven, with localized effects from freshwater (i.e., riverine) discharge. Beyond the shelf, the Loop Current in the Eastern Gulf chiefly drives mesoscale circulation. Meanders of the Loop Current create warm-core anticyclonic eddies (anticyclones) once or twice annually that migrate westward. The anticyclones in turn spawn cold-core cyclonic eddies (cyclones). Together, anticyclones and cyclones govern the circulation of the continental slope in the Central and Western Gulf. The Loop Current and anticyclones are dynamic features that transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf. Cyclones, in contrast, contain high concentrations of nutrients and stimulate localized production. The combination of added nutrients into the northern Gulf from river outflow and mesoscale circulation features enhances productivity, and consequently the abundance of various species of fishes and cephalopods that cetaceans prey upon in the northern Gulf. The dynamics of these oceanographic features in turn affect the spatial and temporal distribution of prey species and ultimately influence cetacean diversity, abundance, and distribution (Mullin et al., 1994b; Davis et al., 2000).

Studies conducted during the GulfCet I program demonstrated a correlation of cetacean distribution patterns with certain geomorphic features such as seafloor depth or topographic relief. These studies suggested that seafloor depth was the most important variable in habitat partitioning among cetacean species in the northern Gulf (Baumgartner, 1995; Davis et al., 1998). For example, GulfCet I surveys, along with other surveys (such as the subsequent GulfCet II program) and opportunistic sightings of cetaceans within the U.S. GOM, found that only the Atlantic spotted dolphin and the coastal form of the bottlenose dolphin were common inhabitants of the continental shelf. The remaining species of cetaceans known to regularly occur in the Gulf (with possible exception of the Bryde's whale) were sighted on the continental slope (Mullin et al., 1994b; Jefferson, 1995; Davis et al., 1998 and 2000). During the GulfCet II program, the most commonly sighted cetaceans on the continental slope were bottlenose dolphins (pelagic form), pantropical spotted dolphins, Risso's dolphins, and dwarf/pygmy sperm whales. The most abundant species on the slope were pantropical spotted and spinner dolphins. Sperm whales sighted during GulfCet II surveys were found almost entirely in the north-central and northeastern Gulf, and near the 1,000-m (3,280-ft) isobath on the continental slope (Davis et al., 2000).

An objective of the GulfCet II program was to correlate a number of environmental parameters such as selected hydrographic features with cetacean sighting data in an effort to characterize cetacean habitats in the GOM (Davis et al., 2000). From GulfCet II surveys, sightings of cetaceans along the slope were concentrated in cyclones where production (in this case, measured chlorophyll concentration) was elevated; increased primary production within these cyclonic features enhances secondary production, including preferred prey items. Sightings of these oceanic species, however, were much less frequent in water depths greater than 2,000 m (6,562 ft) and in anticyclones. Sperm whales tended to occur along the mid-to-lower slope, near the mouth of the Mississippi River and, in some areas, in cyclones and zones of confluence between cyclones and anticyclones. From these data, it was suggested that the greater densities of cetaceans sighted along the continental slope, rather than abyssal areas, of the northern Gulf, probably result from localized conditions of enhanced productivity, especially along the upper slope, and as a result of the collisions of mesoscale eddies with the continental margin (Davis et al., 2000).

In the north-central Gulf, the relatively narrow continental shelf south of the Mississippi River delta may be an additional factor affecting cetacean distribution, especially in the case of sperm whales (Davis et al., 2000). Outflow from the Mississippi River mouth transports large volumes of low salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow may also be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. In either case, this input of nutrient-rich water leads to a localized deepwater environment with enhanced productivity and may explain the presence of a resident population of sperm whales within 50 km (31 mi) of the Mississippi River delta in the vicinity of the Mississippi Canyon.

GulfCet I and II survey data determined that most cetacean species routinely or commonly sighted in the northern Gulf apparently occur in these waters throughout the year. The distribution of certacean species may change in response to the movement of prey species associated with the extent of river discharge and the presence and dynamic nature of mesoscale hydrographic features such as cyclones. Seasonal abundance of certain species or species assemblages in slope waters, however, may vary at least regionally (Baumgartner, 1995; Davis et al., 1998 and 2000).

Sirenians

West Indian Manatee

The West Indian manatee (*Trichechus manatus*) is the only sirenian known to occur in tropical and subtropical coastal waters of the southeastern U.S., GOM, Caribbean Sea, and the Atlantic coast of northern and northeastern South America (Reeves et al., 1992; Jefferson et al., 1993; O'Shea et al., 1995). There are two subspecies of the West Indian manatee: the Florida manatee (*T. m. latirostris*), which ranges from the northern GOM to Virginia; and the Antillean manatee (*T. m. manatus*), which ranges from northern Mexico to eastern Brazil, including the islands of the Caribbean Sea.

During warmer months, manatees are common along the west coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida and less common farther westward. In winter, the population moves southward to warmer waters. The winter range is restricted to smaller areas at the southern tip of Florida and to waters near localized warm-water sources, such as power plant outfalls and natural springs in west-central Florida. Crystal River, in Citrus County, is typically the northern limit of the manatee's winter range on the Gulf Coast. Manatees are found at a few small sites farther north. There are nine winter-aggregation sites on the Florida west coast for manatees (USDOI, FWS, 1995). The major sites are (1) Crystal and Homasassa Rivers (natural springs) (Citrus County), (2) Tampa Electric Company Big Bend Power Plant (Hillsborough County), (3) Florida Power Corporation Bartow Power Plant (Pinellas County), (4) Florida Power & Light Company Fort Myers Power Plant (Lee County), and (5) Port of the Islands Marina (Collier County). The number of manatees, and probably the proportion of the manatee population, using localized warm-water refuges have increased appreciably (MMC, 1999). It is not known to what extent the increasing use of refuges in the Tampa Bay area is due to manatee population growth and/or redistribution of the manatees formerly wintering in southern Florida. Manatees are uncommon along the Florida Panhandle and are infrequently found (strandings and sightings) as far west as Louisiana and Texas (Powell and Rathbun, 1984; Rathbun et al., 1990; Schiro et al., 1998).

Aerial surveys to estimate manatee populations are conducted during colder months when manatees aggregate at warm-water refuges in Florida. There are approximately 1,300 manatees on the Gulf Coast of Florida (Ackerman, personal communication, 1999). One manatee that died in Louisiana waters was determined to be from Tampa Bay, Florida; this determination was based on a photoidentification rematch (Schiro et al., 1998). The manatees occasionally appearing in south Texas waters might be strays from Mexico rather than Florida (Powell and Rathbun, 1984). Few manatees are known to occur along the northeastern coast of Mexico close to Texas (Lazcano-Barrero and Packard, 1989); manatees in south Texas and northern Mexico are probably stragglers from central Mexico. Manatees found in east Texas probably come from Florida.

The Antillean manatee subspecies in Mexico occurs along much of the southeastern Mexican coast from Nautla, Veracruz, to the Belize border and south to Brazil, but it is still reasonably abundant in three principal areas in southeast Mexico: vast wetland systems in the states of Tabasco and Chiapas, the bays and coastal springs along the northern and eastern coasts of the state of Quintana Roo, and the rivers near Alvarado in the state of Veracruz (Lefebvre et al., 1989). A study of manatees in Mexico near the Belize border in Quintana Roo estimates about 200 animals (Ackerman, personal communication, 1999). There are no population estimates for manatees in Mexico on the west side of the Yucatan Peninsula (Campeche) and near the Texas border (Ackerman, personal communication, 1999). There is also no evidence of manatees traveling between Cuba and Florida; it is assumed that the deep Florida Straits are a barrier to regular dispersal since it would be too difficult for the animals to travel across.

Two important aspects of manatee physiology influence their behavior and distribution: nutrition and metabolism. Manatees are herbivores that feed opportunistically on a wide variety of submerged, floating, and emergent vegetation (USDOI, FWS, 1995). Distribution of the manatee is limited to low-energy, inshore habitats supporting the growth of seagrasses (Hartman, 1979). Manatees have an unusually low metabolic rate and a high thermal conductance that leads to energetic stresses in winters, which are ameliorated by migrations to warmer areas and aggregations in warm water refugia (Hartman, 1979; O'Shea et al., 1995; Deutsch et al., 1999). Manatees primarily use open coastal (shallow nearshore) areas and estuaries, and are also found far up freshwater tributaries. Shallow grass beds with access to deep channels are preferred feeding areas in coastal and riverine habitats (USDOI, FWS, 1995). Manatees often use secluded canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs, for feeding, resting, mating, and calving (USDOI, FWS, 1995). Natural and artificial freshwater areas are sought by manatees occurring in estuarine and brackish areas (USDOI, FWS, 1995) for drinking. Florida manatees can exist for some time without freshwater, but it is believed that they must have access to freshwater periodically to survive (Reynolds and Odell, 1991). It is important that adequate freshwater sources be a component of manatee conservation strategies. Manatee protection has focused on protecting essential manatee habitats (seagrass beds have declined substantially in most parts of the State), as well as reducing direct causes of mortality, injury, and disturbance from human activity

3.2.6. Fisheries and Essential Fish Habitat

3.2.6.1. Fisheries

The GOM supports a great diversity of fish resources that are related to variable ecological factors, including salinity, primary productivity, and bottom type. These factors differ widely across the GOM and especially between the inshore and offshore waters. Characteristic fish resources are associated with the various environments and are not randomly distributed. High densities of fish resources are associated with particular habitat types. Approximately 46 percent of the southeastern United States wetlands and estuaries important to fish resources are located within the GOM (Mager and Ruebsamen, 1988). Consequently, estuary-dependent species of finfish and shellfish dominate the fisheries. Nearly all species significantly contributing to the GOM's commercial catches are estuarine dependent. Even the offshore demersal species are indirectly related to the estuaries because they influence the productivity and food availability on the continental shelf (Darnell and Soniat, 1979; Darnell, 1988).

About 10 percent of finfish in the GOM are not directly dependent on estuaries during their life history. This group can be divided into demersal and pelagic species. Coastal pelagics would include mackerels, cobia, bluefish, amberjack, and dolphin. These species move seasonally. Deep waters of the GOM appear to be a significant spawning area for other commercially important pelagic species such as tuna and swordfish. Information on fish larvae from deepwater areas of the GOM is discussed in the Final EIS for Lease Sale 181 (USDOI, MMS, 2001; pages III-75 through III-81).

Oceanic Pelagics

Common oceanic pelagic species include tunas, marlins, sailfish, swordfish, dolphins, wahoo, and mako sharks. In addition to these large predatory species, there are halfbeaks, flyingfishes, and driftfishes (Stromateidae). Lesser-known oceanic pelagics include opah, snake mackerels (Gempylidae), ribbonfishes (Trachipteridae), and escolar.

Oceanic pelagic species occur throughout the GOM, especially at or beyond the shelf edge (approximately 200 m). Oceanic pelagics are reportedly associated with mesoscale hydrographic features such as fronts, eddies, and discontinuities. Fishermen contend that yellowfin tuna aggregate near sea-surface temperature boundaries or frontal zones. Power and May (1991), however, found no correlation between longline catches of yellowfin tuna and sea-surface temperature (defined from satellite imagery) in the GOM. The occurrence of bluefin tuna larvae in the GOM associated with the Loop Current boundary and the Mississippi River discharge plume is evidence that these species spawn in the GOM (Richards et al., 1989). Many of the oceanic fishes associate with drifting *Sargassum*, which provides forage areas and/or nursery refugia.

3.2.6.2. Essential Fish Habitat

Healthy fish resources and fishery stocks depend on essential fish habitat (EFH) waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages for managed species, EFH has been identified throughout the GOM, including all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ).

There are Fishery Management Plans (FMP) in the GOM region for shrimp, red drum, reef fishes, coastal migratory pelagics, stone crabs, spiny lobsters, coral and coral reefs, billfish, and highly migratory species. The GOM Fishery Management Council's (FMC) *Generic Amendment for Addressing Essential Fish Habitat Requirements* amends the first seven FMP's listed above, identifying estuarine/inshore and marine/offshore EFH for over 450 managed species (about 400 in the Coral FMP). Although not part of the GOM Fishery Management Council's FMP's, separate Fishery Management Plans have been finalized by NMFS for Atlantic tunas, swordfish and sharks, and the Atlantic billfish fishery. The GOM FMC's *Generic Amendment* also identifies threats to EFH and makes a number of general and specific habitat preservation recommendations for pipelines and oil and gas exploration and production activities within State waters and OCS areas. These recommendations can be found in the Final EIS for Lease Sale 181 (USDOI, MMS, 2001; page III-91). Pelagic species would be the only managed fisheries in the area of the proposed action.

3.2.7. Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrhynchus DeSotoii*) is the only listed threatened fish species in the GOM. A subspecies of the Atlantic sturgeon, Gulf sturgeon are classified as anadromous, with immature and mature fish participating in up river migrations. Gill netting and biotelemetry have shown that subadults and adults spend 8-9 months each year in rivers and 3-4 of the coolest months in estuaries or Gulf waters. Sturgeons that are less than two years old remain in riverine habitats and estuaries throughout the year (Clugston, 1991). According to Wooley and Crateau (1985) Gulf sturgeon occurred in most major riverine and estuarine systems from the Mississippi River to the Suwannee River, Florida, and marine waters of the central and eastern GOM south to Florida Bay. Important waters west-to-east and north-to-south are Biloxi Bay, Pascagoula Bay, Mobile Bay, Choctawhatchee Bay, Apalachicola River, Ochlockounee River, and Suwanee River. It is not possible, at present, to estimate the sizes of populations of the Gulf sturgeon throughout its range, but extant occurrences in 1996 include the Mississippi River and Lake Pontchartrain, Louisiana, to Charlotte Harbor, Florida (Patrick, personal communication, 1996). Eggs have now been discovered in six locations within the Choctawhatchee River system in Florida and Alabama (Patrick, personal communication, 1998). During the riverine stage, adults cease feeding, undergo gonadal maturation, and migrate upstream to spawn. The subspecies spawns in freshwater reaches of rivers. Eggs are deposited on coarse substrate in deep areas or holes with hard bottoms where some current is present (Sulak and Clugston, 1998; Fox et al., 2000). The decline of the Gulf sturgeon is believed to be due to overfishing, the damming of coastal rivers, and the degradation of water quality (Barkuloo, 1988).

Gulf sturgeon in the rivers and estuaries are interrupted when migrating by capture with nets suspended from floats in the rivers and river mouths. Gill nets with mesh wide enough not to close the very large opercula are used. Radio and sonar tracking and tag-recapture techniques track migration up and down the rivers and to and from the estuaries. The open Gulf is monitored by ultrasonic and radio telemetry and by conventional fishing gear. Migration to the sea is recorded in fall when the fish disappear from river mouths and estuaries. No capture or tracking is feasible in the open Gulf when the fish migrate into it because cold fronts come every 2-3 days, with up to 9-ft seas. Conditions are dangerous for the size of the vessel required, and the paths traveled in the open Gulf cannot be followed beyond the estuaries. Migration in the open Gulf is studied using pop-up tags, which are still in an early stage of development.

Sturgeons are bottom-suction feeders that have ventrally located, highly extrusible mouths. The sturgeon head is dorsoventrally compressed with eyes dorsal so benthic food under the sturgeon's mouth is not be visible. They have taste barbels, like catfish, to detect prey. The barbels are also useful for feeding in high-order streams when they are muddy. Gulf sturgeons are common in clear water streams also, however. The barbels may locate food at night when visibility of prey is low. An adaptation of sturgeon to the large habitat scale of rivers and offshore waters is mobility provided by a forked tail for prolonged swimming efficiency. Not coincidentally, such a tail is possessed by other anadromous migrants like alewives, blueback herring, American shad, Atlantic and Pacific salmon, and sea-going trout. A major threat to sturgeon populations in various species worldwide is damming of the mainstem rivers.

3.2.8. Areas of Special Biological Concern

Five areas of special biological concern are considered in this SEA. These habitats are the Florida Keys National Marine Sanctuary (FKNMS), Florida Middle Ground (FMG), two new restricted fisheries areas, Steamboat Lumps and Madison and Swanson Special Management Areas, and Big Bend Seagrass Aquatic Preserve. Figure III-4 in the Final EIS for Lease Sale 181 shows the locations for FMG and the special management areas on the eastern Florida continental shelf (USDOI, MMS, 2001).

The FKNMS contains significant coral reef habitats, but the sanctuary lies more than 345 mi (555 km) from the proposed action. Corals within the FKNMS occur at shallow depths from the low tide level to about 60 m (200 ft).

The FMG is located closer to the proposed action but is still at a considerable distance (207 mi or (333 km). This live-bottom habitat is one of the larger and more significant features on the west Florida Shelf and includes some live coral growth. However, it is not a coral reef and has been described as a "degradational environment" from observations of abundant reef rubble and very few living reef-building organisms. The shallowest point of the FMG is 23 m. The depth protects live-bottom organisms from any oil spill components passing over the feature on the surface.

The Madison and Swanson and Steamboat Lumps areas have been closed to all fishing except for highly migratory species since June 1, 2000. These areas have been designated as Special Management Areas designed to protect gag (grouper) spawning aggregations from fishing activities.

The Big Bend Seagrass Aquatic Preserve lies in a 10-mi-wide belt along the coast of western Florida, south of the Apalachicola delta. The preserve is located along the nearshore and shoreface of all or parts of Wakullasi, Jefferson, Taylor, Dixie, and Levy Counties, about 300 mi (482 km) east-northeast from the area of the proposed action. The preserve has the characteristics of other seagrass habitats described in Chapter 3.2.1.3.

3.3. OTHER RELEVANT ACTIVITIES AND RESOURCES

3.3.1. Socioeconomic Conditions and Other Concerns

3.3.1.1. Economic and Demographic Conditions

3.3.1.1.1. Socioeconomic Impact Area

The MMS defines the GOM impact area for population, labor, and employment as that portion of the GOM coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. For this analysis, the coastal impact area consists of 80 counties and parishes along the U.S. portion of the GOM. This area includes 24 counties in Texas, 26 parishes in Louisiana, 4 counties in Mississippi, 2 counties in Alabama, and 24 counties in the Panhandle of Florida. Inland counties and parishes are included where offshore oil and gas activities are known to exist, where offshore-related petroleum industries are established, and where one or more counties or parishes within a Metropolitan Statistical Area (MSA) are on the coast; all counties and parishes within the MSA are included.

For analysis purposes, MMS has divided the impact area into the 10 subareas listed below. This impact area is based on the results of a recent MMS socioeconomic study, "Cost Profiles and Cost Functions for Gulf of Mexico Oil and Gas Development Phases for Input-Output Modeling." One of the objectives of this study was to allocate expenditures from the offshore oil and gas industry to the representative onshore subarea where the dollars were spent. Table E-1 (Appendix E) presents these findings in percentage terms. In the table, the IMPLAN number is the code given to the industry (sector) by the input-output software (IMPLAN) used to calculate impacts in Chapter 4.3.1.1. It is analogous to the standardized industry code (SIC). As shown in the table, very little has been spent in the Florida subareas. This is to be expected given the lack of offshore leasing in this area and Florida's attitude towards oil and gas development off their beaches. The table also makes clear the reason for including all of the GOM subareas in the economic impact area. Expenditures in Texas to several sectors are either exclusively found there or make up a very large percentage of the total. In addition, a significant percentage of total sector expenditures are allocated to each Louisiana subarea. The following subareas (which include the counties/parishes as listed below) are considered as the economic impact area for the proposed activity:

LA-1	LA-2	LA-3	MA-1
Acadia, LA	Ascension, LA	Jefferson, LA	Baldwin, AL
Calcasieu, LA	Assumption, LA	Orleans, LA	Mobile, AL
Cameron, LA	.East Baton Rouge, LA	Plaquemines, LA	Hancock, MS
Iberia, LA	Iberville, LA	St. Bernard, LA	Harrison, MS
Lafayette, LA	Lafourche, LA	St. Charles, LA	Jackson, MS
Livingston, LA	St. James, LA	Stone, MS	St. Landry, LA
St. Martin, LA	St. Mary, LA	St. John the Baptist, LA	
Vermilion, LA	Tangipahoa, LA	St. Tammany, LA	
	Terrebonne, LA		
	West Baton Rouge, LA		

TX-1

Aransas, TX
Calhoun, TX
Cameron, TX
Jackson, TX
Kenedy, TX
Kleberg, TX
Nueces, TX
Refugio, TX
San Patricio, TX
Victoria, TX
Willacy, TX

TX-2

Brazoria, TX
Chambers, TX
Fort Bend, TX
Galveston, TX
Hardin, TX
Harris, TX
Jefferson, TX
Liberty, TX
Matagorda, TX
Montgomery, TX
Orange, TX
Waller, TX
Wharton, TX

FL-1

Bay, FL
Escambia, FL
Okaloosa, FL
Santa Rosa, FL
Walton, FL

FL-2

Dixie, FL
Franklin, FL
Gulf, FL
Jefferson, FL
Levy, FL
Taylor, FL
Wakulla, FL

FL-3

Charlotte, FL
Citrus, FL
Collier, FL
Hernando, FL
Hillsborough, FL
Lee, FL
Manatee, FL
Pasco, FL
Pinellas, FL
Sarasota, FL

FL-4

Miami-Dade, FL
Monroe, FL

The proposed activity in the Eastern Gulf of Mexico sale is expected to have economic consequences throughout all 10 of the coastal subareas, as well as global impacts. Most of the probable changes in population, labor, and employment resulting from the proposed activity would likely occur in the 24 counties in Texas and the 26 parishes in Louisiana because the oil and gas industry is best established in this region. Some of the likely changes in population, labor, and employment resulting from the proposed activity would also occur in the six Alabama and Mississippi counties due to their established oil and gas industry and proximity to the offshore location. Changes in economic factors (in minor service and support industries) from the proposed activity would occur, to a much lesser extent, in the 24 counties of the Florida Panhandle because their economy only marginally includes primary and support industries for oil and gas development

3.3.1.1.2. Population and Education

Table E-2 (Appendix E) depicts baseline population projections for the potential impact area. Baseline projections are for the impact area in the absence of the proposed activity. The analysis area consists of highly populated metropolitan areas (such as the Houston MSA, which predominate Subarea TX-2) and sparsely populated rural areas (as is much of Subarea TX-1). Some communities in the analysis area experienced extensive growth during the late 1970's and early 1980's when OCS activity was booming. Following the drop in oil prices, many of these same areas experienced a loss in population (Gramling, 1984; Laska et al., 1993). All subarea populations are expected to grow at a higher rate than the United States' average annual population growth rate over the life of the proposed actions, reflecting the region migration pattern of favoring the south and west over the northeast and Midwest (USDOC, Bureau of the Census, 2001). This is a continuation of historic trends. Average annual population growth projected over the life of the proposed actions range from a low of 0.45 percent for Subarea LA-3 (dominated by the Orleans MSA) to a high of 3.27 percent for Subarea FL-3 in the lower panhandle of Florida. Over the same time period, the population for the United States is expected to grow at about 1.36 percent per year.

At present, the 2000 U.S. Census data for education at the county/parish level have not been released. The last available data at this level is the 1990 Census data. Therefore, this analysis uses the 2000 U.S. Census Supplementary Survey Profile educational attainment data for States. For people 25 years and over, 75.2 percent of the population in the U.S. has graduated from high school, while 20.3 percent has received a bachelor's degree. Texas' educational attainment percentages are higher than the national average for both categories: 76.8 and 23.5 percent, respectively. Louisiana, while higher than the national average for high school graduates, 76.7 percent, is lower for college degrees, 19.5 percent. Mississippi's educational attainments are lower than the Nation's for both categories—74.3 and 18.6 percent, respectively. Alabama, like Louisiana, has a higher than national high school graduation rate (76.0%), but a lower rate for bachelor's degree (20.2%). Florida mirrors Texas; its educational attainments are higher than the national rates—81.9 and 23.2 percent, respectively.

3.3.1.1.3. Infrastructure and Land Use

The Gulf of Mexico OCS Region has one of the highest concentrations of oil and gas activity in the world. The offshore oil and gas industry has experienced dramatic changes over recent years, particularly since 1981. Historically, most of the activity has been concentrated on the continental shelf off the coasts of Texas and Louisiana. Future activity is expected to extend into progressively deeper waters and into the Eastern Planning Area (EPA). To date, only exploration activities have taken place off the shores of the State of Florida. The high level of offshore oil and gas activity in the GOM is accompanied by an extensive development of onshore service and support facilities. The major types of onshore infrastructure include gas processing plants, navigation channels, oil refineries, pipelines and pipeline landfalls, pipecoating and storage yards, platform fabrication yards, separation facilities, service bases, terminals, and other industry-related installations such as landfills and disposal sites for drilling and production wastes.

Land use in the impact area varies from state to state. The coasts of Florida and Texas are a mixture of urban, industrial, recreational beaches, wetlands, forests, and agricultural areas. Alabama's coastal impact area is predominantly recreational beaches, and small residential and fishing communities. Mississippi's coast consists of barrier islands, some wetlands, recreational beaches, and urban areas. Louisiana's coast impact area is mostly vast areas of wetlands; some small communities and industrial areas extend inward from the wetlands.

3.3.1.1.4. Navigation and Port Usage

A service base is a community of businesses that load, store, and supply equipment, supplies, and personnel needed at offshore work sites. Although a service base may primarily serve the OCS planning area and subarea in which it is located, it may also provide significant services for the other OCS planning areas and subareas. As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range of travel, greater speed of travel, and larger carrying capacity. Service bases with the greatest appeal for deepwater activity have several common characteristics: strong and reliable transportation system; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; location central to OCS deepwater activities; adequate worker population within commuting distance; and insightful strong leadership. Typically, deeper draft service vessels require channels with depths of 6-8 m. The proposed activity is expected to impact Port Fourchon, Louisiana, the designated service base for the proposed action. The Port of Fourchon, at the mouth of Bayou Lafourche on the Gulf of Mexico, is a major onshore staging area for OCS oil and gas activities in the CPA, WPA, and EPA and the headquarters of LOOP. Chapter 3.3.3.2 in the Final Multisale EIS for the CPA and WPA (USDOI, MMS, 2002b) discusses the Port Fourchon area in detail.

3.3.1.1.5. Employment

Table E-3 (Appendix E) depicts baseline employment projections for the potential impact area. Baseline projections are for the impact area in the absence of the proposed activity. Average annual employment growth projected over the life of the proposed actions range from a low of 1.19 percent for Subarea LA-3 (predominated by the Orleans MSA) to a high of 5.43 percent for Subarea FL-3 in the lower panhandle of Florida. Over the same time period, employment for the United States is expected to grow at about 2.25 percent per year, while the GOM analysis area is expected to grow at about 2.06 percent per year. As stated above, this represents growth in general employment for the subareas. Continuation of existing trends, both in OCS activity and other industries in the area, are included in the projections.

The industrial composition for the subareas in the WPA and that in the CPA are similar. With the exception of Subareas LA-2, LA-3, and FL-4, the top four ranking sectors in terms of employment in the analysis area are the service, manufacturing, retail trade, and State and local government sectors. In Subareas LA-2 and LA-3, construction replaces manufacturing as one of the top four industries on the basis of employment, In Subarea FL-4, transportation, communication, and public utilities replaces manufacturing as one of the top four industries on the basis of employment. The service industry employs more people in all subareas. The service industry is also the fastest growing industry.

3.3.1.1.6. Current Economic Baseline Data

Oil and natural gas prices are used to evaluate the oil and gas industry's ability to economically develop resources. As of December 19, 2002, Henry Hub Natural Gas closed at $4.995 per million BTU (Oilnergy, 2002). The wholesale price of natural gas reached a 19-month high after the Energy Information Administration reported a sharper than expected decline in supplies (14% below year-ago levels). The price of natural gas to be delivered in January settled at $5.10 per 1,000 cubic feet on the New York Mercantile Exchange (NYMEX), the highest closing price since April 23, 2001. Despite recent gains in natural gas prices, natural gas drilling is still adjusting to the sharp decline in natural gas prices that occurred in 2001 and the relatively high inventory levels earlier this year. As of December 13, 2002, there were 711 rigs drilling for natural gas in North America, compared with 757 a year ago, a decline of 6.1 percent. However, rigs drilling for gas in the Gulf increased from 99 to 101 over the same period.

With world oil markets on edge over the nationwide strike in Venezuela, rising tensions between the United States and Iraq, and uncertainty over OPEC's plans for production, NYMEX West Texas Intermediate for February delivery closed at $31.97 per barrel on December 24, 2002 (up more than 50% from a year ago). The strike has crippled Venezuela's oil output, depriving the U.S. of its fourth-largest source of inputs. Crude prices had been high through most of the year amid fears of a possible American attack on Iraq. The rally in crude oil futures has been spurred by high declines in U.S. crude inventories as reported by the American Petroleum Institute and Energy Information Administration (EIA). The U.S. crude oil stocks are likely to continue to decline as the impact of the Venezuelan stoppage filters through the system.

Exploration and production (E&P) expenditures are another indicator of the energy industry's strength. Lehman Brothers released the final results of its Original E&P Spending Survey of 231 companies, indicating that U.S. E&P expenditures in 2003 are expected to decline 0.7 percent from $30.5 billion in 2002 to $30.3 billion. Independents' spending is forecast to decline a modest 0.4 percent, while the majors are expected to reduce expenditures by 1.1 percent. Lehman Brothers' analysts found that more companies spent an increased percentage of their budget offshore in 2002 (almost a 2:1 ratio) and that an even greater percentage of companies plan to spend an increased percentage of their budgets offshore in 2003.

In addition to E&P spending, drilling rig use is employed by the industry as a barometer of economic activity. As of December 20, 2002, the fleet utilization rate for all marketed mobile rigs in the GOM was 72.0 percent, compared to 59.1 percent a year ago (One Offshore, 2002). This breaks down as a 72.7 percent fleet utilization rate for jackups (average day rates of $17,500-$45,000); 69.2 percent for semisubmersibles (average day rates of $30,000-$165,000); 87.5 percent for drillships (average day rates are about $180,000); and 57.1 percent for submersibles (average day rates of $22,000-$24,000). Platform rigs in the Gulf recorded a 48.6 percent fleet utilization rate, while inland barges had a 50.0 percent utilization rate. Offshore rig utilization and day rates continue to reflect weakness in many of the world's rig markets. Competitive jackup rig fleet utilization increased in the Gulf of Mexico over November 2002, reversing a three-month decline. But since the fleet utilization remains below 80 percent with ample rig time available, there is little opportunity to bid rates up. Volatility continues in the mid-water depth semi market, with the overall trend towards improved fleet utilization. Day rates for semis are expected to continue their roller coaster ride of 2002 in the near term (OneOffshore 2002).

As rig utilization rates have fallen and the market has become much softer, drilling contractors are no longer lamenting the lack of skilled crews to run their rigs. While some contractors are recruiting full speed ahead, some are only recruiting for deepwater vessels, while others are not recruiting at all or only at the entry level. With some operators still stinging from laying off too many crews during the last downturn, it appears that many companies are more careful about laying off crews this time in response to a slowing market. If companies begin laying off personnel, when the market turns up again, drilling contractors may once again be left out in the cold when it comes to recruiting skilled personnel (One Offshore, 2001b).

The still depressed GOM rig market continues to hit offshore service vessel (OSV) operators hard with the smaller vessel owners hit the hardest. The most significant barometer of rig activity is what the energy companies are thinking, even if commodity prices are high enough to make money. The October 2002 average day rates for supply boats and crewboats used by the offshore oil and gas industry decreased from the October 2001 figures and, for the most part, utilization rates for these vessels followed suit. However, anchor-handling tug/supply vessels (AHTS) average day rates increased over the same time period and maintained a 100 percent utilization rate. Average day rates for AHTS vessels ranged from $12,000 for under 6,000-hp vessels (up $1,500 from last year's rate) to $15,000 for over 6,000-hp vessels (up $2,000 from last year's rate); utilization rates were 100 percent for both. Supply boat average day rates ranged from $4,733 for boats up to 200 ft (down $1,831 from a year ago) and $10,100 for boats 200 ft and over (down $775 from a year ago); utilization was 78 percent and 100 percent, respectively. Crewboat average day rates ranged from $2,000 for boats under 125 ft (down $645 from a year ago) to $2,400 for boats 125 ft and over (down $1,240 from last year's average rates); utilization was 77 percent and 87 percent, respectively (Greenberg, 2002).

Commencing with Central GOM Lease Sale 178 Part 1 in March 2001, new royalty relief provisions for both oil and gas production in the GOM's deep and shallow waters were enacted. These rules will govern the next three years of lease sales. Central Gulf Lease Sale 178 Part 1 resulted in 534 leases (an increase of 59.88% or 200 blocks from Central Gulf Lease Sale 175 in March 2000). Of these 534 leases, 348 were in shallow water (0-400 m). This increase of 67.30 percent from the last Central Gulf lease sale largely reflects the intensified interest in natural gas due to higher prices over the last year and the new royalty relief provisions. The 186 blocks receiving bids in deepwater (greater than 400 m) reflect an increase of 47.62 percent or 60 blocks. Again, this dramatic increase in leasing could be a result of the recently issued royalty relief provisions. Western GOM Lease Sale 180 and Central GOM Lease Sale 178 Part 2, offering the newly available United States' blocks beyond the U.S. Exclusive Economic Zone, were held on August 22, 2001. No bids were received for blocks offered in Central Gulf Lease Sale 178 Part 2. Of the 4,114 blocks offered in Western Gulf Lease Sale 180, 320 received bids. About 55 percent of blocks receiving bids (177 blocks) in Western Gulf Lease Sale 180 are in deepwater, and 175 of these deepwater blocks were leased. In Sale 181 in the Eastern GOM held on December 5, 2001, all 95 deepwater blocks receiving bids were leased. In Central GOM Sale 182, held March 20, 2002, 294 shallow-water blocks and 195 deepwater blocks were leased. In Western GOM Sale 184, held August 21, 2002, 161 shallow-water blocks and 154 deepwater blocks were leased.

3.3.1.1.7. Environmental Justice

On February 11, 1994, President Clinton issued an Executive Order to address questions of equity in the environmental and health conditions of impoverished communities. The most effective way of assuring that Federal actions do not disproportionately affect minority or low-income neighborhoods is to locate and identify such neighborhoods so that there is explicit knowledge of their presence from the outset of a proposed project. Figure III-12 in the Final EIS for Lease Sale 181 (USDOI, MMS, 2001) shows households with an annual income under $25,000 for the coastal counties and parishes of Mississippi, Alabama, and the Florida Panhandle.

Low incomes also coincided with concentrations of minority populations: black, Hispanic, and/or Native American. Minority populations within the impact region include African-Americans living in all the Gulf Coast States and Asian-Americans in Louisiana, Mississippi, and Alabama. Few Native Americans live in coastal counties, and there are no recognized tribal lands in any of the coastal counties from Mississippi to the panhandle of Florida, according to maps of tribal lands and locations published in December 1998 by the Bureau of Indian Affairs.

Members of the Houma Nation live principally in Lafourche Parish and close to Port Fourchon, where they could be directly affected by increases in oil/gas activity from the proposed action.

3.3.2. Commercial Fisheries

Water depths in the block of the proposed action range from 6,560 to 7,420 ft (1,999 to 2,262 m). Fish species of principal interest in this deepwater area are the oceanic pelagic species. At this depth, there are no managed bottom-dwelling or commercially important fish species.

The GOM provides more than 26 percent of the commercial fish landings in the continental U.S. (67% when Alaska is excluded) and yielded the Nation's second largest regional commercial fishery weight and third in value in 1999 (total for all species: 1,947 million pounds and $776 million). Commercially important species include the estuary-related species such as menhaden, shrimps, oyster, crabs, and sciaenids (drums). The GOM shrimp fishery is the most valuable in the U.S. accounting for 71.5 percent of the total domestic production (USDOC, NMFS, 1997). Menhaden was the most valuable finfish species landed in 1999 with a total value of $78.5 million.

Oceanic pelagic fishes were not landed in high quantities relative to other finfish groups during 1983-1993 in the Eastern Gulf; however, they were very valuable, ranking second to reef fishes in average dollar value of landings. The most important species, yellowfin tuna and swordfish, were caught primarily by surface longline in oceanic waters offshore the shelf break. Bay County, Florida, and to a lesser extent Santa Rosa County, were the only counties reporting sizeable proportions of oceanic pelagic fishes in their landings. Because these fisheries operate in the open Gulf, catches responsible for specific State landings could have been made in waters outside the region.

On November 1, 2000, NMFS put into effect a new regulation to reduce bycatch and bycatch mortality in the pelagic longline fishery. Two rectangular areas in the northern Gulf are closed year-round to pelagic longline fishing. These closed areas cover 32,800 mi^2 (84,950 km^2). The proposed blocks lie approximately 15 nmi inside the western boundary of the northernmost closure area where longline fishing is not permitted. This region has been identified by NMFS as a swordfish nursery area, and where there has historically been a low ratio of swordfish kept to the number of undersized swordfish discarded, which over the period of 1993-1998 has averaged less than one swordfish kept to one swordfish returned. The area closure is expected to produce approximately a 4 percent reduction in Gulf and Atlantic undersized swordfish bycatch. The DeSoto Canyon area coordinates are shown in Table 3-5.

Table 3-5

Area of Longline Fishing Ban, Eastern Planning Area

Upper Area	Lower Area
North boundary: 30 °N. latitude	North boundary: 28 °N. latitude
South boundary: 28 °N. latitude	South boundary: 26 °N. latitude
East boundary: 86 °W. longitude	East boundary: 84 °W. longitude
West boundary: 88 °W. longitude	West boundary: 86 °W. longitude

Additional information or greater depth of discussion on commercial fisheries can be found in the Final EIS for Lease Sale 181 (USDOI, MMS, 2001). A map showing the location of the longline fishing ban areas and the EPA sale area is shown in Figure III-9 of the Final EIS (USDOI, MMS, 2001).

3.3.3. Recreation/Tourism

The northern GOM coastal zone is one of the major recreational regions of the U.S., particularly for marine fishing and beach activities. Gulf Coast shorelines offer a diversity of natural and developed landscapes and seascapes. Major recreational resources include coastal beaches, barrier islands, estuarine bays and sounds, river deltas, tidal marshes, and the nearshore and offshore waters of the GOM. Other recreational resources include publicly owned and administered areas, such as national seashores, State and local parks, beaches, and wildlife lands, as well as designated preservation areas, such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers. Gulf Coast residents and tourists from throughout the nation, as well as from foreign countries, use these resources extensively and intensively for recreational activity. Commercial and private recreational facilities and establishments such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary-interest areas. Bird watching, or public enjoyment of locating, identifying, and observing coastal and marine birds, is a recreational activity of growing interest and importance all along the Gulf Coast.

3.3.4. Archaeological Resources

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest (30 CFR 250.2). The Archaeological Resources Regulation (30 CFR 250.26) provides specific authority to each MMS Regional Director to require archaeological resource surveys, analyses, and reports. Surveys are required prior to any exploration or development activities on leases within the high probability-areas (NTL 2001-G01).

Prehistoric

The MMS recognizes both the 12,000 B.P. and 60-m (197-ft) water depth as the seaward extant of prehistoric archaeological site potential on the OCS. The water depth in DeSoto Canyon Blocks 180 and 224 are deepwater blocks in depths ranging from 6,560 to 7,420 feet. The water depth of lease blocks is deeper than the earliest known prehistoric sites in the Gulf. Based on the extreme water depth of these lease blocks, any oil or gas exploration or development will not impact any prehistoric archaeological resources.

Historic

With the exception of the Ship Shoal Lighthouse structure, historic archaeological resources on the OCS consist of historic shipwrecks. A historic shipwreck is defined as a submerged or buried vessel, at least 50 years old, that has foundered, stranded, or wrecked and is presently lying on or is embedded in the seafloor. This includes vessels (except hulks) that exist intact or as scattered components on or in the seafloor. A 1977 MMS archaeological resources baseline study for the northern GOM concluded that two-thirds of the total number of shipwrecks in the northern Gulf lie within 1.5 km (0.9 mi) of shore. Most of the remaining wrecks lie between 1.5 km and 10 km (0.9 mi and 6.2 mi) of the coast (CEI, 1977). A subsequent MMS study published in 1989 found that changes in the late 19th and early 20th century sailing routes increased the frequency of shipwrecks in the open sea in the Eastern Gulf to nearly double that of the Western and Central Gulf (Garrison et al., 1989). The highest observed frequency of shipwrecks occurred within areas of intense marine traffic, such as the approaches and entrances to seaports and the mouths of navigable rivers and straits.

Review of Garrison et al. (1989) and the new MMS shipwreck database Pearson et al. (2002) indicated there are no shipwrecks that fall within DeSoto Canyon Blocks 180 and 224. These shipwreck databases should not be considered an exhaustive lists of shipwrecks. Regular reporting of shipwrecks did not occur until late in the 19th century, and losses of several classes of vessels, such as small coastal fishing boats, were largely unreported in official records. Wrecks occurring in deeper water would have a moderate to high preservation potential. In the deep water, temperature at the seafloor is extremely cold, which slows the oxidation of ferrous metals. The cold water would also eliminate the wood-eating shipworm *Terredo navalis* (Anuskiewicz, 1989, page 90).

Aside from acts of war, hurricanes cause the greatest number of wrecks in the Gulf. The wreckage of the 19th century steamer *New York* which was destroyed in a hurricane in 1846, lies in 16 m (52 ft) of water and has been documented by MMS (Irion and Anuskiewicz, 1999) as scattered over the ocean floor in a swath over 457 m (1,500 ft) long. Shipwrecks occurring in shallow water nearer to shore are more likely to have been reworked and scattered by subsequent storms than those wrecks occurring at greater depths on the OCS. Historic research indicates that shipwrecks occur less frequently in Federal waters. However, these wrecks are likely to be better preserved, less disturbed, and, therefore, more likely to be eligible for nomination to the National Register of Historic Places than are wrecks in shallower State waters.

4. POTENTIAL ENVIRONMENTAL IMPACTS

4.1. PHYSICAL ENVIRONMENT

4.1.1. Impacts on Water Quality

Impact-producing factors from the proposed action include possible spills and blowouts, the overboard discharge of operational wastes from drilling operations and from the routine operations of support vessels, and discharges from onshore support facilities.

Impacts from Rig Emplacement and Removal

Impacts from rig emplacement and removal (resuspension of bottom sediments) would not occur since OEI would use a DP semisubmersible to drill all of the proposed wells. Also, no anchoring would occur. The jetting of surface casing for the exploration wells may result in localized sediment suspension and higher levels of turbidity and degraded water quality proximal to the borehole location.

Impacts from Support Vessel Operations

OEI proposes to drill six wells over a two-year period. Each well would need 50-90 days to drill. Actual drilling operations would occur during 49 weeks. Anticipated support vessel and travel frequency would fluctuate with drilling activities.

Vessel usage of coastal waters may degrade water quality through bilge water discharges, discharges of treated sanitary and domestic wastes, wake erosion of channel banks, incidental trash and debris, spills, and dredging operations to maintain channels used by support vessels. New MARPOL regulations that further restrict the levels of oil and grease in bilge water discharges in coastal areas (40 CFR 110) were designed to diminish the types of impacts that have been historically noted from such discharges.

Antifouling marine paints used on vessels and structures at the service bases can be spilled or enter the marine environment slowly through deterioration of the painted surfaces. Port Fourchon, Louisiana, is already used extensively by the oil industry and the addition of one or two vessels per day would not alter the impacts to water quality already at the port.

Spills are most likely to occur in connection with offloading and onloading activity and fueling carried out by or on support vessels. Spills of diesel or other fuels originating under these circumstances are expected to be small and to evaporate quickly, affecting water quality for a few days at most.

Impacts from Spills

Offshore spills from the proposed action are possible if an accident were to damage the diesel storage tanks on the semisubmersible or support vessels during routine operations or the transfer of fuel from tank to tank. The largest individual tank on the *Cajun Express* or a similar drilling unit has a capacity to hold 7,705 bbl of diesel with a combined storage capacity of 37,787 bbl of diesel of all the tanks. If the tank should rupture, depending on the type of tank failure and amount of spillage, the diesel would evaporate and mix into the water column resulting in a temporary decrease in water quality around the rig for a period of days to weeks. The time to recover would depend on the size of the spill or the effectiveness of the spill response. Deployment of response equipment could substantially clean up the spill while close to the origin, resulting in minimal impacts to the surrounding environment. OEI is expected to take appropriate cleanup measures should the situation require it. Tables C-1, C-2, and C-3 show the historical record of OCS spills (≥1,000 bbl) from facilities, pipelines, and blowouts, respectively, as a means to establish probability of occurrence.

Should OEI discover hydrocarbons in a well(s) from the proposed action, there is the potential for an oil spill resulting from an accidental blowout during the drilling operations. The possibility of a release is reduced by safety features on the semisubmersible and subsea equipment, which include well control, pollution prevention, and blowout prevention equipment as described in 30 CFR 250. OEI estimates a worst-case discharge of 20,000 of 30 API crude from a blowout scenario. An analysis was conducted by MMS personnel to determine a potential blowout scenario for inclusion in this SEA. This analysis concluded that a blowout could continue for up to two days at a rate of 17,000 bbl/day before it could reasonably be assumed that the well would shut-in on its own without further intervention (Smith, personal communication, 2001).

According to Table C-5, the spill risk (combined probability of an oil spill occurring from a blowout and contacting identified environmental features) is less than 0.5 percent for all modeled environmental resources or land segments for 3, 10, or 30 days. The major impact to water quality would be between the seafloor source and the location where the oil surfaces, i.e., the subsea plume. In the water column, the oil would disperse over time and microbial degradation would quickly begin to remove hydrocarbons from the water column. If oil contacts a shoreline, it would be in a degraded and weathered state. The nearest shoreline, the Northeast Pass of the Mississippi delta, is 82 mi (132 km) from the proposed action. Impacts to coastal water quality from the proposed action are expected to be negligible to minor.

Impacts of a Blowout

The proposed action is for drilling six exploration wells in two contiguous blocks in the EPA sale area. A spill could occur during exploratory drilling. Table C-3 shows the historical record of OCS spills from blowouts. In the unlikely event of a subsurface blowout, impacts would depend upon the nature and severity of the blowout. Most of the impacts would result from physical disturbance to the seafloor and the resuspension of bottom sediments in addition to hydrocarbons venting from the borehole. The possibility of a release is reduced by safety features on the rig, which include well control, pollution prevention, and blowout prevention equipment as described in 30 CFR 250. A blowout would have an immediate response and the duration of the event is likely to be hours rather than days. The impacts to water quality would occur during the blowout event and for a period of days to weeks afterward. Although not documented in the vicinity of DeSoto Canyon, mud volcanoes that vent hydrocarbon, hydrocarbon seeps, and brine seeps are part of the geological regime of the deep GOM (Roberts and Carney, 1997). The disturbance from a blowout would not have more of an impact than natural phenomena present in the deepwater environment.

Impacts from Oil-field Discharges

Overboard discharges are projected to occur from the proposed action (Tables D-1 and D-2). The approximate duration for drilling and temporarily abandoning a well in the DeSoto Canyon Blocks 180 and 224 is 50 days. According to the data provided by OEI, each well would generate approximately 20,000 bbl/well of water-based fluids (WBF) and 4,000 bbl/well cuttings (for the WBF option) or 11,100 bbl/well of synthetic-based fluids (SBF) and 4,250 bbl/well of SBF wetted cuttings (for the SBF option). An additional 5,000 bbl/well WBF and 2,000 bbl/well cuttings would be discharged at the seafloor prior to the installation of the marine riser. The WBF and WBF cuttings may be discharged through the USEPA general permit. However, if synthetic-based fluids are used, there would be no discharge of fluids and possibly no discharge of cuttings, depending on the USEPA permit requirements.

A large number of studies have examined the environmental consequences of water-based drilling fluids and cutting discharges, along with associated completion fluids. Study results showed that typical drilling discharges frequently caused some heavy metal and hydrocarbon sediment contamination that resulted in measurable biological effects on benthic organisms for several hundred meters from the discharge (USEPA, 1993), depending on the water depth. No gross functional alterations in marine organisms were reported (Avanti Corporation, 1993). Physical changes to sediment also affect the benthic population in the vicinity of the well. These studies were conducted in much shallower depths than the proposed action. It is expected that the muds and cuttings would be dispersed during the descent through the water column and would not result in a measurable level of contamination.

Cement plugs, blowout preventer fluid, desalinization unit discharge, uncontaminated bilge water, seawater, boiler blowdown, and diatomaceous earth filters are all minor discharges that can occur from the completion operations. These quantities are expected to be extremely small and of short duration. There would be 3,600 bbl/well of grey water (domestic) waste discharge and the same amount of sanitary waste discharge for each well in the DeSoto Canyon Prospect. Deck drainage effluent is primarily washwater and rainwater. Any oil and grease, the main contaminants identified in deck drainage, will be controlled by the NPDES permit requirement for no visible sheen.

Overboard discharges should be rapidly diluted and dispersed. Impacts to water quality would be minimal and confined to an area within a few meters of the discharge site. None of the quantities and categories of wastes discharged overboard are expected to result in significant impacts to offshore water quality.

Impacts to Coastal Water Quality from Onshore Support Bases

OEI plans to use the existing onshore service base at Port Fourchon, Louisiana, and commercial waste disposal facilities located in Louisiana and Texas. Point-source effluents from these facilities are controlled by requirements in the NPDES permits for these facilities. Domestic and sanitary wastewater would be collected and delivered to a municipal treatment plant or discharged through a permitted onsite wastewater treatment system. USEPA NPDES storm water effluent limitations control storm water discharges from supporting facilities. Thus, effluent discharges from these facilities would be negligible and should not contribute to coastal water quality degradation.

The facility's presence, along with the associated access routes, alters the natural hydrology and geography of the area over time, resulting in increased erosion and landloss. Nonpoint source run-off, such as rainfall that has drained from a public road, may contribute hydrocarbon and trace-metal pollutants to adjacent drainage canals. OEI does not expect to expand or construct any additional buildings at these bases with respect to the proposed activities. Thus, runoff attributable to the proposed action would be negligible.

4.1.2. Impacts on Air Quality

The projected air emissions submitted by Ocean Energy, Inc. for this project (for drilling option A—synthetic mud) are below the MMS exemption levels. Ocean Energy, Inc. has estimated the emissions associated with this project. These emission projections are required to represent the worst case and are summarized in Table 4.1.

Table 4-1

Air Quality

Total Emissions (tons)					
Year	PM	SO_x	NO_x	VOC	CO
2003	74.75	342.92	2,569.60	77.09	560.64
2004	53.40	244.96	1,835.55	55.07	400.48
2005	53.40	244.96	1,835.55	55.07	400.48
MMS Exemption Level	2,730.60	2,730.60	2,730.60	2,730.60	64,173.37

There will be a limited degree of degradation of air quality in the immediate vicinity of the proposed activities. The activities in the proposed action are scheduled to last 346 days of actual drilling time. The impacts are not expected to significantly affect onshore air quality.

Air quality would be affected if a blowout occurs. Highly volatile, low-molecular-weight hydrocarbons would be released to the atmosphere from the sea surface. Volatile organic compounds (VOC's) in the released hydrocarbons are precursors to photochemically produced ozone. A spike in VOC's could contribute to a corresponding spike in ozone, especially if the release were to occur on a hot and sunny day in a NO_2-rich environment. The nearest onshore areas are all currently in attainment for ozone. If a fire occurs, particulate and combustible emissions will be released in addition to the VOC's.

4.2. Biological Environment

4.2.1. Impacts on Coastal Habitats

4.2.1.1. Impacts on Barrier Beaches and Associated Dunes

The following descriptions of potential impacts of spills on coastal barrier beaches and associated dunes and wetlands are based on analyses in the Final EIS for Lease Sale 181 (USDOI, MMS, 2001). That document described the potential impacts of a 6,400-bbl spill occurring offshore.

Appendix C contains an analysis of the potential for an oil spill and potential for impacts from an oil spill associated with an accidental blowout during drilling from any well in DeSoto Canyon Blocks 180 and 224. Table C-5 indicates a very low probability (<0.5%) of such a spill occurring and contacting environmental resources or land segments. Spill prevention and spill response is also discussed in Appendix C.

Contact between an oil slick and a beach would depend upon environmental conditions (e.g., wind, waves, currents, and temperature). The length of beach that might be contacted could range up to around 12.5 mi (20 km) (USDOI, MMS, 2001). The possible range for dispersal patterns of contacting oil ranges from small diffusely, scattered specks to heavy concentrations spread over the beach.

Severe adverse impacts to dunes contacted by a spill are very unlikely. For storm tides to carry oil from a spill across and over the dunes, strong southerly winds must persist for an extended time prior to or immediately after the spill. Strong winds required to produce the high tides would also accelerate oil slick dispersal, spreading, and weathering, thereby reducing impact severity at a landfall site. In addition, a study in Texas showed that oil disposal on vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

Cleanup operations associated with large oil spills can affect the stability of barrier beaches more than the spill itself. If large quantities of sand were removed during spill cleanup operations, a new beach profile and sand configuration could be established in response to the reduced sand supply and volume. The net result of these changes would be accelerated rates of shoreline erosion, especially in a sand-starved, eroding-barrier setting such as that found along the Louisiana coast. The State governments around the Gulf have recognized these problems and have established policies to limit sand removal by cleanup operations.

In conclusion, the proposed action is not expected to adversely alter barrier beach or dune configurations significantly as a result of related oil spills.

4.2.1.2. Impacts on Wetlands

A description of the potential oil spill resulting from an accidental blowout during drilling of a proposed well is provided in Appendix C. The information below regarding potential impacts of oil spills on wetlands is based on analyses in the Final EIS for the Lease Sale 181 (USDOI, MMS, 2001).

Numerous investigators have studied the impacts of oil spills on wetland habitats in the Gulf area. Often, seemingly contradictory conclusions are generated from these impact assessments. Contradictions can be explained by differences in oil concentrations contacting vegetation, kinds of oil spilled, species and communities of vegetation affected, soil types, season of year, pre-existing stress levels on the vegetation, and numerous other factors. In overview, the data suggest that light-oiling impacts generally cause plant dieback with recovery within two growing seasons without artificial replanting. Such impacts to vegetation are considered short term and reversible (Webb et al., 1985; Alexander and Webb, 1987; Lytle, 1975; Delaune et al., 1979; Fischel et al., 1989).

Table C-5 indicates a very low probability (<0.5%) for an oil spill resulting from an accidental blowout occurring and contacting environmental resources or land segments. As discussed in USDOI, MMS (2001), distant offshore spills have a further diminished probability of impacting inland wetlands and shorelines, largely due to their sheltered locations.

The service base for the proposed action would be Port Fourchon, Louisiana. Extensive wetlands are found around the port and its access channels, Belle Pass, and Bayou Lafourche. The majority of the ports past expansions have involved the filling of wetlands. Increasing the number or collective-area use of OCS-related support activities at Port Fourchon would exert additional expansion pressures there. Accommodating those pressures would cause the loss of some surrounding wetlands. Oil-spill cleanup activities that increase foot and vehicle traffic over wetlands could damage those wetlands due to trampling. Trampling may directly damage wetland vegetation or work oil deeper or more extensively into sediments than would have otherwise occurred.

The probability of an inland fuel-oil spill, for example, in or around the Port Fourchon landing area, associated with the proposed action is very small. Should a spill occur inshore or in nearshore waters, it presents a much greater potential for adversely impacting wetlands because of their close proximity. Oil could then accumulate in thick layers on the marsh and in protected pools and embayments.

For wetlands, the critical concentration of oil is that concentration above which (1) resulting impacts to wetlands would take longer than two growing seasons to resolve, (2) some plant mortality occurs, and (3) some permanent wetland loss occurs. Critical concentrations of various oils are currently unknown and are expected to vary broadly for wetland types and plant species, in natural situations. Due to the accumulation of other stressors at work in coastal Louisiana, the critical concentration of oil resulting in long-term impacts to wetlands is assumed to be much lower than for the more stable coastal wetlands of Mississippi, Alabama, and Florida. Less than critical concentrations may cause limited mortality and dieback of above-ground foliage for one growing season. Higher concentrations would cause mortality of much of the contacted vegetation, but 35 percent of the affected area would recover within 4 years. Oil detection in wetland soils may persist for at least 5 years. After 10 years, permanent loss of 10 percent of the affected wetland area would be expected as a result of accelerated landloss that is indirectly caused by the spill. If a spill contacts wetlands exposed to wave attack, additional and accelerated erosion will occur, as documented by Alexander and Webb (1987).

In conclusion, adverse impacts to wetlands resulting from a spill related to the proposed action are highly unlikely to occur. However, if a related offshore spill occurs, and oceanographic and meteorological conditions are such that a large amount of oil contacts wetlands, adverse impacts could occur. If an unlikely fuel-related oil spill occurs inshore, wetlands in the spill vicinity would be adversely impacted. The proposed use of Port Fourchon would maintain and perhaps increase pressures to further expand that port, which would involve wetland destruction.

4.2.1.3. Impacts on Seagrasses

The probability of an oil spill resulting from the proposed action is very low, as described in Appendix C. Generally, the described possible oil spills are much less likely to contact submerged vegetation beds than are inshore spills because the beds are generally protected by barrier islands, peninsulas, sand, spits, and currents. No seagrass beds are known to exist in the vicinity of Port Fourchon, where most project-supporting vessel traffic would occur. No seagrass beds would be impacted should an inshore spill occur in this area.

Most submerged vegetation in this region usually remains submerged, due to the micro-tidal regime of the northern Gulf. Should water turbulence and turbidity increase sufficiently, some of the oil would be emulsified; suspended particles would absorb oil from a sheen as well as emulsified droplets, decreasing their suspendability. The degree of impact depends on water depth, currents, and weather in the affected area during the presence of a slick as well as oil density, solubility, and emulsability.

Typically, submerged vegetation reduces water velocity among the vegetation as well as for a short distance above it. Reduced flow velocity or turbulence enhances sedimentation. Minute oil droplets, whether or not they are bound to suspended particulates, may adhere to the vegetation or other marine life; they may be ingested by animals, particularly by filter, suspension, and sediment feeders; or they may settle onto the bottom in or around a bed. In all of these situations, oil has a limited life since it will be degraded chemically and biologically while it is being taken out of the environment physically, i.e., by sedimentation (Zieman et al., 1984). Because estuaries have a greater suspended particulate load and greater microbial populations, oil degrades more rapidly there (Lee, 1977). The most probable danger under these more likely circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in grass beds or attached to grass fronds.

Only during extremely low, wind-driven tidal events might seagrass beds be exposed to the air, such that they might be directly impacted by an oil slick. Even then, their roots and rhizomes remain buried in the water bottom. Given the geography of the coastal area discussed, a strong wind that could lower the water that much generally would be a northerly wind, which would push water out of bays and sounds and drive a slick away from the coast. In this situation, oil that was already in the bay or sound would be driven against the southern shores. Any seagrass beds that may be exposed there may be contacted.

A more damaging scenario would be for a slick that might pass over and remain over a submerged bed of vegetation in a protected embayment during typical fair-weather conditions. This would reduce light levels in the bed and interfere with the photosynthetic process. If light reduction continues for several days, chlorophyll content in the leaves will be reduced (Wolfe et al., 1988), causing the grasses to yellow and reduce productivity. Shading by such an oil slick should not last long enough to cause mortality, depending upon the slick thickness, currents, weather, and the nature of the embayment.

Also, a slick that remains over a submerged vegetation bed in an embayment would reduce or eliminate oxygen exchange between the air and the water of the embayment. Currents may not flush adequate oxygenated water between the embayment and the larger waterbody. Seagrasses and related epifauna might be stressed and perhaps suffocated if the biochemical oxygen demand is high, as would be expected for a shallow waterbody that contains submerged vegetation and an additional burden of oil (Wolfe et al., 1988).

Clean up of slicks that contact shallow or protected waters (0-5 ft deep) may be performed using john boats, booms, anchors, and skimmers mounted on boats or shore vehicles. Personnel assisting in oil-spill cleanup in water shallower than 3-4 ft may wade through the water to complete their tasks. Foot traffic and these types of equipment easily damage seagrass beds. Oil can also be worked more deeply into their sediments by these activities.

As described for wetlands, oil that penetrates or is buried into the water bottom is less available for dissolution, oxidation, or microbial degradation. Oil may then be detectable in the sediments for 5 years or more, depending upon circumstances.

Navigational traffic that may support the proposed action is discussed in Chapter 1.3.5. Navigational vessels that vary their route from established navigational channels can directly scar beds of submerged vegetation with their props, keels (or flat bottom) and anchors (Durako, et al., 1992). No seagrass beds are known to exist in the vicinity of Port Fourchon, which is where most traffic between the project site and shore would pass.

In conclusion, a project-related oil slick from the described offshore spill is highly unlikely to impact a seagrass bed. Should impacts occur, they would be minimal.

4.2.2. Impacts on Offshore Habitats

4.2.2.1. Impacts on Pelagic Environment

An oil spill resulting from an accidental blowout during drilling could occur (Appendix C). Impacts on phytoplankton populations in the immediate vicinity of discharged drill muds would be minimal because of the low toxicity and quick dilution of the muds, the volume of the receiving waters, and the rapid regeneration rates of phytoplankton populations (e.g., the large dinoflagellate *Prorocentrum micans* can divide 1.3 times daily under optimum conditions) (Williams, 1973). The rapid dilution of the muds and cuttings released at the drill sites minimizes the effects on plankton further afield. It is not known whether food (phytoplankton) availability to zooplankton controls abundance or productivity of major fisheries. However, the rapid dilution and dispersion of operational discharges would minimize impacts on phytoplankton populations. Individual plankters may be subject to sublethal effects for short periods, but there would be no persistent environmental consequences.

An NRC (1985) summary stated that phytoplankton populations have demonstrated no mass toxic effect in the field, either from a spill or from chronic input conditions. This may be the result of the rapid regeneration time exhibited by algal cells (only several hours or days) and recruitment from adjacent waters. Since concentrations of hydrocarbons would not persist long enough to consistently cause lethal or sublethal toxic effects, no significant impacts on phytoplankton populations are anticipated. Contamination of sediment in shallow water may affect benthic resting spores of certain species of shallow water phytoplankton that form after the end of a stage of phytoplankton succession.

Zooplankton discussed here are mostly the small copepods that graze on phytoplankton and are a major link to fishes higher in the food web. Sources of possible impacts on zooplankton include drilling discharges from the drillship, other chronic operational discharges, and oil spills. Discharges may interfere with filter-feeding organs or mechanically damage them. Ingestion of suspended inorganic particles may reduce energy intake, causing mortality of some subadult copepodite stages important in the diet of some fish larvae. Lack of ovarian development may affect the availability of copepod eggs and large vital in the diet of first-feeding larvae of many fish species. Sublethal concentrations of petroleum hydrocarbons could result in cellular and physiological changes, which could lead, at least initially, to abnormal behavior such as disruption of feeding and/or reproductive patterns.

Although quantitative data are not available, it is assumed that the abundance of grazing zooplankton would, under certain circumstances, be limited by the availability of phytoplankton as food. This could occur during periods of decreased phytoplankton availability following a phytoplankton bloom, when zooplankton may still be abundant. The impacts on zooplankton from hydrocarbon pollution effects on phytoplankton are therefore difficult to quantify. Similarly, in the absence of quantitative data, it is reasonable to assume that fish stocks would, under certain conditions, be limited by availability of zooplankton.

The potential impacts of the proposed activity on plankton populations would be localized and short term and are not expected to be significant.

4.2.2.2. *Impacts on Benthic Environment*

Nonchemosynthetic Benthic Communities

Benthic communities other than chemosynthetic organisms could be impacted by a bottom-disturbing seafloor blowout or operational discharges. An oil spill resulting from an accidental blowout during drilling is presumed for this analysis (Appendix C). It is assumed that all of the spill would rise to the surface. A blowout at the seafloor could also resuspend large quantities of bottom sediments and even create a large crater, destroying many organisms within an area of a 300-m radius of the well site. These impacts are the same as those encountered in shallower continental shelf waters.

Because of the great water depths, discharges of drilling muds and cuttings at the surface are spread across broad areas of the seafloor and create thinner accumulations than in shallower areas on the continental shelf.

Impacts are possible from muds and cuttings that are discharged directly to the seafloor before a riser is connected to circulate them to the surface. Jetted or drilled cuttings discharged at the bottom from the initial wellbore would total as much as 226 m^3 (Halliburton Red Book). Although the full extent of the area and depth of burial from these activities are not known, the potential impacts are expected to be localized and short-term. These impacts would occur only on a small portion of the available seafloor in the deepwater GOM and are not considered significant because the area affected is insignificant compared to the available habitable space. Of particular concern are deepwater coral communities that can occur on exposed carbonate outcrops in the deep Gulf. Only one high-density community is currently well documented in Viosca Knoll Block 826. While these coral communities are at a fixed location and are probably sensitive to the impacts of settling particulates from muds and cuttings, these communities are likely protected due to the avoidance of the associated hard substrate and potential co-occurring chemosynthetic communities. Also, there are no known areas of hard substrate near the area covered by the proposed action.

Highly motile megafauna (primarily benthic fish and some crustaceans and bivalves) would be capable of moving to new locations and avoid the majority of these physical impacts. Nonmotile fauna could be smothered. Depending on the organism type, just a few centimeters of burial could cause death. Some types of macrofauna could burrow through gradual accumulations of overlying sediments. These impacts would be are very localized and reversible at the population level through recolonization. The recovery from the impact of a blowout would be similarly reversible.

Effluents other than muds or cuttings from the proposed action would be subject to rapid dilution and dispersion and would not have an impact on the seafloor. Oil and chemical spills are also not considered to be a potential source of measurable impacts to nonchemosynthetic benthic communities due to the water depth. Oil spills from the surface would tend not to sink. Accidental oil discharges at depth or on the bottom would tend to rise in the water column.

Chemosynthetic Communities

There are no documented chemosynthetic communities in the vicinity of the two contiguous blocks comprising the proposed action. The nearest known chemosynthetic community is approximately 31 nmi (57 km) north-northwest of the area of the proposed action, in Viosca Knoll Block 826 (Figure III-6 from the Final EIS for Lease Sale 181 (USDOI, MMS, 2001)). The possibility exists that chemosynthetic communities may exist in the area but are undocumented. The use of a DP drilling system or DP semisubmersible removes the possibility of harming chemosynthetic communities by anchoring because there is no need to anchor. A biological review was conducted on the EP utilizing geophysical records that could indicate the potential presence of chemosynthetic communities as required by NTL 2000-G20. No seafloor faults are within 1,500 ft of any well location. Also, no potential fluid macroseepage mounds or mud volcanoes that could provide gas to support chemosynthetic communities are within 1,500 ft of any well sites. NTL 2000-G20 requires operators who propose activities that could disturb seafloor areas in water depths of 400 m (1,312 ft) or greater to maintain the following separation distances from features or areas that could support high-density chemosynthetic communities: (1) setback of at least 1,500 ft from mud and cuttings discharge location; and (2) at least 250 ft from the location of all other proposed seafloor disturbances (including those caused by anchors, anchor chains, wire ropes, seafloor template installation, and pipeline construction).

4.2.2.3. Impacts on Sea Turtles

The major impact-producing factors related to the proposed action that could affect sea turtles include water-quality degradation from operational discharges, helicopter and service-vessel traffic and noise, drilling unit lighting, OCS-related debris, oil spills, and oil-spill response activities.

Operational Discharges

Drill muds and drill cuttings are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Most operational discharges, as regulated, are diluted and dispersed when released in offshore areas and are considered to have sublethal effects on sea turtles (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling fluids or waste discharge can biomagnify and bioaccumulate in the food web, which could kill or debilitate jellyfish or other important prey species of sea turtles. Sea turtles could potentially bioaccumulate heavy metals that occur in drilling mud, which could ultimately reduce reproductive success in the turtles. This would be an impact that already stressed turtle population(s) probably could not tolerate. Samples from stranded turtles in the GOM carry high levels of organochlorides and heavy metals (Sis et al., 1993).

Noise and Vessel Collisions

There have been no systematic studies of the reactions of sea turtles to aircraft overflights and even anecdotal reports are scarce; aircraft noise may be heard by a sea turtle at or near the surface and cause it to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic can elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Startle reactions could result in increased surfacings, possibly causing an increase in the risk of vessel collision. Vessel-related injuries were noted in 13 percent of stranded turtles examined from strandings in the GOM and on the Atlantic Coast during 1993 (Teas, 1994), but this figure includes those that could have been struck by boats postmortem. Reactions, such as any avoidance behavior, might result in disruption of normal activities, including feeding. Sea turtles may avoid important habitat areas where persistent noise disturbance occurs. Information is limited on the possible consequences that these disturbances may have on sea turtles over a long period.

Semisubmersible drill rigs produce an acoustically wide range of sounds at frequencies and intensities that may be detected by turtles. Turtle hearing sensitivity is not well studied. 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; Moein Bartol et al., 1999). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Captive loggerhead and Kemp's ridley turtles exposed to brief audio-frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads (O'Hara and Wilcox, 1990; Moein et al., 1993; Lenhardt, 1994); some loggerheads exposed to low-frequency sound responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). An anecdotal observation of a free-ranging leatherback's response to the sound of a boat motor suggests that leatherbacks may be sensitive to low-frequency sounds, but the response could have been to mid- or high-frequency components of the sound (Advanced Research Projects Agency, 1995). The potential direct and indirect impacts of sound on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Based on conclusions of Lenhardt et al. (1983) and O'Hara and Wilcox (1990), low-frequency sound transmissions could cause increased surfacing behavior and deterrence from the area near the sound source. The potential for increased surfacing behavior could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators. If sound affects any prey species, negative consequences to sea turtles would depend on the extent to which prey availability is altered. Noise-induced stress has not been studied in sea turtles.

Drilling Unit Lighting

Hatchlings are known to be attracted to light (Raymond, 1984; Witherington and Martin, 1996). Since the semisubmersible drilling rig would be located over 100 mi from turtle nesting areas, attraction of hatchlings to the rig is expected to be minimal. Response by older sea turtles to artificial lighting on deepwater rigs is unknown. Lights can attract a variety of other marine organisms, including potential prey for the turtles. This activity may be sufficient to attract sea turtles indirectly. Potential predators of sea turtles might also be attracted to fish congregations around the platforms.

Trash and Debris

A wide variety of trash and debris is commonly observed in the Gulf. Marine debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some of this material is accidentally lost during drilling operations. Turtles can become physically entangled in drifting debris and ingest small fragments of synthetic materials (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; USDOI, MMS, 1989). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles could drown, suffer impaired ability to catch food or avoid predators, incur wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior patterns that place them at a survival disadvantage (Laist, 1997). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, and impaction of the alimentary canal by ingested plastics worldwide. Tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles actively seek out and consume plastic sheeting. Ingested debris can block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals. Weakened animals could then be more susceptible to predators and disease, and less fit to breed and nest successfully. It is expected that sea turtles would seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40).

In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters, went into effect January 1, 1989.

Oil Spills

An oil spill resulting from an accidental blowout during drilling could occur (Appendix C). When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location; oil type, dosage, and weathering; impact area; oceanographic and meteorological conditions; season; and life history stage of the animal (NRC, 1985). All sea turtle species and lifestages are vulnerable to the harmful effects of oil through direct contact or by fouling of their habitats and food. Experiments on the physiologic and clinicopathologic effects of oil have shown that major body systems in sea turtles are adversely affected by short exposure to weathered oil. Although disturbances may be temporary, long-term effects remain unknown, and chronically ingested oil may accumulate in organs. Exposure to oil can be fatal, particularly to juvenile and hatchling sea turtles. Direct contact with oil can harm developing turtle embryos.

Oil can adhere to the body surface of marine turtles. Turtles can become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988; Gramentz, 1988). A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986).

Turtles surfacing in an oil spill would inhale petroleum vapors. Any interference with operation of the lungs would probably reduce a sea turtle's capacity for sustained activity (aerobic scope) and its dive time; both effects decrease the turtle's chance of survival.

Studies on the effect of oil on digestive efficiency are underway, but Lutcavage et al. (1995) report finding oil in the feces of turtles that had swallowed oil in experiments. Van Vleet and Pauly (1987) reported that oil ingested by turtles did not pass rapidly through the digestive tract but was retained within the system for a period of several days, thus increasing the likelihood that toxic components of the oil could be passed on to other internal organs and tissues.

Eggs, hatchlings, and small juveniles are particularly vulnerable to contact with oil (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Hatchling and small juvenile turtles are particularly vulnerable to contacting or ingesting oil because the currents that concentrate oil spills also form the debris mats in which young turtles are sometimes found (Carr, 1980; Collard and Ogren, 1989; Witherington, 1994). The result of sea turtles feeding selectively in surface convergence lines could be prolonged contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). Assuming olfaction is critical to imprinting of hatchling turtles, oil-fouling of a nesting area might disturb imprinting or confuse the turtles on their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985; Chan and Liew, 1988).

Some captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding the oil, or became agitated and had short submergence levels (Lutcavage et al., 1995). Sea turtles pursue and swallow tarballs, and there is no concrete evidence that free-ranging turtles can detect and avoid oil (Odell and MacMurray, 1986). A loggerhead turtle sighted during an aerial survey in the GOM surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989).

After the Gulf of Iraq war, a stranded green turtle did not appear to have been oiled, but upon necropsy, was found to have large amounts of oil in its liver and stomach tissues (Greenpeace, 1992).

Oil-Spill Response Activities

Spill-response activities could adversely affect sea turtle habitat and cause displacement from these preferred areas. Impacting factors might include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape. Some of the resulting impacts from cleanup could include interrupted or deterred nesting behavior, crushed nests, entanglement in booms, and increased mortality of hatchlings due to predation during the increased time required to reach the water (Newell, 1995; Lutcavage et al., 1997). Additionally, turtle hatchlings and adults can become disoriented, and normal behavior can be disrupted by human presence as well as industrial activity. Individual turtles covered with oil have been cleaned, rehabilitated, and released (e.g., Florida Dept. of Environmental Protection et al., 1997; Mignucci-Giannoni, 1999). The strategy for cleanup operations should vary, depending on the season, recognizing that disturbance to the nest may be more detrimental than the oil (Fritts and McGehee, 1982). As mandated by the Oil Pollution Act of 1990 (OPA), seagrass beds and live-bottom communities, both sea turtle habitats, are expected to receive individual consideration during oil-spill cleanup. Required oil-spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these sea turtle habitats with spilled oil. Studies are completely lacking regarding the effects of dispersants and coagulants on sea turtles (Tucker and Associates, Inc., 1990).

Summary and Conclusion

Drilling wastes may contaminate the food web of sea turtles. Reproductive success in the turtles may then be reduced or mortality increased, retarding recovery of the populations of turtles. Sea turtles or their prey may be displaced from the turtles' feeding habitat by noise, spilled oil, or oil spill response activities. Noise from the proposed action may cause permanent hearing impairment. Such impairment is not expected, however, because the sound would become unpleasant and would be avoided first. Response of turtles to lights on offshore structures is unknown. Discharge of debris that could result in death or serious injury is expected to be minimal because it is strictly prohibited. When oil is spilled, inhaled oil fumes, ingested oil, or consumed oiled prey may increase concentration of oil in tissues and raise the mortality rate. Spill response activities could have impacts on the habitat preferred by sea turtles and cause displacement to habitat of lesser quality. Spill prevention and spill response is also discussed in Appendix C.

Small numbers of turtles could be injured or killed by chance collision with service vessels. Sickness or deaths may result from eating indigestible trash, particularly plastic items, lost from drilling rigs and service vessels. There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, turtle populations. Although an interaction with a spill could occur, primarily sublethal effects are expected due to avoidance and natural dispersion/weathering of the spill in the offshore environment. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; but there is uncertainty concerning the possible effect.

The proposed action is not expected to have long-term adverse effects on the size and productivity of any turtle species or population stock in the northern GOM.

4.2.3. Impacts on Coastal and Marine Birds

4.2.3.1. Nonendangered and Nonthreatened Species

This section discusses the possible effects of the proposed action on coastal and marine birds of the GOM and its contiguous waters and wetlands. Sources of potential adverse impacts are air emissions, water quality degradation resulting from operational discharges, helicopter and service-vessel traffic and noise, discarded trash and debris from service vessels and the drilling unit, oil spills and spill-response activities. Any effects would be especially critical for intensively managed populations such as endangered and threatened species that need to maintain a viable reproductive size or that depend upon a few key habitat factors.

Air Emissions

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are projected to have minimum effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations. Such emissions are projected to have negligible effects on onshore air quality because of the atmospheric regime, emission rates, and distance of these emissions from the coastline. These judgments are based on average steady state conditions; however, there will be days of low mixing heights and low wind speeds that could decrease air quality. These conditions are characterized by fog formation, which in the Gulf occurs about 35 days a year, mostly during winter. Impacts from offshore sources are reduced in winter because the frequency of significant onshore winds decreases (37%) and the removal of pollutants by rain increases. The summer is more conducive to air quality effects as onshore winds occur more frequently, approximately 61 percent of the time.

Noise

Helicopter and service-vessel traffic related to the proposed action could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. These impact-producing factors could contribute to indirect population loss through reproductive failure resulting from nest abandonment. The FAA (Advisory Circular 91-36C) and corporate helicopter policy state that, when flying over land, the specified minimum altitude is 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Pilots traditionally have taken great pride in not disturbing birds, however. It is expected that approximately 10 percent of helicopter trips would occur at altitudes somewhat below the minimum listed above as a result of inclement weather. Although these incidents are very short term in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment.

Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. The effects of service-vessel traffic on birds offshore would be negligible.

Operational Discharges

Chapter 4.1.1. provides an analysis of the effects of the proposed action on water quality. Expected degradation of coastal and estuarine water quality resulting from of OCS-related discharges may affect coastal birds directly by means of acute or chronic toxic effects from direct ingestion or contact, or indirectly through the contamination of food sources that come in direct contact with discharges. Seabirds (e.g., laughing gulls) that remain and feed in the vicinity of offshore OCS structures and platforms could also be affected by operational discharges or runoff in the offshore environment. These impacts could also be both direct and indirect.

Trash and Debris

Coastal and marine birds are commonly entangled and snared in discarded trash and debris. In addition, many species readily ingest small plastic debris, either intentionally or incidentally. Interaction with plastic materials is very serious and can lead to permanent injuries and death. It is expected that coastal and marine birds would seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters, went into effect January 1, 1989. It is expected that OCS natural gas-related plastic debris would seldom interact with coastal and marine birds and, therefore, the effect would be negligible.

Oil Spills

An oil spill resulting from an accidental blowout during drilling could occur (Appendix C). Various birds along contacted shoreline could experience mortality and reproductive losses. Oil may contact birds directly. Indirect contact with oil on contaminated vegetation and food resources may also occur. Recovery would depend on later influxes of birds from nearby feeding, roosting, and nesting habitat, and by the extent of oiling.

Oil-Spill Response Activities

Oil-spill cleanup methods often require heavy foot and vehicle traffic on beaches and wetland areas, application of oil dispersant and bioremediation chemicals, and the distribution and collection of oil containment booms and absorbent material. The presence of humans, along with boats, aircraft, and other equipment, would also disturb coastal birds after a spill. Investigations have shown that oil-dispersant mixtures pose a threat similar to that of oil to successful reproduction in birds (Albers, 1979; Albers and Gay, 1982). The external exposure of adult birds to oil/dispersant emulsions may reduce chick survival more than exposure to oil alone would; however, successful dispersal of a spill will generally reduce the probability of exposure of coastal and marine birds to oil (Butler et al., 1988). It is possible that changes in size of an established breeding population may also be a result of disturbance in the form of increased human activity for cleanup and monitoring efforts or to the intensified research activity after the oil spills (Maccarone and Brzorad, 1994). Studies are indicating that rescue and cleaning of oiled birds makes no effective contribution to conservation, except conceivably for species with a small world population (Clark, 1978 and 1984). A growing number of studies indicate that current rehabilitation techniques are not effective in returning healthy birds to the wild (Anderson et al., 1996; Boersma, 1995; Sharp, 1995 and 1996). Preventative methods, such as scaring birds from the path of an approaching oil slick or the use of booms to protect sensitive colonies in an emergency, have extremely limited applicability (Clark, 1984). Spill prevention and spill response is also discussed in Appendix C.

4.2.3.2. Endangered and Threatened Species

The impacting factors discussed in Chapter 4.2.3.1 with respect to birds that are not endangered or threatened also apply to endangered or threatened species such as the plovers, bald eagle, brown pelican, and roseate tern.

Piping and Southeastern Snowy Plovers

An oil spill resulting from an accidental blowout during drilling could injure or kill birds foraging or roosting along the shoreline. The amount of shoreline affected, however, would be small compared to the extensive shoreline habitat available. The combined probability of bird presence with spill contact would be exceedingly small.

Bald Eagle

The bald eagle feeds on fish, waterfowl, shorebirds, and carrion near water. The bald eagle may eat dead or dying contaminated fish and birds because it consumes carrion.

Brown Pelican

The brown pelican is a species of special concern in Louisiana and Mississippi, and is no longer listed as endangered or threatened in Florida or Alabama (USDOI, FWS, 1998). This bird has no nesting reported in Mississippi. The bird nests on Guillard Island, Mobile Bay, which is a dredge spoil island.

It is expected that the majority of effects from the major impact-producing factors on the brown pelican would be sublethal (behavioral effects and nonfatal exposure to or intake of oil, diesel, or discarded debris), causing temporary disturbances and displacement of localized groups inshore. Chronic stress, such as digestive upset, partial digestive occlusion, sublethal poisoning, or behavior changes, however, is often undetectable in birds. It can serve to weaken individuals (especially serious for migratory species) and expose them to infection and disease. Death could result primarily from an oil spill and associated spill-response. Any reduction in population size represents a threat to their existence.

Brown peilcans may encounter periodic disturbance and temporary displacement of localized groups and individuals from the proposed action. Decreases in numbers of adults and/or nests could occur as a result of spilled oil or diesel fuel if spill-related coastal habitat loss or degradation occurs. Groups experiencing the loss of individuals could require up to several years to recover to a predisturbance condition. Given the species in the area and feeding strategies, the brown pelican is the species most likely to be impacted should an oil or diesel spill occur in coastal areas from vessels supporting the exploration program in the proposed action.

Roseate Tern

Although listed as threatened in Alabama and Florida, it is rare in the Florida Panhandle region. A recognized breeding population is found only as far north as south Florida.

Summary and Conclusion

Small numbers of birds could be affected sublethally or killed by oil spills or spill-response activities that disturb nests or young birds. The combined probability of an exploration well blowout and contact with shoreline areas, however, is less than 0.5 percent, a very small probability. Small numbers of birds could be impaired by consumption of indigestible trash, particularly plastic items, lost from exploration drilling rigs or service vessels.

The proposed action is not expected to cause have long-term adverse effects on the size and productivity of critical breeding stocks, and would not affect critical nesting habitat in the northern GOM over the long term.

4.2.4. Impacts on Beach Mice

Alabama, Perdido Key, Choctawhatchee, and St. Andrew beach mice are designated as protected species under the Endangered Species Act of 1973. The mice occupy restricted habitat behind coastal foredunes of Florida and Alabama (Ehrhart, 1978; USDOI, FWS, 1987). Documented beach mouse occurrences are on the Fort Morgan Peninsula, in Gulf State Park (Perdido Key Unit), along Gulf Islands National Seashore, in Topsail Park, and on Shell Island. Portions of these areas have been designated as critical habitat.

The major impact-producing factors associated with the proposed action that may affect the mice include (1) beach trash and debris, (2) an oil spill resulting from an accidental blowout during drilling, and (3) spill-response activities. Trash and debris may be mistakenly consumed by beach mice or ensnare them. It is expected that beach mice would seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters, went into effect January 1, 1989. Analysis of the potential for an oil spill to occur from an accidental blowout during drilling, and the potential for impacts, is discussed in Appendix C. Table C-5 shows that the probability of such a spill occurring and contacting the shoreline is very low (<0.5%). Direct contact with spilled oil can cause skin and eye irritation. Other direct toxic effects come from asphyxiation from inhalation of fumes, oil ingestion, and food contamination. Indirect oil impacts include food reduction. Vehicular traffic and activity associated with oil-spill cleanup activities can degrade preferred habitat, destroy nests, and cause displacement.

A slick cannot wash over the foredunes into beach mouse habitat unless carried by high seas and heavy storm swells. Given the low probabilities of an oil spill resulting from an accidental blowout during drilling occurring, reaching mouse habitat coincidentally with a storm surge, and affecting beach mice, no impacts of oil spills on beach mice from the proposed action are expected.

In the unlikely event of crude oil contact, spill cleanup activities are not expected to disturb beach mice or their habitats. The home range of the beach mice is designated habitat that receives particular consideration during spill cleanup, as directed by Oil Pollution Act of 1990. Because of the critical designation and general status of protected species habitats, spill contingency plans include requirements to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent spilled petroleum from contacting mouse habitat.

An impact from the proposed action on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but highly unlikely as a result of beach trash and debris, oil spills, and spill-response activities because of the low probability of spill occurrence and contact and because of the protected species and habitat requirements for cleanup included in the Oil Pollution Act of 1990.

The proposed action is not expected to harm the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice or their habitats.

4.2.5. Impacts on Marine Mammals

The major impact-producing factors associated with the proposed action that may affect marine mammals include degradation of water quality resulting from operational discharges, noise from the operating drilling unit, helicopter and vessel traffic, floating trash and debris, oil spills, and oil-spill response activities. These major impact-producing factors may result in acute or chronic disturbances to marine mammals.

Operational Discharges

Drilling muds and cuttings are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; NRC, 1983; Kennicutt, 1995). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web. Marine mammals generally are inefficient assimilators of petroleum compounds in food (Neff, 1990). Analyses of samples from stranded GOM bottlenose dolphins showed high levels of organochlorides and heavy metals (e.g., Salata et al., 1995; Kuehl and Haebler, 1995). The significance of this cannot be determined, however, because of the lack of baseline information with which to make comparisons. Many heavy metals presumably are acquired from food, but the ultimate sources are poorly known (API, 1989). It is known that neritic cetacean species tend to have higher levels of metals than those frequenting oceanic waters (Johnston et al., 1996). Cetaceans feeding on cephalopods have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). Oceanic marine mammals have higher cadmium concentrations than neritic species. There also is, in many cases, a striking difference between the high mercury levels in the toothed whales and the lower values found in baleen whales, which is probably attributable to the different prey species consumed by baleen whales, as well as differences in the habitat (Johnston et al., 1996).

Aircraft

Aircraft overflights in proximity to cetaceans can elicit a startle response. Whales often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as the activity the animals are engaged in and water depth (Richardson et al., 1995). Whales engaged in feeding or social behavior are often insensitive to overflights. Whales in confined areas or those with calves, sometimes seem more responsive. This behavioral response could be a result of noise and/or visual disturbance. The effects appear to be transient, and there is no indication that long-term displacement of whales occur. Absence of conspicuous responses to an aircraft does not demonstrate that the animals are unaffected; it is not known whether these subtle effects are biologically significant (Richardson and Würsig, 1997).

Vessel Traffic

Of 11 species known to be hit by vessels, fin whales are struck most frequently, sperm whales are hit commonly, and records of collisions with Bryde's whales are rare (Laist et al., 2001). Data compiled of 58 collisions indicate that all sizes and types of vessels can collide with whales; most lethal or severe injuries are caused by ships 80 m or longer; whales usually are not seen beforehand or are seen too late to be avoided; and most lethal or severe injuries involve ships traveling 14 kn or faster. Vessel collisions can significantly affect small populations of whales, such as northern right whales in the western North Atlantic (Laist et al., 2001). In areas where special caution is needed to avoid such animals, measures to reduce the vessel speed below 14 kn may be warranted.

Increased traffic from support vessels associated specifically with the proposed action would increase the probability of collisions between vessels and marine mammals occurring in the area. These collisions can cause major wounds on cetaceans and/or be fatal (e.g., northern right whale, Kraus, 1990, and Knowlton et al., 1997; bottlenose dolphin, Fertl, 1994; sperm whale, Waring et al., 1997). Debilitating injuries may have negative effects on a population through impairment of reproductive output. Slow-moving cetaceans (e.g., northern right whale) or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale) might be expected to be the most vulnerable. Smaller delphinids often approach vessels that are in transit to bow-ride. It would appear that delphinids are agile enough to easily avoid being struck by vessels. There are many occasions, however, that dolphins are either not attentive (due to behaviors they are engaged in or perhaps because of their age/health) or there is too much vessel traffic around them, and they are struck by propellers.

Though cetaceans should be able to avoid vessels, operators should take actions to avoid moving directly at a whale(s) or dolphin(s). In accordance with the Marine Mammal Protection Act, NOAA Fisheries has guidelines for operators of boats with regard to proper maneuvering around cetaceans. It is suggested that operators in areas of sperm whale concentration should take care to steer clear of these animals, because the whales must spend several minutes resting at the water surface after long dives and may not be able to dive during these periods.

Toothed whales (and baleen whales, to a lesser extent) show some tolerance of vessels but may react at distances of several kilometers or more when confined by environmental features or when they learn to associate the vessel with harassment. Evidence suggests that certain whales have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. The continued presence of various cetacean species in areas with heavy boat traffic indicates a considerable degree of tolerance to ship noise and disturbance. An experiment involving playback of low-frequency sound in the Canary Islands suggests that sperm whales from an area that has heavy vessel traffic have a high tolerance for noise (Andre et al., 1997). There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity, unless they occur frequently.

Long-term displacement of animals, in particular baleen whales, from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance are stressed or otherwise affected in a negative, but inconspicuous way (Richardson et al., 1995). Stress or "alert" responses could occur quite early during an encounter. For example, Myrick and Perkins (1995) found stress responses occurring as early as the chase stage in purse-seine netting on dolphins.

It is possible that manatees could occur in coastal areas where they could be affected by vessels traveling to and from the drilling site. If a manatee should be present in an area where there is vessel traffic, they could be injured or killed by colliding with boats (Wright et al., 1995). It is very common for manatees to have propeller gouges in their skin from vessel collisions. Inadequate hearing sensitivity at low frequencies may be a contributing factor to the manatees' inability to effectively detect boat noise and avoid collisions with boats (Gerstein et al., 1999).

Noise

Exploratory drilling structures 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. Odontocetes use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Low-frequency hearing has not been studied in many species, but bottlenose dolphins can hear sounds at frequencies as low as 40-125 Hz. Below 1 kHz, where most industrial noise energy is concentrated, sensitivity seems poor (Richardson et al., 1995). Pilot whales and sperm whales changed their behavior (in particular, ceased vocalizations) during low-frequency transmissions from the Heard Island Feasibility Test in the southern Indian Ocean (Bowles et al., 1994); this throws doubt on the assumed insensitivity of odontocete hearing at low frequencies. Baleen whales mainly utter low-frequency sounds that overlap broadly with the dominant frequencies of many industrial sounds. There are indirect indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995). Drilling noise from conventional metal-legged structures and anchored semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). There is particular concern for baleen whales that are apparently more dependent on low-frequency sounds than are other marine mammals; many industrial sounds are concentrated at low frequencies. Conventionally-moored drilling rigs are not dynamically positioned and therefore do not produce the higher levels of underwater noise caused by stabilizing propeller jets used for DP MODUs. There are few published data on underwater noise levels near platforms and on the marine mammals near those facilities (Richardson et al., 1995). Strongest reactions from marine mammals would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Human-made sounds may affect the ability of marine mammals to communicate and to receive information about their environment (Richardson et al., 1995). Such noise may interfere with or mask the sounds used and produced by these animals and thereby interfere with their natural behavior. These sounds may frighten, annoy, or distract marine mammals 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 marine mammals' 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 whether suitable food is readily available. Additionally, animals subject to a high-energy drain, especially females in late pregnancy or lactation, probably would be most severely affected. Sounds may also disturb the species (such as fishes, squids, and crustaceans) upon which the marine mammals prey (NRC, 1994). 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 animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is possible, but little studied in marine mammals. Aversive levels of noise might cause animals to become irritable, affecting feed intake, social interactions, or parenting; all of these effects might eventually result in population declines (Bowles, 1995).

Trash and Debris

In recent years, there has been increasing concern about manmade debris (discarded from offshore and coastal sources) and its impact on the marine environment (e.g., Shomura and Godfrey, 1990; Laist, 1997). Both entanglement in and ingestion of debris has caused the death or serious injury of marine mammals (Heneman and Center for Environmental Education, 1988; MMC, 1998). The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes probably originating from all types of vessels. Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; Laist, 1997; MMC, 1998). Many types of plastic materials are used during drilling activities. The offshore oil and gas industry was shown to contribute 13 percent of the trash and debris recovered at Padre Island National Seashore (Miller et al., 1995) during a beach sweep. 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 U.S. Coast Guard enforces.

Oil Spills

Each major grouping of marine mammals (e.g., sirenians, and baleen and toothed whales) confronts spilled hydrocarbons in different ways. Oil spills could affect marine mammals through various pathways: surface contact, inhalation, ingestion, and baleen fouling (Geraci, 1990). Much of the information on the effects of oil on marine mammals comes from studies of fur-bearing marine mammals. Sea otters exposed to the Exxon Valdez spill experienced high incidences of emphysema, petroleum hydrocarbon toxicosis, abortion, and stillbirths (Williams and Davis, 1995). Direct contact with oil and/or tar for cetaceans can lead to irritation and damage of skin and soft tissues (such as mucous membranes of the eyes), fouling of baleen plates so as to hinder the flow of water and interfere with feeding, and incidental ingestion of oil and/or tar. Studies by Geraci and St. Aubin (1982 and 1985) have shown that the cetacean epidermis functions as an effective barrier to noxious substances found in petroleum. Unlike other mammals, penetration of such substances in cetacean skin is impeded by tight intercellular bridges, the vitality of the superficial cells, the thickness of the epidermis, and the lack of sweat glands and hair follicles (Geraci and St. Aubin, 1985). The cetacean epidermis is nearly impenetrable, even to the highly volatile compounds in oil, and when skin is breached, exposure to these fractions does not impede the progress of healing (Geraci and St. Aubin, 1985). Cetacean skin is free from hair or fur, which in other marine mammals, such as pinnipeds and otters, tends to collect oil and/or tar, which effectively reduces the insulating properties of the fur (Geraci, 1990). Dolphins maintained at a captive site in Sevastopol, Ukraine, that were exposed to petroleum products initially exhibited a sharp depression of food intake along with an excitement in behavior, eye inflammation, and changes in hemoglobin as well as erythrocyte content (Lukina et al., 1996). Prolonged exposure to oil led to a depression of those blood parameters, as well as changes in breathing patterns and gas metabolism, while nervous functions became depressed and skin injuries and burns appeared (Lukina et al., 1996). Experiments with harbor porpoise in similar conditions possibly resulted in aspiration pneumonia (Lukina et al., 1996). Dolphins exposed to oil at a Japanese aquarium that draws seawater from the ocean began developing cloudy eyes (Reuters, 1997).

Fresh crude oil or volatile distillates release toxic vapors that when inhaled can lead to irritation of respiratory membranes, lung congestion, and pneumonia. Subsequent absorption of volatile hydrocarbons into the bloodstream may accumulate into such tissues as the brain and liver, causing neurological disorders and liver damage (Geraci and St. Aubin, 1982; Hansen, 1985; Geraci, 1990). Toxic vapor concentrations just above the water's surface (where cetaceans draw breath) could reach critical levels for the first few hours after a spill, prior to evaporation of volatile aromatic hydrocarbons and other light fractions (Geraci and St. Aubin, 1982).

Trained, captive bottlenose dolphins exposed to oil could not detect light oil sheen, but could detect thick dark oil based on visual, tactile, and presumably echolocation cues (Geraci et al., 1983; Smith et al., 1983). Captive studies also showed that dolphins completely avoided surfacing in slick oil after a few brief, initial tactile encounters. The reaction of free-ranging cetaceans to spilled oil is varied, ranging from avoidance to apparent indifference (reviewed by Geraci, 1990; Smultea and Würsig, 1991). In contrast to captive studies, bottlenose dolphins during the *Mega Borg* spill did not consistently avoid entering slick oil, which could increase their vulnerability to potentially harmful exposure to oil chemicals (Smultea and Würsig, 1991 and 1995). It is possible that some overriding behavioral motivation (such as feeding) induced dolphins to swim through the oil; that slick areas were too large for dolphins to feasibly avoid; or that bottlenose dolphins have become accustomed to oil due to the extent of oil-related activity in the Gulf (Smultea and Würsig, 1995). The latter could result in temporary displacement from migratory routes. After the *Exxon Valdez* spill, killer whales did not appear to avoid oil; however, none were observed in heavier surface slicks (Matkin et al., 1994). It is unknown whether animals in some cases are simply not affected by the presence of oil, or perhaps are even drawn to the area in search of prey organisms attracted to the oil's protective surface shadow (Geraci, 1990). The probable effects on cetaceans swimming through an area of oil would depend on a number of factors, including ease of escape from the vicinity, the health of the individual animal, and its immediate response to stress (Geraci and St. Aubin, 1985).

Spilled oil can also lead to the reduction or contamination of prey. Feeding strategies of cetaceans could lead to ingestion of oil-contaminated food or incidental ingestion of floating or submerged oil or tar. Zooplankton may become contaminated by direct contact and/or by ingesting oil droplets and tainted food. Marine fish also take up petroleum hydrocarbons from water and food, though apparently do not accumulate high concentrations of hydrocarbons in tissues and may transfer them to predators (Neff, 1990). Harmful hydrocarbon fractions might be swallowed or consumed through contaminated prey (Geraci, 1990) and foul the feeding apparatus of baleen whales (though laboratory studies suggest that such fouling has only transient effects) (Geraci and St. Aubin, 1985). In general, the potential for ingesting oil-contaminated prey organisms with petroleum-hydrocarbon, body-burden content is highest for benthic feeding whales and pinnipeds. The potential is reduced for plankton-feeding whales and lowest for fish-eating whales and pinnipeds (Würsig, 1990). Baleen whales occurring in the GOM feed on small pelagic fishes (such as herring, mackerel, and pilchard) and cephalopods (Cummings, 1985). An analysis of stomach contents from captured and stranded toothed whales suggest that they are deep-diving animals, feeding predominantly on mesopelagic fish and squid or deepwater benthic invertebrates (Heyning, 1989; Mead, 1989). Delphinids feed on fish and/or squid, depending upon the species (Mullin et al., 1991).

As noted by St. Aubin and Lounsbury (1990), there has been no experimental study and only a handful of observations suggesting that oil have harmed any sirenian. Dugongs (relatives of the manatees) have been found dead on beaches after the Gulf War oil spill and the 1983 Nowruz oil spill caused by the Iran-Iraq War (Preen, 1991; Sadiq and McCain, 1993). Some dugongs were sighted in the oil sheen after the Gulf War (Pellew, 1991). Four types of impacts to dugongs from contact with oil include asphyxiation due to inhalation of hydrocarbons; acute poisoning due to contact with fresh oil; lowering of tolerance to other stress due to the incorporation of sublethal amounts of petroleum fractions into body tissues; and nutritional stress through damage to food sources (Preen, 1989, in Sadiq and McCain 1993). Manatees concentrate their activities in shallow water, often resting at or just below the surface, which should bring them in contact with spilled oil (St. Aubin and Lounsbury, 1990). Manatees are nonselective, generalized feeders that might consume tarballs along with their normal food though such occurrences have been rarely reported (review in St. Aubin and Lounsbury, 1990). A manatee might also ingest fresh petroleum, which some researchers have suggested might interfere with the manatee's secretion process of its unique gastric glands or harm intestinal flora vital to digestion (Geraci and St. Aubin, 1980; Reynolds, 1980). Oil spills within the confines of preferred river systems and canals, particularly during winter (when the animals are most vulnerable physiologically), could endanger local populations. Manatees able to escape such areas might be forced into colder waters, where thermal stress could complicate the effects of even brief exposure to oil (St. Aubin and Lounsbury, 1990). The habits and environmental tolerances of manatees are not likely to bring them into contact with deepwater exploration activities. The greater risk is from shoreline or coastal contacts that may be detrimental. For a population whose environment is already under great pressure, even a localized incident could be damaging (St. Aubin and Lounsbury, 1990). Spilled oil might affect the quality or availability of aquatic vegetation, including seagrasses upon which manatees feed.

Indirect consequences of oil pollution on marine mammals are those effects that may be associated with changes in the availability or suitability of various food sources (Hansen, 1992). No long-term effects from bioaccumulation of hydrocarbons have been demonstrated; however, an oil spill may physiologically stress an animal making them more vulnerable to disease, parasitism, environmental contaminants, and/or predation (Geraci and St. Aubin, 1980).

Spill Response

Spill-response activities include the application of dispersant chemicals to the affected area and designed to break oil on the water's surface into minute droplets, which then break down in seawater. Essentially nothing is known about the effects of oil dispersants on cetaceans, except that removal of the oil from the surface would reduce the risk of contact and render it less likely to adhere to skin, baleen plates, or other body surfaces (Neff, 1990). The acute toxicity of most oil dispersant chemicals is considered to be low when compared to the constituents and fractions of crude oil and refined products, and studies have shown that the rate of biodegradation of dispersed oil is equal to or greater than that of undispersed oil (Wells, 1989). Varieties of aquatic organisms accumulate and metabolize surfactants from oil dispersants. Enzymatic hydrolysis of the surfactant yields hydrophilic and hydrophobic components. The former probably are excreted via the gills and kidneys, whereas the latter accumulate in the gall bladders of fish and are excreted very slowly (Neff, 1990). Metabolism of surfactants is thought to be rapid enough that there is little likelihood of food chain transfer from marine invertebrates and fish to consumers, including marine mammals (Neff, 1990). Biodegradation is another process used for removing petroleum hydrocarbons from the marine environment, utilizing chemical fertilizers to augment the growth of naturally occurring hydrocarbon-degrading microorganisms. Toxic effects of these fertilizers on cetaceans are presently unknown.

Summary and Conclusion

Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible trash, particularly plastic items, lost from drilling rigs and service vessels. There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Although an interaction with a spill could occur, primarily sublethal effects are expected due to avoidance and natural dispersion/weathering of the spill in the offshore environment. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnifications, but there is uncertainty concerning the possible effect.

The proposed action is not expected to cause fatalities or to have long-term adverse effects on the size and productivity of any marine mammal species or population stock in the northern GOM.

4.2.6. Impacts on Fish Resources and Essential Fish Habitat

The major sources of discharges to marine waters associated with the proposed action are the drilling muds and cuttings. Although synthetic mud discharge is not directly permitted, a certain amount of mud would adhere to drill cuttings. Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the plume disperses rapidly, is very near background levels at a distance of 1,000 m from the discharge point, and is usually undetectable at distances greater than 3,000 m (USDOI, MMS, 2000 and 2001).

Analysis of the potential for and impacts from an oil spill resulting from an accidental blowout during drilling of one of the proposed exploratory wells in DeSoto Canyon Blocks 180 and 224 is provided in Appendix C. If a blowout was controlled early (within a few hours or days), the impact on fisheries and commercial populations would likely be undetectable to very minor. The MMS determined that the oil-spill volume to be analyzed in this SEA (20,000 bbl) would be the result of an accidental blowout during drilling involving 17,000 bbl per day for a most likely duration of two days.

Adult fish must experience continual exposure to relatively high levels of hydrocarbons over several months before secondary toxicological compounds that represent biological harm are detected in the liver (Payne et al., 1988). The direct effects of spilled oil on fish occur through the ingestion of oil or oiled prey and through the uptake of dissolved petroleum products through the gills and epithelium by adults and juveniles (NRC, 1985). Upon exposure to spilled oil, liver enzymes of fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Ordinary environmental stresses may increase the sensitivity of fish to oil toxicity. These stresses may include changes in salinity, temperature, and food abundance (Evans and Rice, 1974; NRC, 1985). Migratory species, such as mackerel, cobia, and crevalle jack, could be impacted if oil spills covered large areas of nearshore open waters.

In the event that oil spills should occur in coastal bays, estuaries, or waters of the OCS proximate to mobile adult finfish or shellfish, the effects are expected to be nonlethal and the extent of damages are expected to be limited and lessened due to the capability of adult fish and shellfish to avoid an oil spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. For floating eggs and larvae contacted by spilled oil, the effect is expected to be lethal. The only adult fish kill on record following an oil spill was on the French coast in 1978 when several tons of small rock-clinging fish (not commercially harvested) were killed at the site of the *Amoco Cadiz* wreck (volume of oil spilled was approximately six times that of the *Exxon Valdez).*

There will be some temporary unavoidable loss of fishing space due to the physical presence of the exploratory drilling structure that could otherwise have been used for pelagic fishing such as longlining. However, it is unlikely that longlining activities would have occurred near the OEI project areas, (particularly in LL Blocks 5 and 6) due to the close proximity to the NOAA Fisheries longline closure area (only 1,000 feet from the boundary). No other commercial fisheries exist in the area and there are no commercially important demersal species at the water depth of this proposed action.

4.2.7. Impacts on Gulf Sturgeon

An oil spill resulting from an accidental blowout during drilling is presumed for this analysis (refer to Appendix C). There is a very low probability (<0.5%) of such a spill occurring and contacting identified environmental resources. It is assumed that most of the spill would rise to the surface.

Oil spills are the OCS-related factor most likely to impact the Gulf sturgeon. Oil can affect Gulf sturgeon by direct ingestion or ingestion of oiled prey or by the absorption of dissolved petroleum products through the gills. Contact with or ingestion/absorption of spilled oil can result in death or nonfatal physiological irritation, especially of gill epithelium and liver function in adult Gulf sturgeon. Upon any exposure to spilled oil, liver enzymes of adult fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Behavior studies of other fish species suggest that adult sturgeon are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982)

The Gulf sturgeon could be impacted by oil spills resulting from the proposed action. The impact of the proposed action on the Gulf sturgeon could cause nonfatal irritation of gill epithelium and liver tissue.

4.2.8. Impacts on Areas of Special Biological Concern

Five areas of special biological concern are addressed in this SEA because they are listed as environmental resources with a probability of contact (within 30 days) should an oil spill resulting from an accidental blowout during drilling occur. Table C-5 shows the probability that an oil spill ≥1,000 bbl resulting from a blowout in DeSoto Canyon, Blocks 180 and 224 and contacting any of these resources, is less than 0.5 percent.

The Florida Keys National Marine Sanctuary lies more than 345 mi (555 km) from the 2 contiguous blocks of the proposed action. The location of the sanctuary on the southern tip of the Florida coast is so distant that there is no credible likelihood of impact. The Florida Middle Ground (FMG) is located closer to the proposed action but is still at a considerable distance (207 mi or 333 km).

The Madison and Swanson and Steamboat Lumps areas are located 140 mi (225 km) and 205 mi (330 km), respectively, from the proposed action. The minimum water depth of the FMG is about 23 m, which would tend to insulate this environment from the effects of an oil spill on the surface. Similar to the FMG, the Madison and Swanson fish spawning areas are in relatively deep water (70-100 m) and would not be impacted from spilled oil on the sea surface.

The Big Bend Seagrass Aquatic Preserve would be affected by oil spills and spill response in the same manner as other submerged seagrass habitats described in Chapter 4.2.1.3. Considering the distances from the four contiguous blocks of the proposed action and the weathering that would occur to spilled oil that traveled those distances, the likelihood that any measurable impact would be discerned is remote.

4.3. Other Relevant Activities and Resources

4.3.1. Socioeconomic Conditions and Other Concerns

4.3.1.1. Impacts on Economic and Demographic Conditions

In Chapter 3.3.1.1.1. MMS defined the potential impact region as that portion of the GOM coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. In this section, MMS staff project how and where future changes would occur and whether they correlate with the proposed action.

4.3.1.1.1. Population and Education

The impact region's population will continue to grow, but at a slower rate. Minimal effects on population are projected from activities associated with the proposed action. While some of the labor force is expected to be local to the Port Fourchon, Louisiana, most of the additional employees associated with the proposed action are not expected to require local housing. Activities related to the proposed activity are not expected to significantly affect the region's educational level.

Conclusion

Activities related to the proposed activity are not expected to significantly affect the region's population and educational level.

4.3.1.1.2. Infrastructure and Land Use

While OCS-related servicing should increase in Port Fourchon, Louisiana, no expansion of these physical facilities is expected to result from the proposed activity. Changes in land use throughout the region as a result of the proposed activity are expected to be contained and minimal. While land use in the impact area will change over time, the majority of this change is estimated as general regional growth. Increased OCS deepwater activity is expected to impact Port Fourchon and other OCS ports with deepwater capability. The proposed activity is not expected to cause expansion to the Port Fourchon support base that OEI plans to use.

Conclusion

The proposed action is not expected to significantly affect the region's infrastructure and land use.

4.3.1.1.3. Navigation and Port Usage

The proposed action would use the existing onshore support bases located in Port Fourchon, Louisiana, for marine and air transportation to handle the equipment required for the proposed exploratory drilling activities. OEI would use onshore facilities located in Fourchon as a port of debarkation for supplies and equipment. Port Fourchon is capable of providing the services necessary for the proposed activities; therefore, no onshore expansion or construction is anticipated with respect to the proposed action.

During drilling and completion operations, a crewboat is expected to make three trips per week, a supply boat is expected to make three trips per week, and a helicopter is expected to make a total of nine trips per week to the drillsites. The total trips for the estimated 49 weeks of the drilling schedule is 147 trips each for crewboats and supply boats and 441 helicopter trips.

Conclusion

No impacts to navigation and port usage are expected as result of this proposed action.

4.3.1.1.4. Employment

The importance of the oil and gas industry to the coastal communities of the GOM is significant, particularly in Louisiana, eastern Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activity over recent years have resulted in similar fluctuations in population, labor, and employment in the GOM region. This economic analysis focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the impact region.

To improve regional economic impact assessments and to make them more consistent with each other, MMS recently developed a methodology for estimating changes to employment and other economic factors. The methodology developed to quantify these impacts on population and employment takes into account changes in OCS-related employment, along with population impacts resulting from these employment changes within each individual coastal subarea.

The model for the GOM region has two steps. Because there are no publicly available models that estimate the expenditures resulting from offshore oil and gas activities, the first step in the model estimates the expenditures resulting from the drilling of six exploratory wells and assigns these expenditures to industrial sectors in the 10 MMS coastal subareas defined in Chapter 3.3.1.1.1. A contracted effort, "Modeling the Economic Impacts of Offshore Oil and Gas Activities in the Gulf of Mexico: Methods and Applications," was used for this. The second step in the model uses multipliers from the commercial input-output model IMPLAN (using 1999 data, the latest available data) to translate these expenditures into direct, indirect, and induced employment and other economic factors. Direct employment results from the first round of industry spending. It is the employment that results from the initial dollars spent by OEI on the exploratory wells. Indirect employment results as the initial spending reverberates through the economy. First, the suppliers of the goods and services for the platform and wells spend the initial direct dollars from the industry. Then, these dollars are re-spent by other suppliers until the initial dollars have trickled throughout the economy. Labor income produces induced spending by the households receiving that income.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocation of expenditures can vary considerably. Because local economies vary, a separate set of IMPLAN multipliers is used for each MMS coastal subarea to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position through-out the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

Total employment (direct, indirect, and induced) projections for the drilling of six exploratory wells in 2003 are expected to be negligible at about 345 jobs throughout the Gulf of Mexico impact area. This is less than 0.3 percent for any given subarea's baseline employment. The baseline projections of employment used in this analysis are described in Table E-3 (Appendix E). Because these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities. Based on model results, direct employment associated with the proposed action is estimated at about 145 jobs. Indirect employment for the proposal is projected at about 95 jobs, while induced employment is calculated to be about 105 jobs. Although the majority of employment is expected to occur in coastal TX-2, employment is not expected to exceed 1 percent of the total employment in any given subarea.

The resource costs of cleaning up an oil spill, both onshore and offshore, were not included in the above analysis for two reasons. First, oil-spill cleanup activities reflect the spill's opportunity cost. In other words, some of the resources involved in the cleanup of an oil-spill, in the absence of that spill, would have produced other goods and services (e.g., tourism activities). Secondly, the occurrence of a spill is not a certainty. Spills are random accidental events. Given that the exploratory wells are drilled as described in the proposal, the timing, numbers, sizes, offshore locations of occurrence, and onshore locations of contact of potential spills occurring over the drilling life of the plan are all unknown variables. Appendix A discusses oil spills in general, and the expected sizes, number, and probability of a spill from the proposed action. Additionally, the cost involved in any given cleanup effort is influenced by a variety of factors: whether or not the oil comes ashore; the type of coastal environment contacted by the spill; weather conditions at the time of the incident; the type and quantity of oil spilled; and the extent and duration of the oiling. Nevertheless, the opportunity cost employment associated with cleaning up an oilspill is expected to run within $1.9 to $4.5 million per 1,000 bblof oil spilled. Based on MMS model results, should a spill occur, it is projected to cost about 35-80 person-years of employment per 1,000 bbl spilled for cleanup and remediation depending on whether some of the oil contacts land. The risk of a blowout from the drilling of the six wells is expected to be minimal. Employment associated with oil-spill cleanup is expected to be of short duration (less than 6 weeks) aside from employment associated with the legal aspects of a spill.

Conclusion

Negligible impacts to employment, including those that could result from a blowout and related spill cleanup scenario, are expected as a result of this proposed action.

4.3.1.1.5. Environmental Justice

Executive Order 12898, entitled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, signed by President William J. Clinton, directs Federal agencies to assess whether their actions have disproportionate environmental effects on people of ethnic or racial minorities or people with low incomes. Those environmental effects encompass human health, social, and economic consequences.

Given the State of Florida's opposition to oil and gas extraction in OCS waters off its coast, MMS does not anticipate any negative environmental effects on the minority or poor persons in the Florida counties. In addition, disproportionate and negative effects should not occur in the rest of the impact area because the facilities, the land use, and the industry employment patterns already exist. If these change, especially if they increase and cause disruptions of local neighborhoods, then the relevant regulatory agencies should pay particular attention to how these neighborhoods are affected.

4.3.2. Impacts on Commercial Fisheries

There is no evidence that commercial fisheries in the Gulf have been adversely affected on a regional population level by oil spills. Although the worst-case blowout scenario could introduce a moderate amount of oil ($\geq$1,000 bbl) to surface waters over a short period of time, adult fish would likely avoid the area of a spill, but fish eggs and larvae in proximity to the spill area would be killed.

Regardless of spill size, adult fish are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982). This behavior explains why there has never been a commercially important fish kill on record following an oil spill. Observations at oil spills around the world, including the *Exxon Valdez* spill in Prince William Sound, consistently indicate that free-swimming fish are rarely at risk from oil spills (NRC, 1985). Some recent work has demonstrated avoidance of extremely small concentrations of hydrocarbons. Farr et al. (1995) reported the behavioral avoidance of dissolved concentrations of a PAH as low as 14.7 µg/l by a species of minnow.

The combined probability of an oil spill resulting from an accidental blowout event with the probability of contact to all modeled land segments or environmental resources is less than 0.5 percent.

Commercial fishermen would actively avoid the area of a spill and the area where there are ongoing activities to control a blowout. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches from oil or dispersants would prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This in turn could decrease landings and/or value of catch for several months. However, GOM species can be found in many adjacent locations, Gulf commercial fishermen do not fish in one locale, and they have responded to past petroleum spills without discernible loss of catch or income by moving elsewhere for a few months.

For oil spills resulting from the proposed action to have a substantial effect on a commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be concentrated in the immediate spill area. Oil spills that contact coastal bays, estuaries, and waters of the Gulf when pelagic eggs and larvae are present have the greatest potential to affect commercial fishery resources. An oil spill contacting a low-energy inshore area would affect localized populations of commercial fishery resources, such as menhaden, shrimp, and blue crabs.

Oil components would have to be present in highly toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977). When contacted by spilled oil, floating eggs and larvae (with their limited mobility and physiology), and most juvenile fish are killed (Linden et al., 1979; Longwell, 1977). Fish over-produce eggs on an enormous scale and the overwhelming majority of them die at an early stage, generally as food for predators. It is likely that even a heavy death toll of larvae and young from a single large oil spill would not have a detectable effect on the adult populations that are exploited by commercial fisheries. This has been confirmed during and after the *Torrey Canyon* spill off southwest England and the *Argo Merchant* spill off Nantucket. In both cases, a 90 percent death of fish eggs and larvae, pilchard and pollack, respectively, was observed in the affected area, but this had no impact on the regional commercial fishery (Baker et al., 1991).

Water depths in the area of the proposed action range from 6,560 to 7,420 ft (2,000 to 2,262 m). There are no commercially-managed bottom-dwelling or commercially important fish species at these depths that would be impacted, and the area is closed to longline fishing. As a result, it is expected that marine environmental degradation from the proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations or EFH. It is also expected that subsurface blowouts that may occur as a result of the proposed action would have a negligible effect on Gulf fish resources.

4.3.3. Impacts on Recreation/Tourism

The proposed actions would be located in DeSoto Canyon Blocks 180 and 224, which is approximately 82 mi (131 km) from the nearest shore (Louisiana coastline) and is also in approximately 7,420 ft (2,262 m) water depth. Drilling rigs located farther than 15 mi from shore would not be noticeable or recognizable from shore; hence, there would be no visual or aesthetic effect on beach users or coastal tourists in Alabama or northwest Florida from the exploration drilling in the proposed action.

Since the proposed activities in DeSoto Canyon are located far offshore, in extremely deep water, and are not located near any of Alabama's Artificial Reef Areas, no adverse impacts to offshore recreational fishermen (space conflicts, water turbidity) are expected.

The probability of an oil spill resulting from an accidental blowout occurring and then contacting land segments or environmental resources is less than 0.5 percent (Table C-5). Depending on factors such as season, length of beach affected, publicity, effectiveness, and duration of cleanup methods, some displacement of recreational use at the specifically affected beach area would occur during cleanup operations.

4.3.4. Impacts Concerning Military Use

DeSoto Canyon Blocks 180 and 224 are located in designated Military Warning Area EWTA-1. In accordance with Lease Stipulation No. 3, the operator is required to enter into an agreement with the Air Armament Center, Robert J. Arnold, Encroachment Committee Chariman, Eglin Air Force Base, Florida 32542-5495 [contact Mr. Arnold at (850) 882-3614] concerning the control of electromagnetic emissions and use of boats and aircraft in EWTA-1. OEI has indicated that they will make notification to the military (EWTA-1) prior to conducting operations on these blocks.

No environmental effects are anticipated from OEI's compliance with this lease stipulation and advisory, and potential multiple-use conflicts on the OCS will be minimized.

4.3.5. Impacts to Archaeological Resources

Prehistoric

DeSoto Canyon Blocks 180 and 224 are not specifically located within either of the MMS's designated high-probability areas for the occurrence of prehistoric or historic archaeological resources. Lease blocks with a high probability for prehistoric archaeological resources may only be found land-ward of a line that roughly follows the 60-m (197-ft) bathymetric contour. As stated in Chapter 3.3.4, MMS recognizes both the 12,000 B.P. date and 60-m water depth as the seaward extant of prehistoric archaeological potential on the OCS. The water depth of these lease blocks is approximately 8,700-9,000 ft. Based on the extreme water depth of these blocks, there is simply no potential for prehistoric archaeological resources. Therefore, any oil or gas exploration would not impact prehistoric archaeological resources.

Historic

The areas of the northern Gulf of Mexico that are considered to have a high probability for historic period shipwrecks as defined by a MMS-funded study and shipwreck model (Garrison et al., 1989). The study expanded the shipwreck database in the Gulf of Mexico from 1,500 to more than 4,000 wrecks. Statistical analysis of shipwreck location data identified two specific types of high-probability areas--the first within 10 km of the shoreline, and the second proximal to historic ports, barrier islands, and other loss traps. High-probability search polygons associated with individual shipwrecks were created to afford protection to wrecks located outside of the two aforementioned high-probability areas.

An Archaeological Resources Stipulation was included in all Gulf of Mexico lease sales from 1974 through 1994. The stipulation was incorporated into operational regulations effective November 21, 1994. The language of the stipulation was incorporated into the operational regulations under 30 CFR 250.26 with few changes, and all protective measures offered in the stipulation have been adopted by the regulation.

NTL 2002-G01 issued March 15, 2002 supersedes all other archaeological NTL's and LTL's and makes minor technical amendments; updates cited regulatory authorities and continues to mandate a 50-m remote-sensing survey line spacing density for historic shipwreck surveys in water depth of 60 m or less. The NTL also requires submission of an increased amount of magnetometer data to facilitate MMS analysis. Survey and report requirements for prehistoric sites have not been changed.

Several OCS-related, impact-producing factors may cause adverse impacts to unknown historic archaeological resources. Offshore exploration by using either a conventionally-moored semisubmersible anchored to the seafloor with chain catenary or tension lines, a dynamically positioned semisubmersible, or a dynamically positioned drill ship could result in impacting an historic shipwreck. Direct physical contact with a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

Petroleum spills have the potential to affect historic archaeological resources. Impacts to historic resources would be limited to visual impacts and, possibly, physical impacts associated with spill cleanup operations. The OCS operations may also generate tons of ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources during magnetometer surveys. The task of locating historic resources via an archaeological survey is, therefore, made more difficult as a result of leasing activity.

Summary

The greatest potential impact to a historic shipwreck as a result of the proposed action would result from the seafloor disturbance from exploratory drilling. DeSoto Canyon Blocks 180 and 224 fall within the MMS GOM Region's low-probability area for the occurrence of historic shipwrecks. Oil and gas activities associated with proposed exploration of the DeSoto Canyon Blocks 180 and 224 could impact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with the proposed action are not expected to affect historic archaeological resources.

5. ENVIRONMENTAL SAFEGUARDS

Lease Stipulations

The lease for DeSoto Canyon Blocks 180 (OCS-G 23493) and 224 (OCS-G 23497) contain the following stipulations:

Stipulation No. 1 — Military Areas: EWTA-1
Stipulation No. 2 — Evacuation
Stipulation No. 3 — Coordination
Stipulation No. 4 — Marine Protected Species

Copies of these stipulations are included in Appendix B.

6. CONSULTATION AND COORDINATION

Necessary consultations with NOAA Fisheries and FWS regarding potential impacts to EFH and endangered species, repectively, resulting from the proposed action were conducted during the Lease Sale 181 EIS process (USDOI, MMS, 2001).

The States of Alabama, Florida, and Louisiana have an approved Coastal Zone Management (CZM) Program. Therefore, certificates of Coastal Zone Consistency and CZM required and necessary data from those States are required for the proposed activities. The MMS mailed the EP and other required and necessary information to the appropriate State agencies responsible for managing the CZM programs. The plan was mailed to Alabama Department of Environmental Management (ADEM), Florida Department of Environmental Protection (FDEP), and Louisiana Department of Natural Resources (LDNR) on December 18, 2002. In a letter dated January 6, 2003, LDNR has indicated that the plan is consistent with the Louisiana Coastal Resource Program as required by Section 307(c)(3)(B) of the Coastal Zone Management Act of 1972 as amended. The EP was also sent to the Eglin Air Force Base Encroachment Committee on December 18, 2002.

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9. APPENDICES

Appendix A — Mitigations
Appendix B — Lease Stipulations
Appendix C — Analysis of the Potential for an Accidental Oil Spill and Potential for Impacts
Appendix D — General Geology and Geological Hazards
Appendix E — Socio-Economic Conditions
Appendix F — Physical Oceanography
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Appendix A

MITIGATIONS

MITIGATIONS

Mitigation

1. Please be advised that drilling permits cannot be issued for the proposed wells until concurrence with your coastal zone management consistency certification has been received by this office from the Alabama Department of Environmental Management or until concurrence with the certification has been conclusively presumed. (6.3)
2. Please be advised that drilling permits cannot be issued for the proposed wells until concurrence with your coastal zone management consistency certification has been received by this office from the Florida Department of Community Affairs or until concurrence with the certification has been conclusively presumed. The plan may require further evaluation based upon issues raised by the Florida Department of Community Affairs during its consistency review. (6.5)

Reminder of Existing Provisions

Ocean Energy Inc. must comply with all requirements of U.S. Environmental Protection Agency (USEPA) Region 4's National Pollutant Discharge Elimination System (NPDES) permit. They must submit Discharge Monitoring Reports to USEPA's Region 4 as required.

Appendix B

LEASE STIPULATIONS

Stipulation No. 1 -- Military Areas

(a) Hold and Save Harmless

Whether compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occur in, on, or above the OCS, to any persons or to any property of any person or persons in connection with any activities being performed by the lessee in, on, or above the OCS, if such injury or damage to such person or property occurs by reason of the activities of any agency of the United States Government, its contractors, or subcontractors, or any of its officers, agents or employees, being conducted as a part of, or in connection with, the programs or activities of the command headquarters listed at the end of this stipulation.

Notwithstanding any limitation of the lessee's liability in Section 14 of the lease, the lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the United States, its contractors or subcontractors, or any of its officers, agents, or employees. The lessee further agrees to indemnify and save harmless the United States against all claims for loss, damage, or injury in connection with the programs or activities of the aforementioned military installation, whether the same be caused in whole or in part by the negligence or fault of the United States, its contractors, or subcontractors, or any of its officers, agents, or employees and whether such claims might be sustained under a theory of strict or absolute liability or otherwise.

(b) Electromagnetic Emissions

The lessee agrees to control its own electromagnetic emissions and those of its agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning and water test areas in accordance with requirements specified by the commander of the command headquarters listed in the following table (hereinafter "the appropriate command headquarters") to the degree necessary to prevent damage to, or unacceptable interference with, Department of Defense flight, testing, or operational activities, conducted within individual designated warning and water test areas. Prior to entry into the particular warning or water test area, the lessee, its agents, employees, invitees, independent contractors or subcontractors, must coordinate electromagnetic emissions with the appropriate onshore military installation command headquarters.

(c) Operational

The lessee, when conducting or causing any activities in the individual designated warning and water test areas, shall enter into an agreement with the appropriate command headquarters prior to commencing such activities. Such an agreement will provide for positive control of personnel and property associated with lessee's activity and operations existing in the warning and water test areas at any time.

Warning and Water Test Areas	Command Headquarters
Eglin Water Test Areas 1 and 3	Air Armament Center Attention: Robert J. Arnold Encroachment Committee Chairman 101 West "D" Ave., Suite 222 Eglin AFB, Florida 32542-5492 Telephone: (850) 882-3614

Stipulation No. 2 -- Evacuation

(a) The lessee, recognizing that oil and gas resource exploration, exploitation, development, production, abandonment, and site cleanup operations on the leased area of submerged lands may occasionally interfere with tactical military operations, hereby recognizes and agrees that the United States reserves and has the right to temporarily suspend operations and/or require evacuation on this lease in the interest of national security. Such suspensions are considered unlikely in this area. Every effort will be made by the appropriate military agency to provide as much advance notice as possible of the need to suspend operations and/or evacuate. Advance notice of fourteen (14) days shall normally be given before requiring a suspension or evacuation, but in no event will the notice be less than four (4) days. Temporary suspension of operations may include the evacuation of personnel, and appropriate sheltering of personnel not evacuated. Appropriate shelter shall mean the protection of all lessee personnel for the entire duration of any Department of Defense activity from flying or falling objects or substances and will be implemented by a written order from the MMS Regional Supervisor for Field Operations (RS-FO), after consultation with the appropriate command headquarters or other appropriate military agency, or higher authority. The appropriate command headquarters, military agency or higher authority shall provide information to allow the lessee to assess the degree of risk to, and provide sufficient protection for, lessee's personnel and property. Such suspensions or evacuations for national security reasons will not normally exceed seventy-two (72) hours; however, any such suspension may be extended by order of the RS-FO. During such periods, equipment may remain in place, but all production, if any, shall cease for the duration of the temporary suspension if so directed by the RS-FO. Upon cessation of any temporary suspension, the RS-FO will immediately notify the lessee such suspension has terminated and operations on the leased area can resume.

(b) The lessee shall inform the MMS of the persons/offices to be notified to implement the terms of this stipulation.

(c) The lessee is encouraged to establish and maintain early contact and coordination with the appropriate command headquarters, in order to avoid or minimize the effects of conflicts with potentially hazardous military operations.

(d) The lessee shall not be entitled to reimbursement for any costs or expenses associated with the suspension of operations or activities or the evacuation of property or personnel in fulfillment of the military mission in accordance with subsections (a) through (c) above.

(e) Notwithstanding subsection (d), the lessee reserves the right to seek reimbursement from appropriate parties for the suspension of operations or activities or the evacuation of property or personnel associated with conflicting commercial operations.

Stipulation No. 3 -- Coordination

(a) The placement, location, and planned periods of operation of surface structures on this lease during the exploration stage are subject to approval by the MMS Regional Director (RD) after the review of an operator's Exploration Plan (EP). Prior to approval of the EP, the lessee shall consult with the appropriate command headquarters regarding the location, density, and the planned periods of operation of such structures, and to maximize exploration while minimizing conflicts with Department of Defense activities. When determined necessary by the appropriate command headquarters, the lessee will enter a formal Operating Agreement with such command headquarters, that delineates the specific requirements and operating parameters for the lessee's proposed activities in accordance with the military stipulation clauses contained herein. If it is determined that the proposed operations will result in interference with scheduled military missions in such a manner as to possibly jeopardize the national defense or to pose unacceptable risks to life and property, then the RD may approve the EP with conditions, disapprove it, or require modification in accordance with 30 CFR 250. The RD will notify the lessee in writing of the conditions associated with plan approval, or the reason(s) for disapproval or required modifications. Moreover, if there is a serious threat of harm or damage to life or property, or if it is in the interest of national security or defense, pending or approved operations may be suspended in accordance with 30 CFR 250. Such a suspension will extend the term of a lease by an amount equal to the length of the suspension, except as provided in 30 CFR 250.169(b). The RD will attempt to minimize such suspensions within the confine of related military requirements. It is recognized that the issuance of a lease conveys the right to the lessee as provided in section 8(b)(4) of the Outer Continental Shelf Lands Act to engage in exploration, development, and production activities conditioned upon other statutory and regulatory requirements.

(b) The lessee is encouraged to establish and maintain early contact and coordination with the appropriate command headquarters, in order to avoid or minimize the effects of conflicts with potentially hazardous military operations.

(c) If national security interests are likely to be in continuing conflict with an existing operating agreement, the RD will direct the lessee to modify any existing operating agreement or to enter into a new operating agreement to implement measures to avoid or minimize the identified potential conflicts, subject to the terms and conditions and obligations of the legal requirements of the lease.

Stipulation No. 4 -- Marine Protected Species

The National Marine Fisheries Service (NMFS) Biological Opinion for Lease Sale 181 requires the following non-discretionary terms and conditions:

(a) MMS will condition permits issued to oil companies to require collection and removal of flotsam resulting from activities related to exploration, development, and production of this lease.

(b) MMS will condition permits issued to oil companies requiring them to post signs in prominent places on all vessels and platforms used as a result of activities related to exploration, development, and production of this lease detailing the reasons (legal and ecological) why release of debris must be eliminated.

(c) MMS will develop, in conjunction with NMFS, a mandatory observer training program. This program will include methods by which observers are to report sightings of sea turtles and large whales and any takes of sea turtles or cetaceans resulting from vessel operations.

(d) The lessee or operator must require personnel to contact, as soon as possible, the MMS Protected Species Biologist, Gulf of Mexico Region Office of Leasing and Environment, upon discovering any injured or dead sea turtles, marine mammals, or Gulf sturgeon. Parties responsible for injured or dead sea turtles, marine mammals, or Gulf sturgeon shall assist in collecting the impacted animals at the request of the MMS.

Lessees and operators will be instructed how to implement these non-discretionary measures in Notices To Lessees to be issued in late 2001 and/or early 2002.

Appendix C

ANALYSIS OF THE POTENTIAL FOR AN ACCIDENTAL OIL SPILL AND POTENTIAL FOR IMPACTS

ANALYSIS OF THE POTENTIAL FOR AN ACCIDENTAL OIL SPILL AND POTENTIAL FOR IMPACTS FROM OCEAN ENERGY INC.'S DESOTO CANYON BLOCKS 180 AND 224, TUSCANY PROJECT, INITIAL EXPLORATION PLAN N-7622

Introduction

The National Environmental Policy Act (NEPA) requires Federal agencies to consider potential environmental impacts (direct, indirect, and cumulative) of a proposed action as part of agency planning and decision-making. The NEPA analyses address many issues relating to potential impacts, including issues that may have a very low-probability of occurrence, but which the public considers important or for which the environmental consequences could be significant.

The past several decades of spill data show that impacts from accidental oil spills associated with oil and gas exploration and development are low-probability events in Federal OCS waters of the Gulf of Mexico (GOM). This document summarizes key information about the probability of accidental spills from offshore oil and gas activities in the GOM.

Spill Prevention

The MMS has comprehensive pollution prevention requirements that include numerous redundant levels of safety devices, as well as inspection and testing requirements to confirm that these devices work. Many of these requirements have been in place since about 1980. Spill trends analysis for the GOM OCS show that spills from facilities have decreased over time, indicating that MMS engineering and safety requirements have minimized the potential for spill occurrence and associated impacts. Details regarding MMS engineering and safety requirements can be found at 30 CFR 250.800 Subpart H.

OCS Spills in the Past

This summary of past OCS spills presents data for the period 1985-1999. The 1985-1999 time period was chosen to reflect more modern engineering and regulatory requirements and because OCS spill rates are available for this period. For the period 1985-1999, there were no spills ≥1,000 bbl from OCS platforms, eight spills ≥1,000 bbl from OCS pipelines, and no spills ≥1,000 bbl from OCS blowouts (Tables C-1 through C-3). It should be noted that past OCS spills (Tables C-1 through C-3), some of which are considerably greater than 1,000 bbl, have not resulted in any documented significant impacts to shorelines or other resources. The Draft EIS for Lease Sales 189 and 197 (USDOI, MMS, 2002a) provides additional information and discussion on past OCS spills.

Estimating Future Potential Spills

The MMS estimates the risk of future potential spills by multiplying variables to result in a numerical expression of risk. These variables include the potential of a spill occurring based on historical OCS spill rates and a variable for the potential for a spill to be transported to environmental resources based on trajectory modeling. The following sections describe the spill occurrence and transport variables used to estimate risk and the risk calculation for the proposed action.

Spill Occurrence Variable (SOV) Representing the Potential for a Spill

The SOV is derived based on past OCS spill frequency; that is, data from past OCS spills are used to estimate future potential OCS spills. The MMS has estimated spill rates for spills from facilities, pipelines, and drilling.

Spill rates for facilities and pipelines have been developed for several time periods and an analysis of trends for spills is presented in Anderson and Labelle (2000). Spill rates for the most recent period analyzed, 1985-1999, are presented here. Data for this recent period should reflect more modern spill-prevention requirements.

Spill rates for facilities and pipelines are based on the number of spills per volume of oil handled. Spill rates for drilling activity are based on the number of spills associated with activities during drilling. These rates include spills from blowouts, drill rigs, supply vessels, fuel storage, and other drilling activities. Spill rates for the period 1985-1999 are shown in Table C-4. It should be noted that there were no platform or drilling spills ≥1,000 bbl for the period 1985-1999. Use of "zero" spills would result in a zero spill rate. To provide a non-zero spill rate for conservative (bias toward overestimation) future predictions of spill occurrence, the spill period was expanded to include older spill data. The data period was expanded to 1980 to include a spill from facilities and to 1971 to include a spill from a well blowout. Spill rates are combined with site-specific data on production or pipeline volumes or number of wells being drilled to result in a site-specific SOV.

Transport Variable (TV) – Representing the Potential for a Spill to be Transported to Important Environmental Resources

The TV is derived using an oil-spill trajectory model. This model predicts the direction that winds and currents would transport spills. The model uses an extensive database of observed and theoretically computed ocean currents and fields that represent a statistical estimate of winds and currents that would occur over the life of an oil and gas project, which may span several decades. This model produces the TV that can be combined with other variables, such as the SOV, to estimate the risk of future potential spills and impacts.

Risk Calculation for the Proposed Action

The proposed action includes the drilling of six exploration wells in DeSoto Canyon Blocks 180 and 224. Table C-5 presents an estimate of spill risk to resources using two variables—the SOV and the TV. The SOV used is the risk per well of a spill during drilling. This risk, presented in Table C-4, is 0.00004 or 4×10^{-5}. This value is multiplied by 6 for the six wells proposed and the resulting value, 0.00024, is used to address the risk of a spill during the proposed action.

The environmental resources analyzed within this EA are presented in Table C-5. The final column in Table C-5 presents the result of combining the SOV and the TV. The risk of a spill from an exploratory blowout could be considered to be so low as to be near zero.

Given the low risk of resources being exposed to spills as a result of the proposed action, spill-prevention requirements, and spill-response requirements, significant impacts to environmental resources are unlikely. The Draft EIS for Lease Sales 189 and 197 (USDOI, MMS, 2002a) in the Eastern Planning Area provides additional information on spills and potential impacts. The following section addresses the spill-response preparedness requirements of MMS.

Spill Response

The MMS has extensive requirements both for the prevention of spills and preparedness to respond to a spill in the event of an accidental spill. The MMS's spill-prevention requirements and the low incidence of past OCS spills were addressed earlier in this appendix. The following sections present information on MMS's requirements for spill-response preparedness.

MMS Spill-Response Program

The MMS's Oil Spill Program oversees the review of oil-spill response plans, coordinates inspection of oil-spill response equipment, and conducts unannounced oil-spill drills. This program also supports continuing research to foster improvements in spill prevention and response. Studies funded by MMS address issues such as spill prevention and response, *in-situ* burning, and dispersant use.

In addition, MMS works with the U.S. Coast Guard and other members of the multiagency National Response System to further improve spill-response capability in the GOM. The combined resources of these groups and the resources of commercially contracted oil-spill response organizations result in extensive equipment and trained personnel for spill response in the GOM.

Spill Response for this Project

The subject operator has an oil-spill response plan on file with MMS and has current contracts with offshore oil-spill response organizations.

Potential spill sources for this project include an accidental blowout (20,000 bbl of 30 API crude oil per day – which represents the calculated uncontrolled flow), a spill of liquid oil stored on the drill rig (approximately 7,705-bbl capacity in the largest storage tank), or a spill from the associated support vessel (largest vessel having a 2,667-bbl capacity). The operator has addressed these spill sources in their oil-spill response plan and has demonstrated spill-response preparedness for accidental releases from these sources.

The MMS will continue to verify the operator's capability to respond to oil spills via the MMS Oil Spill Program. The operator is required to keep their oil-spill response plan up to date in accordance with MMS regulations. The operator must also conduct an annual drill to demonstrate the adequacy of their spill preparedness. The MMS also conducts unannounced drills to further verify the adequacy of an operator's spill-response preparedness; such a drill could be conducted for the proposed action.

Table C-1

Historical Record of OCS Spills ≥1,000 Barrels from OCS Facilities, 1985–1999

Spill Date	Area and Block (water depth and distance from shore)	Volume Spilled (bbl)	Cause of Spill
None	None	0	*

*No OCS facility spills ≥1,000 bbl during the period 1985-1999.

Table C-2

Historical Record of OCS Spills ≥1,000 Barrels from OCS Pipelines, 1985–1999

Spill Date	Area and Block (water depth and distance from shore)	Volume Spilled (bbl)	Cause of Spill
February 7, 1988	South Pass 60 (75 ft, 3.4 mi)	15,576	Service vessel's anchor damaged pipeline
January 24, 1990	Ship Shoal 281 (197 ft, 60 mi)	14,423*	Anchor drag, flange and valve broke off
May 6, 1990	Eugene Island 314 (230 ft, 78 mi)	4,569	Trawl drag pulled off valve
August 31, 1992	South Pelto 8 (30 ft, 6 mi)	2,000	Hurricane Andrew, loose drilling rig's anchor drag damaged pipeline
November 22, 1994	Ship Shoal 281 (197 ft, 60 mi)	4,533*	Trawl drag
January 26, 1998	East Cameron 334 (264 ft, 105 mi)	1,211*	Service vessel's anchor drag damaged pipeline during rescue operation
September 29, 1998	South Pass 38 (110 ft, 6 mi)	8,212	Hurricane Georges, mudslide parted pipeline
July 23, 1999	Ship Shoal 241 (133 ft, 50 mi)	3,200	Jack-up barge sat on pipeline

*condensate

Table C-3

Historical Record of OCS Spills ≥1,000 Barrels from OCS Blowouts, 1985–1999

Spill Date	Area and Block (water depth and distance from shore)	Volume Spilled (bbl)	Cause of Spill
None	None	0	*

*No OCS blowout spills ≥1,000 bbl during the period 1985–1999.

Table C-4

Spill Rates Used to Estimate the Future Potential for Spills

Spill Source	Volume of Oil Handled in Billions of Barrels	Number of Wells Drilled	No. of Spills ≥1,000 Barrels	Risk of Spill from Facilities or Pipelines per Billion Barrels	Risk of Spill from Drilling per Well
Facilities	7.41 [a]	Not Applicable	1[a]	>0 to <0.13[c]	Not Applicable
Pipelines	5.81	Not Applicable	8	1.38	Not Applicable
Drilling	Not Applicable	23,610	1[b]	Not Applicable	>0 to < 0.00004[c]

[a] There were actually zero spills ≥1,000 bbl from facilities during the period 1985-1999. The data shown represent 1980-1999. The spill period for facility spills was expanded to 1980 to include a spill for facilities to result in a nonzero risk.

[b] There have been no spills ≥1,000 bbl from drilling activities during the period 1985-1999. Drilling activities include spills from blowouts, drill rigs, supply vessels, fuel storage, and other drilling activities. The data shown represent 1971-1999. One spill ≥1,000 bbl occurred in this period – a 1,500-bbl diesel spill from a drill rig damaged in a storm.

[c] There were no facility or drilling spills ≥1,000 bbl for the period 1985-1999; however, a nonzero spill rate was calculated by expanding the facility and drilling period to 1980 and 1971. Therefore, the spill rates for these categories are presented as greater than zero but below the rates calculated by expanding the data period.

Table C-5

Spill Risk Estimate

Environmental Resource	Spill Occurrence Variable [1]	Transport Variable [2] within 30 days	Spill Risk [3] Within 30 days
	(%)	(%)	(%)
Counties			
Cameron, TX	0.024	<0.5	<0.5
Willacy, TX	0.024	<0.5	<0.5
Kenedy, TX	0.024	<0.5	<0.5
Kleberg, TX	0.024	<0.5	<0.5
Nueces, TX	0.024	<0.5	<0.5
Aransas, TX	0.024	<0.5	<0.5
Calhoun, TX	0.024	<0.5	<0.5
Matagorda, TX	0.024	<0.5	<0.5
Brazoria, TX	0.024	<0.5	<0.5
Galveston, TX	0.024	<0.5	<0.5
Chambers, TX	0.024	<0.5	<0.5
Jefferson, TX	0.024	<0.5	<0.5
Cameron, LA	0.024	<0.5	<0.5
Vermilion, LA	0.024	<0.5	<0.5
Iberia, LA	0.024	<0.5	<0.5
St. Mary, LA	0.024	<0.5	<0.5
Terrebonne, LA	0.024	1	<0.5
Lafourche, La	0.024	1	<0.5
Jefferson, LA	0.024	<0.5	<0.5
Plaquemines, LA	0.024	13	<0.5
St. Bernard, LA	0.024	4	<0.5
Harrison, MS	0.024	1	<0.5
Jackson, MS	0.024	1	<0.5
Baldwin, AL	0.024	2	<0.5
Mobile, AL	0.024	<0.5	<0.5
Escambia, FL	0.024	1	<0.5
Santa Rosa, FL	0.024	<0.5	<0.5
Okaloosa, FL	0.024	1	<0.5
Walton, FL	0.024	1	<0.5
Bay, FL	0.024	2	<0.5
Gulf, FL	0.024	1	<0.5
Franklin, FL	0.024	1	<0.5
Wakulla, FL	0.024	<0.5	<0.5
Jefferson, FL	0.024	<0.5	<0.5
Taylor, FL	0.024	<0.5	<0.5
Dixie, FL	0.024	<0.5	<0.5
Levy, FL	0.024	<0.5	<0.5
Citrus, FL	0.024	<0.5	<0.5
Hernando, FL	0.024	<0.5	<0.5
Pasco, Fla.	0.024	<0.5	<0.5
Pinellas, FL	0.024	<0.5	<0.5
Hillsborough, FL	0.024	<0.5	<0.5
Manatee, FL	0.024	<0.5	<0.5
Sarasota, FL	0.024	<0.5	<0.5
Lee, FL	0.024	<0.5	<0.5
Collier, FL	0.024	<0.5	<0.5
Monroe, FL	0.024	<0.5	<0.5

Table C-5. Spill Risk Estimate (continued).

Environmental Resource	Spill Occurrence Variable (1)	Transport Variable (2) within 30 days	Spill Risk (3) Within 30 days
State Offshore Waters			
Texas State Offshore Waters	0.024	<0.5	<0.5
Western Louisiana Offshore Waters	0.024	12	<0.5
Eastern Louisiana Offshore Waters	0.024	14	<0.5
Mississippi Offshore Waters	0.024	3	<0.5
Alabama Offshore Waters	0.024	4	<0.5
Florida Panhandle Offshore Waters	0.024	8	<0.5
Florida Peninsula Offshore Waters	0.024	<0.5	<0.5
Beaches			
Coastal Bend Area Beaches	0.024	<0.5	<0.5
Matagorda Area Beaches	0.024	<0.5	<0.5
Galveston Area Beaches	0.024	<0.5	<0.5
Sea Rim State Park	0.024	<0.5	<0.5
Louisiana Beaches	0.024	1	<0.5
Gulf Islands	0.024	3	<0.5
Gulf Shores	0.024	2	<0.5
Panhandle Beaches	0.024	6	<0.5
Big Bend Beaches	0.024	<0.5	<0.5
Southwest beaches	0.024	<0.5	<0.5
Ten Thousand Islands	0.024	<0.5	<0.5

(1) The percent chance of a spill event occurring from the proposed action.

(2) The percent chance that winds and currents will move a point projected onto the surface of the Gulf beginning within the DeSoto Canyon area (E1-1) and ending at specified shoreline segments or environmental resources within 30 days. These results are the results of a numerical model that calculates the trajectory of a drifting point projected onto the surface of the water using temporally and spatially varying winds and ocean current fields. These probabilities do not factor in the risk of spill occurrence, consideration of the spill size, any spill response or cleanup actions, or any dispersion and weathering of the slick with time.

(3) The probability of a spill occurring and contacting identified environmental features represents the weighted risk that accounts for both the risk that a large spill will occur and the risk that it will contact locations where the resources occur, given the assumptions already described in (1) and (2).

(4) <0.5 = less than 0.5%.

Appendix D

General Geology and Geological Hazards

General Geology and Geological Hazards

Geologic Setting

There are two major sedimentary provinces in the Gulf Coast region: a Cenozoic province (western and central part of the Gulf) and a Mesozoic province (the eastern Gulf). The Mesozoic Province is mostly a carbonate terrain of limestone and reefs from Jurassic to Cretaceous age (205-65 Mya), with fewer than 350 exploration wells. The Cenozoic Province is a clastic terrain characterized by thick deposits of sand and shale from Paleocene to Recent age (65 Mya to present) underlain by Jurassic and Cretaceous carbonate rocks. The EPA sale area is thought to lie in an area underlain by deep Mesozoic carbonate plays and also shallower Cenozoic clastic plays (Lore et al., 2001). The two contiguous blocks of the proposed action lie within this area.

The area of the proposed action, DeSoto Canyon Blocks 180 and 224, lies northeast of the Mississippi Fan, an extensive Pleistocene-age sediment transport fairway on the Louisiana continental slope. The two contiguous blocks lie in water depths from 6,560 to 7,420 ft (2,000-2,262 m) in an area bounded to the southwest by the Mississippi Fan, to the north by the Sigsbee Escarpment, and to the east by the Florida escarpment.

The continental shelf landward of the EPA sale area was the site of significant deposition during the Mesozoic. Upper Jurassic marine sediments, including a thick sequence of salt, filled a deep basin underlying what is now the continental shelf located north and east of the EPA sale area. Lower Cretaceous reefs and patch reefs developed along the shelf edge boundary (see Figure A-1 from the Final EIS for Lease Sale 181) (USDOI, MMS, 2001)). The Mesozoic Province extends eastward from the Cretaceous shelf edge off the coast of Mississippi, Alabama, and Florida towards the coastline of Florida. The Cretaceous shelf edge lies northeast of the EPA sale area and intersects it only in the northeast corner. The last major depositional phases in this province event took place during the Miocene when deltas built seaward from the east and north depositing reservoir quality sediments in stream channels, barrier bar deposits on the shelf, and submarine fan deposits in the EPA sale area.

Although this Mesozoic Province has experienced limited drilling and most control points are on the shelf, some general statements can be made concerning resources. The hydrocarbon potential has been realized throughout the entire geologic interval from Jurassic to Pleistocene from the very shallow, young Pleistocene (1,500-4,000 ft; 450-1200 m) to the intermediate Cretaceous James Formation (14,000-16,000 ft; 4250-4900 m) and the deep, older Jurassic Norphlet Formation (15,000-24,000 ft; 4,575-7,300 m). The younger Cenozoic clastic is proven by the many field developed to the west, including those in deep water. The hydrocarbon potential of the underlying carbonate is proven in onshore and nearshore fields but is unknown in deepwater. Carbonate rocks often require favorable diagenesis (physical and chemical alterations to the sediments after deposition), faulting, fracturing, and stratigraphy to enhance their characteristic low porosity and permeability. The variability of porosity and permeability within carbonate rocks increases the deeper play risk in factors such as the potential drainage area, production rates, and resource volume.

Potential Geologic Hazards

The geological and geophysical data for DeSoto Canyon Blocks 180 and 224 were evaluated by MMS's Office of Field Operations and Office of Leasing and Environment. No H_2S has been found in wells drilled in the Eastern GOM.

To comply with the requirements at 30 CFR 254, the operator has provided an estimated worst-case blowout volume of 17,000 bbl/day for the proposed project. The estimate provided by OEI was determined through comparisons with other GOM fields.

There have been no spills ≥1,000 bbl in the GOM from blowouts during the period 1985-1999. The risk per well of a spill resulting from a blowout during drilling of the six wells that are part of the proposed action at was calculated by MMS to be 0.00007 ($7x10^{-5}$) or 7 chances out of 10,000 wells drilled. This value is multiplied by 6 for the six wells in the proposed action, and the resulting value ($2.3x10^{-5}$), or 2.3 chances out of 10,000 is the risk of a spill during the drilling of the six exploratory wells that are part of the exploration program (Appendix C). An analysis was conducted by MMS personnel to determine a potential blowout scenario in this SEA. If a blowout from one of the proposed wells occurred, the well would be likely to bridge over, shutting off the flow. OEI's deeper objective would be more plastic and have more potential to bridge over than the shallower target and other younger reservoirs seen to date in the deepwater GOM. The analyst felt that the large hydrostatic back pressure at the mudline would also limit the possibility of a surface blowout (Smith, personal communication, 2001). This analysis concluded that it could be expected that the blowout could continue for up to two days at a rate of 17,000 bbl/day before it would reasonably be assumed that the well would shut in on its own without further intervention (Smith, personal communication, 2001). This potential blowout scenario is analyzed in this SEA.

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Appendix E

Socioeconomic Conditions

Table E-1

Onshore Allocations

Sector	Sector Definition	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	FL-1	FL-2	FL-3	FL-4	Gulf-Other	US-Other
38	Oil & Gas Operations	0.00	0.34	0.09	0.06	0.15	0.00	0.00	0.00	0.00	0.00	0.23	0.12
50	New Gas Utility Facilities	0.07	0.38	0.05	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.11	0.07
53	Misc Natural Resource Facility Construction	0.03	0.21	0.23	0.15	0.30	0.02	0.00	0.00	0.00	0.00	0.01	0.03
56	Maintenance and Repair, Other Facilities	0.06	0.31	0.04	0.08	0.09	0.08	0.00	0.00	0.00	0.00	0.21	0.11
57	Other Oil & Gas Field Services	0.00	0.30	0.26	0.12	0.16	0.00	0.00	0.00	0.00	0.00	0.07	0.05
160	Office Furniture and Equipment	0.15	0.54	0.00	0.00	0.08	0.23	0.00	0.00	0.00	0.00	0.00	0.00
178	Maps and Charts (Misc Publishing)	0.12	0.59	0.02	0.06	0.11	0.10	0.00	0.00	0.00	0.00	0.01	0.00
206	Explosives	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
209	Chemicals, NEC	0.03	0.64	0.04	0.10	0.04	0.04	0.00	0.00	0.00	0.00	0.04	0.04
210	Petroleum Fuels	0.11	0.50	0.09	0.16	0.09	0.05	0.00	0.00	0.00	0.00	0.00	0.00
232	Hydraulic Cement	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.50	0.30
258	Steel Pipe and Tubes	0.00	0.50	0.31	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.08	0.04
284	Fabricated Plate Work	0.04	0.63	0.06	0.09	0.05	0.14	0.00	0.00	0.00	0.00	0.00	0.00
290	Iron and Steel Forgings	0.00	0.81	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.14	0.00
307	Turbines	0.05	0.65	0.00	0.10	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
311	Construction Machinery & Equipment	0.06	0.42	0.00	0.06	0.19	0.11	0.00	0.00	0.00	0.00	0.11	0.06
313	O&G Field Machinery & Equipment	0.03	0.18	0.27	0.18	0.22	0.00	0.00	0.00	0.00	0.00	0.05	0.04
331	Special Industrial Machinery	0.00	0.00	0.00	0.38	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.03
332	Pumps & Compressors	0.04	0.30	0.17	0.22	0.09	0.00	0.00	0.00	0.00	0.00	0.12	0.06
354	Industrial Machines, NEC	0.05	0.66	0.06	0.10	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00
356	Switchgear	0.00	0.63	0.00	0.07	0.11	0.07	0.00	0.00	0.00	0.00	0.11	0.00
374	Communication Equipment, NEC	0.13	0.50	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.13	0.00
392	Shipbuilding and Ship Repair	0.09	0.24	0.05	0.24	0.18	0.19	0.00	0.00	0.00	0.00	0.00	0.00

Table E-1. Onshore Allocations (continued).

Sector	Sector Definition	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	FL-1	FL-2	FL-3	FL-4	Gulf-Other	US-Other
399	Transportation Equipment, NEC	0.00	0.78	0.06	0.11	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
401	Lab Equipment	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
403	Instrumentation	0.04	0.13	0.39	0.27	0.08	0.00	0.00	0.00	0.00	0.00	0.08	0.04
435	Demurrage/Warehousing/Motor Freight	0.11	0.37	0.21	0.09	0.09	0.01	0.00	0.00	0.00	0.00	0.07	0.00
436	Water Transport	0.02	0.27	0.10	0.25	0.22	0.04	0.01	0.00	0.01	0.00	0.06	0.00
437	Air Transport	0.03	0.42	0.11	0.11	0.08	0.02	0.00	0.00	0.00	0.01	0.21	0.00
441	Communications	0.09	0.51	0.07	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00
443	Electric Services	0.13	0.36	0.06	0.15	0.12	0.18	0.00	0.00	0.00	0.00	0.00	0.00
444	Gas Production/Distribution	0.10	0.54	0.08	0.07	0.05	0.03	0.00	0.00	0.00	0.00	0.05	0.04
445	Water Supply	0.08	0.43	0.08	0.12	0.05	0.11	0.00	0.00	0.00	0.00	0.01	0.01
446	Waste Treatment/Disposal	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
454	Eating/Drinking	0.00	0.24	0.28	0.08	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
455	Msc Retail	0.09	0.48	0.06	0.10	0.15	0.11	0.00	0.00	0.00	0.00	0.00	0.00
459	Insurance	0.04	0.47	0.07	0.12	0.09	0.00	0.00	0.00	0.00	0.00	0.17	0.03
462	Real Estate	0.09	0.47	0.04	0.08	0.11	0.08	0.00	0.00	0.00	0.00	0.11	0.01
469	Advertisement	0.06	0.45	0.06	0.08	0.15	0.08	0.00	0.00	0.00	0.00	0.12	0.01
470	Other Business Services	0.00	0.60	0.11	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.09	0.05
473	Msc. Equipment Rental and Leasing	0.09	0.26	0.22	0.10	0.10	0.01	0.00	0.00	0.00	0.00	0.18	0.03
490	Doctors & Veterinarian Services	0.09	0.53	0.06	0.09	0.14	0.08	0.00	0.00	0.00	0.00	0.00	0.00
494	Legal Services	0.07	0.48	0.07	0.11	0.19	0.08	0.00	0.00	0.00	0.00	0.00	0.00
506	Environmental/Engineering Services	0.06	0.38	0.11	0.08	0.08	0.03	0.01	0.00	0.02	0.00	0.20	0.01
507	Acct/Msc Business Services	0.06	0.46	0.05	0.09	0.13	0.07	0.00	0.00	0.00	0.00	0.11	0.01
508	Management/Consulting Services	0.04	0.54	0.04	0.09	0.11	0.05	0.00	0.00	0.00	0.00	0.11	0.01
509	Testing/Research Facilities	0.00	0.38	0.14	0.14	0.05	0.00	0.00	0.00	0.00	0.00	0.21	0.11

Source: Dismukes et. al., 2001

Table E-2

Population Forecast From 2000 to 2041 by Year and by Coastal Subarea (in thousands)

Year	LA-1	LA-2	LA-3	MA-1	TX-1	TX-2	FL-1	FL-2	FL-3	FL-4	CGOM	WGOM	EGOM	GOM
2000	667.12	1,009.54	1,337.60	920.12	920.58	5,158.08	774.39	128.07	3,954.32	2,340.67	3,934.36	6,078.66	7,197.46	17,210.48
2001	672.18	1,020.72	1,343.62	930.79	930.98	5,238.54	787.39	129.53	4,022.21	2,362.41	3,967.32	6,169.52	7,301.53	17,438.37
2002	677.35	1,032.14	1,350.07	941.63	941.65	5,320.26	800.68	131.07	4,091.10	2,384.86	4,001.19	6,261.91	7,407.70	17,670.81
2003	682.66	1,043.66	1,356.53	952.61	952.50	5,402.58	813.98	132.59	4,160.29	2,408.00	4,035.47	6,355.07	7,514.87	17,905.41
2004	688.01	1,055.31	1,363.03	963.72	963.47	5,486.16	827.51	134.14	4,230.65	2,431.38	4,070.07	6,449.64	7,623.67	18,143.38
2005	693.29	1,066.73	1,369.47	974.61	974.23	5,567.43	840.64	135.65	4,298.86	2,454.36	4,104.10	6,541.66	7,729.51	18,375.26
2006	698.70	1,078.41	1,376.22	985.73	985.30	5,650.56	854.05	137.23	4,368.60	2,478.49	4,139.06	6,635.87	7,838.37	18,613.29
2007	704.16	1,090.21	1,382.99	996.98	996.51	5,734.94	867.67	138.82	4,439.48	2,502.86	4,174.34	6,731.45	7,948.83	18,854.62
2008	709.66	1,102.14	1,389.80	1,008.35	1,007.84	5,820.57	881.51	140.44	4,511.50	2,527.47	4,209.96	6,828.41	8,060.92	19,099.29
2009	715.20	1,114.20	1,396.65	1,019.86	1,019.30	5,907.49	895.57	142.07	4,584.70	2,552.32	4,245.91	6,926.78	8,174.66	19,347.36
2010	720.38	1,125.14	1,403.21	1,030.25	1,029.64	5,983.33	907.72	143.54	4,647.77	2,575.09	4,278.97	7,012.97	8,274.12	19,566.06
2011	726.20	1,137.43	1,410.76	1,041.94	1,041.44	6,069.85	921.64	145.17	4,720.05	2,601.26	4,316.33	7,111.28	8,388.12	19,815.73
2012	732.08	1,149.85	1,418.35	1,053.77	1,053.36	6,157.62	935.78	146.82	4,793.45	2,627.70	4,354.04	7,210.98	8,503.74	20,068.76
2013	738.00	1,162.40	1,425.99	1,065.73	1,065.43	6,246.66	950.13	148.48	4,868.00	2,654.41	4,392.11	7,312.09	8,621.01	20,325.21
2014	743.97	1,175.09	1,433.66	1,077.82	1,077.63	6,336.99	964.70	150.17	4,943.70	2,681.38	4,430.54	7,414.62	8,739.95	20,585.11
2015	749.53	1,186.60	1,440.99	1,088.74	1,088.63	6,416.17	977.37	151.69	5,009.36	2,706.02	4,465.86	7,504.81	8,844.44	20,815.11
2016	755.65	1,199.33	1,449.10	1,100.87	1,100.92	6,505.30	991.66	153.38	5,083.64	2,733.69	4,504.94	7,606.21	8,962.38	21,073.53
2017	761.83	1,212.18	1,457.25	1,113.13	1,113.34	6,595.66	1,006.17	155.09	5,159.02	2,761.65	4,544.39	7,708.99	9,081.93	21,335.31
2018	768.05	1,225.18	1,465.45	1,125.53	1,125.90	6,687.28	1,020.90	156.81	5,235.52	2,789.89	4,584.21	7,813.17	9,203.11	21,600.50
2019	774.33	1,238.32	1,473.70	1,138.06	1,138.60	6,780.17	1,035.83	158.56	5,313.15	2,818.42	4,624.40	7,918.77	9,325.96	21,869.12
2020	780.19	1,250.28	1,481.58	1,149.44	1,150.11	6,862.28	1,048.94	160.14	5,381.16	2,844.53	4,661.48	8,012.39	9,434.78	22,108.65
2021	786.67	1,263.57	1,490.31	1,162.08	1,162.96	6,954.70	1,063.76	161.94	5,460.95	2,873.84	4,702.62	8,117.67	9,560.49	22,380.77
2022	793.20	1,276.99	1,499.09	1,174.87	1,175.96	7,048.36	1,078.79	163.76	5,538.93	2,903.44	4,744.15	8,224.32	9,684.92	22,653.39
2023	799.79	1,290.56	1,507.92	1,187.80	1,189.10	7,143.29	1,094.04	165.60	5,618.02	2,933.35	4,786.07	8,332.39	9,811.00	22,929.46
2024	806.43	1,304.27	1,516.81	1,200.87	1,202.39	7,239.49	1,109.49	167.46	5,698.24	2,963.56	4,828.38	8,441.88	9,938.75	23,209.01
2025	812.61	1,316.73	1,525.25	1,212.71	1,214.41	7,324.63	1,123.09	169.14	5,765.56	2,991.12	4,867.31	8,539.04	10,048.91	23,455.25
2026	819.36	1,330.72	1,534.24	1,226.06	1,227.98	7,423.27	1,138.95	171.03	5,847.89	3,021.93	4,910.38	8,651.25	10,179.81	23,741.44
2027	826.17	1,344.86	1,543.28	1,239.55	1,241.70	7,523.25	1,155.05	172.95	5,931.39	3,053.06	4,953.86	8,764.95	10,312.46	24,031.26
2028	833.03	1,359.15	1,552.38	1,253.19	1,255.58	7,624.57	1,171.37	174.90	6,016.09	3,084.51	4,997.74	8,880.15	10,446.86	24,324.75
2029	839.95	1,373.59	1,561.52	1,266.98	1,269.61	7,727.25	1,187.92	176.86	6,101.99	3,116.29	5,042.04	8,996.86	10,583.05	24,621.95
2030	846.93	1,388.18	1,570.73	1,280.92	1,283.80	7,831.32	1,204.70	178.84	6,189.12	3,148.39	5,086.75	9,115.12	10,721.06	24,922.93
2031	853.96	1,402.93	1,579.98	1,295.01	1,298.15	7,936.79	1,221.72	180.85	6,277.50	3,180.82	5,131.89	9,234.93	10,860.89	25,227.71
2032	861.06	1,417.83	1,589.29	1,309.26	1,312.65	8,043.68	1,238.98	182.88	6,367.14	3,213.58	5,177.45	9,356.33	11,002.59	25,536.36
2033	868.21	1,432.90	1,598.66	1,323.67	1,327.32	8,152.01	1,256.49	184.93	6,458.06	3,246.69	5,223.43	9,479.33	11,146.17	25,848.93
2034	875.42	1,448.12	1,608.08	1,338.23	1,342.16	8,261.79	1,274.24	187.01	6,550.27	3,280.13	5,269.86	9,603.95	11,291.65	26,165.46
2035	882.70	1,463.50	1,617.56	1,352.96	1,357.16	8,373.06	1,292.25	189.11	6,643.80	3,313.92	5,316.72	9,730.22	11,439.08	26,486.01
2036	890.03	1,479.05	1,627.09	1,367.85	1,372.32	8,485.82	1,310.50	191.23	6,738.67	3,348.06	5,364.02	9,858.15	11,588.46	26,810.63
2037	897.42	1,494.77	1,636.68	1,382.90	1,387.66	8,600.11	1,329.02	193.38	6,834.90	3,382.54	5,411.76	9,987.77	11,739.84	27,139.37
2038	904.88	1,510.65	1,646.32	1,398.12	1,403.17	8,715.93	1,347.80	195.55	6,932.49	3,417.39	5,459.96	10,119.10	11,893.23	27,472.28
2039	912.39	1,526.69	1,656.02	1,413.50	1,418.85	8,833.31	1,366.84	197.75	7,031.48	3,452.59	5,508.61	10,252.16	12,048.66	27,809.43
2040	919.97	1,542.91	1,665.78	1,429.05	1,434.70	8,952.28	1,386.15	199.96	7,131.89	3,488.16	5,557.72	10,386.98	12,206.16	28,150.86
2041	927.62	1,559.31	1,675.60	1,444.78	1,450.74	9,072.84	1,405.74	202.21	7,233.72	3,524.09	5,607.30	10,523.58	12,365.76	28,496.63

Source: Woods and Poole Economics, Inc., 2002

Table E-3

Employment Forecast from 2000 to 2041 by Year and by Subarea (in thousands)

Year	LA-1	LA-2	LA-3	MA-1	TX-1	TX-2	FL-1	FL-2	FL-3	FL-4	CGOM	WGOM	EGOM	GOM
2000	377.47	571.95	781.67	515.20	454.25	3,046.85	427.04	44.99	2,248.28	1,306.73	2,246.29	3,501.10	4,027.03	9,774.42
2001	381.65	580.15	787.95	522.71	460.67	3,095.53	435.03	45.55	2,298.83	1,324.75	2,272.46	3,556.20	4,104.15	9,932.81
2002	386.15	590.66	793.66	529.89	466.67	3,143.66	442.85	46.10	2,347.94	1,341.81	2,300.36	3,610.33	4,178.69	10,089.39
2003	391.13	597.79	799.20	537.22	472.64	3,192.77	450.71	46.63	2,396.65	1,358.41	2,325.34	3,665.41	4,252.40	10,243.15
2004	396.19	605.00	804.77	544.65	478.68	3,242.66	458.72	47.17	2,446.37	1,375.22	2,350.61	3,721.33	4,327.47	10,399.42
2005	401.12	612.06	810.28	551.90	484.58	3,291.14	466.47	47.69	2,494.20	1,391.66	2,375.37	3,775.72	4,400.02	10,551.11
2006	406.59	620.40	816.60	559.63	490.78	3,342.60	474.56	48.24	2,543.53	1,408.55	2,403.22	3,833.38	4,474.86	10,711.47
2007	412.12	628.86	822.98	567.47	497.06	3,394.87	482.78	48.79	2,593.82	1,425.64	2,431.43	3,891.93	4,551.03	10,874.39
2008	417.74	637.43	829.40	575.41	503.42	3,447.96	491.15	49.34	2,645.12	1,442.94	2,459.98	3,951.38	4,628.55	11,039.90
2009	423.43	646.11	835.87	583.47	509.87	3,501.87	499.66	49.92	2,697.43	1,460.44	2,488.88	4,011.74	4,707.45	11,208.07
2010	428.46	653.79	841.92	590.56	515.60	3,548.60	506.92	50.41	2,740.96	1,476.14	2,514.73	4,064.20	4,774.43	11,353.35
2011	434.19	662.57	849.67	598.72	522.23	3,603.53	515.28	50.97	2,791.75	1,494.05	2,545.16	4,125.76	4,852.05	11,522.97
2012	440.01	671.47	857.50	606.99	528.94	3,659.31	523.78	51.53	2,843.48	1,512.18	2,575.96	4,188.25	4,930.98	11,695.20
2013	445.90	680.48	865.39	615.38	535.74	3,715.96	532.42	52.10	2,896.18	1,530.54	2,607.16	4,251.70	5,011.24	11,870.09
2014	451.88	689.62	873.36	623.88	542.62	3,773.49	541.20	52.68	2,949.85	1,549.11	2,638.74	4,316.11	5,092.84	12,047.68
2015	457.17	697.71	880.71	631.38	548.75	3,823.42	548.75	53.20	2,995.06	1,565.76	2,666.96	4,372.16	5,162.78	12,201.90
2016	463.11	706.94	889.98	639.94	555.91	3,882.59	557.39	53.77	3,047.79	1,585.13	2,699.96	4,438.50	5,244.08	12,382.54
2017	469.12	716.29	899.34	648.63	563.16	3,942.68	566.16	54.35	3,101.45	1,604.74	2,733.38	4,505.84	5,326.69	12,565.92
2018	475.22	725.76	908.80	657.43	570.51	4,003.70	575.07	54.93	3,156.06	1,624.59	2,767.22	4,574.21	5,410.64	12,752.07
2019	481.39	735.36	918.37	666.36	577.96	4,065.66	584.12	55.52	3,211.62	1,644.68	2,801.48	4,643.62	5,495.94	12,941.04
2020	486.90	743.91	927.09	674.27	584.60	4,119.61	591.98	56.06	3,259.01	1,662.71	2,832.17	4,704.20	5,569.74	13,106.11
2021	493.05	753.66	937.98	683.29	592.41	4,183.83	600.92	56.64	3,314.18	1,683.95	2,867.98	4,776.24	5,655.69	13,299.91
2022	499.28	763.55	948.98	692.43	600.34	4,249.05	610.00	57.23	3,370.29	1,705.46	2,904.24	4,849.39	5,742.98	13,496.61
2023	505.58	773.56	960.12	701.70	608.37	4,315.29	619.21	57.83	3,427.35	1,727.25	2,940.97	4,923.66	5,831.64	13,696.26
2024	511.97	783.70	971.39	711.09	616.50	4,382.57	628.56	58.43	3,485.38	1,749.31	2,978.16	4,999.07	5,921.69	13,898.91
2025	517.67	792.71	981.53	719.41	623.71	4,440.89	636.71	58.98	3,535.04	1,768.97	3,011.32	5,064.60	5,999.70	14,075.62
2026	524.21	803.11	993.05	729.03	632.05	4,510.12	646.33	59.60	3,594.89	1,791.57	3,049.40	5,142.18	6,092.38	14,283.96
2027	530.83	813.64	1,004.71	738.79	640.50	4,580.44	656.09	60.22	3,655.75	1,814.46	3,087.97	5,220.94	6,186.52	14,495.42
2028	537.54	824.31	1,016.50	748.67	649.07	4,651.84	666.01	60.85	3,717.65	1,837.64	3,127.02	5,300.91	6,282.13	14,710.06
2029	544.33	835.12	1,028.43	758.69	657.75	4,724.36	676.07	61.48	3,780.59	1,861.11	3,166.57	5,382.11	6,379.25	14,927.93
2030	551.20	846.08	1,040.50	768.84	666.55	4,798.01	686.28	62.12	3,844.59	1,884.89	3,206.62	5,464.56	6,477.88	15,149.06
2031	558.17	857.17	1,052.71	779.13	675.46	4,872.81	696.65	62.77	3,909.68	1,908.97	3,247.18	5,548.27	6,578.07	15,373.52
2032	565.22	868.41	1,065.07	789.55	684.50	4,948.77	707.17	63.43	3,975.88	1,933.35	3,288.25	5,633.27	6,679.83	15,601.35
2033	572.36	879.80	1,077.57	800.12	693.65	5,025.92	717.85	64.09	4,043.19	1,958.05	3,329.85	5,719.57	6,783.18	15,832.60
2034	579.59	891.34	1,090.22	810.83	702.93	5,104.27	728.70	64.76	4,111.64	1,983.06	3,371.97	5,807.20	6,888.16	16,067.33
2035	586.91	903.03	1,103.01	821.68	712.33	5,183.85	739.70	65.43	4,181.25	2,008.40	3,414.63	5,896.17	6,994.79	16,305.59
2036	594.32	914.88	1,115.96	832.67	721.86	5,264.66	750.88	66.11	4,252.05	2,034.06	3,457.83	5,986.51	7,103.09	16,547.44
2037	601.83	926.87	1,129.06	843.81	731.51	5,346.73	762.22	66.80	4,324.03	2,060.04	3,501.57	6,078.24	7,213.10	16,792.92
2038	609.43	939.03	1,142.31	855.10	741.29	5,430.08	773.74	67.50	4,397.24	2,086.36	3,545.87	6,171.38	7,324.84	17,042.09
2039	617.13	951.34	1,155.72	866.54	751.21	5,514.74	785.42	68.21	4,471.69	2,113.01	3,590.74	6,265.94	7,438.33	17,295.01
2040	624.93	963.82	1,169.28	878.14	761.25	5,600.71	797.29	68.92	4,547.40	2,140.00	3,636.17	6,361.96	7,553.61	17,551.74
2041	632.82	976.46	1,183.01	889.89	771.44	5,688.02	809.33	69.64	4,624.39	2,167.34	3,682.18	6,459.45	7,670.70	17,812.33

Source: Woods and Poole Economics, Inc., 2002

Appendix F

PHYSICAL OCEANOGRAPHY

PHYSICAL OCEANOGRAPHY

The GOM is a semienclosed basin connecting with the Caribbean Sea through the Yucatan Channel and the Straits of Florida.

The most prominent source of mesoscale variability in the Eastern GOM is the Loop Current. Caribbean waters entering the Gulf through the Yucatan Channel are constrained by its 1,820-m effective sill depth. Once free of the Yucatan Channel, flow from the Yucatan Current proceeds northward into the GOM becoming the Loop Current. Loop Current waters are relatively salty and warm, having core salinities at or above 36.65 practical salinity unit (psu) and a temperature of around 22.5°C at the 125 to 150-m depth. The location of this current has been documented as far north as the continental slope just south of Mobile, Alabama, at 29.75° N latitude. The Loop Current also influences the northeastern GOM both directly due to intrusion of the Loop Current itself and indirectly by means of elongated filaments of Loop Current water that extend outward from the Loop Current front, as well as by clockwise-rotating closed rings called Loop Current Eddies (LCE's) that the Loop Current spawns. The Loop Current extends from the surface to roughly a 1,000-m depth, below which there is evidence of opposing currents and vortex-like features of weaker velocity. The Loop Current and LCE's may have surface speeds as high as 150-200 cm/s or more, which decrease with depth. Speeds at 500-m depth are common around 10 cm/s (Cooper et al., 1990).

Cold core and warm core eddies have been observed to dominate the deepwater circulation patterns of the continental slope and rise, abyssal plain, and DeSoto Canyon. The Sturges et al. (1993) model suggests a surprisingly complex circulation pattern beneath the anticyclone, with vortexlike and wavelike features that interact with the bottom topography. These model findings are consistent with Hamilton's (1990) interpretation of observations. Cyclonic circulation may be associated with upwelling, which brings cooler, deeper water towards the surface. Small cyclonic eddies around 50-100 km in diameter have been observed over the continental slope off both Louisiana (Hamilton, 1992) and the Florida Panhandle (Jochens and Nowlin, 1998). These eddies can persist for six months or longer and are relatively stationary.

Abyssal currents in the GOM have been directly measured by current meters at instrument depths of up to 3,175 m. The major low-frequency velocity fluctuations in the bottom 1,000-2,000 m of the water column have the characteristics of Topographic Rossby Waves (TRW). These are long waves of wavelength 150-250 km having periods greater than 10 days and group velocity estimated at 9 km/day. They are characterized by columnar motions that are bottom intensified. They move westward at higher group velocities than the typical anticyclonic eddy translation velocity of 3-6 km/day. The Loop Current and LCE's are thought to be major sources of these westward propagating TRW's (Hamilton, 1990).

In general, past current observations in the deepwater GOM have revealed decreases in current speed with depth. During late 1999, a limited number of high speed current events, at times approaching 2 kn, were observed at depths exceeding 1,500 m in the northern GOM (MMS unpublished data).

Cold fronts, as well as diurnal and seasonal cycles of heat flux at the air/sea interface, affect near-surface water temperatures, although water at depths greater than about 100 m remains unaffected by surface boundary heat flux. Water temperature is greater than air temperature at the air/sea interface during all seasons. Frontal passages over the region can cause changes in velocity structure in the upper layers also, specifically increasing current speeds and variability. These fronts occur with frequencies from 3 to 10 days (weatherband frequency). Storms and hurricanes as far away as the Yucatan Peninsula can induce strong currents in the northeast GOM (Brooks, 1991; page 13). Hurricanes increase surface current speeds and cool the surface waters in much the same way as do cold fronts, but hurricanes may stir the mixed layer to an even greater depth (Molinari, 1979). Surface waves and sea state may limit normal oil and gas operations as well as oil-spill response activities (Brower et al., 1972). During passage of a cold front, the cold air mass is warmed as it travels over surface waters. In deeper waters, the mixed layer deepens. In the summer, vertical density stratification increases with the development of a seasonal thermocline. In deeper waters, the mixed layer is diminished. The transition between summer and winter is believed to occur with passage of the first cold front, and the transition from winter to summer coincides with the last cold front (Molinari and Festa, 1978). Seasonal variation of northeast GOM monthly mean sea surface temperature (SST) in response to the seasonal change of solar heating is reported by Dynalysis of Princeton (1993), Kelly (1991), Florida A&M University (1988), U.S. Navy (1986), and Robinson (1973). The maximum monthly mean SST (28-30°C) occurs in July-August and the minimum monthly mean SST (15-22°C) occurs in January-February. At 1,000-m water depth, the temperature remains close to 4.9° C year-round.

The salinity field in the northeastern GOM is the result of a mixture of Mississippi River water, low salinity water from the adjacent sounds and bays, and high salinity water from the deep GOM (Barry A. Vittor and Associates, 1985). Monthly mean surface salinity plots prepared by Dynalysis of Princeton (1993) show that salinity in this region is mostly oceanic with value ranging from 33 to 36 ppt. Surface salinities along the northern Gulf display seasonal variations because of the cycles of freshwater input from local precipitation and rivers. Water depths greater than 1,400 m in the GOM are relatively homogeneous with respect to salinity, which ranges from 34.963 to 34.976 psu as noted by a Texas A&M University data collection in the winter months of 1962 (McLellan and Nowlin, 1963).

The astronomical tide in the GOM can be characterized by a small amplitude and different behavior of the diurnal and semidiurnal components (Reid and Whitaker, 1981). The dominant tidal components in the GOM are the diurnal, luni-solar (K1), and principal lunar (O1) acting as Hemholtz modes, and the semidiurnal, principal lunar (M2) (Reid and Whitaker, 1981). The period of these components are T_{K1}=23.934 hrs, T_{O1}=25.819 hrs, and T_{M2}=12.421 hrs. Sea levels along the GOM also exhibit a seasonal cycle. A time series of sea levels spanning 57 years (1923-1980) at Pensacola, Florida, shows a minimum sea level in January with a monotonic increase that peaks in September. Another type of sea-level change is caused by meteorological forces, which in the area of interest could be equal to or greater than the astronomical tides.

The GOM's wave climate is characterized as being generated inside the Gulf and with hurricanes as a significant source of wave energy (Aubrey and Fields, 1992). National Data Buoy Center (NDBC) buoys offshore in the Eastern GOM recorded a mean wave height of ~1.2 m and a maximum wave height of ~6 m. The wave height also varies seasonally. The highest mean wave height (~1.6 m) occurs in winter; spring and fall have an identical mean wave height of ~1.4 m; and the lowest mean wave height (~0.9 m) occurs in summer. The maximum wave height also displays a similar seasonal variation: highest in winter (>8 m) and lowest in summer (~1.8 m), with spring and fall wave heights about equal (~4 m).

A wave hindcast for the entire GOM shows that in this area the average significant wave height is about 1 m with a period of 5 seconds with a most frequent direction between 135° and 157.5° (Hubertz and Brooks, 1989). The largest hindcast waves are near 4.7 to 2.7 m and periods of 11-8.3 seconds. These larger waves are associated with directions varying from 138° to 210°. The wave height and period associated with the 100-year storm in this region are maximum wave heights of 18-24 m with a wave period at 11-15 seconds (Coats, 1992). Recent measurements of waves associated with Hurricane Andrew in the GOM revealed that the wave period could be as high as 16 seconds with another significant wave at the first harmonic caused by nonlinear dynamics (DiMarco et al., 1994).

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Appendix G

Figures

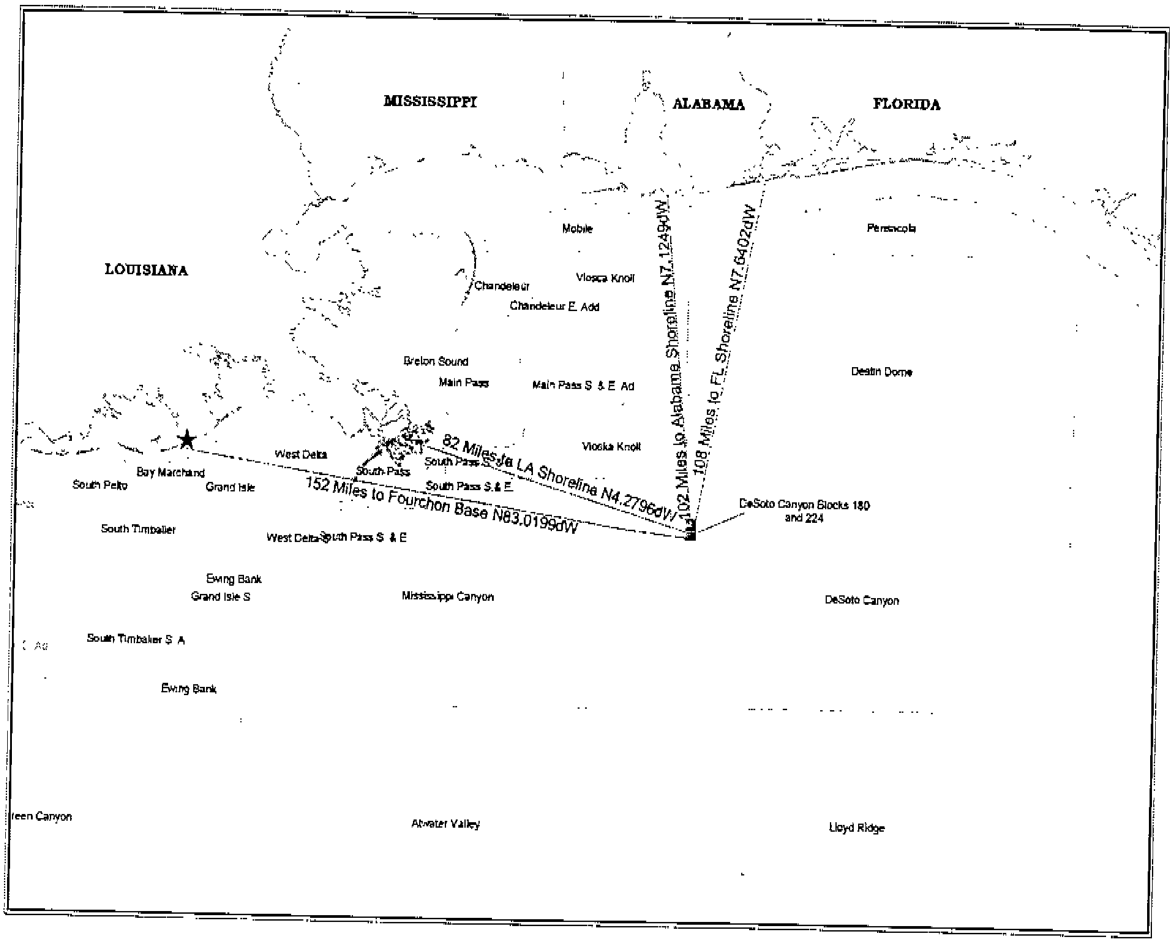
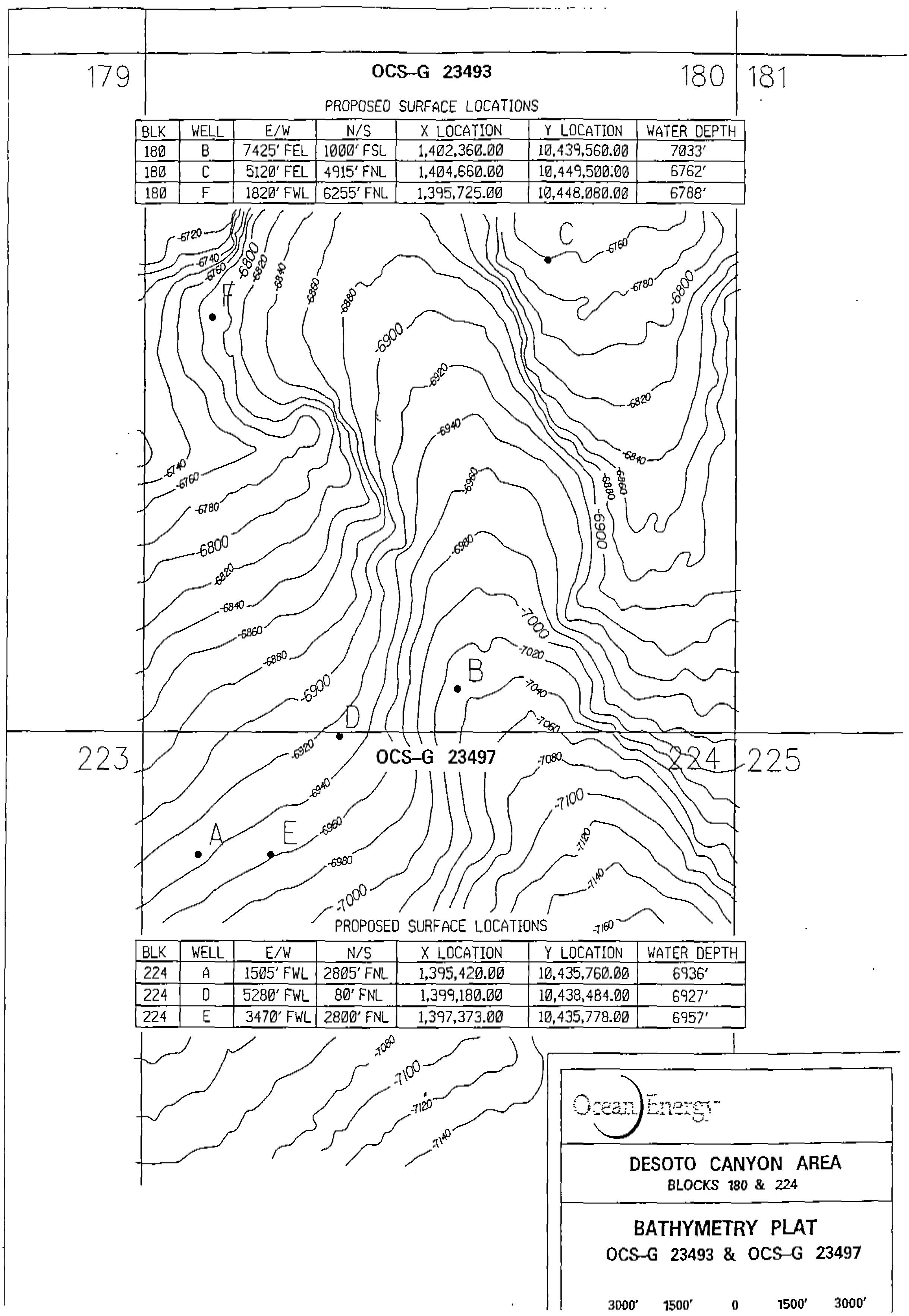


Figure G-1. Location Map Showing DeSoto Canyon Blocks 180 and 224 Relative to the Shoreline and Onshore Bases.



PROPOSED SURFACE LOCATIONS

BLK	WELL	E/W	N/S	X LOCATION	Y LOCATION	WATER DEPTH
180	B	7425' FEL	1000' FSL	1,402,360.00	10,439,560.00	7033'
180	C	5120' FEL	4915' FNL	1,404,660.00	10,449,500.00	6762'
180	F	1820' FWL	6255' FNL	1,395,725.00	10,448,080.00	6788'

PROPOSED SURFACE LOCATIONS

BLK	WELL	E/W	N/S	X LOCATION	Y LOCATION	WATER DEPTH
224	A	1505' FWL	2805' FNL	1,395,420.00	10,435,760.00	6936'
224	D	5280' FWL	80' FNL	1,399,180.00	10,438,484.00	6927'
224	E	3470' FWL	2800' FNL	1,397,373.00	10,435,778.00	6957'

Figure G-2. Bathymetric Map Showing Well Locations for DeSoto Canyon Blocks 180 and 224.