It could be concluded that routine, non-accidental discharges of used drilling muds and drill cuttings are probably benign with respect to pelagic fishes--so long as no hydrocarbons have been added. First, the fishes' mobility imparts to them the potential for avoidance of noxious intrusions, and second, dilution is rapid in the upper water column and it may not be possible for lethal concentrations of toxic materials to accumulate anywhere but inside the discharge pipe itself.

A continuous discharge of used drilling fluids and downhole cuttings can adversely affect bottom-dwelling communities in two ways. The material may physically smother animals that cannot move out of the way, and leachate concentrations at or very near potentially toxic levels may accumulate.

Animals that live all or most of their lives on or immediately above the seabottom must be further divided into two functional groups. Mobile organisms, mostly fishes, are capable of getting out of the way of oncoming objects, such as a descending slurry of mud and debris. Such degradations of the bottom habitat can affect them only if they are especially sensitive to dissolved toxins by sorption, or if they ingest toxic particles. Investigations, already referred to, indicate that epibenthic fishes (for which data exists) exhibit a low sensitivity to normal toxin concentrations. Ingestion of particles containing toxic compounds would appear to be a hazard, but little research has been published on this topic (see Conklin et al. 1980 for an exception).

Sessile organisms cannot escape danger as they are incapable of movement. Their fate in the presence of an exploratory drilling operation will be treated together with infauna. Animals that

FINDING OF NO SIGNIFICANT IMPACT

BRITISH-BORNEO EXPLORATION, INC.
GULF OF MEXICO, OFFSHORE, LOUISIANA AND MISSISSIPPI
GREEN CANYON AREA, BLOCK 254, OCS-G 7049
GREEN CANYON AREA, BLOCK 298, OCS-G 8010
(Control No. N-6222UA)

Minerals Management Service
Gulf of Mexico Region
1201 Elmwood Park Boulevard
New Orleans, LA 70123

J. Brashier, Chief, Environmental Operations — Date: 2/3/99

I. FINDING

British-Borneo Exploration, Inc. (1201 Louisiana Suite 3500, Houston, Texas 77002) submitted to the Gulf of Mexico Region of the Minerals Management Service a proposed Initial Development Operations Coordination Document to drill, complete and produce one subsea well (Well No. 1) from a surface location in Green Canyon Area Block 298, commence production of four previously drilled subsea wells (Wells No.1, No. 3, No. 4ST#1, No. 5) with surface locations in Green Canyon Area Blocks 254 and 298, and construct Platform A in Green Canyon Area Block 254. The platform will be the Allegheny SeaStar TLP A platform, installed utilizing McDermott's dynamically positioned DB 50 barge. Safety features include well control and blowout prevention equipment as described in 30 CFR 250.406, 250.407, 250.408 and 250.409, 250.514, 250.515, and 250.516. The proposed drilling and platform construction is described and analyzed in the attached Site Specific Environmental Assessment released in December, 1998.

Based on the environmental analysis contained in the Site Specific Environmental Assessment, the MMS has determined that British-Borneo Exploration, Inc.'s Initial Unit Development Operations Coordination Document, with mitigating measures, will not cause significant (40 CFR 1508.27) or undue harm to the quality of the human environment and preparation of an Environmental Impact Statement will not be necessary.

II. MANAGEMENT CONSIDERATIONS

The proposed action was reviewed for potential effects to the quality of the human environment. The attached SEA documents this review which is summarized in the following.

Potential impacts to air quality were reviewed and mitigation to obtain approval from the Regional Supervisor prior to conducting the proposed burning of produced liquid hydrocarbons and to include updated information on the anticipated peak flow rates, durations, and sulfur content with your burn request, are provided in this FONSI. Since the proposed operations would be located in Military Warning Area W-92, the lessees must coordinate with the appropriate base commander when operating in this area. Impacts to benthic communities were analyzed and it was determined that proposed drilling activities will have no effect on chemosynthetic communities. Potential impacts from an accidental release of oil from a high volume blowout is of concern; however, the historical database indicates that it is rare for such a pollution event to occur. For the period from 1971-1995, based on 24,237 wells drilled, there were 17 well blowouts that resulted in the release of oil (0.07 percent probability). Mitigating the potential for a blowout and spill are the well control and blowout prevention equipment, procedures, and inspections required in 30 CFR 250.406, 250.407, 250.408 and 250.409, 250.514, 250.515, and 250.516. Further mitigating potential impacts from an accidental oil spill is, British-Borneo Exploration Inc.'s approved Regional Oil Spill Response Plan which will permit access to 41,500 bbl/day derated capacity of skimming equipment and other response equipment maintained by Clean Gulf Associates.

III. MITIGATION

Your plan indicates the burning of produced liquid hydrocarbons. Please be reminded that 30 CFR 250.1105 requires you to obtain approval from the Regional Supervisor for Production and Development prior to conducting the proposed burning activities.

Because there is a potential for exceeding the 3- and 24-hour SO_2 onshore ambient air concentration significance levels as prescribed by 30 CFR 250.303(e) during your proposed produced liquid hydrocarbon burn, please be advised that you will include updated information on the anticipated peak flow rates, durations, and sulfur content with your burn request submitted in accordance with 30 CFR 250.1105(c). If the projected sulfur content is less than one percent, you will also include in your burn request the results of an analysis of the liquid hydrocarbon to be burned or a correlative liquid hydrocarbon. Using the submitted information, this office will determine whether revision of your DOCD will be necessary pursuant to 30 CFR 250.204(q)(1) before your flare request can be approved.

Please be reminded of your lease stipulation which requires you to enter into an agreement with the Naval Air Station, Air Operations Department, Air Traffic Division/Code 52, New Orleans, Louisiana 70146-5000 (contact ACC A. W. Thrift at 504/678-3100 or 504/678-3101) concerning the control of electromagnetic emissions and use of boats and aircraft in Military Warning Area W-92.

SITE-SPECIFIC ENVIRONMENTAL ASSESSMENT PREPARED FOR INITIAL UNIT DEVELOPMENT OPERATIONS COORDINATION DOCUMENT (DOCD) N-6222U GREEN CANYON AREA, BLOCKS 254 & 298

I. Purpose and Need for the Action

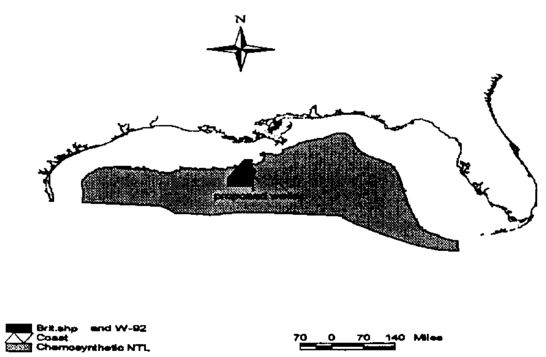
A. Introduction

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 is required to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources and that free market competition is maintained.

The purpose of this Site-Specific Environmental Assessment (SEA) is to assess the specific impacts associated with proposed oil and gas exploration, development and production activities. This Initial Unit Development Operations Coordination Document represents an action that is normally categorically excluded [516 DM Chapter 6, Appendix 10 C (10)]. However, the action represents an exception to Categorical Exclusions (516 DM Chapter 2, Appendix 2, 2.3). The potential for a high volume blowout during the proposed activities may have highly controversial environmental effects. Therefore, an SEA was prepared.

This SEA implements the tiering process outlined in 40 Code of Federal Regulations (CFR) 1502.20 which encourages agencies to tier environmental documents eliminating repetitive discussions of the same issue. By use of reference to the most recent Final Environmental Impact Statement for the Gulf of Mexico for Lease Sales 169, 172, 175, 178, and 182 and by tiering, this SEA concentrates on environmental issues specific to the proposed action.

Figure 1
British Borneo
Proposed initial DOCD
in Green Canyon Blocks 254 & 298



B. The Proposed Action

On June 14, 1998, British-Borneo Exploration, Inc. filed an Initial Unit Development Operations Coordination Document to drill, complete and produce one subsea well (Well No. 1), commence production of four previously drilled subsea wells (Wells No.1, No. 3, No. 4ST#1, No. 5) and construct Platform A in Green Canyon Area Blocks 254 and 298. The proposed development area would be located approximately 90 miles south of Lafourche Parish, Louisiana (Figure 1). Water depths at the drilling site would be approximately 2,900 feet to 3,200 feet below sea level. The shorebase for this action would be Fourchon, Louisiana.

C. Issues

Would there be impacts to air quality from burning produced liquid hydrocarbons?

Would there be impacts to biological chemosynthetic communities in the drilling area?

Would there be impacts to the environment from an accidental release of oil from a high volume blowout in the drilling area?

Would there be impacts to Military Warning Area W-92 from boat or air traffic electromagnetic emissions?

D. The Decision to be Made on This Analysis

Should British-Borneo Exploration, Inc. be allowed to drill, complete and produce one new well, commence production of four previously drilled subsea wells and construct Platform A in Green Canyon Area Blocks 254 and 298, (OCS-G 7049, OCS-G 8010)?

II. The Alternatives Considered

A. Non-approval of the Proposal

The operator would not be allowed to drill, complete and produce one new well, commence production of four previously drilled subsea wells and construct Platform A in Green Canyon Area Blocks 254 and 298, (OCS-G 7049, OCS-G 8010)? This alternative would result in no impact from the proposed action, and could prevent development of much needed hydrocarbon resources and thereby result in loss of royalty income for the United States. Considering this aspect and the fact that minimal impacts are anticipated, this alternative was not selected.

B. Approval with Existing and/or Additional Mitigation

Measures which British-Borneo Exploration, Inc. proposes to implement to limit potential environmental effects are discussed in the Initial Unit Development Operations Coordination Document application submitted June 14, 1998. The following mitigation measures and recommendations will be included in MMS's approval of the proposed Initial Unit Development Operations Coordination Document to ensure environmental protection, consistent environmental policy, and safety as required by the National Environmental Policy Act, as amended:

1. Your plan indicates the burning of produced liquid hydrocarbons. Please be reminded that 30 CFR 250.1105 requires you to obtain approval from the Regional Supervisor for Production and Development prior to conducting the proposed burning activities.

2. Because there is a potential for exceeding the 3- and 24-hour SO_2 onshore ambient air concentration significance levels as prescribed by 30 CFR 250.303(e) during your proposed produced liquid hydrocarbon burn, please be advised that you will include updated information on the anticipated peak flow rates, durations, and sulfur content with your burn request submitted in accordance with 30 CFR 250.1105(c). If the projected sulfur content is less than one percent, you will also include in your burn request the results of an analysis of the liquid hydrocarbon to be burned or a correlative liquid hydrocarbon. Using the submitted information, this office will determine whether revision of your DOCD will be necessary pursuant to 30CFR 250.204(q)(1) before your flare request can be approved.

3. Please be reminded of your lease stipulation which requires you to enter into an agreement with the Naval Air Station, Air Operations Department, Air Traffic Division/Code 52, New Orleans, Louisiana 70146-5000 (contact ACC A. W. Thrift at 504/678-3100 or 504/678-03101) concerning the control of electromagnetic emissions and use of boats and aircraft in Military Warning Area W-92.

Minerals Management Service has established operating regulations and procedures to ensure that proposed activities are orderly, safe and pollution free. Minerals Management Service regulations (30 CFR 250 Subpart D and E) establish performance standards with which the lessee must comply when conducting OCS oil and gas drilling and well-completion operations. These regulations include requirements for specific equipment, redundant safety systems, testing of safety systems, and training, and are described as hydrocarbon spill prevention and operating safeguards in the following paragraphs.

During drilling, lessees are required to take necessary precautions to keep their wells under control at all times (30 CFR 250.400). Minerals Management Service has well casing and cementing requirements for all wells drilled on the OCS (30 CFR 250.404P). The quantities, characteristics, use, and testing of drilling muds and the related drilling procedures must be designed and implemented to prevent the loss of well control (30 CFR 250.408). Blowout Provender (BOP) systems must be designed, installed, used, maintained, and tested to assure well control (30 CFR 250.406-407). Redundancy within the BOP system is required by MMS to ensure safety and reliability. For example, this redundancy includes; multiple pipe rams and a shear ram capable of cutting drill pipe; redundant underwater hydraulic control manifolds; backup hydraulic reserves; multiple remote control panels; and redundant choke/kill lines.

Lessees must also conduct well control drills (30 CFR 250.408). These drills enhance the preparedness of the rig crews to deal with a well-control emergency and are in addition to the other safety training and drills (e.g.. fire, hydrogen sulfide). Both announced and scheduled annual inspections of offshore facilities are conducted by MMS to ensure that environmental protection equipment and safety equipment are installed and operating properly.

Proposed operations must meet or exceed the safety standards set by MMS. Minerals Management Service requires the use of the "Best Available and Safest Technology (BAST) for OCS operations. BAST requirements include state-of-the-art drilling technology and pollution control equipment (30 CFR 250.400). In an effort to provide state-of-the-art technology guidance to OCS operators drilling in deepwater environments, the International Association of Drilling Contractors (IADC) and the Offshore Operators Committee (OOC) have published a document entitled "IADC/OOC Deepwater Well Control Guidelines" (IADC, 1998). This document was designed to aid the oil and gas drilling industry by making them aware of the rapidly evolving technology and techniques dealing with deepwater operations. This document provides guidance for deepwater operators on the following topics: well planning, well control procedures, equipment, emergency response and training.

During well-completion operations, lessees are required to protect against harm or damage to life (including fish and other aquatic life), property, natural resources of the OCS including any mineral deposits (in areas leased and not leased), the national security or defense, or the marine, coastal, or human environment (30 CFR 250.500). Prior to engaging in well-completion operations, crew members are instructed in the safety requirements of the operations to be performed, possible hazards to be encountered, and general safety considerations to protect personnel, equipment, and the environment (30 CFR 250.506).

Well-control fluids, equipment, and operations shall be designed, utilized, maintained, and/or tested as necessary to control the well in foreseeable conditions and circumstances (30 CFR 250.514). The blowout preventer (BOP) system, system components and related well-control equipment shall be designed, used, maintained, and tested in a manner necessary to assure well control in foreseeable conditions and circumstances (30 CFR 250.515 - 516). Wellhead, tree, and related equipment shall have a pressure rating greater than the shut-in tubing pressure and shall be designed, installed, used, maintained, and tested so as to achieve and maintain pressure control (30 CFR 250.517). Subsurface safety equipment shall be installed, maintained, and tested in compliance with regulations outlined in Subpart H - Oil and Gas Production Safety Systems.

III. Environmental Effects

A. Introduction

In accord with *The National Environmental Policy Act (NEPA) of 1969, as amended (Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, § 4(b), Sept. 13, 1982)* and the Council on Environmental Quality (CEQ) implementing regulations 40 CFR Sec. 1502.15 *Affected Environment*, the following potential environmental effects were identified from the proposed action. Mitigative measures are included to eliminate or reduce the potential effect from the proposed activities to a level no significance as described in 40 CFR Sec. 1508.27.

B. Air Quality

The projected air emissions submitted, by British-Borneo, for this project are below the MMS exemption levels. This would be a temporary mooring system, and by definition it is a temporary source. As a temporary source, PSD Class I new source review (NSR), by FWS is not required. The proposed well test includes the burning of 5000 barrels of oil per day for two days. Since it is not possible to rule out the possibility of this exceeding the 3-hour and 24-hour significance level for sulfur dioxide, Mitigation 2.10 (Potential to exceed SO_2 significance levels) has been placed on this proposal. The Minerals Management Service regulations at 30 CFR 250.1105(a)(3) allow the Regional Supervisor to restrict flaring operations which degrade air quality. The approval of this plan does not grant approval of the proposed flaring and burning operations. British-Borneo is required to obtain separate approval of the flaring and burning operations from the Regional Supervisor, Production and Development prior to conducting the proposed burning activities, as stated in Mitigation 2.9. (See Appendix B).

C. Chemosynthetic Communities

The geophysical survey maps and survey reports summarized in the chemosynthetic community review (Appendix B) conducted by Environmental Geo-Sciences, Inc., Technical Disciplines, Inc., Geo-Sciences, Inc. and a 3-D survey by Diamond Geophysical for British Borneo indicate no areas to be contacted by the wells, their anchors and chains or platform have characteristics indicative of chemosynthetic communities. A dynamically positioned vessel will be used for the platform construction, so impacts beyond the drill hole will not occur. However, a semi-submersible vessel will be used for the previously drilled wells, so impacts beyond the drill holes could occur.

A general description of chemosynthetic communities and the site-specific review of chemosynthetic communities in the proposed project area are included in Appendix B.

D. Oil Spills

The potential oil spills analyzed are all considered accidental, ranging from diesel fuel releases from storage tanks on the offshore rig, diesel fuel releases from transfers from the supply vessels to the rig, and hydrocarbon spills as a result of a blowout. (See the Accidental Hydrocarbon Discharge Analysis in Appendix C).

E. Military Warning Areas

The proposed activities would be located in Military Warning Area W-92 . When operating in this area, oil and gas lessees or their contractors coordinate with the appropriate base commander. These coordinating efforts reduce impacts, particularly for safety, and also control electromagnetic emissions to prevent unacceptable interference to Department of Defense operations.

F. Other Environmental Effects

Other environmental effects were considered but potential impacts from the proposed activities were deemed insignificant (40 CFR 1508.27) and are not discussed in this SEA. Examples of these include: Archaeological Resources, Recreational Resources, Socioeconomic Conditions.

IV. Consultation With Other Agencies

None.

V. References

British-Borneo Exploration, Inc. 1998. Initial Unit Development Operations Coordination Document N-6222U Application.

U.S. Department of the Interior. Minerals Management Service. 1996. Final Environmental Impact Statement. Gulf of Mexico Sales 166 and 168: Central and Western Planning Areas. OCS EIS/EA MMS 96-0058. Washington, D.C. Available from NTIS, Springfield, VA. Volume I, and Volume II.

U.S. Department of the Interior. Minerals Management Service. 1997. Final Environmental Impact Statement. Gulf of Mexico Sales 169, 172, 175, 178 and 182: Central and Western Planning Areas. OCS EIS/EA MMS 97-0033. Washington, D.C. Available from NTIS, Springfield, VA. Springfield, VA. Volume I, and Volume II.

VI. Preparers

Coordinator: Robert M. Gillard, Ph.D. - Environmental Scientist

Preparers: Robert M. Gillard, Ph.D. - Environmental Scientist
Darice Breeding - Physical Scientist
Liz Peuler- Supervisor Environmental Protection Specialist
Terry Scholten - Air Quality Specialist
Sam Holder - Natural Resource Specialist
Greg Boland, Ph.D. - Biologist

Editor: Liz Peuler- Supervisory Environmental Protection Specialist
Clay Pilié - Acting Supervisory Environmental Protection Specialist

Typist: Joanne Waite - Secretary

VII. Appendices

Appendix A Air Quality Review

Appendix B Chemosynthetic Community Reviews

Appendix C Oil Spill Review

APPENDIX A

Air Quality Review

DESCRIPTION OF THE ENVIRONMENT: AIR QUALITY

These operations will occur west of 87.5 degrees west longitude and hence falls under MMS's jurisdiction for enforcement of the Clean Air Act. The air over the OCS water is not classified, but is presumed to be better than the National Ambient Air Quality Standards for all criteria pollutants. The blocks involved are offshore, approximately 90 miles south of Lafourche Parish, Louisiana. Lafourche Parish currently classified as nonattainment (incomplete data) for the 1-hour ozone National Ambient Air Quality Standard (NAAQS); it is in attainment of all other applicable ambient air quality standards.

The primary meteorological influences upon air quality and the dispersion of emissions are the wind speed and direction, the atmospheric stability, and the mixing height.

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 do blow from all directions in the area of concern.

Not all of the Pasquill-Gifford stability classes are commonly found offshore in the Gulf of Mexico. Specifically, stability class F is rare, this is the extremely stable condition which typically develops at night over land with rapid radiative cooling; this large body of water is simply incapable of losing enough heat overnight to set up a strong radiative inversion. Likewise, stability class A is also rare. It is the extremely unstable condition which requires a very rapid warming of the lower layer of the atmosphere, along with cold air aloft. This is normally brought about when cold air is advected in aloft and strong insolation rapidly warms the earth's surface, which in turn, warms the lowest layer of the atmosphere. Once again, the ocean surface is incapable of warming rapidly and, therefore, you would not expect to find stability class A over the ocean. For the most part, the stability is neutral to slightly unstable.

The mixing heights offshore are quite shallow, 900 m or less. The exception to this is close to shore, where the influence of the land penetrates out over the water for a short distance. Transient cold fronts also have an impact on the mixing heights; some of the lowest heights can be expected to occur with frontal passages and on the cold air side of the fronts. This effect is caused by the frontal inversion.

EFFECTS ON AIR QUALITY

The projected air emissions submitted by British-Borneo, for this project are below the MMS exemption levels. These projections are required to represent the worst case, and therefore should be higher than the actual emissions to be emitted. The emissions are summarized below:

EMISSIONS (Tons)

	No_x	CO	SO_x	VOC	TSP
1998	32.27	7.04	4.37	0.97	0.70
1999	875.84	164.59	104.65	139.72	13.64
2000	332.56	51.60	7.88	263.25	1.99
2001	780.12	183.02	103.51	29.34	20.98
2002	780.12	183.02	103.51	29.34	20.98
2003	780.12	183.02	103.51	29.34	20.98
2004	780.12	183.02	103.51	29.34	20.98
2005	780.12	183.02	103.51	29.34	20.98
MMS Exemption Level	2,997.00	69,314.07	2,997.00	2,997.00	2,997.00

The proposed well test includes the burning of 5000 barrels of oil per day for two days. From the little information provided it is not possible to rule out the possibility of this exceeding the 3-hour and the 24-hour significance level for sulfur dioxide (SO_2). Information on the sulfur content of the liquid and on the maximum 3-hour and maximum 24-hr flow rates are needed to adequately quantify the maximum 3-hour and 24-hour emission rates and from these compute the potential onshore impacts.

MMS SO_2 SIGNIFICANCE LEVELS ONSHORE IMPACT ($\mu g/m^3$)

Averaging Period	Onshore Concentration
Annual	1
24-hour	5
3-hour	25

Assuming a 1.00 percent by weight sulfur content in the liquid, and a maximum burn rate of 208.3 barrels per hour, the emission rate from the liquids would be 1,375 pounds per hour of SO_2. Some simple screening computations were made using SCREEN3, a U.S. EPA approved screening model to examine the impact on the offshore environment. Based on the listed assumptions, the SCREEN3 results indicate that this proposed burn would have a significant impact on air quality in the offshore environment as the ambient air concentrations within 8.5 km of the source could potentially exceed the 5-min intervention level (IL). This level was established by the U.S. EPA to protect people from acute respiratory problems caused by elevated levels of SO_2.

U.S. EPA AMBIENT AIR QUALITY STANDARDS
($\mu g/m^3$)

Reference Standard	Averaging Period	Concentration
NAAQS	Annual	235 $\mu g/m^3$
NAAQS	24-hour	365 $\mu g/m^3$
NAAQS	3-hr	1,300 $\mu g/m^3$
IL	5-min	1,565 $\mu g/m^3$

The Minerals Management Service regulations at 30 CFR 250.1105(a)(3) allow the Regional Supervisor to restrict flaring operations which degrade air quality. The approval of this plan does not grant approval of the proposed flaring and burning operations. British-Borneo is required to obtain separate approval of the flaring and burning operations from the Regional Supervisor, Production and Development. During that process the flaring and burning operations will be reviewed again. Further information will be needed at that point to evaluate the requested operations, specifically the maximum sulfur content by weight of the liquid to be burned and the maximum 3-hour and 24-hour burn rates will be necessary to evaluate the burn.

SO_2 primarily affects the lung tissues. When SO_2 oxidizes in water, it produces both sulfurous and sulfuric acids. If SO_2 dissolves in the water of the respiratory tract, the resulting acidity is irritating to the pulmonary tissues. Adverse health effects associated with elevated concentrations of SO_2 include effects on breathing, respiratory illness, and aggravation of existing respiratory and cardiovascular illness. Asthmatics, even those on medication and under control, are most at risk.

UNAVOIDABLE IMPACTS:

Development activities in and around the proposed facility in Green Canyon 254 will result in a minor impact to air quality in the immediate area of the facility. Long range transport of the air pollutants can result in a small incremental increase in ambient air concentrations of these pollutants at onshore areas.

Air quality will be affected if a blowout occurs. Volatile organic hydrocarbons would be released to the atmosphere. The VOCs in the released hydrocarbons are precursors to photochemically produced ozone. If a fire occurs during the blowout, particulate and combustible emissions will be released.

MITIGATION:

Mitigation 2.9 - Burning of produced liquid hydrocarbons

Your plan indicates the burning of produced liquid hydrocarbons. Please be reminded that 30 CFR 250.1105 requires you to obtain approval from the Regional Supervisor for Production and Development prior to conducting the proposed burning activities.

Mitigation 2.10 - Potential to exceed SO_2 significance levels (Burning)

Because there is a potential for exceeding the 3- and 24-hour SO_2 onshore ambient air concentration significance levels as prescribed by 30 CFR 250.303(e) during your proposed produced liquid hydrocarbon burn, please be advised that you will include updated information on the anticipated peak flow rates, durations, and sulfur content with your burn request submitted in accordance with 30 CFR 250.1105(c). If the projected sulfur content is less than one percent, you will also include in your burn request the results of an analysis of the liquid hydrocarbon to be burned or a correlative liquid hydrocarbon. Using the submitted information, this office will determine whether revision of your DOCD will be necessary pursuant to 30 CFR 250.204(q)(1) before your flare request can be approved.

REFERENCES:

U.S. Environmental Protection Agency. 1993. Compilation of air pollutant emission factors/ Volume I: stationary point and area sources. AP-42, fifth edition. Research Triangle Park, NC: U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 1998. Green book, nonattainment areas for criteria pollutants. http://www.epa.gov/oar/oaqps/greenbk/o1hna.html

U.S. Environmental Protection Agency. 1998. SCREEN3 model and user's guide.

APPENDIX B

Chemosynthetic Community Reviews

Deep Water Chemosynthetic Communities

The deepwater chemosynthetic communities consist of organisms that are most abundant in water deeper than 400 m and that derive their energy, in the absence of light, from chemosynthetic processes rather than the photosynthetic processes of shallow water. The primary chemosynthetic organisms are bacteria, both free-living as bacterial mats and symbiotic in the tissues of other organisms.

Most of the following is from the U.S. Department of Interior (1997). Chemosynthetic clams, mussels, and tube worms, have been discovered in association with hydrocarbon and H_2S seeps in the northern Gulf of Mexico. Although these communities are widespread across the northern Gulf of Mexico slope and often form dense populations, they are sometimes found in very sparse concentrations of less than one animal per m^2. The occurrence of chemosynthetic organisms dependent on hydrocarbon seepage has been documented in water depths as shallow as 290 m (Roberts et al., 1990), but the most dense aggregations of these organisms have been found at water depths of around 500 m and deeper.

The geographic range of chemosynthetic communities in the Gulf of Mexico, has been found to include the Texas, Louisiana, and Alabama continental slope with a depth range varying from less than 500 m to 2,200 m (MacDonald, 1992). Four general community types have been described by MacDonald et al. (1990). These are communities dominated by vestimentiferan tube worms (*Lamellibrachia c.f. barhami* and *Escarpia* n.sp.), mytilid mussels (Seep Mytilid Ia, Ib, and III), vesicomyid clams (*Vesicomya cordata* and *Calyptogena ponderosa*), and infaunal lucinid or thyasirid clams (*Lucinoma* sp. and *Thyasira* sp.). Recently, in July, 1997, populations of an unidentified species of ice worm have been found in abundance and should be added to the list. These faunal groups tend to display distinctive characteristics in terms of how they aggregate, the size of aggregations, the geological and chemical properties of the habitats in which they occur and, to some degree, the heterotrophic fauna that occur with them. Heterotrophic species at seep sites are a mixture of species unique to seeps and those that are a normal component from the surrounding environment.

All evidence indicates that hydrocarbon seeps and the associated chemosynthetic communities persist in the same locations for long time periods (Powell, 1993). Powell has estimated mussel communities persisting in the same sites for 2,000-4,000 years. A lucinid clam community was estimated persisting at a seep location for more than 3,500 years and a thyasirid clam bed was found to persist in a seep location for 500-1,000 years. He found general consistency with few cases in which the community type changed (from mussel to clam communities, for example) or had disappeared completely.

Recovery of impacted communities would be slow. Initial evidence indicates that tube worm communities are relatively slow growing, with larger tube worms estimated to be over 200 years old (MacDonald, 1993). MacDonald found that juvenile mussels at hydrocarbon seeps initially grow rapidly, but the growth rate drops markedly in adults. Attempts to measure the growth rates in clams have been unsuccessful to date. Recolonization experiments of denuded seep communities indicate no visible recolonization of tube worm communities over the three-year period of the study, and no visible larval recruitment or adult immigration in disturbed mussel areas.

Chemosynthetic communities have been a source of controversy over the past few years, in part because of the unusual environmental requirements and the hypothesized sensitivity of the communities to oil and gas activities. Industry does not normally target the low-pressure zones that sustain chemosynthetic organisms. If industry did produce from reservoirs supporting chemosynthetic organisms, MMS believes it is unlikely that an operator could withdraw hydrocarbons to the extent that it would deplete the food supply.

Potential adverse impacts to deepwater chemosynthetic communities would come from OCS-related bottom disturbing activities associated with pipelaying, anchoring and structure emplacement, as well as from a seafloor blowout. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area with recovery requiring years. Dense chemosynthetic communities are protected from OCS activities because, although at least 43 community sites have been located across the northern Gulf of Mexico continental slope, they are considered rare, slow to recover and of great scientific interest and importance. Companies conducting activities at water depths greater than 400 m must analyze for the likeness of community presence as part of their multisensory geophysical survey required for the action. As described in the Chemosynthetic Community review, Appendix A, the proposed developmental action should not disturb chemosynthetic communities and no mitigative measures will be required for the protection of potential communities on this proposed plan.

Literature cited

MacDonald, I.R. 1992. Chemosynthetic ecosystems study literature review and data synthesis, volumes I-III. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 92-0033 through 92-0035.

MacDonald, I.R. 1993. Presentation at the Thirteenth Gulf of Mexico Transfer Meeting. Sponsored by the Minerals Management Service, Gulf of Mexico OCS Region, December 4-6, 1993, New Orleans, LA.

MacDonald, I.R., N.L. Guinasso, Jr., J.F. Reilly, J.M. Brooks, W.R. Callender, and S.G. Gabrielle. 1990. Gulf of Mexico hydrocarbon seep communities: VI. Patterns in community structure and habitat. Geo-Marine Letters. 10:244-252.

Powell, E.N. 1993. Presentation at the Thirteenth Gulf of Mexico Transfer Meeting. Sponsored by the Minerals Management Service, Gulf of Mexico OCS Region, December 4-6, 1993, New Orleans, LA.

Roberts, H.H., P. Aharon, R. Carney, J. Larkin, and R. Sassen. 1990. Sea floor responses to hydrocarbon seeps, Louisiana c continental slope. Geo-Marine Letter. 10(4): 232-243.

U.S. Department of the Interior. Minerals Management Service. 1997. Final Environmental Impact Statement. Gulf of Mexico Sales 169, 172, 175, 178, and 182: Central Planning Areas. OCS EIS/EA MMS 97-0033. Washington, D.C. Available from NTIS, Springfield, VA. Volume I, and Volume II.

September 15, 1998

Biochemosynthetic Community Review

Green Canyon Area, Blocks 254, 298, 297 (BH)
Lease OCS-G 7049, 8010, 8876
DOCD NO. N-6222U

This review results from 4 previous chemosynthetic reviews and 4 surveys conducted on the same array of blocks. The chemosynthetic reviews are for plans; N-1853, R-2685 in Block GC 254; S-3759U, S-3762A for Block GC 298 with anchors in GC 297. The multisensory surveys are: from Environmental Geo-Sciences, Inc. for Exxon in GC 254, GC 297 in 1989; Technical Disciplines, Inc. in GC 297 for Ensearch Exploration, Inc. in 1989; Geo-Sciences, Inc. for Reading & Bates Development Co. in GC 253, 297 and a 3-D survey by Diamond Geophysical for British Borneo conducted and reviewed for this plan.

Although there is possibility of chemosynthetic communities in the areas covered in the surveys, none are within the bottoms to be effected by the present development plan. According to British Borneo (personal communication), the anchor pattern of the proposed Well No. 1 in GC Block 298 will be essentially identical to that of the well cleared and drilled previouslu for Plan S-3759U.

Following from this conclusion, therefore, no mitigative measures will be required for approval of this plan. However, should future activities be proposed for this block in areas other than those proposed in this plan, additional analyses will be required, and mitigative measures may be imposed.

Robert M. Gillard, Ph.D.

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APPENDIX C

Oil Spill Review

ATTACHMENT A
ACCIDENTAL HYDROCARBON DISCHARGE ANALYSIS

Prepared for British Borneo Exploration, Inc. proposal for the installation of Platform A (TLP) (Allegheny Project) in Green Canyon Block 254, the drilling and completion of well no. 1 in Green Canyon Block 298 and the production of 4 previously drilled and completed wells in Green Canyon Blocks 254 and 297 - N-6222

1. Hydrocarbon Spill Accidents

A. Potential Sources of A Spill As A Result Of The Proposal

This proposal covers the installation of Platform A (TLP) (Allegheny Project) in Green Canyon Block 254, the drilling and completion of well no. 1 in Green Canyon Block 298 and the production of 4 previously drilled and completed wells in Green Canyon Blocks 254 and 297. The no. 1 well in Green Canyon Block 298 will be drilled and completed with the semi-submersible drilling rig (MV "Atwood Hunter"). All of the wells will be subsea. The single column TLP will be installed in approximately 3300 feet of water.

Production from the subsea wells will flow via 4-inch steel catenary risers back to the tension leg platform. Flexible control umbilicals will run from the TLP to the wells. Oil and gas production will flow from the TLP by proposed 12-inch oil and gas right-of-way steel catenary risers/pipelines to a point approximately four miles away in a northeast direction.

Potential sources of hydrocarbon spills from the proposed operations would include:

- the loss of hydrocarbons during the proposed operations;
  - resulting from a storage tank(s) accident on the TLP;
  - during a transfer operation mishap(s) between the supply vessel and the TLP;
- the loss of hydrocarbons as a result of a blowout; and
- the loss of hydrocarbons as a result of a pipeline spill

- TLP Storage and Transfer Operations

The TLP will have a storage capacity totaling approximately 3117 bbl for liquid oils. The largest capacity liquid oil tank can hold 2,036 bbl. Supply vessels will make approximately 3 to 4 trips per week to the proposed location during the drilling and completion activities and approximately 2 trips per week during the production activities during which the transfer of hydrocarbon products could occur. The following table lists the storage capacity for the tanks identified by British Borneo as capable of holding liquid oils by oil type and volume:

Table 1. Storage of Liquid Oils

Type of Storage	No. of Storage Vessel(s)	Maximum Capacity (bbls)
Test Separator	1 Tank	63
Oil Tanks	2 Tanks	450
HP Separator	1 Tank	338
LP Separator	1 Tank	230
Treater	1 Tank	2036
Total	6 Tanks	3117

* British Borneo indicates that the produced oil will be transported by pipeline.

- **Blowouts**

Blowouts can occur during any phase of development: exploratory drilling, development drilling, completion, production, or workover operations. Blowouts occur when improperly balanced well pressures result in sudden, uncontrolled releases of fluids from a wellhead or wellbore. Historically, since 1971, most blowouts have resulted in the release of gas, blowouts resulting in the release of oil has been rare (see Section I.B.).

Although not a new potential source of spills, the likelihood of spills from loss of control (blowouts) in deepwater may be different from the risk of spills in shallow water. Further investigation is required before the consequences of blowouts in deep water can be fully evaluated. Of particular concern is the ability to stop well control loss once it begins, thus limiting the size of a spill. Regaining well control in deepwater may be a problem since it could require the operator to cap and control well flow at the seabed in great water depths (in this instance, over 3,300 feet) and could require simultaneous fire-fighting efforts at the surface. In addition, the availability of rig, riser, and associated deepwater drilling equipment may be limited at the time of a spill.

In the event that a subsea blowout occurs the intervention that would most likely be employed to regain control of the well would be the drilling of a relief well. Drilling an intervention well could take anywhere from 30 to 90 days (Regg, 1998; Stauffer, 1998; McCarrel, 1998). The actual amount of time required to drill the relief well will depend upon the complexity of the intervention, the location of a suitable rig, the type of operation that must be terminated in order to release the rig (e.g. may need to run casing before releasing the rig), and any problems mobilizing personnel and equipment to the location. If another rig is needed to conduct the intervention and it can be obtained in the GOM, it is estimated that the entire intervention effort for a subsea blowout could take anywhere from 60 -120 days (Regg, 1998; Stauffer, 1998; McCarrel, 1998).

- **Pipeline Spills**

The installation of pipelines in deepwater raises some unique concerns regarding the potential for oil spills. One of these concerns is the ability for surface detection of a leak from a deepwater pipeline. Because natural gas solubilities increase by orders of magnitude in deepwater and because of the oil densities, surface detection may be almost impossible. Leaks may be detected by pressure drops in the lines and confirmed by ROV inspection. Additional concerns are the ability to timely repair damage to deepwater pipelines and the unknowns regarding the potential effects of the steep terrain prevalent in some deepwater areas on pipelines.

B. Historical Spill Information

- **Storage and Transfer Operation Spills**

The Minerals Management Service's database on diesel spills that occurred from drilling operations conducted on the OCS between 1976 and 1985 was analyzed. These years were chosen because they appeared to be the most complete recording of these events. From 1976 to 1985, there were approximately 80 reported diesel spills > 1 bbl related to OCS drilling. There is no information available on diesel spills ≤ 1 bbl. Although none of the diesel spill events captured in the MMS database for 1976-1985 involved TLPs, it is assumed that the recorded events are representative of diesel spill events that could involve this type of facility.

Sixty of the 80 diesel spills (75 percent) in the MMS database occurred as a result of an accident during transfer operations. The majority of transfer accidents occurred due to human error of some type (personnel falling asleep, unmanned transfer operations, etc.) and, secondly, due to the malfunction or failure of the transfer equipment, which was sometimes due to weather conditions. Requirements now exist that reduce the risk of some of the transfer accidents historically caused by human error. Causes of the spills that were not associated with transfer mishaps were equally divided between equipment malfunctions/failures involving the fuel tanks on a rig and collisions involving supply vessels. Of the 80 spills > 1 bbl reported, 8 occurred due to collisions involving vessels. Difficulties with deepwater operations that could cause diesel spill events are not reflected in this data.

Historically, diesel spill sizes from OCS operations have ranged from < 1 bbl to 1,500 bbl. A vessel collision was the cause of the only diesel spill > 1,000 bbl to occur during drilling. In 1979, an anchor-handling boat collided with a drilling platform in the Main Pass Area and released 1,500 bbl of diesel. Of the 80 diesel spills > 1 bbl occurring from 1976 to 1985, approximately 65 involved spills > 1 bbl but < 50 bbl, 15 cases involved spills > 50 bbl. Of these 15 larger spills, only 10 were > 100 bbl, and only one was > 1,000 bbl (MMS, OCS Events File, 1995). The mode of these data is 2 bbl, the median spill is 5 bbl, and the average spill is 68 bbl (skewed due to the 1,500-bbl spill).

The likelihood of a diesel spill occurring from drilling operations is based on comparing the total number of diesel spills found in the MMS database with the number of OCS well starts reported for this same time period and by applying the Poisson process (USDOI, MMS, 1997). During 1976-1985, the time period that includes the 80 spills, there were approximately 11,944 well starts reported for OCS leases (USDOI, MMS, 1997). Applying these statistics to the drilling scenario proposed by British Borneo (i.e., the drilling of 1 well), there is:

- an 0.7 percent probability that a diesel spill > 1 bbl would occur;
- a 0.5 percent probability that a diesel spill between 1 and 50 bbl would occur;
- a 0.12 percent probability that a diesel spill > 50 bbl would occur; and
- less than a 0.008 percent probability that a diesel spill > 1,000 bbl would occur.

\- **Blowouts and Production Related Spills**

In order to enhance the prevention of blowouts, MMS has identified requirements for well control and blowout prevention equipment, procedures, and inspections as specified in 30 CFR 250.406 - 409 and 30 CFR 250.514 - 516.

From 1971 to 1995, a total of 899 bbl of crude oil and condensate were spilled in 17 of 101 development drilling and nondrilling blowout events that occurred from facilities and operations on the federal OCS (USDOI, MMS, 1995). From 1971 to 1995, there were 24,237 wells drilled, thus the historical record indicates that there is a spill rate of 0.0007 per well for a blowout with a release of oil to occur.

Data maintained since 1964 on spills of 1000 bbl or greater from offshore platforms and pipelines have documented only 11 spills of 1000 bbl or more from platforms on the OCS (all OCS areas included). The majority of these spills occurred due to bad weather conditions. This spill event data, in conjunction with the historic production of OCS leases, allow the estimation of a spill rate. This spill rate has not been uniform through time and several revisions have been made (Nakassis, 1982; Lanfear and Amstutz, 1983; Anderson and Labelle, 1990; Anderson and Labelle, 1994). The latest revisions in the spill rate found a decrease in the spill rate for platforms (Anderson and Labelle, 1990; Anderson and Labelle 1994). These reductions were attributed to improved safety practices in the oil industry. Based on historical data, MMS has estimated the rate at which spills occur from platforms for oil spills larger and or equal to 1000 bbl as 0.45 spills per billion bbl produced.

The probability that an oil spill of 1000 bbl or larger will occur from the proposed platform is estimated using a Poisson Distribution and using the spill rate of 0.45 spills per billion bbl produced (Anderson and Labelle, 1994). The other parameter needed to determine this probability would include the amount of oil produced (estimated to be on average 9,640 BOPD), which in this case would be time dependant. A longer period of time would increase the probability because the amount of oil produced would increase. Using this information, the following table presents the time period, the amount of oil produced by the platform, and the probability of one or more spills of 1000 bbl or greater occurring:

TIME	HYDROCARBONS PRODUCED (Bbbl)	PROBABILITY*
Month	0.0003	0.013%
Year	0.003	0.13%
10 Years	0.03	1.3%

*It should be noted that the probability of an oil spill depends very strongly on the volume produced. If the wells maintain the estimated peak production rate of 25 MBOPD, then the probability for an oil spill would increase substantially.

The historical record shows that there have only been four large oil spills exceeding 10,000 bbl as a result of OCS activities (all OCS areas included) - of which two resulted from platforms. These two platform spills resulted from blowouts , which along with the Santa Barbara blowout incident , prompted the implementation of new and stringent operation regulations pertaining to drilling procedures, subsurface safety valves, and platform safety devices. Based on historical data, MMS has estimated the rate at which spills occur from platforms for oil spills larger and or equal to 10,000 bbl as 0.16 spills per billion bbl produced.

The probability that an oil spill of 10,000 bbl or larger will occur from the proposed platform is estimated using a Poisson Distribution and using the spill rate of 0.16 spills per billion bbl produced (Anderson and Labelle, 1990). The other parameter needed to determine this probability would include the amount of oil produced (estimated to be on average 9,640 BOPD), which in this case would be time dependant. A longer period of time would increase the probability because the amount of oil produced would increase. Using this information, the following table presents the time period, the amount of oil produced by the platform, and the probability of one or more spills of 10,000 bbl or greater occurring:

TIME	HYDROCARBONS PRODUCED (Bbbl)	PROBABILITY*
Month	0.0003	0.005%
Year	0.003	0.05%
10 Years	0.03	0.48%

* It should be noted that the probability of an oil spill depends very strongly on the volume produced. If the wells maintain the estimated peak production rate of 25 MBOPD, then the probability for an oil spill would increase substantially.

The probability estimates do not reflect unforeseen natural events such as hurricanes or geologic events. Probabilities for up to 10 years are provided in the tables because the estimated life of the reserves is projected by the operator to be 10 years. Please note that the historical database used as the basis to the above discussion reflects drilling in the shallower shelf waters. Because of differences in deepwater drilling operations it can not yet be determined with any degree of certainty whether this same trend will continue in the deepwater areas of the OCS.

- **Pipeline Spills**

For spills occurring in federal waters and greater than or equal to 1,000 bbl, the spill rate is 1.32 spills/Bbbl of produced oil for Outer continental Shelf pipelines. This pipeline spill rate is based on the entire OCS production (transportation) record and all historic pipeline spill records (12 spills/9.1 Bbbl transported). Since details regarding the proposed pipelines were not provided in this application, probabilities for a spill to occur from the pipeline(s) that will be associated with the TLP will not be determined in this analysis.

C. Spill Volume(s) To Be Analyzed

To comply with the requirements at 30 CFR 254, the operator has provided an estimated worst case spill volume for the proposed activity. The worse case scenario provided by British Borneo assumes that a blowout would result in a release of 16,000 bbl of oil per day. (British Borneo , 1998).

This EA will analyze a 16,000 bbl/day blowout over both a 60 and a 120 day time period. The 60 and 120 day time periods were selected to represent the range of time it could take to control a deepwater blowout (refer to the discussion in Section I.A. Blowouts). In addition, this analysis will also consider, as a separate scenario, the loss of the entire contents of the hydrocarbon storage tanks (3117 bbl) on the TLP.

2. Vulnerability of Potentially Affected Resources To Hydrocarbon Spills

- **Subsurface Spill Movement**

Since research funded by MMS to determine oil spill behavior from subsurface well blowouts in deepwater is currently underway, this analysis does not attempt to predict or model the potential movement of an oil slick while it is subsurface.

- **Surface Spill Movement**

The likelihood that a surface slick occurring in deepwater can be transported to shore was determined by the most recent Oil Spill Risk Analysis (OSRA) model (Price et.al., 1997). The offshore oil spill launch areas used in this OSRA model were determined by subdividing the

OCS into broad areas determined by water depth. The results of this OSRA run indicate that there is a 19 percent probability that a hypothetical spill could reach the U.S. shoreline within 30 days if it occurred from the TLP.

In addition, the OSRA run for Lease Sales 157 and 161 (USDOI, MMS, 1994), which subdivides the offshore GOM into 132 oil spill launch areas, indicates that should a spill occur in the subject lease blocks and persist in the environment for 30 days, there is a probability for the spill to impact the coastal area ranging from Matagorda County , Texas, to Plaquemines Parish, Louisiana. This OSRA run indicates that a spill from the subject block could impact the shoreline in Terrebone Parish, Louisiana within 10 days. This same OSRA run indicates that there would be a less than 0.5 percent chance for a spill from the subject blocks to impact any shoreline area within 3 days. The following table presents the 10 and 30 day OSRA results for Lease Sales 157 and 161.

Table 3. Conditional Probabilities (Expressed As A Percent Chance) That An Oil Spill From The TLP Will Contact A Certain Land Segment Within 10 or 30 Days, Gulf of Mexico OCS Lease Sales 157 and 161

Land Segment	Conditional Probabilities for 10 Days (expressed as a percent chance)	Conditional Probabilities for 30 Days (expressed as a percent chance)
Matagorda, Texas	n*	1
Brazoria, Texas	n	n
Galveston/Chambers, Texas	n	1
Jefferson Texas	n	1
Cameron, Louisiana	n	6
Vermilion, Louisiana	n	4
Iberia, Louisiana	n	4
St. Mary, Louisiana	n	1
Terrebonne, Louisiana	1	8
Lafourche, Louisiana	n	3
Jefferson, Louisiana	n	1
Plaquemines, Louisiana	n	2

* n = less than 0.5%.

Although the oil spill scenario analyzed in this SEA could continue for up to 120 days, the OSRA model results discussed in this section are limited to 30 day runs. It is expected that if the OSRA model considered the full 60 or 120 day blowout scenarios that the results would indicate potential impacts to a much broader shoreline area.

3. Assumptions about the Characteristics and Fates of Spilled Hydrocarbons

- Characteristics of Hydrocarbons

Information submitted by British Borneo indicates that a crude oil having an average API of 28 is expected. Additional information regarding the estimated chemical characteristics of the oils that will be handled transported or stored at the TLP is included in British Borneo's submittal.

- Subsurface

The form that a slick will take if released during a subsea blowout may be very different from oil spilled at the surface and may affect the residence time of the slick. Very little is understood about the chemical behavior, transport, and physics of the rising plume during a subsea blowout, under the temperature and pressure conditions encountered in deepwater. A recently completed modeling effort showed that hydrates might form from some of the gaseous components in a blowout fluid. A deepwater blowout study funded by MMS (Ross, 1997) modeled the fate of a release of 30,000 bbl of oil per day and 60 million cubic feet of gas per day during a deepwater blowout. One of the scenarios modeled assumed a blowout in water depths greater than 900 meters. Blowouts at this depth are expected to result in a very fast conversion of all of the gas to hydrate and the oil is expected to rise to the water surface due only to its buoyancy.

In contrast, field trials and modeling efforts recently completed by IKU Petroleum Research (Rye and Brandvik, 1997) showed that the stratification of the ambient water masses may prevent the subsurface plume from reaching the sea surface. If the oil were to reach the sea surface, it could be far from the spill's subsea origin. It may consist of oil droplets that form a very thin surface slick spread over a larger area, accelerating the speed at which the slick breaks up and dissipates. Not all of the oil originally released is expected to reach the surface in the form of a surface slick. Minerals Management Service, in collaboration with industry, is currently funding a study that will provide an in depth analysis of oil spill behavior from subsurface well blowouts in deepwater. A complete analysis of this issue cannot be completed until the results of this study effort are available.

- Surface

The NOAA Automated Data Inquiry (ADIOS) calculations essentially predict the material balance of spilled hydrocarbons as a function of time assuming the spilled oil is not transported subsea. For the evaluation of this proposed action, the ADIOS program was run for several different scenarios.

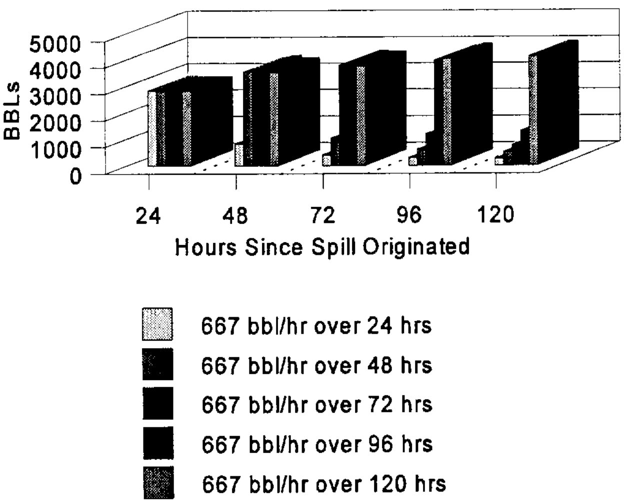
The first scenario assumed a surface release of a representative diesel fuel oil with a hypothetical spill volume of 3117 bbl. The representative diesel fuel oil used in this ADIOS model run has an API gravity of 31.6 and a pour point between -27.0 degrees C and -6.0 degrees C. The scenario used assumed the immediate loss of 3117 bbl of diesel fuel oil under conservative winter conditions (20.1 degrees C sea surface temperature and low wind speeds (6 knots) with no frontal passages).

The ADIOS model results for the first scenario (3117 bbl instantaneous diesel spill) indicate that over 90 percent of a diesel slick of this size will either evaporate or disperse within 114 hours. After 114 hours the model results indicated that approximately 269 bbl of spilled hydrocarbons could remain on the water surface. Based upon extrapolations of the results of this hypothetical ADIOS model run it is not anticipated that a 3117 bbl diesel oil slick would persist on the water surface for more than 10 days.

Because the ADIOS model runs are limited to a maximum timeframe of five days, seven spill scenarios were run in an attempt to determine trends which would assist in predicting the fate of a 60 and a 120 day oil spill event that could potentially spill at a rate of 16,000 bbl/day. An oil having chemical characteristics as similar as possible to the crude oil that the operator projected they might encounter during drilling was chosen as an input for these six scenarios. The representative oil used in these ADIOS model runs has an API gravity of 27.0. Since little information is available regarding the fate of oil that is either released subsurface at these water depths (greater than 3000 feet) or that remains subsurface, for these scenarios, a surface slick of these volumes was assumed.

Figure 1. Volume of Oil Lost Per Day/16,000 BBL/Day Scenario

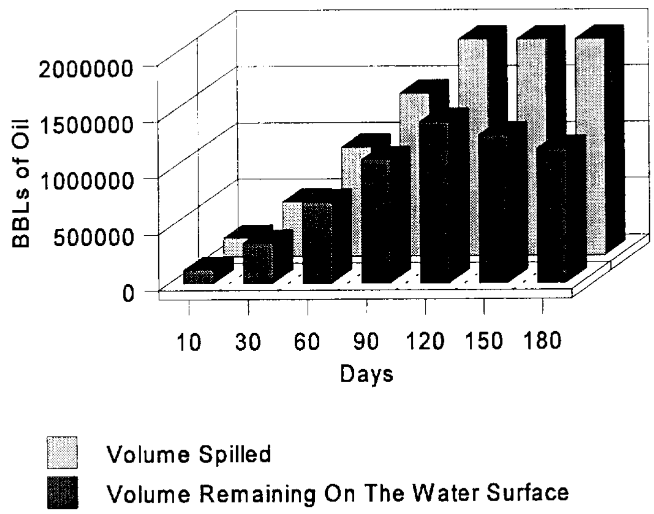
Five Adios Spill Scenarios



Five of the ADIOS oil spill scenarios assumed the continuous loss of 16,000 bbl of oil/day for various periods of time (e.g. 24 hours, 48 hours, 72 hours, 96 hours, and 120 hours) under conservative winter weather-conditions (20.1 degrees C sea surface temperature and low wind speeds (6 knots) with no frontal passages). The volume of oil lost per day, in barrels, is depicted in Figure 1. for each of these ADIOS model runs. The remaining two oil scenarios assumed the loss of the same amount of oil per day under variable winds up to 20 kts. There was no discernible difference observed in the weathering of the oil when the runs using variable wind inputs were compared to the runs using a constant 6 knot wind input. All of the ADIOS model results showed that the majority of oil that was lost due to weathering occurred due to evaporation. The results indicate that very little oil was lost in any of the ADIOS model runs due to dispersion.

As indicated in Figure 1., the volume of oil lost was consistent for each of the 16,000 bbl/day release scenarios as long as oil continued to spill at 667 bbl/hr. Once no additional oil spilled, each of the weathering model runs indicated that the daily volume lost decreased drastically. Figure 1. shows that approximately 2800 bbls of oil was consistently lost within the first 24 hours for all of the spill scenarios. Results of those scenario runs involving 667 bbl/hr (16,000 bbl/day) spill inputs beyond 24 hours indicate that the slicks continued to weather at a rate of 3,500-4,100 bbl of oil each day.

Figure 2. Volume Of Oil Remaining on the Water Surface
(16,000 BBl/Day Continuous Spill up to 120 Days)



Based upon the conclusions drawn from the information depicted in Figure 1., this analysis will assume that 4,100 bbls of oil/day will be lost due to weathering after the first 24 hours during both a 60 and a 120 day spill event. Figure 2. depicts the volume of oil that this agency estimates could remain on the sea surface as a result of a spill event involving a 667 bbl/hr release of oil over 120 days. Based upon the above assumptions, for a scenario involving a 120 day oil release at a rate of 667 bbl/hr, on day 120, approximately 1,430,372 bbls of a 1,920,000 bbl spill are expected to remain on the water surface after weathering. Using this same assumption, if the blowout is controlled by day 60, approximately 716,372 bbl of a 960,000 bbl spill would be expected to remain on the water surface after weathering. The ADIOS model results also indicate that this type of oil spill event is expected to weather very slowly after the actual spillage has been stopped. This is evident by the slow decrease in total volume remaining for days 150 and 180 as depicted in Figure 2.

As evident by the results of the ADIOS model runs and the information depicted in Figures 1. and 2., oil spilled during a deepwater blowout event which could last from 60-120 days would result in a substantial amount of oil remaining on the water surface for an extensive period of time - particularly at a 16,000 bbl/day rate.

4. Hydrocarbon Spill Containment/Cleanup Capabilities and Effectiveness

British Borneo will be responsible for ensuring that response to a spill of oil would be in full accordance with the applicable Federal and State laws and regulations as well as with British Borneo's own policy for accidental spill prevention and containment. The proposal is covered by British Borneo's Regional Oil Spill Contingency Plan, which provides the basis for an oil spill response for this action. The Regional OSCP covering British Borneo's facilities is designed to help personnel respond quickly and effectively to environmental incidents and is a guide that will be followed in handling spill response situations.

The ability to respond to a spill that might occur in the deepwater areas of the OCS will vary dependant upon a number of factors. Among these factors are the chemical and physical characteristics of an oil, the volume of oil spilled, the rate of spillage, the weather conditions at the time of a spill, the source of the spill (e.g. drillship storage spill or surface or subsurface blowout), and the amount of time necessary for response equipment or chemical countermeasures to reach a spill site. Spills in deepwater may be larger due to the high production rates associated with deep water wells and the length of time it could take to stop the source of pollution (e.g., subsea blowout). In addition, response times to the deep water locations may be longer than elsewhere in the GOM. However, the distance from shore (approximately 95 miles) will generally allow some additional time for cleanup efforts and natural dissipation of the oil to take place.

- **Subsurface Slick**

As previously discussed, there is a possibility that oil released subsea (e.g., subsea blowout) in these deep water environments could remain submerged for some period of time and travel away from a spill site. There are few practical spill response options for dealing with submerged oil. It should be expected that it will not be possible to predict the movement of or to detect the submerged oil in a deep water environment. Containment and recovery would only be possible when the oil is in shallow, clear, sheltered waters where the oil is relatively stationary and restricted in extent (Brown et.al., 1998)

The model results of a recently completed study (Ross, 1997), which was discussed previously, indicated that slicks formed in those cases where the gas plume does not develop (in water depths greater than 900 m) will be narrower at the source than bubble plume slicks (assumed to occur in water depths ranging from 300-750 m) and more patchy. These slicks (where a gas plume does not develop) will be thin and as a result are not expected to be successfully contained and/or removed from the water surface through the typical mechanical oil spill response booming and removal operations. Chemical dispersants appear to be the only likely viable spill response countermeasure that would be effective under these conditions. It is possible that natural dispersion of these slicks would alleviate the necessity for any response action for blowouts in some deepwater locations (S.L. Ross, 1997). Minerals Management Service is presently funding a study to provide an in-depth analysis of oil spill behavior from subsea blowouts and subsea pipeline releases in deepwater. The ability to properly determine appropriate spill response countermeasures to these deepwater events will depend upon the results of this study.

Since the application of dispersants may be the only feasible oil spill response option to some deepwater spills, the availability and suitability of dispersant application in the deepwater environment is a concern. At present, the Oil Spill Removal Organizations (OSROs) with whom British Borneo has contracts all have access to Airborne Support Inc. (ASI) located in Bourg, Louisiana. ASI has a stockpile of 45,300 gal of the dispersant Corexit 9527 available for application by two DC-3 and one DC-4 aircraft. At a 20:1 application ratio, each DC-3 holds enough dispersant to spray a slick of approximately 476 bbl of oil and the DC-4 can spray a 952 bbl slick. At this same 20:1 ratio, the 45,300 gal stockpile of dispersant available through ASI in Bourg, Louisiana is sufficient to spray a 22,000 bbl oil spill; however, numerous sorties would be required to apply this volume of dispersant. These planes could make three sorties each day. Based upon this assumption, using the three aircraft presently under contract, British Borneo should be able to apply dispersants to 7140 bbls of spilled oil daily provided that enough dispersant is available to support an ongoing response. Additional dispersant stockpiles are available in the Gulf Region. In addition, manufacturers can produce and deliver additional dispersants to the Houma area within 24 hours. For long-term spill response, additional dispersant application equipment can be brought from other regions of the United States and Europe. However, it should be noted that the April 1998 Final Report of the Preparedness Partnership Project sponsored by the Texas General Land Office states that although a work group was initially tasked with looking into the capability of applying dispersants on a 250,000 bbl spill, the team quickly concluded that there was not enough equipment or dispersant stockpiled to respond to that large an incident (Texas General Land Office, 1998).

- **Surface Spill**

British Borneo would be expected to mount a response strategy to effectively respond to a spill. Equipment, that is contractually available to the operator through OSRO membership or contracts to be called out to respond to a spill situation can be obtained through Clean Gulf Associates. Initially, the operator plans to call equipment out from spill response equipment stockpiles in Fort Jackson and Houma, Louisiana. During a spill event, the operator would be expected to cascade in additional equipment as deemed necessary to respond to the spill. Estimated response times for the equipment identified by British Borneo to arrive onsite is provided in Table 2.

Table 2

Estimated Response Times For Selected Offshore Skimming/Containment/Storage Equipment Identified by British Borneo For Spill Response

Location of Equipment	Source	Amt./ Type	Staging Area	Derated skimming capacity (bbl)*	Storage capacity (bbl)	Total Response Time
Houma, LA	CGA	2 FRUs	Fourchon, LA	6800	376	13.5 hrs
	CGA	Hoss Barge	Houma, LA	6200	4130	19hrs
Ft. Jackson	CGA	2 FRUs	Venice, LA	6800	376	18.5 hrs
	CGA/MSRC	450 Barge	Spill Site	N/A	44700	19 hrs
TOTAL SKIMMING CAPACITY				19,800		
TOTAL STORAGE CAPACITY					49,582	

* The derated skimming capacity was determined using the USCG guidance requiring a reduction of the equipment's nameplate capacity by using a 20 percent efficiency factor in the calculations.

Once all of the equipment identified by British Borneo that will be procured is operational, the total recovery capacity onsite is estimated at 19,800 bbl per day. Additional skimming capacity is available through CGA from other locations in the GOM. In the event that other equipment would be needed or in the event that some of the equipment would need replacing in order to support a long term a-round-the-clock response effort, British Borneo would be expected to obtain additional equipment from these other equipment bases in the Gulf of Mexico. In total, CGA has 41,500 bbl/day open ocean skimming capacity available in the GOM. Response times for this equipment would vary dependant upon its location and the type of equipment transported.

The following table compares the recovery capacity of the identified skimming equipment to the amount of available recovered oil storage capacity during the time frames required for this equipment to be onsite and operational.

Table 3

Offshore Spill Response Recovery Capacity

Hours Since Spill Originated	Volume (bbl) Remaining on Water Surface (3117 bbl diesel spill scenario)*	Volume (bbl) Remaining on Water Surface (667 bbl/hr crude oil spill scenario)*	Calculated Daily Recovery Capacity Onsite (bbl/day)**	Recovered Waste Storage Onsite (bbl)
13.5 hrs	2,338	7,654	6800	376
19 hrs	2,026	10,645	19,800	49,582

* The amount of oil remaining on the water surface was estimated by using the results of the ADIOS Model runs.

** These estimates were determined using the USCG guidance using a 20 percent efficiency factor in the calculation.

As the above table indicates, approximately 49,582 bbl of recovered oil storage capacity could be onsite within 19 hours. Having sufficient recovered oil storage onsite in a timely manner is important since a lack of storage would limit the amount of oil that could be recovered despite the fact that all the necessary skimming and containment equipment may already be onsite. It is important for the skimming and containment equipment to be deployed and operational with sufficient storage capacity as soon as possible after a spill event occurs as the slick could get away from a cleanup contractor. Once this occurs, the spill response would require the dedication of additional containment and cleanup equipment since isolated slicks could then need to be chased down. The lack of sufficient recovered oil storage onsite has historically been one of the factors that reduces the effectiveness of a spill response operation. In the event that a large multi-day spill response effort would be needed, the oil storage capacity identified in British Borneo's plan could be augmented from other sources within and outside the Gulf of Mexico.

Although this section has primarily focused on mechanical oil spill response, since no single spill response method is 100 percent effective, it is likely that larger spills in deep waters under the right conditions will require the simultaneous use of all available cleanup methods (e.g. mechanical cleanup, insitu burning, and dispersant application). The ADIOS model results discussed in Section 3. of this attachment indicate that there is a relatively short time frame or window of opportunity (36-40 hours) for the optimal use of both dispersants and insitu burning. Under the best conditions; mechanical recovery can typically only remove 10-15 percent of the volume spilled. On average, the application of dispersants has been effective historically on 33 percent of the oil that is treated. For example, using these percentages one can estimate that for every 16,000 bbl of oil spilled each day approximately 1600 bbl could be recovered by mechanical means and 2380 bbl could be removed through dispersant application (conservatively assuming that 7140 bbl of spilled oil is treated with dispersants per day). Assuming that 4100 bbl/day of oil is lost due to weathering, approximately 7,920 bbl out of the 16,000 bbl/day spilled would be expected to remain on the water surface. Over 120 days, the estimated volume of oil that could be expected to remain on the water surface under this scenario would total 950,400 bbl. Under this same scenario over 60 days, approximately 475,200 bbl would be expected to remain on the water surface.

The adequacy of British Borneo's proposed equipment and capabilities should be verified through the annual oil spill drills that MMS requires British Borneo to conduct. These drills should monitor British Borneo's readiness to deal with potential oil spills of all sizes. If changes in the response strategy are deemed necessary during the conduct of these drills, MMS should require that British Borneo amend their proposed response strategy and Regional Response Plan, if necessary.

- **Near shore/Shoreline Protection and Cleanup Strategies**

British Borneo cited the CGA manuals for an identification of environmental resources found within the potentially impacted area and for potential shoreline protection and cleanup strategies that may be employed in the event of a spill that threatens the shoreline.

5. Description of Affected Birds, Cetaceans, Sea turtles, Fish Resources, Coastal Barrier Beaches, and Wetlands and The Potential Hydrocarbon Impacts On Them

a. Description and Impacts on birds

(1) Description

The offshore waters, coastal beaches, and contiguous wetlands from Matagorda County, Tx., to Plaquemines Parish, La., are herein separated into five major groups: seabirds, shorebirds, marsh birds, wading birds, and waterfowl. Many species are mostly pelagic and, therefore, rarely sighted nearshore. The remaining species are found within coastal and inshore habitats (Clapp et al., 1982). Surveys show that Louisiana is a primary state in the southern and southeastern U.S. for nesting coastal and marine birds.

Seabirds are a diverse group of birds that spend much of their lives on or over saltwater; they live far from land most of the year, except at breeding time when they return to nesting areas along coastlines (Terres, 1991). In the Gulf, here are three main groups of seabirds--the orders Procellariiformes (petrels, albatrosses, and shearwaters), Pelecaniformes (pelicans, gannets and boobies, cormorants, tropicbirds, and frigatebirds), and Charadriiformes (phalaropes, gulls, terns, noddies, and skimmers) (Clapp et al., 1982; Harrison, 1983). Nesting seabirds on the Gulf include pelicans, cormorants, laughing gulls, eight species of terns, and black skimmers (Martin and Lester, 1991; Pashley, 1991).

Shorebirds are those members of the order Charadriiformes generally restricted to coastline margins (beaches, mudflats, etc.). Gulf of Mexico 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). Along the central Gulf Coast, 44 species of shorebirds have been recorded; only 6 nest in the area, the remaining are wintering residents and/or "staging" transients (Pashley, 1991).

The term "marsh bird" is a general term for a bird that lives in or around marshes and swamps. Collectively, the following families have representatives in the northern Gulf: Ardeidae (herons and egrets), Ciconiidae (storks), Threskiornithidae (ibises and spoonbills), Gruidae (crane), and Rallidae (rails, moorhens, gallinules, and coots). Wading birds are some of those birds that have adapted to living in marshes. They have long legs that allow them to forage by wading into shallow water, while their long necks and bills are used to probe under water or to make long swift strokes to seize fish, frogs, aquatic insects, crustaceans, and other prey (Terres, 1991).

Waterfowl belong to the taxonomic order Anseriformes and include swans, geese, and ducks. Many species usually migrate from wintering grounds along the Gulf Coast to summer nesting grounds in the north.

The following coastal and marine birds species that inhabit or frequent the north-central and western Gulf of Mexico coastal areas are recognized by FWS as either endangered or threatened: peregrine falcon, piping plover, bald eagle, brown pelican, and least tern. The American peregrine falcon (*Falco peregrinus*) of North America is separated into three subspecies: Arctic, American, and Peale's. Only the subspecies American peregrine falcon (*F. peregrinus anatum*) is protected by the Endangered Species Act. On the Gulf Coast, about 99% of the fall migrants of this species are the Arctic peregrine falcon subspecies which will not be analyzed. The piping plover (*Charadrius melodus*) is a migratory shorebird that is endemic to North America. This species remains in a precarious state given its low population numbers, sparse distribution, and continued threats to habitat throughout its range.

The brown pelican (*Pelicanus occidentalis*) is one of two pelican species in North America. In recent years, there has been a marked increase in brown pelican populations along its entire former range. In coastal areas of Texas, Louisiana, and Mississippi, where populations are not secure, the brown pelican remains listed as endangered. The least tern (*Sterna antillarum*) is listed as endangered, except within 50 mi of the coast.

(2) Impacts

The loss of all of the diesel from the largest-volume storage tank on the drillship would result in a spill of 3,117 bbl. The probability of this event is less than 0.008%. With projected oil spill response and clean-up efforts offshore, most of a diesel spill would be recovered before it could reach the coast.

The occurrence of spills, and their subsequent locations over the Gulf of Mexico, which may contact a barrier island shoreline, mostly depends upon where each spill originates, the type of spilled hydrocarbons, and the seasonal, meteorological, and oceanographic conditions during and after a spill. Results of the OSRA model show probabilities of contact to environmental resources from oil spills greater than 1000 bbl. Based on the OSRA model (Price et al., 1999), should an oil spill happen in the lease blocks of the proposed action (Green Canyon 254 and 298), there would be a 31% probability of a spill impacting any land area within 30 days. The stretch of coast with the greatest chance of being contacted by such a spill is from Cameron to Lafourche Parish in Louisiana. The available OSRA model runs were limited to 30 days. If the OSRA model runs were extended for the complete 120-day blowout scenario, probabilities could be greater for contact of a spill with land. A broader shoreline could be affected if land was contacted by larger volumes of oil for a longer period of time.

The greatest concern regarding potential impacts from an accidental oil spill from the proposed action would be about a blowout. The estimated flow rate from the well if blown out is 16,000 bbl/day. The probability of such a blowout is very low (0.07%). However, if a blowout occurred, very large amounts of oil would remain on the water for an extended period of time. Several hundred thousand barrels of oil could remain on the water surface for up to 120 days, even with weathering and cleanup efforts.

Very small quantities of oil have been found to produce mortality and developmental defects in avian embryos (Leighton, 1990). Toxicity can be acute but long-term effects can also occur in exposed adults, chicks exposed to oil or fed contaminated food, and chicks hatched from eggs of exposed birds (Fry et al., 1985). Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration.

The magnitude of bird mortality following an oil spill would depend on the size of the local bird population (often a function of season and weather), foraging behavior(s), whether or not the population is aggregated or dispersed into smaller subunits at the time of the spill, and the quantity of oil spilled and its persistence in the environment (NRC, 1985).

The birds most vulnerable to direct effects include those species that spend most of their time swimming on and under the sea surface, and often aggregate in dense flocks (Piatt et al., 1990; Vauk et al., 1989). This group includes loons, grebes, sea ducks and pochards, and cormorants. Coastal birds, including shorebirds, waders, marsh birds, and certain waterfowl, may be the hardest hit indirectly through destruction of their feeding habitat and/or food source (Hansen, 1981; Vermeer and Vermeer, 1975). Population recovery following destruction of a local breeding colony or a large group of wintering migrants would likely be slow for many species because of their inherently low reproductive potential and/or distance to neighboring colonies, which may act as refugia and later provide recruits to the area affected by the spill (Cairns and Elliot, 1987; Trivelpiece et al., 1986; Samuels and Ladino, 1983/1984).

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).

Any effects are especially critical for intensively managed populations such as endangered and threatened species that need to maintain a viable reproductive population size or that depend upon a few key habitat factors. Any species that are low in density and scattered may be less likely to be affected by a point disturbance; however, large oil or diesel spills are not point disturbances.

Oil that remains offshore could impact sea ducks and other seabirds. Oil reaching low salinity water may affect estuarine waterfowl and diesel entering estuarine bays could affect such birds there. The impacts on the nonlisted shorebirds just discussed above apply also to the piping plover, listed as threatened. This shorebird winters on the Gulf coast away from the high energy beaches.

No bald eagle's nests are found on the coast in the area of highest potential spill landfall, from Cameron Parish to Plaquemines Parish. Hence the species will not be analyzed here. The most common peregrine falcon along the gulf coast in winter is the Arctic peregrine falcon subspecies. The American peregrine composes 1% or less of the coastal peregrines. This species preys pretty much exclusively on other birds captured in flight. Contact with oil would only happen if oiled prey were taken. However, oiling would inhibit flight of potential prey and ultimately cause death, reducing the probability of the peregrine capturing oiled prey. The species does not breed on the Gulf coast so oiling during nesting will not happen.

The brown pelican is listed as endangered in Louisiana, (U.S. DOI, FWS, 1998). Impacts on brown pelican are as for impacts on unlisted seabirds, as analyzed above in this section.

b. Description and Impacts on Cetaceans

(1) Description

Cetaceans are divided into two major suborders: Mysticeti (baleen whales) and Odontoceti (toothed whales). Seven baleen and 21 toothed whale species have been reported for the Gulf. Only two of the seven baleen whales occurring in the Gulf are not listed as endangered or threatened. Bryde's whales are found in tropical and warm temperate waters (Cummings, 1985). It is likely that the Gulf represents at least a portion of the range of a dispersed, resident population of Bryde's whale (Davis and Fargion, 1996). The minke whale is widely distributed in tropical, temperate, and polar waters. These records may represent strays from low-latitude breeding grounds elsewhere in the western North Atlantic (Mitchell, 1991).

With the exception of the sperm whale, none of the toothed whales occurring in the Gulf are listed as endangered or threatened. There are four species of beaked whales known to occur in the Gulf. All remaining species of nonendangered whales and dolphins found in the Gulf are members of the family Delphinidae. Bottlenose dolphins are the most common delphinid in the nearshore waters and outer edge of the continental shelf. The Atlantic spotted dolphin is the only species, other than the bottlenose dolphin, that commonly occurs over the continental shelf (Mullin et al., 1991 and 1994a; Davis and Fargion, 1996). Most killer whale sightings have been in offshore waters greater than 200 m deep, although there are other sightings from over the continental shelf (Davis and Fargion, 1996).

There are five baleen (northern right, blue, fin, sei, and humpback) whale species, one toothed (sperm) whale species. The sperm whale is common in the Gulf, while the baleen whales are considered uncommon (Davis and Fargion, 1996). The northern right whale is one of the stockiest of all whales. The northern right whale is one of the world's most endangered whales. Confirmed historical records of northern right whales in the Gulf of Mexico consist of a single stranding in Texas (Schmidly et al., 1972) and a sighting off Florida (Moore and Clark, 1963; Schmidly, 1981). The blue whale is the largest animal known. Records of the blue whale in the Gulf consist of two strandings on the Texas coast (Lowery, 1974). The fin whale is the second largest rorqual. There are seven reliable reports of fin whales in the Gulf, indicating that fin whales are not abundant in the Gulf of Mexico (Davis and Fargion, 1996). The sei whale is a medium-sized rorqual. Sei whales are open ocean whales, not often seen close to shore (Jefferson et al., 1993). The sei whale is represented in the Gulf by only four reliable records (Davis and Fargion, 1996). This species should be considered most likely to be of accidental occurrence in the Gulf. The humpback whale is more robust in body than other balaenopterids. There are seven reliable sighting records for humpbacks in the Gulf (Weller et al., 1996).

The sperm whale is the largest toothed whale. Sperm whales in the Gulf were found to occur at mean depths of 950-1,100 m (Davis and Fargion, 1996). Congregations of sperm whales are commonly seen off the shelf edge in the vicinity of the Mississippi River Delta (Mullin et al., 1991 and 1994a; Davis and Fargion, 1996).

(2) Impacts

Hydrocarbon spills and spill response activities can adversely affect cetaceans. Direct contact with hydrocarbons can lead to irritation and damage of skin and soft tissues. Studies by (Geraci and St. Aubin, 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. Inhalation of vapors can lead to irritation of respiratory membranes, lung congestion, and pneumonia (Geraci and St. Aubin, 1982; Hansen, 1985; Geraci, 1990).

Details of a spill from a deep water blowout are given above in the impacts on aquatic birds section. Reactions of cetaceans to spilled hydrocarbons are varied. There is evidence of both direct avoidance and obvious indifference in heavily oiled areas. Controlled experiments on detection and avoidance response of bottlenose dolphin (*Tursiops truncatus*) to oil films showed that dolphins can see oil at the surface and that they prefer to avoid it (Geraci et al., 1983; Smith et al., 1983; St. Aubin et al., 1985). In the event that "oiling" of cetaceans should occur from a spill associated with the proposed operations, the effects would primarily be sublethal.

c. Description and Impacts on sea turtles

(1) Description

Five species of sea turtle are found in the waters of the Gulf of Mexico: Kemp's ridley, loggerhead, green, leatherback, and hawksbill. All are protected by the Endangered Species Act. Commercial fishing has had a devastating impact on both U.S. and world populations of sea turtles (Witzell, 1994).

Marine turtles spend nearly all of their lives in the water. The females must emerge periodically from the ocean to nest on beaches. Sea turtles are long-lived, slow-maturing organisms.

The green turtle (*Chelonia mydas*) reaches 100 cm in carapace length and 150 kg in weight (USDOC, NMFS, 1990a). Reports of nesting in the northern Gulf are isolated and infrequent. The closest significant nesting aggregations are on the Florida east coast and the Yucaton Peninsula. The leatherback (*Dermochelys coriacea*) has an average adult curved carapace length of 155 cm with adult weight ranging from 200 to 700 kg (USDOC, NMFS, 1992a). Florida is the only site in the continental United States where the leatherback regularly nests (Meylan et al., 1995). The nesting female hawksbill (*Eretmochelys imbricata*) averages about 87 cm in curved carapace length and can weigh up to 80 kg in the Caribbean (USDOC, NMFS, 1993). The Kemp's ridley (*Lepidochelys kempi*) adult weight is generally less than 45 kg and the straight carapace length is around 65 cm (USDOC, NMFS, 1992a). The Kemp's ridley sea turtle is the most imperiled of the world's sea turtles. Eggs are laid annually, primarily in Rancho Nuevo, Tamaulipas, Mexico (USDOC, NMFS, 1992a).

The adult southeastern U.S. loggerhead sea turtle (*Caretta caretta*) has a mean straight carapace length of approximately 92 cm; the corresponding mean body mass is approximately 113 kg (USDOC, NMFS, 1990b). In the Central Gulf, loggerhead nesting has been reported on Gulf Shores and Dauphin Island, Alabama; Ship Island, Mississippi; and the Chandeleur Islands, Louisiana (Fuller et al., 1987). The banks off the central Louisiana coast and near the Mississippi Delta are also important marine turtle feeding areas (Hildebrand, 1982).

(2) Impacts

Details of a spill from a hypothetical deepwater blowout are given above in the impacts on aquatic birds section. If an oil spill would occur, the severity of effects and the extent of damage to marine turtles would be characterized by geographic location, oil type, oil dosage, impact area, oceanographic conditions, meteorological conditions, and season (NRC, 1998). The loggerhead turtle is the only sea turtle to nest on the shores of Louisiana. Oil-spill response activities, such as vehicular and vessel traffic can adversely affect loggerhead sea turtle nesting habitat in the Chandeleur Islands, Louisiana, and cause displacement from these preferred areas.

Fish Resources

(1) Resource Description

The Gulf of Mexico 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 Gulf of Mexico 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 Gulf of Mexico (Mager and Ruebsamen, 1988). Consequently, estuary-dependent species of finfish and shellfish dominate the fisheries. Nearly all species significantly contributing to the Gulf of Mexico'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).

The Gulf of Mexico provides more than 31 percent of the commercial fish landings in the continental United States and yielded the Nation's second largest regional commercial fishery by both weight and value in 1996 (total for all species: 1,510 million pounds and 698 million dollars). Commercially important species include the estuary-related species such as menhaden, shrimps, oyster, crabs, and sciaenids (drums). The Gulf of Mexico shrimp fishery is the most valuable in the United States accounting for 71.5 percent of the total domestic production (USDOC, NMFS, 1997). Menhaden was the most valuable finfish species landed in 1996 with a total value of 54.5 million dollars.

About 10 percent of finfish in the Gulf of Mexico 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 Gulf of Mexico 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 Gulf of Mexico is limited.

Additional information on individual species of finfish and shellfish and their life histories can be found in Section III.B.7 and III.C.2 of the Final EIS for Gulf of Mexico OCS Oil and Gas Lease sales 169, 172, 175, 178, and 182. (USDOI, MMS, 1997).

(2) Potential Impacts on Fisheries

Effects on commercial fisheries would come from the various oil spill scenarios described above in sections 1-3 resulting from surface or subsurface blowouts. Volumes of oil considered could potentially be large. Several blowout scenarios are discussed in the previous section. After consideration of maximum cleanup efficiencies (which would not be possible), spill volumes remaining after weathering would still range into the hundreds of thousands of barrels. The loss of the entire contents of the largest volume diesel storage tank on the drillship is also considered. The probability of such a spill (3117 bbls) is less than 0.008 percent and a slick is not expected to persist on the water surface for more than 10 days as described in section 3 above.

Based on the last available OSRA model runs (Price et al., 1999), should an oil spill occur in the lease block associated with the proposed action (Green Canyon 254, 297 and 298, launch zone 44), there would be a 7 percent chance that a spill would impact the central Gulf menhaden spawning grounds off the coast of Louisiana and an overall 31 percent chance that oil would contact the Gulf shoreline within 30 days. The range of landfall with at least a 1 percent chance of oil reaching it spans over 400 mi between Matagorda county, TX and Plaquemines Parish, LA. The available OSRA model runs were limited to 30 days. It is expected that if the OSRA model runs were conducted for the full 120-day blowout scenario, results would show potential spill impacts to a much broader area of both the menhaden spawning area (as an example) and estuary, and impacts from such a spill would persist over longer periods of time.

There is no available modeling information on the resulting size and distribution of a surface oil spill with the volumes considered here. There is also no available information enabling the assessment of the potential fate of oil originating from the bottom in deepwater and this aspect is not addressed. The geographic range of a surface spill effect depends on the mobility of the resource (fish), the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question (in this case hydrocarbons).

Adults

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 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.

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.

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 almost eight times that of the *Exxon Valdez,* but 1/3 smaller than the worst case blowout described here).

Eggs and Larvae

For OCS-related oil spills to have 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. This area could be very large considering the maximum blowout discharge volume. Oil components also 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). However, 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 from a single large oil spill would not have a detectable effect on the adult populations which 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).

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.

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 nonfatal 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.

Historical Impacts

The estimations of impacts to fisheries from hydrocarbon spills can be calculated from examinations of recent spills such as the *North Cape*, *Breton Point*, *Sea Empress*, and *Exxon Valdez* (Brannon *et al.*, 1995; Maki *et al.*, 1995; Mooney, 1996; Pearson *et al.*, 1995). The amount of oil spilled by each event and its estimated impact to fishing practices, fish resources, and fisheries economics can be used as a guideline to estimate the impacts to deepwater fisheries. Using these examples, a surface or seafloor oil spill greater than 1,000 bbls but less than 10,000 bbls will likely cause less than a 2-3 percent decrease in commercial populations or in commercial fishing.

There is no evidence at this time that commercial fisheries in the Gulf have been adversely affected on a regional population level by oil spills. However, a catastrophic blowout scenario could introduce unprecedented amounts of oil to surface waters over an extended period of time.

(3) Conclusions

As described in section 1B, the historical probability of a blowout occurring during drilling is low (0.0007 or 0.07 percent). If a blowout was controlled early (within a few days), the impact on fisheries and commercial populations would likely be small represented by a decrease of only a few percent. However, resulting spill volumes could be very large. Maximum cleanup efforts would have negligible impact on total spill volumes beyond a time frame of a few days. A blowout event lasting 60 days would result in a total of over 700,000 thousand bbls remaining on the surface after weathering. The worst scenario results in nearly 1.5 million bbls remaining on the surface after weathering, approximately half of the spill volume of the 10 month Ixtoc event.

Adult fish would likely avoid the area of a spill, but fish eggs and larvae within a potentially large area of the northern Gulf of Mexico would be killed. The greatest potential for impact would occur when oil contacted nearshore waters and estuarine environments. This area of impacted coastline could extend for hundreds of miles. If any of these worst case blowout events did occur, impacts on fisheries within the area could be substantial.

e. Coastal Barrier Beaches and Wetlands

(1) Description of Barrier Beaches and Associated Dunes

Coastal barriers of the Central Planning Area of the Gulf of Mexico consist of relatively low land masses that can be divided into several interrelated environments. The beach consists of the foreshore and backshore. The nonvegetated foreshore slopes up form the ocean to the beach berm-crest. The bach-shore is found between the beach berm-crest and the dunes and may be sparsely vegetated. The backshore may occasionally be absent due to storm activity. The dune zone of a barrier landform can consist of a single dune ridge, several parallel dune ridges, or a number of curving dome lines that are stabilized by vegetation. These elongated, narrow landforms are composed of sand and other unconsolidated, predominantly coarse sediments that have been transported and deposited by waves, currents, storm surges, and winds. For additional information, see Page III-19, III. Description of the Affected Environment. B. Biological Resources. 1. Sensitive Coastal Environments. A. Coastal Barrier Beaches and Associated Dunes (U.S. Dept. of the Interior. Minerals Management Service. 1997. Gulf of Mexico OCS Oil and Gas Lease Sales 169, 172, 175, 178 and 182: Central Planning Area--Final environmental impact statement).

(2) Description of Wetlands

According to the U.S. Dept. Of the Interior (Hefner et al., 1994) during the mid-1980's, 8 percent of Alabama (2,651,000 ac), 28 percent of Louisiana (8,784,000 ac), and 14 percent of Mississippi (4,365 ac) were considered wetlands. During the following 10 years, these three states' wetland areas decreased by 1.6, 5.6, and 4.6 percent, respectively. For additional information, see Page III-21, III. Description of the Affected Environment. B. Biological Resources. 1. Sensitive Coastal Environments. b. Wetlands (U.S. Dept. of the Interior. Minerals Management Service. 1997. Gulf of Mexico OCS Oil and Gas Lease Sales 169, 172, 175, 178 and 182: Central Planning Area--Final environmental impact statement).

(3) Impacts

Potential sources of spills from the proposed exploratory drilling include the loss of diesel fuel during drilling operations and the loss of hydrocarbons as a result of a blowout. See Sections 1 through 3 above.

The occurrence of spills, and their subsequent distribution over the Gulf, which may include contact with a barrier shoreline, largely depends upon where each spill originates; the nature of the spilled material; and the seasonal, meteorological, and oceanographic conditions during and after a spill. Results of the OSRA model identify probabilities of contact to environmental resources from oil spills greater than 1,000 bbl. Based on the OSRA model runs (Price et al., 1999), should an oil spill occur in the lease blocks associated with the proposed action (Green Canyon 254 and 298), there would be a 31 percent chance that a spill would impact any land area within 30 days. The stretch of coast with the highest probability of being contacted by such a spill is the region including Cameron to Lafourche Parishes in Louisiana. The available OSRA model runs were limited to 30 days. If the OSRA model runs were conducted for the full 120-day blowout scenario, results could show greater possibilities for a potential oil spill to contact land. A broader shoreline area could be affected if the coast was contacted by larger volumes of oil for a longer period of time.

The loss of the entire contents of the largest-volume, diesel storage tank on the drillship would result in a spill of 3,117 bbl. The probability of such a spill is less than 0.05 percent. The greatest concern regarding potential impacts from an accidental oil spill from the proposed action would be associated with a blowout. The worst case scenario provided by British-Borneo assumed that a blowout would result in the release of 16,000 bbl/day of oil. Due to the great water depths and the limited number of drilling rigs in the Gulf that can work at these depths, it could take up to 120 days for another deepwater rig to intervene and stop a blowout. The probability of such a blowout is very low (0.07 percent). However, if a blowout occurred, very large amounts of oil would remain on the water for an extended period of time. Several hundred thousand barrels of oil were estimated to remain on the water surface for up to 120 days, even after weathering and cleanup efforts are factored in.

The information below regarding potential impacts of oil spills on coastal barrier beaches and associated dunes and wetlands are based on analyses in the Final Environmental Impact Statement for Gulf of Mexico OCS Oil and Gas Lease Sales 169, 172, 175, 178, and 182 (USDOI, MMS, 1997).

Cleanup operations associated with large oil spills can affect the stability of barrier beaches. 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 Gulf State governments have recognized these problems and have established policies to limit sand removal by cleanup operations.

In coastal Louisiana, dune line heights 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 water levels reaching sand dune elevations ranges up to 16 percent. For tides to carry oil from a spill across and over the dunes, strong southerly winds would have to 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 the landfall site. Significant adverse impacts to dunes contacted by a spill is very unlikely, even during abnormally high water levels. In addition, a study in Texas showed that oil disposal on sand and vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

Various types of wetlands are scattered throughout the Louisiana coastal zone. 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. This contradiction can be explained by differences in oil concentrations contacting vegetation, kinds of oil spilled, types of vegetation affected, season of year, pre-existing stress level of the vegetation, soil types, and numerous other factors. In overview, the data suggest that light-oiling impacts causes plant die-back with recovery within two growing seasons without artificial replanting. Therefore, most 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).

The critical concentration of oil is that concentration above which impacts to wetlands will be long term and recovery will take longer than two growing seasons, and which causes plant mortality and some permanent wetland loss. Critical concentrations of various oils are currently unknown and are expected to vary broadly for wetland types and wetland plant species. In coastal Louisiana, the critical concentration of oil resulting in long-term impacts to wetlands is assumed to be 0.1 liter per square meter (l/m^2). Concentrations less than this will cause die-back of the above-ground vegetation for one growing season, but limited mortality. Higher concentrations will cause mortality of contacted vegetation, but 35 percent of the affected area will recover within 4 years. Oil will persist in the wetland soil for at least 5 years. After 10 years, permanent loss of 10 percent of the affected wetland area will be expected as a result of accelerated land loss 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).

Based on these studies, the following model was developed and was used to quantify impacts in the lease sale EIS cited above. For every 50 bbl of spilled oil that contacts wetlands, approximately 2.7 ha of wetland vegetation would experience die-back. Thirty percent of these damaged wetlands are assumed to recover within four years; 85 percent within 10 years. About 15 percent of the contacted wetlands would be converted permanently to open-water habitat.

In conclusion, the proposed action is not expected to adversely alter barrier beach or dune configurations significantly as a result of related oil spills. Although the probability of a large oil spill due to a blowout from the proposed action is very low (0.07 percent), adverse impacts to wetlands could result if a spill occurs. Due to the limitations of the oil spill modeling efforts conducted for the proposed action, estimating the quantity of spilled oil that could potentially contact wetlands following a blowout is not possible. Therefore, calculating potential impacts to wetlands is not possible. However, if such a blowout occurs, and oceanographic and meteorological conditions are such that a large amount of oil contacts wetlands, severe adverse impacts would occur due to die-back and conversion to open water.

References

Alexander, S.K. and J.W. Webb. 1987. Relationship of *Spartina alterniflora* growth to sediment oil content following an oil spill. In: Proceedings, 1987 Oil Spill Conference. April 6-9, 1988, Baltimore, MD. Washington, DC: American Petroleum Institute. Pp. 445-450.

Brannon. E.L., Moulton, L.L., Gilbertson, L.G., Maki, A.W., Skalski, J.R. 1995 "An Assessment of Oil Spill Effects on Pink Salmon Populations Following the Exxon Valdez Oil Spill-Part 1: Early Life History," in Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219, pp. 548-584, Peter G. Wells, James N. Butler, and Jane S. Hughes, Eds., American Society for Testing and Materials, Philadelphia, 1995.

Cairns, D.K. and R.D. Elliot. 1987. Oil spill impact assessment for seabirds: the role of refugia and growth centers. Biological Conservation. 40:1-9.

Clapp, R.B., R.C. Banks, D. Morgan-Jacobs, and W.A. Hoffman. 1982. Marine birds of the southeastern United States and Gulf of Mexico. 3 vols. Washington, DC: U.S. Fish and Wildlife Service, Office of Biological Services. FWS/OBS

Cummings, W.C. 1985. Bryde's whale - *Balaenoptera edeni*. In: Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Vol. 3: the Sirenians and baleen whales. Academic Press, Inc. Pp. 137-154.

Darnell, R.M. 1988. Marine biology. In: Phillips, N.W. and B.M. James, eds. Offshore Texas and Louisiana marine ecosystems data synthesis. Draft final report to the Minerals Management Service, Gulf of Mexico OCS Region, Contract No. 14-12-0001-30380. Vol. II, pp. 203-338.

Darnell, R.M. and T.M. Soniat. 1979. The estuary/continental shelf as an interactive system. In: Livingston, R.J., ed. Ecological processes in coastal and marine systems. New York, NY: Plenum Press. 39 pp.

Davis, R.W. and G.S. Fargion, eds. 1996. Distribution and abundance of cetaceans in the north-central and western Gulf of Mexico: final report. Volume II: technical report. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 96-0027. 357 pp.

Delaune, R.D., W.H. Patrick, and R.J. Bureh. 1979. Effect of crude oil on a Louisiana *Spartina alterniflora* salt marsh. Environ. Poll. 20:21-31.

Evans, D.R. and S.D. Rice. 1974. Effects of oil on marine ecosystems: a review for administrators and policy makers. Fishery Bull. 72(3):625-637.

Farr, A.J., C.C. Chabot and D.H. Taylor. 1995. Behavioral avoidance of flurothene by flathead minnows (Pimephales promelas). Neurotoxicology and Teratology. 17(3):265-271.

Fischel, M., W. Grip, and I.A. Mendelssohn. 1989. Study to determine the recovery of a Louisiana marsh from an oil spill. In: Proceedings, 1989 Oil Spill Conference . . . February 13-16, 1989, San Antonio, TX. Washington, DC: American Petroleum Institute.

Fry, D.M., R. Boekelheide, J. Swenson, A. Kang, J. Young, and C.R. Grau. 1985. Long-term responses of breeding seabirds to oil exposure. Pacific Seabird Group Bulletin, 10. Pp. 48-49.

Fuller, D.A., A.M. Tappan, and M.C. Hester. 1987. Sea turtles in Louisiana's coastal waters. Louisiana Sea Grant College, August 1987.

Geraci, J.R., D.J. St. Aubin, and R.J. Reisman. 1983. Bottlenose dolphins, *Tursiops truncatus*, can detect oil. Can. J. Fish. Aquat. Sci. 40(9):1515-1522.

Geraci, J.R. and D.J. St. Aubin. 1985. Expanded studies of the effects of oil on cetaceans, part I. Final report prepared for the U.S. Dept. of the Interior, Minerals Management Service, Washington, DC. February 1985.

Geraci, J.R. 1990. Physiologic and toxic effects on cetaceans. In: Geraci, J.R. and D.J. St. Aubin, eds. Sea mammals and oil: confronting the risks. San Diego, CA: Academic Press, Inc. Pp. 167-197.

Geraci, J.R. and D.J. St. Aubin. 1982. Study of the effects of oil on cetaceans. Final report prepared for the U.S. Dept. of the Interior, Bureau of Land Management, New York OCS Office, July 20, 1982. 274 pp.

Hansen, D.J. 1981. The relative sensitivity of seabird populations in Alaska to oil pollution. U.S. Dept. of the Interior, Bureau of Land Management, Alaska OCS Region, Anchorage. BLM-YK-ES-81-006-1792.

Hansen, D.J. 1985. The potential effects of oil spills and other chemical pollutants on marine mammals occurring in Alaskan waters. U.S. Dept. of the Interior, Minerals Management Service, Alaska OCS Region, Anchorage. OCS Study MMS 85-0031.

Harrison, P. 1983. Seabirds: an identification guide. Boston, MA: Houghton Mifflin Co. 448 pp.

Hildebrand, H.H. 1982. A historical review of the status of sea turtle populations in the western Gulf of Mexico. In: Bjorndal, K.A., ed. Biology and conservation of sea turtles. Washington, DC: Smithsonian Institution Press. Pp. 447-453.

Jefferson, T.A., S. Leatherwood, and M.A. Webber. 1993. FAO species identification guide. Marine Mammals of the World. Food and Agriculture Organization. Rome. 320 pp.

Leighton, F.A. 1990. The toxicity of petroleum oils to birds: an overview. Oil Symposium, Herndon, VA.

Linden, O., J.R. Sharp, R. Laughlin, Jr., and J.M. Neff. 1979. Interactive effects of salinity, temperature, and chronic exposure to oil on the survival and development rate of embryos of the estuarine killfish Fundulus heteroclitus. Mar. Biol. 51:101-109.

Linden, O., J.R. Sharp, R. Laughlin, Jr., and J.M. Neff. 1979. Interactive effects of salinity, temperature, and chronic exposure to oil on the survival and development rate of embryos of the estuarine killfish Fundulus heteroclitus. Mar. Biol. 51:101-109.

Longwell, A.C. 1977. A genetic look at fish eggs and oil. Oceanus. 20(4):46-58.

Lowery, G.H. 1974. The mammals of Louisiana and its adjacent waters. Baton Rouge, LA: Louisiana State University. 565 pp.

Lytle, J.S. 1975. Fate and effects of crude oil on an estuarine pond. Proceedings of the conference on prevention and control of oil pollution. San Francisco. Pp. 595-600.

Mager, A. and R. Ruebsamen. 1988. National Marine Fisheries Service habitat conservation efforts in the coastal southeastern United States. Mar. Fish. Rev. 50(3):43-50.

Maki, A. W., Brannon, E.J., Gilbertson, L.G., Moulton, L.L., Skalski, J.R., "An Assessment of Oil Spill Effects on Pink Salmon Populations Following the Exxon Valdez Oil Spill-Part 2: Adults and Escapement," in Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219, pp. 585-625, Peter G. Wells, James N. Butler, and Jane S. Hughes, Eds., American Society for Testing and Materials, Philadelphia, 1995.

Hughes, Eds., American Society for Testing and Materials, Philadelphia, 1995.

Malins, D.C., S. Chan, H.O. Hodgins, U. Varanasi, D.D. Weber, and D.W. Brown. 1982. The nature and biological effects of weathered petroleum. Environmental Conservation Division, Northwest and Alaska Fisheries center, National marine Fisheries Service, Seattle. 43pp.

Martin, R.P. and G.D. Lester. 1991. Atlas and census of wading bird and seabird nesting colonies in Louisiana: 1990. Special Publication No. 3, Louisiana Dept. of Wildlife and Fisheries, Louisiana Natural Heritage Program.

Meylan, A. 1988. Spongivory in hawksbill turtles: a diet of glass. Science 239:393-395.

Mooney, T. 1996. Fishermen ask state: Put us back in water. Providence Journal Bulletin. March 12, 1996.

Moore, J.C. and E. Clark. 1963. Discovery of right whales in the Gulf of Mexico. Science 141:269.

Mullin, K.D., W. Hoggard, C.L. Roden, R.R. Lohoefener, C.M. Rogers, and B. Taggart. 1994a. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. U.S. Fish. Bull. 92:773-786.

Mullin, K., W. Hoggard, C. Roden, R. Lohoefener, C. Rogers, and B. Taggart. 1991. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 91-0027. 108 pp.

National Research Council (NRC). 1985. Oil in the sea: inputs, fates, and effects. Washington, DC: National Academy Press. 601 pp.

National Research Council (NRC). 1990. The decline of sea turtles: causes and prevention. Committee on Sea Turtle Conservation. Washington, DC: National Academy Press. 183 pp.

Pashley, D.N. 1991. Shorebirds, gulls, and terns: Louisiana, Mississippi, Alabama. In: Proceedings of the coastal nongame workshop. U.S. Fish and Wildlife Service, Region 4 and Florida Game and Fresh Water Fish Commission. Pp. 79-83.

Payne, J.F., J. Kiceniuk, L.L. Fancey, U. Williams, G.L. Fletcher, A. Rahimtula, and B. Fowler. 1988. What is a safe level of polycyclic aromatic hydrocarbons for fish: subchronic toxicity study on winter flounder (Pseudopleuronectes americanus). Can. J. Fish. Aquat. Sci. 45:1983-1993.

Piatt, J.F., C.J. Lensink, W. Butler, M. Kendziorek, and D.R. Nysewander. 1990. Immediate impact of the *Exxon Valdez* oil spill on marine birds. The Auk. 107(2):387-397.

Pearson, W. H., Moksness, E., and Skalski, J. R., "A Field and Laboratory Assessment of Oil Spill Effects on Survival and Reproduction of Pacific Herring Following the Exxon Valdez Spill," in Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219, pp. 626-661, Peter G. Wells, James N. Butler, and Jane S. Hughes, Eds., American Society for Testing and Materials, Philadelphia, 1995.

Price, J.M., C.F. Marshall, and E.M. Lear. 1999. Supplement to Oil-Spill Risk Analysis: Gulf of Mexico OCS Central and Western Lease Sales, 1998-2002, and Gulfwide OCS Program, 1998-2036. OCS Report 99-0010. Herndon, VA: Dept. of the Interior, Minerals Management Service, Environmental Division.

Samuels, W.B. and A. Ladino. 1983/1984. Calculations of seabird population recovery from potential oil spills in the mid-Atlantic region of the United States. Ecological Modeling, 21. Pp. 63-84.

Schmidly, D.J. 1981. Marine mammals of the southeastern United States coast and the Gulf of Mexico. FWS/OBS-80/41. Washington, DC: U.S. Fish and Wildlife Service, Office of Biological Services. 163 pp.

Schmidly, D.J., C.O. Martin, and G.F. Collins. 1972. First occurrence of a black right whale (*Balaena glacialis*) along the Texas coast. Southw. Natural. 17:214-215.

Smith, T.G., J.R. Geraci, and D.J. St. Aubin. 1983. The reaction of bottlenose dolphins, *Tursiops truncatus*, to a controlled oil spill. Can. J. Fish. Aquat. Sci. 40(9):1522-1527.

Spies, R.B., J.S. Felton, and L. Dillard. 1982. Hepatic mixed-function oxidases in California flatfishes are increased in contaminated environments and by oil and PCB ingestion. Mar. Biol. 70:117-127.

Terres, J.K. 1991. The Audubon Society Encyclopedia of North American Birds. New York: Wing Books. 1109 pp.

Trivelpiece, W.Z., R.G. Butler, D.S. Miller, and D.B. Peakall. 1986. Reduced survival of chicks of oil-dosed adult Leach's storm-petrels. The Condor. 86:81-82.

U.S. Dept. of Commerce. National Marine Fisheries Service. 1990a. Recovery plan for U.S. population of Atlantic green turtle (*Chelonia mydas*). U.S. Dept. of Commerce, National Marine Fisheries Service, St. Petersburg, FL

U.S. Dept. of Commerce. National Marine Fisheries Service. 1993. Recovery plan for hawksbill turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. U.S. Dept. of Commerce, National Marine Fisheries Service, St. Petersburg, FL.

U.S. Dept. of Commerce. National Marine Fisheries Service. 1990b. Recovery plan for U.S. population of loggerhead turtle (*Caretta caretta*). U.S. Dept. of Commerce, National Marine Fisheries Service, St. Petersburg, FL

U.S. Dept. of Commerce. National Marine Fisheries Service. 1992a. Recovery plan for leatherback turtles in the U.S. Caribbean, Atlantic and Gulf of Mexico. U.S. Dept. of Commerce, National Marine Fisheries Service, Washington, DC.

U.S. Dept. of Commerce. National Marine Fisheries Service. 1997. Fisheries of the United States, 1997. Current Fisheries Statistics. Washington, DC.

U.S. Dept. of the Interior. Minerals Management Service. 1995. Oil-spill Risk Analysis. central and Western Gulf of Mexico Outer Continental Shelf Lease Sales 157 and 161: OCS MMS 95-0026.

U.S. Dept. of the Interior. Minerals Management Service. 1997. Oil-Spill Risk Analysis (OSRA) results.

U.S. Dept. of the Interior. Minerals Management Service. 1997. Gulf of Mexico OCS Oil and Gas Lease Sales 169, 172, 175, 178 and 182: Central Planning Area--Final environmental impact statement. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS EIS/EA MMS 97-0033.

Vauk, G., E. Hartwig, B. Reineking, and E. Vauk-Hentzelt. 1989. Losses of seabirds by oil pollution at the German North Sea coast. Topics in Marine Biology. Ros, J.D., ed. Scient. Mar. 53(2-3):749-754.

Vermeer, K. and R. Vermeer. 1975. Oil threat to birds on the Canadian west coast. The Canadian Field-Naturalist. 89:278-298.

Webb, J.W., S.K. Alexander, and J.K. Winters. 1985. Effects of autumn application of oil on *Spartina alterniflora* in a Texas salt marsh. Environ. Poll., Series A. 38(4):321-337.

Witzell, W.N. 1994. The origin, evolution, and demise of the U.S. sea turtle fisheries. Mar. Fish. Rev. 56:8-23.