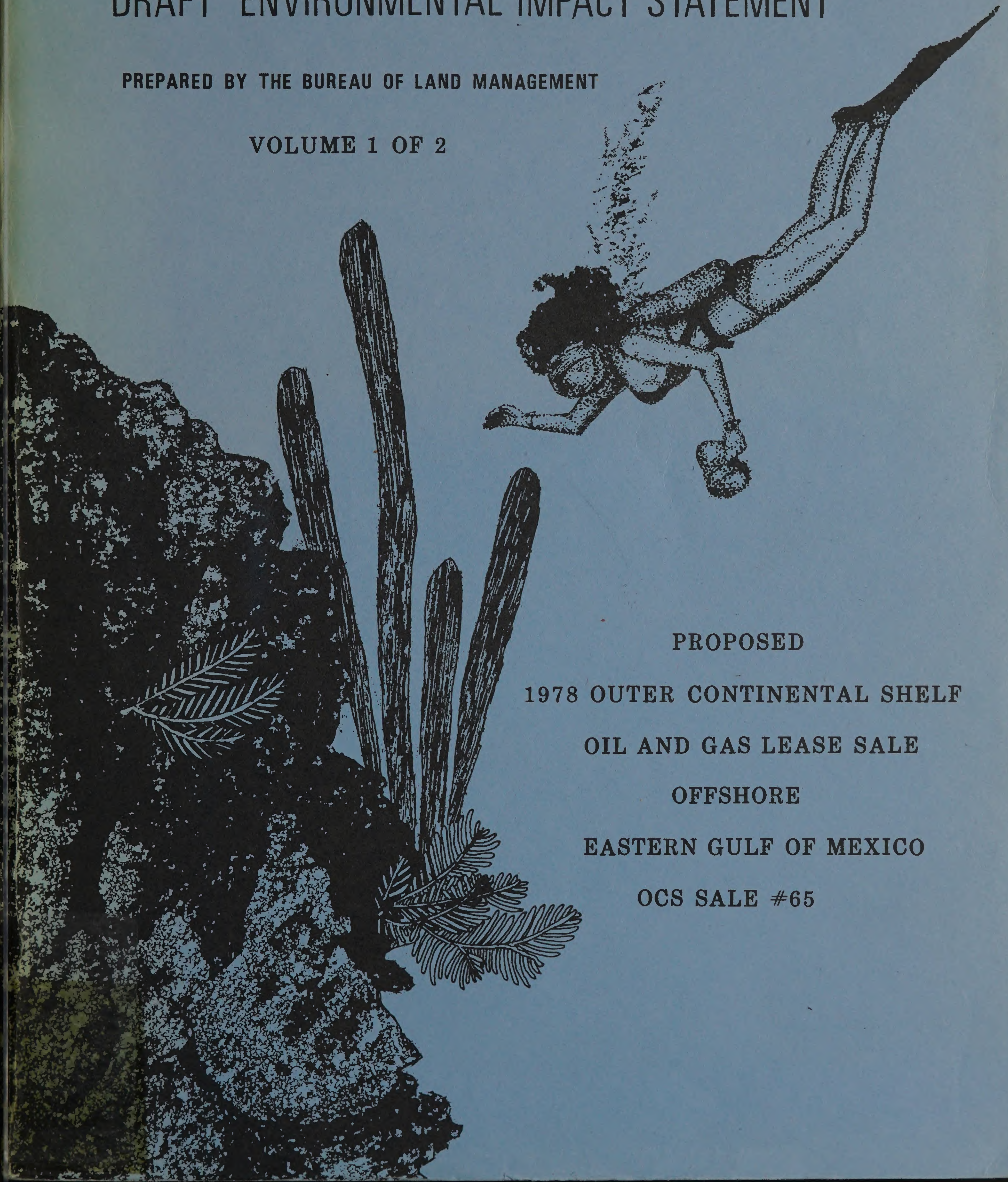
UNITED STATES DEPARTMENT OF THE INTERIOR

DRAFT ENVIRONMENTAL IMPACT STATEMENT

PREPARED BY THE BUREAU OF LAND MANAGEMENT

VOLUME 1 OF 2



PROPOSED

1978 OUTER CONTINENTAL SHELF

OIL AND GAS LEASE SALE

OFFSHORE

EASTERN GULF OF MEXICO

OCS SALE #65

DRAFT

ENVIRONMENTAL IMPACT STATEMENT

PROPOSED

1978

OCS OIL AND GAS LEASE SALE

UNITED STATES DEPARTMENT OF THE INTERIOR

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BLM

George L. Turcott
ACTING DIRECTOR

SUMMARY: PROPOSED OCS LEASE SALE NUMBER 65

(X) Draft

( ) Final Environmental Statement Department of the Interior, Bureau of Land Management, New Orleans OCS Office, New Orleans, Louisiana

1. Proposed Oil and Gas Lease Sale, Eastern Gulf of Mexico Outer Continental Shelf (X) Administrative

( ) Legislative Action

2. This proposed oil and gas lease is the third sale for the eastern Gulf of Mexico (MAFLA) region (See Figure I-1).

One hundred and sixteen (116) tracts (270,023.99 hectares - 667,229.28 acres) of OCS lands are proposed for leasing action. The tracts are located offshore of Florida, Alabama, Mississippi, and Louisiana with distance to shore ranging from approximately 16 to 190 kilometers (10 to 119 statute miles). The tracts are situated in water depths that range from approximately 18 to 350 meters (60 to 1150 feet). If implemented, this sale is tentatively scheduled to be held in October 1978.

Development at the following level is expected: 5-25 platforms, 45-300 wells, 400-700 miles of pipeline, 0-2 oil terminals, storage areas, and gas processing plants.

3. An oilspill risk analysis (Appendix H) was made for 30 resource categories. Also, each proposed lease tract has received a proximity elevation using a matrix technique to identify significant environmental impacts should leasing and subsequent oil and gas exploration and production ensue.

All tracts offered pose some degree of risk to the environment. Accidental or chronic oil spillage is the chief potential cause of impact. Other sources of impact include platform and pipeline installation.

The principal adverse impacts that will occur include: some minimal effects on recreational beaches in the Mississippi Sound area, localized effect on recreational and commercial fishing grounds (particularly oysters) and benthic organisms at sites of development, some potential danger to the habitat of the Florida manatee, and unknown but potential effect on archaeological sites.

Existing air and water quality onshore will be adversely impacted by operations of gas processing plants, should they be constructed.

Beneficial economic impact is anticipated in employment and income with some adverse effect from induced development growth patterns in local areas.

4. Alternatives to the proposed action:

A. Hold the proposed sale in modified form; substitution, addition, or withdrawal of tracts.

B. Withdraw the proposed sale.

C. Delay the proposed sale.

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Section I

Description of the Proposal

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BLM
NEW ORLEANS OCS

A. Proposed Action

1. Location and Reserves

The Federal action known as Proposed OCS Sale No. 65 involves the offering of 116 tracts for leasing for the extraction of oil and gas. The tracts are located on the Outer Continental Shelf in areas located west, south, and east of that portion of the states of Florida, Alabama, Mississippi, and Louisiana that border on the Gulf of Mexico. The largest portion of the proposed lease offering is located off the coast of Florida.

With the exception of two tracts, each tract contains 5,760 acres (2331.04 hectares). Tract 65-32 contains 5454.72 acres and Tract 65-71 contains 5134.56 acres.

The total area offered in all tracts amounts to 667,229.28 acres (270,023.99 hectares). The tracts are located between 10 statute miles (16 kilometers) to 119 statute miles (190 kilometers) from shore. The water depths range from 60 feet (18 meters) to 1,150 feet (350 meters). Thirty-three of the tracts are located in areas where the water depth is equal to or greater than 200 meters.

Seventy-five of the tracts proposed for offering are believed to have potential for oil and gas production, and the remaining 41 tracts are believed to be potentially oil productive.

No commercial oil and gas production has been found on the Outer Continental Shelf in this region, and no marine oil and gas production has been established in this portion of the Gulf of Mexico and therefore, no facilities for the production and transportation of crude and natural gas have been installed on the Outer Continental Shelf in the vicinity of the tracts proposed for leasing.

The U.S. Geological Survey estimates that between 15 and 150 million barrels of oil and 20-175 billion cubic feet of natural gas may be produced as a result of this proposed sale. The production rates may be estimated at between 2,500 and 24,000 barrels of oil per day and between 4 and 32 million cubic feet of gas per day. The daily rates are estimated as rates applicable to that time when development is complete and production stabilizes.

See Figure I-1.

2. Development Assumptions

a. Exploration

Following the awarding of leases, the successful bidders can be expected to drill exploratory wells in order to locate and delineate the areal extent of oil and gas deposits. The most likely number of exploratory wells to be drilled amounts to 75. These wells will probably be drilled by movable offshore drilling units.

b. Development and Production

After the completion of exploratory drilling, platforms would be designed, constructed, and placed in position. Development wells will be drilled from platforms. The most likely number of platforms to be installed is 25, and the most likely number of development wells is 225. Underwater completions may also be utilized. Support facilities for this activity could be located in the Tampa, Panama City, or Mobile Areas. The expected production life is 25 years.

c. Transportation

The most likely method of transportation that will result from the proposed sale will be pipeline transportation of natural gas to shore points in the vicinity of existing onshore natural gas pipelines.

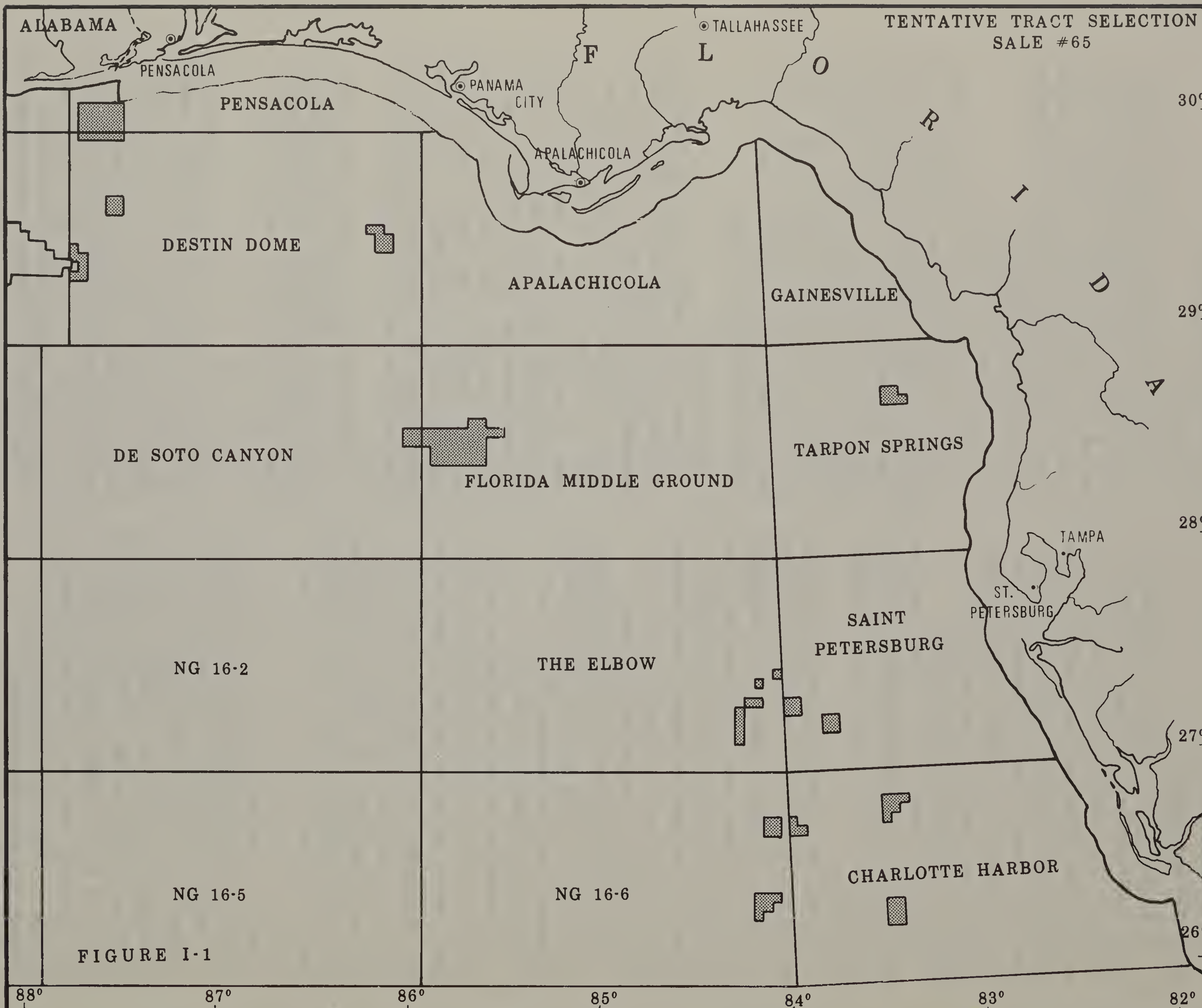
The most likely system for the transport of crude oil would be pipeline transport to onshore storage facilities, and transportation from these terminals to existing refineries by surface marine transport. The most likely pipeline mileage that may be installed is 700 miles, and probable destination points and locations of oil terminal facilities and gas processing plants are the Manatee/Tampa area and the Mobile/Pensacola area.

A possible alternative gathering and transportation system could include the provision of offshore storage on the OCS and direct transportation from these facilities to existing refineries.

d. Termination

Title 43, 3307.3-4 and 3307.3-6 provide for the removal of all structures when no longer required for operations. The removal must be completed within a period of one year following the expiration of the lease, and the structures must be removed to a sufficient depth beneath the surface of the waters to prevent them from being a hazard to navigation and the fishing industry.

OCS Order No. 3 requires that all casing and piling shall be severed and removed to at least 15


TENTATIVE TRACT SELECTION
SALE #65
ALABAMA
PENSACOLA
TALLAHASSEE
F L O R I D A
PANAMA CITY
APALACHICOLA
TAMPA
ST. PETERSBURG
PENSACOLA
DESTIN DOME
APALACHICOLA
GAINESVILLE
DE SOTO CANYON
FLORIDA MIDDLE GROUND
TARPON SPRINGS
NG 16-2
THE ELBOW
SAINT PETERSBURG
NG 16-5
NG 16-6
CHARLOTTE HARBOR
30°
29°
28°
27°
26°
88°
87°
86°
85°
84°
83°
82°
FIGURE I-1

feet below the Gulf floor and the location shall be dragged to clear the well site of any obstructions.

See Table I-1 for a summary of the range of activities needed to develop the oil and gas potential in this sale area estimated by the USGS. Appendix D contains the complete USGS Resource Report.

B. Leasing Process

1. Legal and Administrative Background

In 1953, the Outer Continental Shelf (OCS) Lands Act (67 Stat. 462; 43 U.S.C. Sec. 1331) established Federal jurisdiction over the submerged lands of the continental shelf seaward of the state boundaries. The Act charged the Secretary of the Interior with the responsibility for the administration of the mineral exploration and development on the OCS. It also empowered the Secretary to formulate regulations so that the provisions of the Act might be met.

Subsequent to the passage of the OCS Lands Act of 1953, the Secretary of the Interior designated the Bureau of Land Management (BLM) as the administrative agency for leasing of submerged Federal lands, and the U.S. Geological Survey (USGS) for supervising operations on the OCS. The Department formulated three major goals for the comprehensive management program for marine minerals. These are (1) The orderly development of the marine mineral resources to meet the energy demands of the nation, (2) The protection of the marine and coastal environment, and (3) The receipt of a fair return for the leased minerals resources. These leasing objectives are based on legislative mandates as explained below:

(1) Orderly resource development is based on the OCS Lands Act which gives the Secretary the authority, in order to meet the nation's demand for oil and gas, to grant leases to the highest qualified bidder(s) on the basis of sealed competitive bids. (2) Protection of the marine and coastal environment is a direct outgrowth of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.). This act requires that all Federal agencies shall utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences in any planning and decision-making which may have an impact on man's environment. The products of BLM efforts in this direction are Environmental Impact Statements (EIS's), Environmental Assessment Records, and contract studies designed to identify and characterize different types of environments and the problems they face. (3) Receipt of fair return has its base in two separate mandates. United States Code 31, Sec. 483(a) obligates the Federal Government to obtain a fair return for public lands that are sold or leased. This is further implemented within the Executive Branch by the Office of Management and Budget Circular A-25.

2. Relationship to Existing and Proposed Oil and Gas Development

This proposed action must be viewed as one part of a continuing activity that has been underway since the 1940's. Although primary emphasis in this impact statement has been placed on this particular sale, it should also be put into the perspective of an on-going offshore oil and gas development process. As of June 23, 1977, there have been 34 OCS oil and gas (and five OCS sulfur and salt) lease sales on submerged lands in federal areas of the Gulf of Mexico. See Table I-2 for a summary of federal leased acreage on the Gulf of Mexico OCS.

Currently, the Bureau of Land Management holds 495 permits on the OCS resulting in 5,862 miles of offshore pipelines. These figures are as of October 31, 1977, and exclude 12 pending applications.

As production declines in existing areas, much of the equipment, transportation facilities, and personnel can be used for new areas of activity. As existing areas of production decline, the pipelines in place can be used for new production areas, adjacent or further from shore, reducing the number of pipelines necessary to transport production from new areas to shore. This latter event has already been exercised in some areas offshore Louisiana. Likewise, a reduction in quantity of onshore facilities, such as treatment plants, refineries, storage facilities, etc., is made possible by utilizing existing facilities, equipment, and technology.

Proposed OCS planning schedules are developed in order to project the timing, size, and location of specific sales for an OCS leasing program. See Figure I-2 for the most recent (August 1977) proposed OCS planning schedule. General sale areas are identified and, at a later date, tentative acreage figures are set for each proposed sale on the basis of broad resource knowledge. The goal of the proposed schedule is to provide for orderly development of OCS oil and gas in order to

TABLE I-1. Summary of the range of activities required to develop the estimated resources within the proposed lease sale tracts. (Proposed Sale No. 65)

	This proposed sale
1. Estimated area, construction activity and resources:	
a. Leases offered (hectares)	270,024
b. Exploratory wells	15-75
c. Producing wells	30-225
d. Total wells	45-300
e. Underwater completions	0-1
f. Platforms	5-25
g. Kilometers of pipelines	644-1127
h. Terminal storage facilities	0-2
i. Estimated resources:	
Oil (million bbl)	50-150
Gas (billion cu ft)	20-175
2. Estimated annual crude oil transportation:	
Transported by tanker (million bbl/yr)	1-9
Transported by pipeline:	
Minimum estimate (million bbl/yr)	1
Maximum estimate (million bbl/yr)	9

Note: Above estimates include transportation to shore terminals via pipelines and subsequent transportation to refineries by surface vessel.

3. Estimated volume of commercial mud and drill cuttings: Assume 300 wells with average depth of 10,000 feet. Cuttings: 682 tons per well: Mud components: 230 tons per well	
Drill cuttings (thousand tons)	30.7-204.6
Mud components (thousand tons)	10.4-69.0
4. Estimated volume of produced formation water proposed lease sale area: Assume 0.6 barrels formation water produced for each barrel of oil and condensate:	
Annual production (million bbl/yr)	.55-5.25
Total production (20 yrs) (million bbl)	30.0-90.0
5. Estimated total land use for onshore facilities (hectares)	0-485
6. Estimated pipeline burial disturbance:	3,169-5,445 1/
Offshore: (where burial required) 4,921-9,841 cubic meters/kilometer will be disturbed.	
Onshore: a zone 9-12 meters wide along pipeline right-of-way will be disturbed.	

1/ Thousands of cubic meters

Table I-2. Total Federal Acreage Leased in Gulf of Mexico from the Inception of OCS Leasing Activities Through March 23, 1977

Area	Acreage
Louisiana	8,522,203
Texas	3,186,880
Miss., Ala., Florida	508,437
Total	12,217,520

Federal Acreage Currently Under Lease in Gulf of Mexico as of March 23, 1977

Area	Acreage
Louisiana	5,319,999
Texas	2,116,827
Miss., Ala., Florida	381,717
Total	7,818,543

Note: The above summary does not include the acreage leased in OCS Sale No. 47 (6/23/77) 605,427.

PROPOSED OCS PLANNING SCHEDULE

August 1977

SALE AREA	1977 A	S	O	N	D	1978 J	F	M	A	M	J	J	A	S	O	N	D
CI. Cook Inlet		N	S														
42 N. Atlantic	F		P		N	S											
43 South Atlantic Georgia Embayment			F		P		N	S									
45 Gulf of Mexico				F		P		N	S								
65 Eastern Gulf of Mexico						E		H			F	P		N	S		
51 Gulf of Mexico							E		H			F		P		N	S
49 Mid-Atlantic		T						E		H			F			P	
48 Southern California													E		H		
58 Gulf of Mexico			C		D		T							E		H	
54 South Atlantic Blake Plateau		C				D			T								
Federal/State Beaufort (near shore)			C		D				T								
55 Gulf of Alaska										C		D			T		
62 Gulf of Mexico														C		D	
46 Kodiak																	
52 North Atlantic																C	
53 Cental and Northern California				C							D			T			
60 Cook Inlet																	C
56 South Atlantic Georgia Embayment																	
59 Mid-Atlantic																	
66 Gulf of Mexico																	
57 Bering Norton																	

SALE AREA	1979 J	F	M	A	M	J	J	A	S	O	N	D
CI. Cook Inlet												
42 N. Atlantic												
43 South Atlantic Georgia Embayment												
45 Gulf of Mexico												
65 Eastern Gulf of Mexico												
51 Gulf of Mexico												
49 Mid-Atlantic	N	S										
48 Southern California	F		P		N	S						
58 Gulf of Mexico		F		P		N	S					
54 South Atlantic Blake Plateau	E		H			F		P		N	S	
Federal/State Beaufort (near shore)			E		H			F			N	S
55 Gulf of Alaska								E		H		
62 Gulf of Mexico		T								E		H
46 Kodiak												E
52 North Atlantic	D			T								E
53 Cental and Northern California												
60 Cook Inlet		D			T							
56 South Atlantic Georgia Embayment			C		D			T				
59 Mid-Atlantic									C		D	
66 Gulf of Mexico											C	
57 Bering Norton				C							D	

SALE AREA	1980 J	F	M	A	M	J	J	A	S	O	N	D
CI. Cook Inlet												
42 N. Atlantic												
43 South Atlantic Georgia Embayment												
45 Gulf of Mexico												
65 Eastern Gulf of Mexico												
51 Gulf of Mexico												
49 Mid-Atlantic												
48 Southern California												
58 Gulf of Mexico												
54 South Atlantic Blake Plateau												
Federal/State Beaufort (near shore)												
55 Gulf of Alaska	F		P		N	S						
62 Gulf of Mexico			F		P		N	S				
46 Kodiak		H			F		P		N	S		
52 North Atlantic		H				F		P		N	S	
53 Cental and Northern California				E		H			F		P	
60 Cook Inlet		E				H				F		P
56 South Atlantic Georgia Embayment						E		H			F	
59 Mid-Atlantic		T								E		H
66 Gulf of Mexico	D			T							E	
57 Bering Norton		T										E

SALE AREA	1981 J	F	M	A	M	J	J	A	S	O	N	D
CI. Cook Inlet												
42 N. Atlantic												
43 South Atlantic Georgia Embayment												
45 Gulf of Mexico												
65 Eastern Gulf of Mexico												
51 Gulf of Mexico												
49 Mid-Atlantic												
48 Southern California												
58 Gulf of Mexico												
54 South Atlantic Blake Plateau												
Federal/State Beaufort (near shore)												
55 Gulf of Alaska												
62 Gulf of Mexico												
46 Kodiak												
52 North Atlantic												
53 Cental and Northern California	N	S										
60 Cook Inlet		N	S									
56 South Atlantic Georgia Embayment	P		N	S								
59 Mid-Atlantic			F		P		N	S				
66 Gulf of Mexico	H			F		P		N	S			
57 Bering Norton		H					F		P		N	S

C - Call for Nominations
D - Nominations Due
T - Announcement of Tracts
E - Draft Environmental Statement
H - Public Hearing
F - Final Environmental Statement
P - Proposed Notice of Sale
N - Notice of Sale
S - Sale

THE DEPARTMENT OF THE INTERIOR

FIGURE I-2

maintain an adequate contribution of OCS production to the national supply, and to provide early information concerning areas proposed for leasing activities.

Secretary of the Interior Cecil D. Andrus announced on August 23, 1977, this comprehensive revised planning schedule for oil and gas lease sales on the outer continental shelf for the period 1979 through 1981. The Secretary announced that the planning schedule had been prepared in close consultation with the affected coastal states and took into account the comments received from them and from local governments, industry, environmental groups, and other interested parties.

Secretary Andrus emphasized that the sale schedule will assist public and industry planning and preparations for OCS leasing but decisions on whether to proceed with specific sales will be made by him only after all applicable legal requirements have been made and he has studied the comments of the coastal governors and others on the full range of issues related to the sale.

An estimate of the production and facilities that may result from this proposed sale, with projections as to the status of OCS activity in the year 1983, have been included here on Table I-3 provided by the U.S. Geological Survey.

3. Environmental Studies Program

The Bureau of Land Management has established broad objectives for environmental studies programs in order to satisfy various legislative requirements, including those of the Outer Continental Shelf Lands Act, the Submerged Lands Act, and the National Environmental Policy Act. These objectives are:

(1) The acquisition of information about the Outer Continental Shelf environment that will enable the Department and the BLM to make better management decisions regarding the development of mineral resources on the Federal OCS.

(2) The acquisition of information about the OCS environment which will enable the Department and the BLM to detect the impacts of OCS oil and gas exploration and development on the marine environment, and information which will enable the detection of environmental changes which may occur as a result of oil and gas operations.

(3) The establishment of a basis for prediction of impact of OCS oil and gas activities in frontier areas.

(4) The identification of sensitive habitats, potential geological hazards, and other factors of concern in the marine environment.

(5) The acquisition of impact data that may result in the modification of leasing stipulations, OCS Operating Orders, Notices to Lessees, and guidelines permitting efficient resource recovery while also insuring the protection of the marine environment.

The environmental studies program for the eastern Gulf of Mexico OCS is designed to acquire three distinct types of data: benchmark, descriptive, and predictive. Benchmark data are both qualitative and quantitative data, for which an acceptable statistical significance can be established. These types of data are collected prior to oil and gas production so that any environmental impacts can be detected by monitoring the same parameters during the production stage. Descriptive data fall into two categories. The first is non-quantitative, or semi-quantitative descriptions of the morphological aspects of the environment which identify unique or special cases; the second is non-quantitative biological or chemical data for which statistical significance cannot be feasibly established. These data are primarily used in support of the analyses of effects which are observed through the benchmark and/or predictive data studied. They may also serve as indicators of environmental stress which could lead to the initiation of special studies designed to determine the sources and effects of the stress. Predictive information is primarily composed of physical processes data which can be used to determine the fate of pollutants, and biological effects data which can be used to predict and determine stress levels imposed by oil and gas development.

In order to fulfill its requirements under the marine minerals management goals of the Department of the Interior, the Bureau of Land Management initiated a benchmark studies program in the eastern Gulf in 1974 conducted by the State University System of Florida Institute of Oceanography (SUSIO). The study was designed with heavy reliance on a report resulting from a conference of leading scientists from the region. The report, "A Summary of Knowledge of the Eastern Gulf of Mexico, 1973" was coordinated by SUSIO.

The benchmark program was expanded in 1975 and ran into 1976. The present benchmark study conducted by Dames and Moore was begun in the

TABLE I-3 - STATUS OF OCS LEASING AND FIVE-YEAR PROJECTION

	Proposed Sale #65	Current Status	Increments: 1/ Five-Year Schedule	1983 Status
Acres under lease (million)	.200 2/	7.7 5/	0.8 - 1.5	7 - 10 3/
Reserves to be developed:				
- Oil (million bbl)	15 - 150		500 - 1000	
- Gas (billion cu. ft.)	20 - 175		7 - 12	
Remaining Reserves:				
- Oil (billion bbl)		2.5		2.0 - 3.5
- Gas (trillion cu. ft.)		30.0		20 - 40
Wells	30 - 225	14,272 5/	1,500 - 3,000	15,500 - 17,000
Platforms	5 - 26	2,144	100 - 300	2,200 - 2,600
Miles of Pipelines	400 - 700	8,300 4/	600 - 1,000	8,000 - 9,000
Onshore Terminal/Storage Facilities	0 - 2	52	6 - 10	55 - 65

1/ All figures are for development over the life of the leases issured during the five-year period.

2/ Estimated that .30 of the acreage proposed for offering in this sale will lease.

3/ This assumes that some leases will have expired or will have been relinquished.

4/ Includes approximately 3,100 miles of common carrier pipeline.

5/ U.S. Geological Survey Monthly Report. May 1977

(All data for this table supplied by the U.S. Geological Survey) summer of 1977 after a period of inactivity during the fall 1976 and winter 1977 sampling periods. Several special studies complimentary to the benchmark program have been completed.

The data generated by these studies represent an important addition to the existing data base and enhance the Department's ability to make management decisions that will ensure environmental integrity during oil and gas exploration.

Future studies will add to the data base to support management decisions affecting future exploration, development, and production in the area.

The studies program is envisioned as a long-term study which will be in effect for a minimum of three to five years and most likely will continue for the duration of exploratory and development drilling, establishment of production platforms, the laying of pipelines, and other related activities in the eastern Gulf of Mexico OCS area. Planning and budgeting have been based on an initial three-year period of intensive study, a slow decline in funding and effort over the succeeding two years; and a maintenance, or sustaining level of effort and funding for an indefinite number of years to monitor the effects of OCS oil and gas exploration and development over the long-term. Present estimates indicate that this monitoring period could range from five to fifteen years, but these estimates will continue to be revised depending upon the level of oil and gas activities that may occur in the region.

A synopsis of studies completed, in process, and planned for the eastern Gulf of Mexico is presented below:

(1) Socio-Economic Inventory and Analysis of the Gulf of Mexico Region, contract 08550-CT3-10 was issued 6/29/73. The report documents the socio-economic environment of the Gulf region to facilitate impact evaluations of resource development projects in this geographic area. A final report has been received.

(2) Baseline Environmental Survey of the MAFLA Lease Areas, contract 08550-CT4-11, was issued 5/8/74. The Mississippi-Alabama-Florida (MAFLA) Outer Continental Shelf was sampled for water column, benthic organism, and geological parameters during the spring-summer season, 1974. Hydrocarbon and trace metal concentrations were determined in a wide suite of samples and additions to knowledge of biological assemblages were made. A final report has been received.

(3) Compilation and Summation of Historical and Existing Physical Oceanographic Data from the Eastern Gulf of Mexico, contract 08550-CT4-16 was issued 6/24/74. A compilation of eastern Gulf of Mexico physical oceanographic data was made and the circulation of the region described in a manner designed to aid in the interpretation of bio-geo-chemical data. A final report has been received.

(4) Multivariate Analysis of MAFLA Water Column Baseline Data, contract 08550-CT5-27 was issued 3/20/75. A statistical analysis of the water column data resulting from the baseline study (Study (2) above) was made to show the relations of the parameters and to serve as an aid in designing future studies.

(5) Baseline Monitoring Studies: Mississippi, Alabama, Florida Outer Continental Shelf, 1975-1976 1976, contract 08550-CT5-30 was issued 6/30/75. The study included sampling, analyses, and reporting covering three biological seasons 1975-1976 and the sampling of the spring-summer season of 1976. The investigations included most of the parameters studied in the 1974 effort but over more stations. Geophysical, histology, and rig monitoring were significant additions to the study. A diving program to study the extensive Florida Middle Ground was included. Samples were collected during the spring-summer 1976 season and archived for analysis. A final report has been received.

(6) An Extension of the Determination of the Baseline Compositions of Hydrocarbons in Benthic Epifauna of the Outer Continental Shelf of the Eastern Gulf of Mexico, contract 08550-CT5-43 was issued 6/30/75. Samples archived from the spring-summer 1974 season were analyzed for their high molecular weight hydrocarbon content. A final report has been received.

(7) Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf was a joint study funded by the National Park Service and the Bureau of Land Management. A literary research and synthesis of the archaeological, historical, geological, and technical parameters related to the identification and management of these resources was made. A final report has been received.

(8) A Numerical Modeling and Observational Effort to Develop the Capability to Predict the Currents in the Gulf of Mexico for the use in Pol-

lutant Trajectory Computation was issued 3/10/75. A model was developed to describe open ocean circulation in the Gulf of Mexico and was compared to observed data. A final progress report has been received.

(9) Hydrocarbon Quality Control, contract 08550-CT4-13 was issued 6/17/74. Selected samples from the eastern Gulf of Mexico collected under contracts 08550-CT4-11 and 08550-CT5-30 received quality control on their hydrocarbon content. Reports on all data have been received.

(10) Trace Metal Quality Control contract 08550-CT4-15 was issued 6/20/74. Quality control was effected on 100 samples selected from the benchmark study (08550-CT4-11) for trace metal analyses. A final report was accepted on 11/14/75.

(11) Trace Metal Quality Control, contract 08550-CT5-49 issued 6/24/75. Selected samples collected under contract 08550-CT5-30 received quality control for trace metal contents. A final report has been received.

(12) Ichthyoplankton Abundance and Diversity in the Eastern Gulf of Mexico, contract AA550-CT7-28 was issued 6/17/77. Investigations into the kinds and abundance of ichthyoplankton in the eastern Gulf of Mexico are being made on existing samples to provide baseline information and examine seasonal and annual population changes.

(13) Benchmark Studies for the Eastern Gulf of Mexico, contract AA550-CT7-34 was issued 6/27/77. Water column, benthic biology, and geological parameters are being investigated during the three biological seasons. The final report is due in late 1978.

(14) Survey of the Tarpon Springs Lease Blocks for Proposed Sale 65. A team of divers from BLM and Florida State University covered approximately 95 km of shelf bottom to investigate the possibility of the existence of extensive sensitive habitats. A final report is due by early 1978 (See Appendix F).

(15) Biological Studies on the Florida Middle Grounds. A study of several biological features of the Florida Middle Grounds will be funded this year to augment past studies (08550-CT5-30).

(16) Habitat Studies of the Eastern Gulf of Mexico. A number of lease blocks proposed for tentative Sale 65 will be examined visually, by side scan sonar, and shallow seismology to locate and define significant biota supporting geological features.

(17) Benchmark Monitoring Studies of the Eastern Gulf of Mexico. A monitoring phase study reduced in scope from the present study will be continued during 1978-1979.

4. Call for Nominations

During the Department's initial stages of preparation for the selection of tracts to be offered for oil and gas leasing in tentative Sale No. 51, tentative Sale No. 65 had not been scheduled. The Department had originally intended to offer for lease in tentative Sale No. 51 tracts on the OCS of the central, the western, and the eastern Gulf of Mexico, but after the deadline of April 15, 1977 for submission of nominations and comments, the Department decided to restrict offerings in tentative Sale No. 51 to tracts on the OCS of the central and western Gulf of Mexico. The Department tentatively scheduled Sale No. 65 and on May 27, 1977, issued a call for nominations and comments for the sale (See Appendix I).

The area opened to nominations and comments was contained entirely on the OCS of the eastern Gulf of Mexico (see Figure I-1). It lies between 88° and 81° 50′ west longitude and between 30° 15′ and 25° 55′ north latitude. Its broadest east-west extent is approximately 480 kilometers (approximately 300 miles) and its greatest north-south extent is approximately 430 kilometers (approximately 270 miles). The area lies west and south of the coasts of Florida and south of the coast of Alabama. It covers approximately 14.4 million hectares (approximately 35.7 million acres). The distance from shore of the tracts in the area varies from about 4.8 kilometers (approximately 3 miles) to about 360 kilometers (approximately 225 miles).

In December 1976, the BLM had requested resource reports for tentative Sale No. 51 from several agencies of the federal government. In May 1977, shortly after the Department scheduled tentative Sale No. 65, the BLM requested that the agencies provide updates of the portions of their resource reports germaine to oil and gas leasing in the eastern Gulf of Mexico.

5. Tract Selection.

The deadline for submission of nominations and comments was June 30, 1977. In response to the call, six companies nominated a total of 791 tracts with a combined area of approximately 4.5 million acres (approximately 1.8 million hectares). In addition to nominations, the Department received from the Board of County Commissioners of Pinellas County, Florida, a copy of a resolution expressing opposition to oil and gas leasing in offshore areas near the coast of Pinellas County. (In response to the call for nominations and comments for tentative Sale 51 several comments were received concerning oil and gas development in Charlotte Harbor.)

In June 1977, invitations to attend each of two meetings were sent to the Special Assistant to the Secretary of the Interior, Atlanta; to representatives of BLM, FWS, NMFS, NPS, and USGS; and to representatives of the governors of the states of Alabama, Florida, Louisiana, and Mississippi. The first meeting, the environmental briefing, was held on July 5, 1977; it consisted primarily of presentations of environmental, socioeconomic, geological, and other information bearing on the selection of tracts for the sale. The second meeting was held on July 11, 1977, to provide all attendees additional opportunity to comment on the selection of tracts for the sale. Both meetings were held in the New Orleans OCS Office.

All those invited to these meetings were subsequently invited to a third meeting to be conducted by the BLM's Washington, D.C., headquarters office; in addition, representatives of the Departments of Defense and Transportation were invited. This meeting, held on July 22, 1977, provided those in attendance an additional opportunity to discuss the selection of tracts for the sale. Attendees were briefed by the staff of the BLM on the selection of five tracts at the special request of the state of Alabama and the state's request was accommodated during the tract selection process.

The Department's OCS policy committee met on July 28, 1977, and on that day a tentative tract list for the sale was published. It listed 116 tracts with a combined area of 667,229.28 acres (approximately 270,024 hectares). None of the tracts has been leased previously. Nine of the tracts have been offered in previous sales, but none has been bid on. All but eight have each been nominated for at least one previous sale.

6. Geophysical Exploration

The OCS Lands Act (43 U.S.C. 1340) provides for authorization by the Secretary of Interior for the conduct of geological exploration on the OCS. The enforcement of regulations has been delegated to the Regional Oil and Gas Supervisors of the U.S. Geological Survey. The number of permits granted for geological and geophysical exploration through the year 1976 on the OCS adjacent to the states bordering the Gulf of Mexico include Alabama (95), Florida (244), Louisiana (2,666), Mississippi (73), and Texas (1,159).

In the eastern Gulf of Mexico, adjacent to the states of Alabama, Florida, and Mississippi, the largest number of permits was issued in the year 1973, with 28 applicable to Alabama, 50 applicable to Florida, and 24 applicable to Mississippi. During 1976, 7 permits were issued for OCS exploration adjacent to Florida, and none adjacent to Alabama and Mississippi.

Extensive geophysical exploration can be expected between the time of announcement of a proposed sale and the holding of the sale, as organizations obtain data on which to base their bids. (U.S. Department of Interior, Geological Survey. 1977a).

C. Relationship to Other Governmental Programs

1. Coastal Zone Management

The Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. 1451-1464), administered by the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, provides grants-in-aid to states for the development and implementation of management programs to control land and water uses in the coastal zone.

Amendments to the CZMA were adopted in July 1976 providing a program of supplementary grants and loans to deal with coastal zone impacts of OCS and other energy developments. Of significant interest are a few Act factors as follows:

1) The CZMA requires that federal actions within or directly affecting the coastal zone must be consistent to the maximum extent practicable with a state's CZM program once that program has been approved by the Secretary of Commerce. Conversely, state CZM plans must consider the national interest in facility siting. Local governments in turn must consider state and regional interests in the exercise of their coastal regulatory powers. This consistency provision requires that exploration and development plans of OCS oil and gas lessees will receive consistency review by affected coastal states with approved management plans.

2) Section 308 of the Act, which was developed expressly in the amendments of 1976, outlines the Coastal Energy Impact Program (CEIP) which provides financial assistance, in the form of loans, bond guarantees, and grants, to help coastal states and local communities deal with impacts perpetrated by current or future coastal energy activity. The CEIP seeks to strike a balance between the national objectives of increasing energy self-sufficiency and of protecting and managing the nation's coastal resources.

The two sources of financial assistance are the Coastal Energy Impact Fund (Section 308 (h)) authorizing $800 million over ten years and Formula Grants (308 (b)) authorizing $400 million over eight years. Fund monies can be awarded for any coastal energy activity. Formula Grant monies must be awarded for impacts sustained primarily from OCS energy activity.

To be eligible for assistance under the CEIP, a coastal state must be receiving a grant under Section 305 of the Act or have a coastal management program which has been approved under Section 306 of the Act, or be making satisfactory progress toward the development of a program which is consistent with the policies set forth in Section 305 of the Act.

Assistance under the CEIP can take four possible forms: First, grants for planning for socioeconomic and other environmental consequences of oncoming energy activity can be provided. Second, the CEIP can help finance new or improved public facilities and services needed because of further coastal energy development. Third, repayment assistance can be provided when a borrowing government cannot meet its credit obligations because actual revenues from coastal energy activity are insufficient. And fourth, grants may be provided to ameliorate damage to recreational or other environmental resources when the responsible party cannot be found or charged with damage.

OCS energy activity, including that directly stemming from proposed Lease Sale 65, will definitely stimulate administration of some of these monies. This will take any of the four forms mentioned above and will be the result of either direct or indirect impacts of OCS activity. Interim-final regulations and rules of Coast Energy Impact Program implementation became effective February 4, 1977, and will remain in effect until superceded by final regulations issued by the Department of Commerce. At this writing, indications are that Final Regulations were published by December 1977 and include several "major changes" from the interim-final regulations previously released.

No State adjacent to the proposed sale area has completed or received Secretary of Commerce approval for its Coastal Zone Management Plan. Expected completion dates are discussed for each state in the following pages. The final approved CZM plans for Florida, Alabama, and Mississippi are not expected to totally exclude OCS related developments in the coastal zone. These States have expressed support for OCS energy development if sufficient safeguards for the environmental, social, and economic wellbeing of the adjacent coastal region is provided. State CZM plans may restrict the placement of pipelines, refineries, or other support facilities in areas of particular environmental concern and set standards for their placement elsewhere; however, some provision for their appropriate location is required by the CZM Act, as amended.

Florida

The 1970 Florida Legislature created the Coastal Coordinating Council in recognition of coastal zone problems. Much progress was made by the CCC, including the development of the Florida CZM Atlas, in 1972 (updated in 1976). In 1975 the lead agency for program development became the Bureau of Coastal Zone Planning in the Department of Natural Resources. In 1977 this Bureau was re-established into the Department of Environmental Regulation. Florida's Preliminary Draft CZM Plan is expected to be complete by spring of 1978 and final program approval by the Department of Commerce by the end of 1978.

Florida began receiving planning monies in 1974 and has just run through an extension period from the third year of planning grants. The state has also received CEIP monies including planning allotments, credit assistance, environmental grants, and formula grants.

Florida's basic structure in planning is mandated by the State and Local Government Comprehensive Land Use Planning Act (discussed in Section 4 below) for comprehensive planning on the state and local levels. The 38 coastal counties are required to include a coastal zone element within the Plan which all counties and municipalities are required to produce by July 1, 1979. The

State's proposed CZM program is based on an area approach. Preservation, conservation, and development areas are delineated and allowable and prohibited uses in those areas are to be decided upon. The planning process itself is a 5 step process and includes an inventory of biophysical characteristics, an inventory of existing socio-economic economic parameters, an inventory of environmental quality, a planning analysis, and a management analysis (Florida Department of Natural Resources, DRM, BCZP, 1977a and 1977b).

Alabama

The Alabama legislature, in 1976, passed Act 534 which reconstituted the Alabama Coastal Area Board and delegated to the board responsibility for developing, coordinating, and maintaining a coastal area program. The Coastal Area Board consists of eight members including representatives from state and local government and the academic community.

The Alabama Coastal Area Board, in the summer of 1977, employed an executive director and principal planner and is in the process of recruiting additional staff to develop a CZM program under Section 305 of the Coastal Zone Management Act.

Alabama began receiving planning monies in 1974. This past year, the state received funds from the CEIP as well, including planning allotments, credit assistance, environmental grants, and formula grants. Alabama is not expected to reach the Plan approval stage before 1979, in which year their eligibility for Section 305 planning funds is expected to be exhausted.

According to State Act 534, the CZM program formulated by the board must include an identification of all of the state's coastal resources; an evaluation of those resources; a determination of present and potential uses in the coastal zone and present and potential use conflicts; an inventory and designation of areas of particular concern; broad guidelines on priority of uses in particular areas; adequate consideration of energy facilities siting issues; provision for commenting on permit applications for coastal uses; and, a determination of permissible uses in the coastal zone (Alabama Development Office, 1976; American Institute of Planners, 1976; and Coastal Zone Management Newsletter, 1977).

Mississippi

The Mississippi legislature created the Mississippi Marine Resources Council in 1970 to develop and implement a Coastal Zone Management Plan for the state (Act 293). The 1972 Coastal Wetlands Protection Act further delegated the Marine Resources Council as the state's regulatory agency for activities conducted on state owned coastal wetlands.

Mississippi also began receiving Section 305 planning monies in 1974. This past year, the state has received CEIP (Section 308, CZMA) funds, similar to Florida and Alabama, in the form of planning allotments, credit assistance, environmental grants, and formula grants. Mississippi is not expected to be to the final Plan approval stage by the end of 1978; though, at that time, planning funding eligibility is expected to cease (Coastal Zone Management Newsletter, 1977).

Mississippi's CZM planning goals include the development of available resources for the state's economic benefit; the provision of environmental protection for the natural resources and inhabitants of the state; to focus marine research on coastal zone problems; the formulation of a means of providing for the resolution of use conflicts; and, the facilitation of coordination of activities of the various agencies in the coastal zone (Mississippi Marine Resources Council, all publications).

2. Marine Fisheries Management

The Fishery Conservation and Management Act of 1976 (P.L. 94-265) established a 200-mile fisheries conservation zone off the coasts of the United States and its possessions, effective March 1, 1977. The Act provides for creation of Regional Councils to be composed of fishermen and individuals, representatives of states, and Federal interests responsible for and concerned with commercial and recreational fisheries in the marine environment. Administered under the Department of Commerce, the National Marine Fisheries Service will assist the Regional Councils in developing fishery management plans inclusive of the Outer Continental Shelf. The Gulf of Mexico Fishery Management Council will develop the fisheries plan for the marine environment corresponding to the offshore area under study for proposed Sale 65. This plan will serve as a basis for policy and management decisions relating to fisheries in the Gulf of Mexico.

3. Other Federal Programs

a. Administrative and Regulatory Responsibilities

As indicated in the Tract Selection Process section (I.B.5), leasing procedures and pre-leasing evaluations and analyses are the responsibility of the Department of the Interior - primarily the Bureau of Land Management and the U.S. Geological Survey. The U.S. Fish and Wildlife Service helps design environmental studies and acts in an advisory capacity through much of the leasing process.

Several agencies, including Interior agencies, are involved in regulatory aspects of offshore oil and gas operations which involve their program areas. Offshore structures require permits to assure that navigation is unobstructed by ascertaining that structures are properly marked to protect navigation. These permits are issued by the Department of Defense, Secretary of the Army (Corps of Engineers), and the Department of Transportation (Coast Guard), respectively. Establishment and enforcement of navigational safety regulations is also a responsibility of the Coast Guard. Pipeline safety is regulated by the Materials Transportation Bureau (MTB) in the Department of Transportation.

In May 1976, the Secretary of the Interior and the Secretary of Transportation signed a Memorandum of Understanding (MOU) regarding pipeline safety regulations on the OCS. This MOU specifies each agency's individual responsibility for pipeline safety supervisions and their joint responsibility for inspection, enforcement, and coordination.

The U.S. Geological Survey has published 14 offshore oil and gas operating orders for the Gulf of Mexico, with one additional order currently under consideration. The existing orders and any future published orders will apply to all tracts which may be leased as a result of proposed Sale No. 65. These orders are reproduced in full in Appendix B.

The U.S. Geological Survey also considers safety features of design specifications in approving pipeline applications. BLM grants rights-of-way for pipelines through the Federal OCS.

The Federal Power Commission (FPC) and the Interstate Commerce Commission (ICC) regulate pipelines linked to interstate commerce, and the FPC sets the wellhead price of OCS-produced gas. The FPC is now being merged into the new Department of Energy (DOE). Also, several other OCS functions will be coordinated with DOE under such regulations as may be promulgated by that department, created October 1, 1977 under Executive Order 12009, 42 FR 46267 (September 15, 1977).

Operators must comply with requirements of the Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 466; 86 Stat. 816) which establishes a National Pollutant Discharge Elimination System, 40 CFR Part 125, 38 Federal Register 13528. Interim standards limit oil and grease discharge to 30 mg/l average, not to exceed 52 mg/l on any one day. This system applies to discharges from any point source and requires a permit from the Environmental Protection Agency for the discharge of any pollutant as defined by the Act. Discharges of pollutants without the necessary permit from EPA are unlawful. In accordance with the same Act, the U.S. Coast Guard approves the procedures followed and the equipment used for the transfer of oil from vessel to vessel and between onshore and offshore facilities and vessels. The Geological Survey performs surveillances for oil spills and discharges along the routes of pipelines from shore to the offshore facilities. The Coast Guard conducts pollution surveillance patrols to detect oil discharges within territorial and contiguous waters.

The FWPCA also provides for a National Oil and Hazardous Substances Pollution Contingency Plan for EPA, and the Departments of the Interior, Transportation, and Defense all share responsibility.

In addition, an OCS Advisory Board has been established pursuant to the provisions of the Federal Advisory Committee Act and under the authority of the OCS Lands Act of 1953. The objective of the Board is to advise the Department of the Interior in the performance of discretionary functions under the OCS Lands Act. These functions include all aspects of exploration and development of OCS resources, for example, resource evaluation, environmental assessment, leasing, mitigating of adverse impacts, and development plans. In formulating recommendations the Advisory Board shall, as applicable, request advice from the OCS Environmental Studies Committee.

The Advisory Board is chaired by the Secretary of the Interior or his designee and membership consists of one representative from the following: Department of State, Environmental Protection Agency, Federal Energy Administration, Council on Environmental Quality, and the U.S. Departments of Commerce, Defense, and Transportation. In addition, one representative from each of the 22 coastal States and Pennsylvania are members of the Advisory Board.-

The OCS Environmental Studies Committee was created pursuant to the provisions of the Federal Advisory Committee Act and under the authority of the OCS Lands Act. This Committee advises the Department of the Interior on the design and implementation of studies related to oil and gas exploration and development on the OCS. These studies include baseline or benchmark data collection, evaluation, monitoring, and special studies. The Committee will serve as the scientific counterpart of the OCS Advisory Board.

The Committee is chaired by a Department of the Interior scientist, designated by the Assistant Secretary, Land and Water Resources, and membership consists of one representative each from the Environmental Protection Agency, National Oceanic and Atmospheric Administration, National Science Foundation, the U.S. Coast Guard, U.S. Geological Survey, U.S. Fish and Wildlife Service, and the Bureau of Land Management. In addition, each of the 22 coastal states and Pennsylvania, similar to the Advisory Board, will have one appointed member on the committee. To achieve a balance of views, the Secretary of the Interior can appoint not more than six scientists from the private sector to the committee.

The Marine Mammal Commission under the authority of the Marine Mammal Protection Act of 1972 was established to protect all marine mammals in territorial waters of the U.S. (including imported marine mammals and products). The Commission is composed of scientific advisors while the principal agency that administers the act is the Department of Commerce, NOAA, National Marine Fisheries Service.

The Endangered Species Act of 1973 (P.L. 93-205 2087 Stat. 884) seeks: to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved; to provide a program for the conservation of such endangered species and threatened species; and to take such steps as may be appropriate to achieve the purpose of the treaties and conventions of the United States. This act is administered by the Department of the Interior, Fish and Wildlife Service.

b. Other Federal Activities in the Gulf of Mexico OCS

Military Use

Principal military use of the Gulf of Mexico OCS is by the U.S. Navy. Gunnery, aircraft, missile, and submarine exercises and activities presently take place in this region under the jurisdiction of the Commander, Eastern Sea Frontier. Air National Guard exercises also take place in designated corridors over the OCS.

Ocean Dumping

The use of designated or interim ocean dumpsites will continue through the beginning of the next decade at which time EPA plans to phase out this practice. Given the anticipated level and timing of OCS related operations, ocean dumping would be occurring during the exploration and development phases of this proposed lease sale.

4. Other State Programs

The governors of all of the coastal states are represented on the OCS Advisory Board. At present, the siting, construction, and operation of OCS-related facilities onshore would be subject to a bevy of state regulations and policy guidelines. The following outlines legislation other than that discussed above and state policies which are most likely to affect OCS activities:

Florida

Florida's Bureau of Coastal Zone Planning has identified 24 laws which have high impact on coastal zone activities. Those which have the most significance to OCS development are summarized below:

Local Government Comprehensive Planning Act (Chapter 163 of Florida Statutes) requires mandatory comprehensive planning by cities and counties by 1979. This act is particularly significant to OCS impact planning because it provides that counties, municipalities, and certain other units of local government are required by July 1, 1979, to prepare and adopt comprehensive plans for guiding future development. Among the act's required planning elements are: future land use (Section 7(6)(a)), conservation (Section (6)(d)), recreation and open space (Section 7(6)(c)), intergovernmental coordination (Section 7(6)(h)), and where appropriate, coastal protection (Section 7(6)(g)). Local plans adopted in accordance with provisions of the act have the force of law and are binding upon future actions of local government.

Environmental Land and Water Management Act (Chapter 380) authorizes an inventory of land resources, data collection, state review of local government implementation, and direct state implementation. The state planning agency promulgates guidelines for development of regional impact and development regulations for any area designated as an area of ''critical state concern''.

Water Resources Act (Chapter 373) is related to the two acts outlined above, providing for water management throughout the state. It provides for division of the state into water management districts which have taxation power. The Department of Environmental Regulation surveys and conducts research into water use and quality (including salt water intrusion) and develops water use plans with regulatory authority.

Saltwater Fisheries and Conservation Act (Chapter 370) provides for the administration, supervision, development, and conservation of the state's natural resources, including the development of a comprehensive coastal management plan for the preservation and development of Florida's coastal zone.

Beach and Shore Preservation Act (Chapter 161) provides authority for prevention of erosion and minimization of storm damage on beaches and shores. A permitting program is established under the DNR for coastal construction. Upon the establishment of coastal construction setback lines, construction is prohibited except as provided. Driving on or damage to sand dunes are especially prohibited. Florida Aquatic Preserve Act (Chapter 258) sets aside certain state-owned land in areas of exceptional biological, aesthetic, and scientific value as aquatic preserves. Dredge/fill is allowed only in special circumstances and drilling, mining, and other private activities are excluded. Environmental Control Act (Chapter 403) provides authority for execution of interstate environmental control compacts and environmental regulation. Conservation of Oil and Gas Resources (Chapter 377) provides responsibility to properly manage and regulate oil and gas exploration and development activities in state territory.

Oil Spill Prevention and Pollution Control Act (Chapter 326) provides the authority for prevention and control of oil spills in coastal areas (Florida Department of Natural Resources, DRM, BCZP, 1977a and 1977b).

It is Florida's current policy to support timely development of OCS energy resources as long as constraints are imposed to whatever degree required to protect the environmental quality upon which Florida's major industries depend. The Land and Water Management Act of 1972 (Chapter 380) speaks most directly to onshore industrial development. For example, petroleum storage facilities are specifically mentioned as developments of regional impact (DRI's) and, as such, must be reviewed by the regional planning agency rather that solely the local government. Also, it is a state policy to redevelop existing port facilities where possible and necessary for new development, rather than to establish ports in new areas.

Alabama

In 1973, a joint resolution was passed establishing an environmental land and water management committee to study facts relating to land resource management and development. Aside from that, Alabama has neither state land use legislation nor a comprehensive statewide land use policy. However, planning work is done and it is the responsibility of the Alabama Development Office. Overall state transportation planning and policy formulation is carried out by the Board as well. Other agencies exercising regulatory powers over transportation in the state are the Alabama Docks Department, which administers state ports and harbors, and the Alabama Liquefied Petroleum Gas Board which regulates the transportation and storage of natural gas. The Offshore Harbor and Terminal Commission was created to promote, plan, finance, develop, construct, operate, and manage a deepwater oil port for the State of Alabama. The Commission has tentative plans for the development of Ameraport, which if developed, would be located in deep water off Alabama in the Gulf of Mexico (Alabama Development Office, 1976; American Institute of Planners, 1976; and U.S. Department of Housing and Urban Development, Federal Insurance Administration, 1976).

Mississippi

Mississippi has experienced some OCS activity south of its territorial waters and is influenced by its proximity to the heavy OCS activity off Louisiana. Pipelines from this working area are carrying oil and gas to processing facilities in Mississippi, including an oil refinery in Pascagoula. The environmental protection policy of the state regarding OCS development is largely based on the Ms. Coastal Wetlands Protection Law of 1972, as amended in 1974.

The Coastal Wetlands Protection Law states that no regulated activity shall affect any coastal wetlands without a permit unless specifically excluded. ''Regulated activities'' include dredging, filling, killing or damaging flora or fauna, and construction which would materially effect the tide's ebb and flow. The Mississippi Marine Resources Council reviews and grants or denies the permits necessary under this law.

The Mississippi Research and Development Center is the state's planning agency, with responsibility for public information, management, and administrative functions. Actual planning is conducted by the state's ten planning development districts.

Regulation of waterways is the jurisdiction of various port and harbor commissions. However, their activities are coordinated by the state's Agricultural and Industrial Board. The Public Service Commission regulates pipelines within the state. State mineral leasing activities are controlled by the Mississippi Mineral Lease Commission, while drilling, casing, and plugging of wells is regulated by the Mississippi Oil and Gas Board (U.S. Department of Commerce, NOAA, OCZM and U.S. Department of Interior, BLM, 1977; Stepien, W. P. and Fernandez, S. J., 1977; and Mississippi Marine Resources Council, all publications).

5. Other Local Programs

Local governmental authority and policy regulate siting of pipelines and oil and gas infrastructure either totally or partially. Following is a discussion by state of factors that influence the amount of siting control which local governments potentially have.

FLORIDA

The Local Government Comprehensive Planning Act of 1975 requires that every municipality and county complete land use plans by July 1, 1979 which have regulatory authority. Adoption of this plan is required before enactment of zoning ordinances is possible. The state imposes a mandatory building code which is enforced by the county. Local governments and regional planning councils are currently involved in studies funded through the states (OCS Supplemental Grant-OCZM funds) pertaining to OCS onshore impacts.

ALABAMA

Cities and towns have been granted general zoning and subdivision powers. Counties, however, do not have the authority to enact zoning ordinances except in flood prone areas. Counties may adopt subdivision regulations in accordance with comprehensive plans.

MISSISSIPPI

County and municipal governments have been granted broad authority over their areas of jurisdiction. Land use controls at this level, as a rule, include zoning and subdivision regulations; building codes; performance standards for commercial and industrial facilities such as noise and air and water quality; and flood prone area activity regulations. All local zoning ordinances must be in accordance with local comprehensive land use plans.

The extent to which county and municipal governments exercise their authorized powers varies considerably within and between states. Highly urbanized areas are more likely to utilize their regulatory prerogatives to a greater degree than rural areas (American Institute of Planners, 1976; U.S. Department of Housing and Urban Development, FIA, 1976; and Florida Department of Natural Resources, DRM, BCZP, 1976b).

Section II

Description of the Environment

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BLM
NEW ORLEANS OCS

A. Physical Environment of the Gulf of Mexico Area

1. Geologic Framework

a. General Geology

(1) Geologic Structure

The continental margin of the eastern Gulf of Mexico is dominated by the Florida platform composed of a thick accumulation of neritic to bathyal carbonate and evaporite deposits of Mesozoic and Cenozoic age. Southern peninsular Florida and the adjacent west Florida shelf area may have accreted to the continent by building of carbonate banks atop isolated volcanic plugs and/or fragmented continental block. The eastern Gulf region has been a site of widespread carbonate accumulation since at least early Cretaceous time when carbonate deposition prevailed around the entire periphery of the Gulf basin. Because of greater relative crustal stability of the Florida platform and the presence of rapidly subsiding basins between it and the continental interior, the sediment-starved carbonate-rich environment persisted over most of the region throughout the Cenozoic.

The west Florida carbonate platform merges with the terrigenous province of the northern Gulf in the Desoto Canyon region. Prograding terrigenous clastic deposits have been piled against and over the carbonate platform creating a sharp westward bend in the continental margin and a transition from smooth to highly irregular slope topography. Invasion of the carbonate province by clastic materials produced a zone of stratigraphic transition in the Tertiary sequence that extends over much of the platform north of Middle Ground Arch. Regional seaward dips of platform deposits are interrupted in this region of structural and stratigraphic transition by arching and growth faulting along the Destin Anticline which has formed over a nonpiercement pillow of salt, and by numerous piercement salt domes clustered near the head of DeSoto Canyon (Martin, 1976). See Figure II-1.

(2) Bathymetry and Bottom Sediments

Bathymetrically, the major relief features present in the shelf are relict spur-like ridges at the shelf break and on the outer shelf and the Florida Middle Ground reef complex. One unusual type of bathymetric anomaly is present as elongate notches and offsets in the shelf which are oriented in an east-west direction and which trend normal to the bathymetry. All have the same directional orientation and some, especially those at 28°30′N, are reflected far west as offsets in the face of the Florida Escarpment. Pinnacles and linear coal-algal ridges are common on the outer shelf at the shelf break. The most well-developed pinnacles are observed around the margins of the DeSoto Canyon and on the outer peninsular shelf between 27°N and 28°N. Landward of the shelf break on the peninsular shelf the only large skeletal buildup is the Florida Middle Ground reef complex.

Most of the sediment of the Mississippi River is delivered directly to the shelf edge or is transported to tbe west. As a result the MAFLA continental margin is covered by a sand sheet which is predominantly quartz west of Cape San Blas and carbonate east of Cape San Blas.

Rivers which empty into the eastern Gulf region carry little sediment and virtually none of this is sand sized. Most of the fine sediments delivered to the coast are trapped in estuaries, bays, and lagoons.

Based on data from the SUSIO Report, the MAFLA continental shelf and upper slope can be divided into separate sediment zones as shown in the Bottom Sediment Special Visual (MAFLA Lithologic Chart). In general the St. Bernard Prodelta Facies is composed of fine grained pro-delta sediments characterized by a semectite dominated clay mineral suite. The pro-delta MAFLA sand transition zone sediments are composed primarily of quartz sand with clay. The MAFLA sand is made up of carbonate sands. The west Florida lime muds are typical of the west Florida continental slope. The zone from the DeSoto Canyon to southeast of Cape San Blas is transitional from the quartz clastics to that of carbonate clastics of the northwest Florida margin. Kaolinite becomes the predominant clay mineral and carbonates increase at the eastern edge of the shelf. The west Florida Quartz Sand Sheet is the quartz band zone. The carbonate sand sheet is thin and covers most of the West Florida Shelf (SUSIO, 1976).

b. Potential Geologic Hazards

(1) Seismic

Of lesser importance in the Gulf of Mexico is the risk from earthquakes. No known damage has been recorded from earthquakes on an offshore oil platform or installation in the Gulf of Mexico.

PHYSIOGRAPHIC AND GEOLOGIC PROVINCES

GULF OF MEXICO AND SOUTHEASTERN UNITED STATES

FROM MARTIN, 1976

FIGURE II-1

Seismic risk areas (see Figure II-2) were originally designated for all parts of the U.S. in 1947 by the U.S. Coast and Geodetic Survey and revised several times since then. Seismic risk is expressed in arbitrary numbers from 0 to 3. They are based on historical data considering only the intensity of an earthquake, not the frequency of occurrence, and express the anticipated damage that would occur in that area.

Zone 0 - No damage
Zone 1 - Minor damage
Zone 2 - Moderate damage
Zone 3 - Major damage

In the eastern Gulf of Mexico, seismic risk is negligible (Algermissen and Perkins, 1976). This appears to be a rather unique area due to the lack of seismicity. No earthquakes of any notable intensity have been recorded for this area and only two earthquakes of notable intensity have occurred in the Gulf near this area; one north of Vera Cruz, Mexico and one southeast of the leasing area in over 600 m of water near 93°W and 27°30′N. Neither of these earthquakes produced damaging tsunamis and neither were considered well located events.

(2) Bottom Conditions

Potential hazardous bottom conditions present on the West Florida platform consist of karst topography, unstable slopes, and faulting.

Four major karst trends were mapped by SUSIO; two of these are believed to indicate concentrations of dolines which consist of closed depressions in an area of karst topography that is formed either by solution of surface limestone or by collapse of underlying caves. These are confined to the Big Bend region. The other two karst trends appear to be ''Karren'' (solution furrows or channels formed on the surface of limestone) surfaces and their relationship to breaks in slope suggest that they may bave resulted from locally high fluxes of ground water during previous regressions.

Unstable bottom has been noted on the upper peninsula slope at two localities as indicated in Figure II-3. Unstable slopes also exist around the upper slope in the vicinity of the DeSoto Canyon. This condition is more common on the steeper western side where much slumping, especially to the south, is evident.

Faults are numerous in the area between Horn Island and Pensacola from nearshore to the shelf break. Also a few small faults exist on the shelf offshore from Panama City, extending from about midshelf to nearshore.

Unidentified structures, appearing to result from salt plug intrusion, are found in the area immediately south of Mobile Bay, Alabama. A buried erosion surface, well developed on both the Mississippi-Alabama and Florida panhandle shelf, is present (SUSIO, 1976).

(3) Geopressures

Rapid depositions upon clays can yield abnormal pressures because confined water is slow to leak and would initially assume the load. Abnormal pressure is a hazard during drilling operations. Penzoil-leased High Island Block A-563 blew out of control early on Nov. 6, 1976 and the entire platform and drilling rig sank into the crater formed by escaping gas and salt water. The probable underlying cause for the eventual loss of control was earlier drill pipe fishing operations which damaged the surface pipe integrity (US Department of the Interior, Geological Survey, 1977b).

(4) Geologic Hazards Summary

Although some of the potential geohazards listed above have caused serious problems during exploration and development in the central and western Gulf of Mexico, it may be noted that of the thirteen wells drilled in the eastern Gulf, no serious accidents occurred.

As reported by the USGS Gulf of Mexico - Outer Continental Shelf Failure Statistics for subsurface safety valves and tubing plugs July 1, 1972 - April 30, 1977, subsurface safety devices (SSD's) have increased in reliability during the last 5 years. (Oil and Gas Journal, 1976).

c. Petroleum Geology

The oldest sedimentary rocks penetrated by exploratory wells drilled in the northeastern Gulf are Upper Jurassic in age. They lie for the most part on a Paleozoic basement complex. The subsurface sediments of the eastern region, together with their associated hydrocarbon production, are separated into trends: Upper Jurassic, Lower Cretaceous, Upper Cretaceous, and Tertiary.

The known thickness of Upper Jurassic sediments is over 7000 feet and the production is from both limestone and detrital marine sandstone. Potential reservoirs are located in oolitic and pellet limestones, dolomite, and sandstone facies. The Upper Jurassic trend swings from an

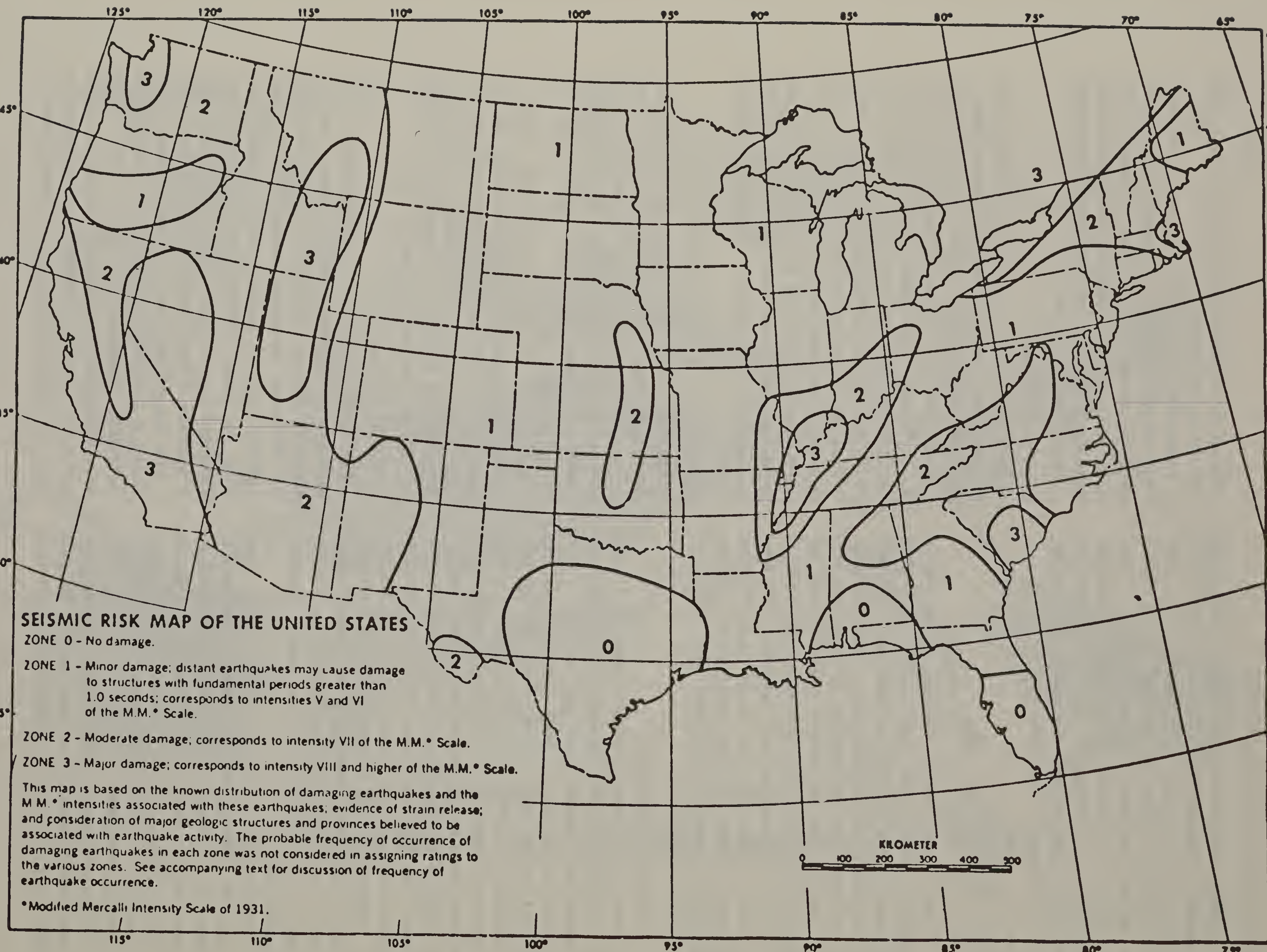


FIGURE II-2 –SEISMIC RISK MAP OF THE UNITED STATES (ALGERMISSEN, 1969)

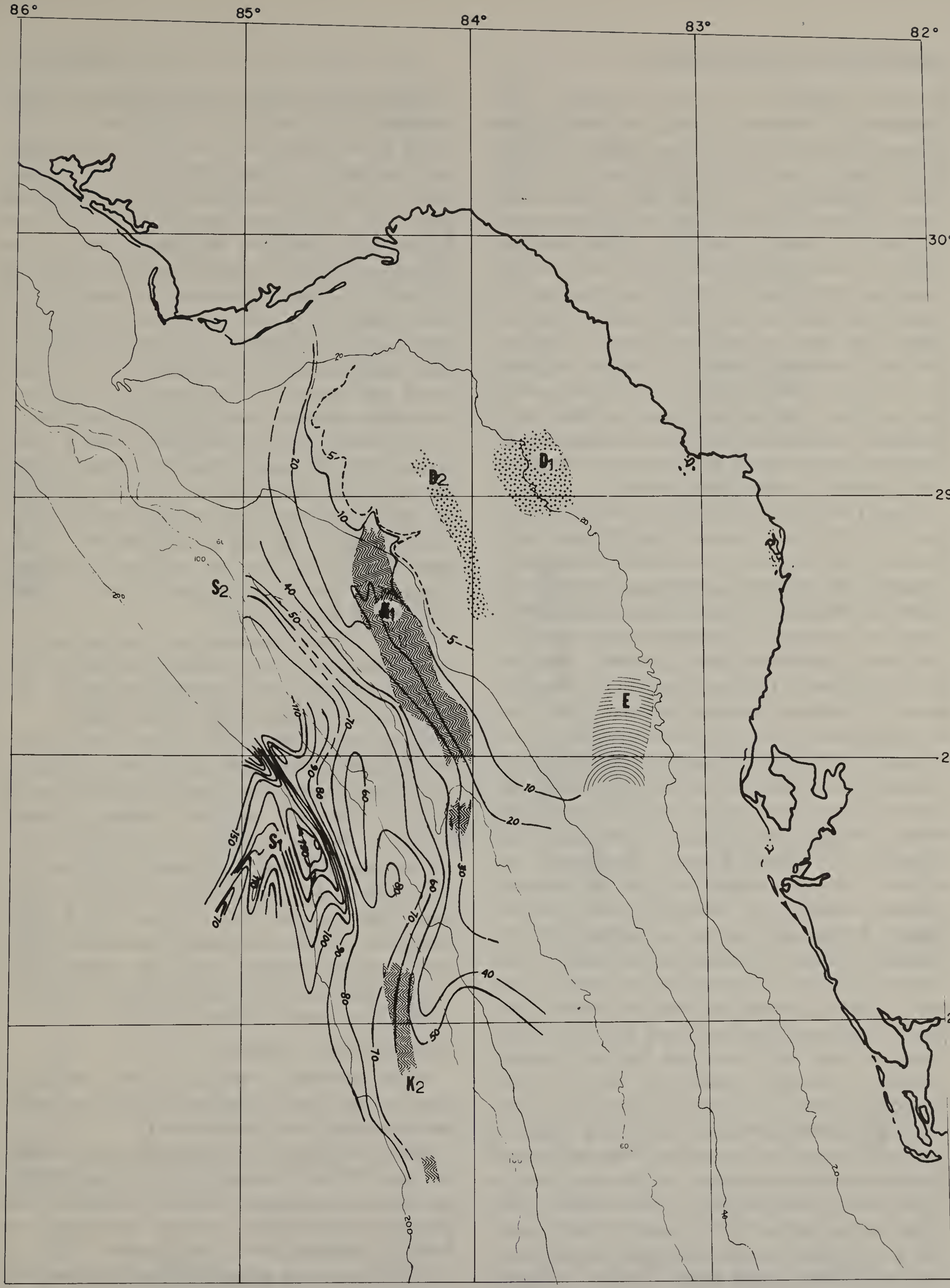


FIGURE II-3 **SUBSURFACE STRUCTURCES**

D_1 AND D_2: AREAS OF DOLINE KARST FEATURES; K_1 AND K_2: KARREN KARST TRENDS; S AND S: SLOPE INSTABILITY EVIDENCED BY CREEP OR SLUMPING; E: MAJOR FILLED VALLEY COMPLEX; "RAW TIME": THICKNESS OF PAST MIOCENE STRATE GIVEN IN 10 MSEC CONTOUR INTERVALS.

FROM: SUSIO, 1976

east-west direction in north Louisiana to a southeasterly direction through Mississippi and Alabama and there is a strong possibility the trend will continue to extend southeastward down the entire Florida shelf. Several fairly large fields have been found in this trend. Of approximately 50 Jurassic fields from the Texas-Louisiana border to the Florida Panhandle, four contain more than 100 million barrels of hydrocarbons. Of these four, three are in north Louisiana and the fourth, Jay Field, located in Escambia County, Florida, is believed to have an ultimate recovery of over 250 million barrels. The recoverable reserves from the Jurassic trend in Mississippi, Alabama, and western Florida is estimated to be 550 million barrels. It is not known how far south these potential Jurassic rocks extend.

Lower Cretaceous rocks attain a thickness inexcess of 8000 feet beneath the Florida shelf. Production in the Lower Cretaceous is mostly associated with detrital marine and deltaic sandstones. In Hancock County, Mississippi, where rocks are dominantly carbonate, production occurs from a sandstone facies. However, there are two exceptions: (1) the production from the reef facies of the Sligo Formation at Black Lake Field in Natchitoches Parish, Louisiana; and (2) the production from rudist bioherms of the Sunniland Limestone in Collier and Dade Counties, Florida. The reef trend in the Lower Cretaceous runs from Mexico through Texas, central Louisiana, then southeast to Hancock County, Mississippi, and seismic evidence strongly suggests its presence offshore south of the DeSoto canyon along the Florida Escarpment as far as latitude 25° N. Although evidence for the presence of the Lower Cretaceous reef trend along the Florida Escarpment is strong, production from the onshore portion of this trend has been very limited to date. There are over 300 fields from Mexico to southwestern Alabama producing from Lower Cretaceous rocks, but only two giant fields, Golden Lane offshore Mexico and Black Lake in central Louisiana, are producing from reef facies. Production from a third reef, the Edwards Reef in south Texas, is not significant. Most fields in this trend are productive in the marine detrital facies. The production from the Sunniland Limestone in southern Florida could trend offshore along the northern edge of the South Florida Basin.

Although the Lower Cretaceous trend appears to have the most potential, the results from a few exploratory wells onshore and offshore are disappointing.

The Upper Cretaceous section, though productive elsewhere on the Gulf Coast, is not considered to be very prospective beneath the Florida shelf with the possible exception of the Lower Tuscaloosa Sandstone. Regionally, the Upper Cretaceous grades laterally from clastic rocks in northwest Florida, to carbonates in south Florida. The Upper Cretaceous in onshore Mississippi, Alabama, and Louisiana is no more than 3000 feet thick and most of the production is from sandstones that appear to be grading into a now nonproductive carbonate facies on the Florida shelf.

The Tertiary rocks of the Florida shelf are considered to be the least prospective. Although there are about 8000 feet of Tertiary rocks just south of the Mississippi coast, this sequence of rocks thins to 6000 feet or less on the Florida shelf. Sediments of Tertiary age are not now considered prospective with the exception of some possible reef traps in the Paleocene.

Figure II-4 is a stratigraphic cross section extending from the Ohio Company's Hernasco No. 1 well to Shell Oil's OCS-G 2527 Block well offshore. See Figure II-5 for well locations.

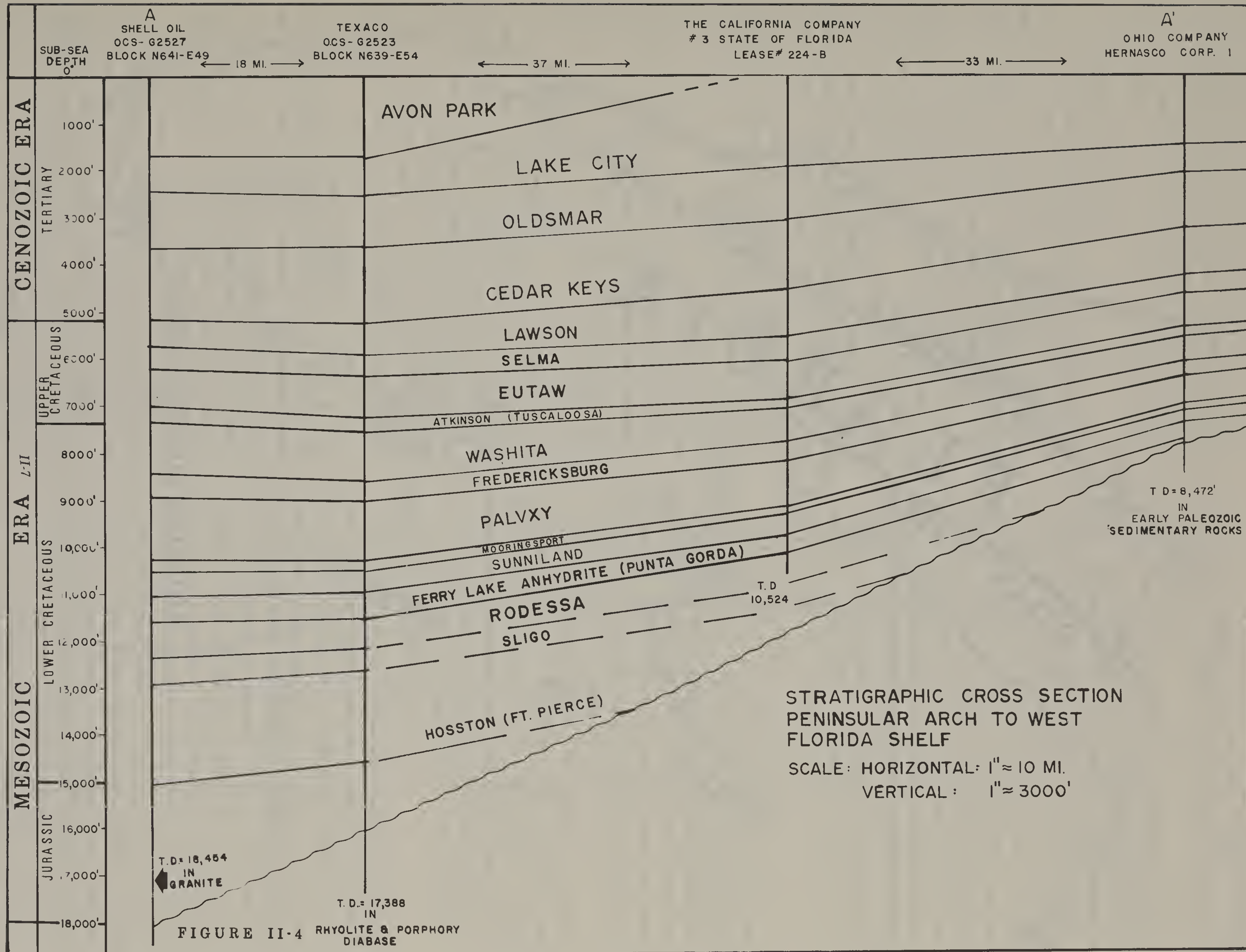
Production in the MAFLA area occurs from onshore carbonate trends of Lower Cretaceous and Upper Jurassic age. These productive trends can be projected offshore; however, limited drilling on Federal acreage has failed to establish any offshore production. Estimates of the oil and gas potential for the MAFLA area are highly speculative because of the sparse well control. Extensive additional drilling is necessary to explore for stratigraphic traps and delineate the Lower Cretaceous and Upper Jurassic prospective trends in the Outer Continental Shelf.

OTHER MINERAL DEPOSITS

Other materials which may have economic value on the Outer Continental Shelf are sulfur, heavy minerals, and shell deposits.

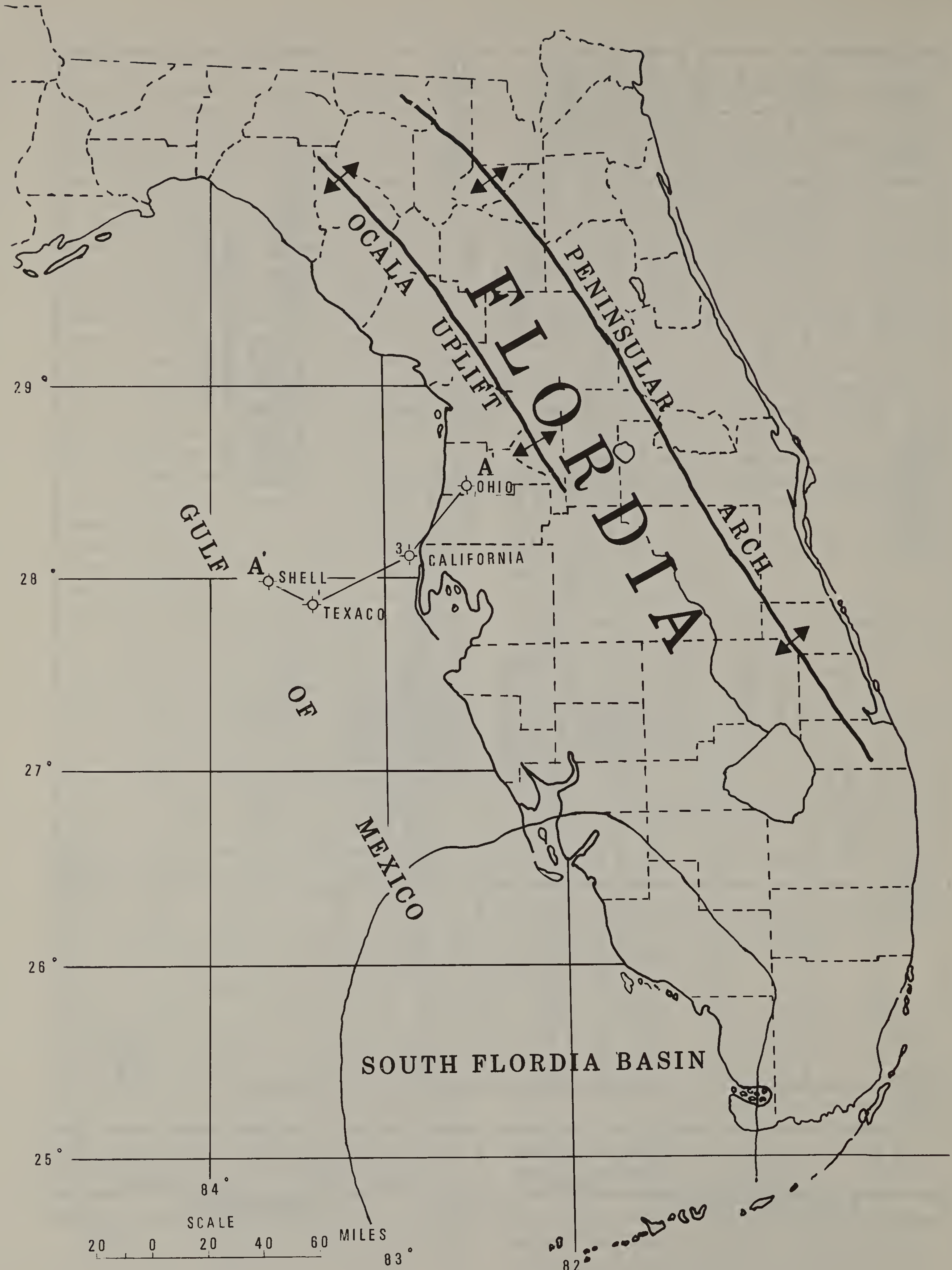
Sulfur is present in the cap rock of salt domes less than 300 feet deep and is also produced from gas wells as hydrogen sulfide. In Alabama and western Florida sulfur is being extracted from some gas produced from Jurassic rocks.

Twenty-six types of heavy minerals occur along the beaches of the Mississippi Sound and along parts of the Florida Panhandle. Tbe average concentration of heavy minerals in beach sand of the



A
SHELL OIL
OCS-G2527
BLOCK N641-E49
18 MI.
TEXACO
OCS-G2523
BLOCK N639-E54
37 MI.
THE CALIFORNIA COMPANY
3 STATE OF FLORIDA
LEASE# 224-B
33 MI.
A'
OHIO COMPANY
HERNASCO CORP. 1
SUB-SEA DEPTH 0'
1000'
2000'
3000'
4000'
5000'
6000'
7000'
8000'
9000'
10,000'
11,000'
12,000'
13,000'
14,000'
15,000'
16,000'
17,000'
18,000'
CENOZOIC ERA
TERTIARY
MESOZOIC ERA
UPPER CRETACEOUS
LOWER CRETACEOUS
JURASSIC
AVON PARK
LAKE CITY
OLDSMAR
CEDAR KEYS
LAWSON
SELMA
EUTAW
ATKINSON (TUSCALOOSA)
WASHITA
FREDERICKSBURG
PALUXY
MOORINGSPORT
SUNNILAND
FERRY LAKE ANHYDRITE (PUNTA GORDA)
RODESSA
SLIGO
HOSSTON (FT. PIERCE)
T.D. 10,524
T D = 8,472' IN EARLY PALEOZOIC SEDIMENTARY ROCKS
T.D.= 18,454 IN GRANITE
T. D.= 17,388 IN RHYOLITE & PORPHORY DIABASE
STRATIGRAPHIC CROSS SECTION PENINSULAR ARCH TO WEST FLORIDA SHELF
SCALE: HORIZONTAL: 1" ≈ 10 MI.
VERTICAL: 1" ≈ 3000'

FIGURE II-4



STRATIGRAPHIC CROSS SECTION

FIGURE II-5

LOCATION PLAT

Mississippi Sound ranges from two to six percent. Concentrations of one to three percent of certain heavy minerals are mined profitably in Florida.

2. Climate

A. General Description

The climate of the northern Gulf of Mexico and adjacent coastal region is determined by four major factors: the North American Continental land mass, the Azores-Bermuda high pressure cell, subtropical latitude, and the relatively warm waters of the Gulf of Mexico itself. The principal influence is the Gulf, resulting in a maritime tropical climate for the region.

During the winter, polar continental air masses move southward into the Gulf of Mexico causing occasional sudden drops in temperature. As these cold fronts reach the Gulf of Mexico, the maritime tropical air flowing northward causes the fronts to abate and become stationary. These stationary fronts are favorable for the formation of low centers that often move west to east along the Gulf Coast or move inland producing low clouds and rain. The cold continental air masses have a tendency to lower the sea surface temperature offshore. The cold water temperatures cause the formation of advective fog in coastal areas from November to March.

By spring, the Bermuda high develops its influence over the region thus improving the wether considerably. The ridge of high pressure usually blocks the movement of storm systems from the west. Occasionally, tropical disturbances and easterly waves will appear in the Gulf of Mexico by early summer (U.S. Dept. of Commerce, NOAA, 1972).

During the summer, southerly winds of the Bermuda high bring warm moist tropial air onshore. Daily shower activity occurs in near shore waters and along the coast with most activity in the afternoon. Westerly and northerly winds generally bring periods of hotter and drier weather into the region.

Easterly waves and tropical storms appear in the Gulf during late summer and early fall. The principal paths of tropical storms into the Gulf are through the Yucatan Channel and Straits of Florida. Over half of these tropial storms become hurricanes during this season. During October and November, the Bermuda high loses its strength and allows continental air to again exert influence on the Gulf of Mexico and coastal region.

B. Pressure, Temperature, Relative Humidity

(1) Pressure

The western extension of the Bermuda high pressure cell dominates circulation throughout the year, weakening in winter and strengthening in summer. The average monthly pressure reaches a minimum in summer ranging from 1014 millibars to 1016 millibars from west to east over the northern Gulf of Mexico region. The average monthly pressure reaches a maximum of 1021 millibars during the winter in this region. The maximum average monthly pressures result from the influnce of continental cold air present during winter. The minimum pressures occur during the summer when the equatorial trough shifts northward influencing the region.

(2) Temperature

Average temperatures at coastal locations vary with latitude and exposure. In winter they depend on the frequency and intensity of penetration by polar air masses from the north. These incursions, when they bring strong northerly wins, are called "northers" and may occur some 15 to 30 times from November through March.

Air temperatures over the open Gulf exhibit narrower limits of variations both on a daily and seasonal basis (Fig. II-6). In the summer, average temperature over much of the Gulf is bout 29° C. Winter air temperatures in the eastern Gulf near the coastal areas average between 17° and 20° C.

(3) Relative Humidity

Over the entire region, the relative humidities are high throughout the year. Maximum humidities occur during the spring and summer months when prevailing southerly winds bring warm moist air into the area. Minimum humidities occur when cold continental air masses bring dry air into the northern Gulf of Mexico during the late fall and winter. Local relative humidity varies only slightly from Mobile, Alabama, where the average annual 6 a.m. reading is 85% an 12 noon is 57%; to Pensaola, Florida, where the 6 a.m. reading is 84% and 12 noon is 60%; to Appalachicola, Florida, where the 6 a.m. average is 86% and the 12 noon average is 68%; to Tampa, Florida, where at 6 a.m. it is 86% and 12 noon it is 57%. This relative humidity decrease during this six hour period is a function of daily warming.

Average summer and winter surface air temperatures for the Gulf of Mexico (Leipper, 1954a).

c. Surface Winds

The Azores-Bermuda atmospheric high pressure cell dominates the cirulation over the Gulf OCS, particularly during the spring and summer months. In late summer there is a general northward shift of the circulation and the Gulf comes under the more direct influence of the equatorial low pressure belt. During the relatively constant summer conditions, the southerly position of the Azores-Bermuda cell brings about predominance of south-easterly winds. The winds tend to become more southerly in the northern part of the Gulf. During the winter, winds usually blow from easterly directions with fewer southerlies but more northerlies. Winds from the west and southwest are rare anytime during the year.

Near the cost, winds are more variable than over the open waters because the coastal winds fall more directly under the influence of the moving cyclonic storms that are characteristic of the continent and because of the sea and land breeze regime.

d. Precipitation, Cloudiness, Visibility

(1) Precipitation

Normal annual precipitation in the proposed sale area varies from 170 cm in Mobile to 163 cm in Pensacola to 145 cm in Appalachicola to 124 cm in Tampa. Peninsular Florida will generally receive over 124 cm but values near Key West are closer to 102 cm. Along most of the Gulf, precipitation is frequent and abundant throughout the year though most stations record the highest precipitation values during the warmer months. The month of maximum rainfall is September for all stations mentioned above except for Mobile which is July and Tampa which is August.

Winter rains are associated with the frequent passage of frontal systems through the area. Rainfalls are generally slow, steady, and relatively continuous, often lasting several days. Snowfalls are rare, and when frozen precipitation does occur it usually melts upon contact with the ground. Incidence of frozen precipitation decreases with distance offshore and rapidly reaches zero. The warmer months usually have convective cloud systems which produce showers and thunderstorms. Thunderstorms of this type rarely cause any damage or have attendent hail. (US Department of Commerce, C&GS, ESSA, 1967 and U.S. Department of Commerce, NOAA, 1972).

(2) Cloudiness

Along the Gulf coast cloudiness averages between 0.5 to 0.6 sky cover with relatively small seasonal variation. October is generally the clearest month and December through March the cloudiest. The highest percentage of Possible sunshine ranges from 60 to 70% with the highest in October. The nature of cloudiness varies with the season. In winter the Gulf coast has occasional gray, overcast days but in summer these are rare.

During the warm season, May through September, cumulus clouds begin developing over northern Gulf waters about 0300 hours and the larger clouds may produce scattered showers which dissipate when carried onshore during the morning by the sea breeze. Onshore cumulus development occurs during the day reaching a maximum in late afternoon, often acompanied by rainfall. (Orton, 1964). Much of the summer clouds are either convective cumuli or high, relatively transparent clouds (U.S. Department of Commerce, NOAA, 1972).

(3) Visibility

Warm, moist Gulf air blowing slowly over chilled land or water surfaces brings about the formation of fog in this area. The period from November through April has the highest frequencies of low visibilities. It is most frequent in the vicinity of harbor entrances and over land areas extending into the Gulf, such as Cape San Blas. Fog generally forms with southerly winds and dissipates during northerly winds. A representative sample shows Mobile with a mean of 37 days of heavy fog per year, Pensacola - 38 days per year, and Appalachicola - 26 days per year (U.S. Department of Commerce, NOAA, 1972). The heaviest occurrence of fog is usually in the early morning hours and is at a maximum in winter months.

Generally, coastal fogs last three or four hours although particularly dense sea fogs may persist for several days. Visibility offshore Louisiana is reduced to less than 5 km on a monthly average of 4% of the time. Poorest visibility conditions occur during winter and early spring when visibility is reduced to less than 5 km between 8% and 10% of the time (Peake and Muller, 1971).

Visibility around the Mississippi Delta may also be lowered occasionally by industrial pollution from up river or from burning timber or marsh lands.

e. Severe Storms

(1) Tropical Cyclones

The largest and most destructive storms affecting the Gulf of Mexico and adjacent coastal zones are tropical cyclones. These have their origin over the warm tropical waters of the central Atlantic Ocean, Caribbean Sea, or southeastern Gulf of Mexico. They occur most frequently between June and late October and there is a relatively high probability that tropical cyclones will cause damage in the Gulf each year (Department of Commerce, NOAA, 1972). Statistics for hurricanes and tropical cyclones are often lumped together since it is often difficult, especially by the older records, to determine the storm intensity while at sea. Figure II-7 is a histogram which indicates the probability in percentage of the occurrence of three categories of severe storms in certain coastal areas. Figure II-8 following it, is a coastal sector locator map to be used in conjunction with Figure II-7 (Simpson and Lawrence, 1971).

Hurricanes vary considerably in intensity track patterns and behavior upon crossing land. McGowen, et al. (1970) explain that the storm approach is marked by rising tides and increased wind velocities. Generally the longer a storm lingers in the Gulf, the larger the bulge of water it pushes ashore as it approaches land. These storm tides are commonly higher in the bays than on Gulf sea beaches, although flooding and pounding waves effect both areas.

There is no preferred approaching route of hurricane tracks although early season cyclones approach generally from the southeast while later ones are more out of the south. In spite of the fact that most hurricanes form in tropical ocean areas, a few are generated in the Gulf of Mexico. During the period 1901-1971, seven hurricanes and seven tropical storms formed in the Gulf north of 25° N and east of 85° W. See the Weather Areawide Visual for selected 1954-1976 hurricane tracks crossing Gulf waters. These storm tracks were traced from 12 hour plots; therefore, the landfall locations are approximate. Also shown are the numbers of storms which occurred over land area from 1885 to 1970.

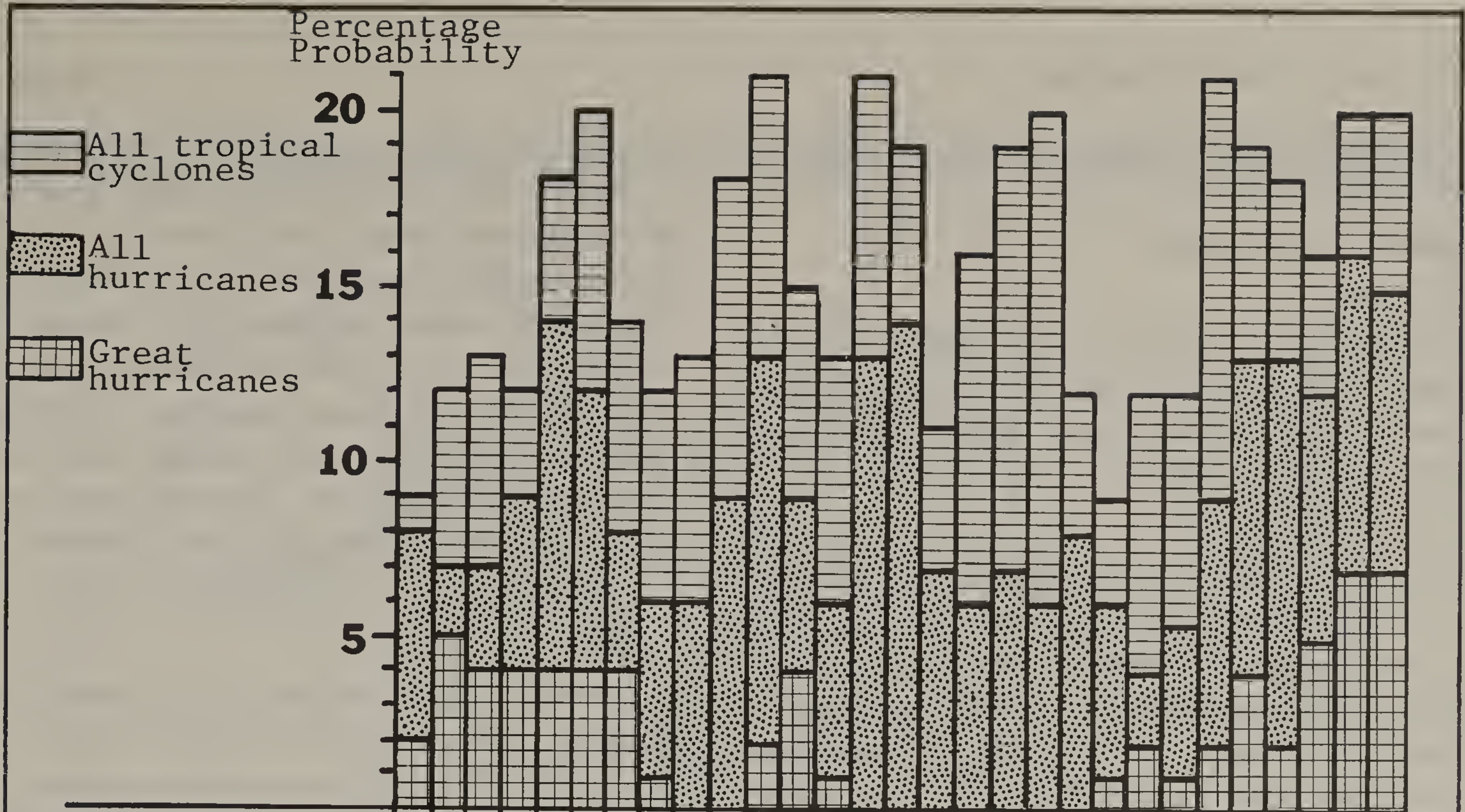
Damage from hurricanes result from high winds and, particularly in the coastal areas, the storm surge or tide which is an abnormally high rise in the water level. Maximum surge height at any location is dependent on many factors including bottom topography, coastline configuration, and storm intensity. The storm surge at Pass Christian, Mississippi associated with hurricane ''Camille'' in 1969 was 25 feet (7.6 m), and that associated with ''Betsy'' in 1965 reached nearly 20 feet (6.1 m) at Bayou Lafourche (U.S. Department of the Army, Corps of Engineers, 1973). Hurricane ''Camille'' was the most severe hurricane in recent Gulf history, with top winds estimated at 324 km (202 miles) per hour, and barometric pressure in her calm eye as low as 26.6 inches (68 cm) of mercury. Hurricane ''Anita'' of late August 1977 came ashore just south of the U.S. border in Mexico-after tracking through the Gulf, bringing storm surge to various parts of the Texas and Louisiana coasts. In the same week, ''Babe'', just strong enough to be termed a hurricane, developed and caused no significant offshore damage. It came ashore near Morgan City, Louisiana three days later.

(2) Extratropical Cyclones

In addition to the summer activity of tropical cyclones, extratropical cyclones that may vary greatly in intensity occur in this area primarily during the winter months. These storms have attained wind speeds as great as 55 to 93 km/hour. They originate in middle and high latitudes forming on the fronts that separate different air masses. The Gulf of Mexico is an area of cyclone development during the cooler months due to the contrast in temperatures of the warm air over Gulf waters and the cold continental air over the United States. These storms rapidly dissipate, or move on, after going out over the Gulf of Mexico.

(3) Polar Outbreaks

A phenomenon known as ''norther'' is quite common in the area in question during the winter months. A norther occurs when cold, polar air moves southward from the cold interior of the North American continent out over the warm waters of the Gulf. This unstable cold air mass, when heated from below, develops strong gusty northerly winds with considerable cloudiness and showers. During a typical winter as many as 30 such polar outbreaks reach the Gulf Coast. The majority of these cold outbreaks, spilling out over the Gulf, produce winds in the 28-37 km/hr range but approximately one-third of these cold outbreaks have winds over 62 km/hr with approximately half of these being vigorous enough to



Coastal Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
All Trop.Cyclones	9	12	13	12	18	20	14	12	13	18	21	15	13	21	19	11	16	19	20	12	9	12	12	21	19	18	16	20	20
All Hurricanes	8	7	7	9	14	12	8	6	6	9	13	9	6	13	14	7	6	7	8	8	6	4	5	9	13	13	12	16	15
Great Hurricanes	2	5	4	4	4	4	4	1	-	-	2	4	1	-	-	-	-	-	-	-	1	2	1	2	4	2	5	7	7

TX | LA | MI-AL | FL

FIGURE II·7 This histogram and table shows the probability (percentage) that a tropical storm, hurricane, or great hurricane will occur in any one year in a 50 mile segment of the coastline. Figure II-8 below locates the numbered coastal segments.

Frequency of tropical cyclones along the U. S. Gulf of Mexico coastline.

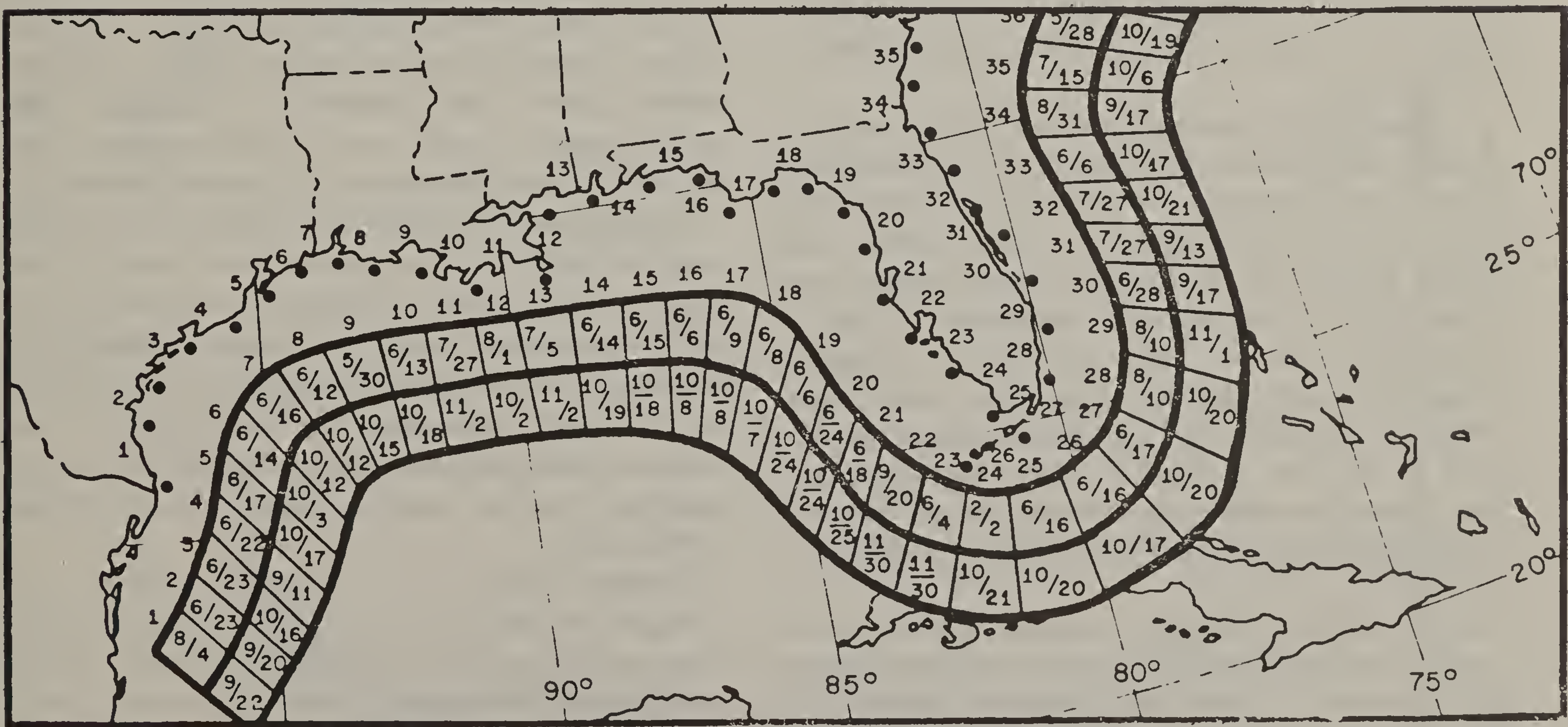


FIGURE II·8 Earliest and latest tropical cyclone occurrences for the period 1886-1970. Numbers within boxes are the month and date of earliest and latest land falls for the indicated coastal segment.

 SOURCE SIMPSON AND LAWRENCE 1971

reach 89 km/hr (US Department of Commerce, C&GS, ESSA, 1967).

3. Physical Oceanography

a. Circulation

The complex circulation in the Gulf of Mexico is irregular and is attributable to four major factors: the Loop Current, tides, winds, and river discharge (Eleuterius, 1974).

(1) Loop Current

The Loop Current is a continuation of the Yucatan Current which enters the Gulf of Mexico through the Straits of Yucatan. Although the current shows great annual and seasonal variability in magnitude and course, in general, it penetrates some distance into the Gulf of Mexico, turns clockwise, and exits through the Straits of Florida. The path of the Loop Current appears to be directly influenced by the topography of the Gulf of Mexico (Physiography Areawide Visual).

The Loop Current is the main feature of deep sea circulation in the eastern Gulf of Mexico, reaching a depth of over 500 m (Ichiye, et al, 1973).

Current trajectories have been mapped in the Gulf for many years by the Naval Oceanographic Office (1955). The Surface Current Wind Roses for the Gulf of Mexico, shown on Visual No. 6, are from a compilation of Naval Oceanographic Office data. Additional Loop Current data are contained in: Eleuterius (1974), Sweet (1974), Ichiye, et al (1973), SUSIO (1975), and Molinari, et al (1977).

The degree of intrusion into the Gulf of Mexico by the Loop Current was proposed to be annually cyclical by Leipper (1970), based on 1965-1966 data, and was confirmed by Maul (1974) and Ichiye, et al (1973). In winter and early spring, the Loop Current penetrates a maximum of up to about 27° N in the Gulf, although it is usually found at lower latitudes. Maximum penetration occurs in summer, reaching approximately 29° N, then in the fall, it again recedes. During spring and summer current speeds in the core of the current approach 0.25 m per second (Figs. II-9, II-10, and II-11).

Large eddies frequently separate from the main current and drift into the western Gulf and decay over a period of three to six months. Figure II-9 shows the northerly extent of the current parallel to the continental shelf of east Louisiana, Mississippi, Alabama, and Florida. An eddy is in the process of being formed on the western loop boundary and will eventually drift westward. The intensification of the loop can be seen as streamlines constrict, thus causing velocities to increase. The streamlines represent a certain volume passing through a plane perpendicular to the contours in a given time; therefore, velocities must increase to maintain the volume flow as streamlines constrict. Figure II-10 represents a fully developed eddy with associated streamlines.

(2) Surface and Continental Shelf Circulation

Surface currents in the Gulf of Mexico are also strongly influenced by the Loop Current. According to SUSIO (1975), the surface velocity distribution of the Loop Current is asymetric. Facing downstream, the speed axis is to the left of the current core. The width of the current is approximately 100 km in the Yucatan Straits. As the flow turns anticyclonically (clockwise), the current slows down and spreads out (Chew, 1974). The width of the current is approximately 150 km in the anticyclonic turn adjacent to the MAFLA area. As the current turns south, the width decreases and reaches a minimum of 75 km in the Straits of Florida due to both topographic constraints (Cuba) and the dynamics of cyclonic turning (Chew, 1974).

The nearshore regime of surface currents in the MAFLA area is strongly influenced by several factors. Among them are winds, tides, offshore current flow, and freshwater discharge from coastal rivers. In most areas, significant winds are the major controlling factor of surface currents.

Wind-driven circulation is caused by frictional drag produced as wind passes over water. Wind stress applied at the sea surface causes net transport of subsurface water at an angle (deflected to the right in the northern hemisphere) proportional to the depth. Discussion of wind fields in the proposed sale area has been included in the Climatology Section and portrayed graphically on Visual No. 6.

Currents around the Mississippi Delta are strongly influenced by this fresh water outflow from the river. Scruton (1956) observed a fresh water plume extending 20 miles off Pass-a-Loutre. This has been confirmed by Eleuterius (1974) whose data indicates that at times this plume extends some forty miles eastward.

FIGURE II-9 Loop Current Streamlines, August, 1966. (Eleuterius, 1974)

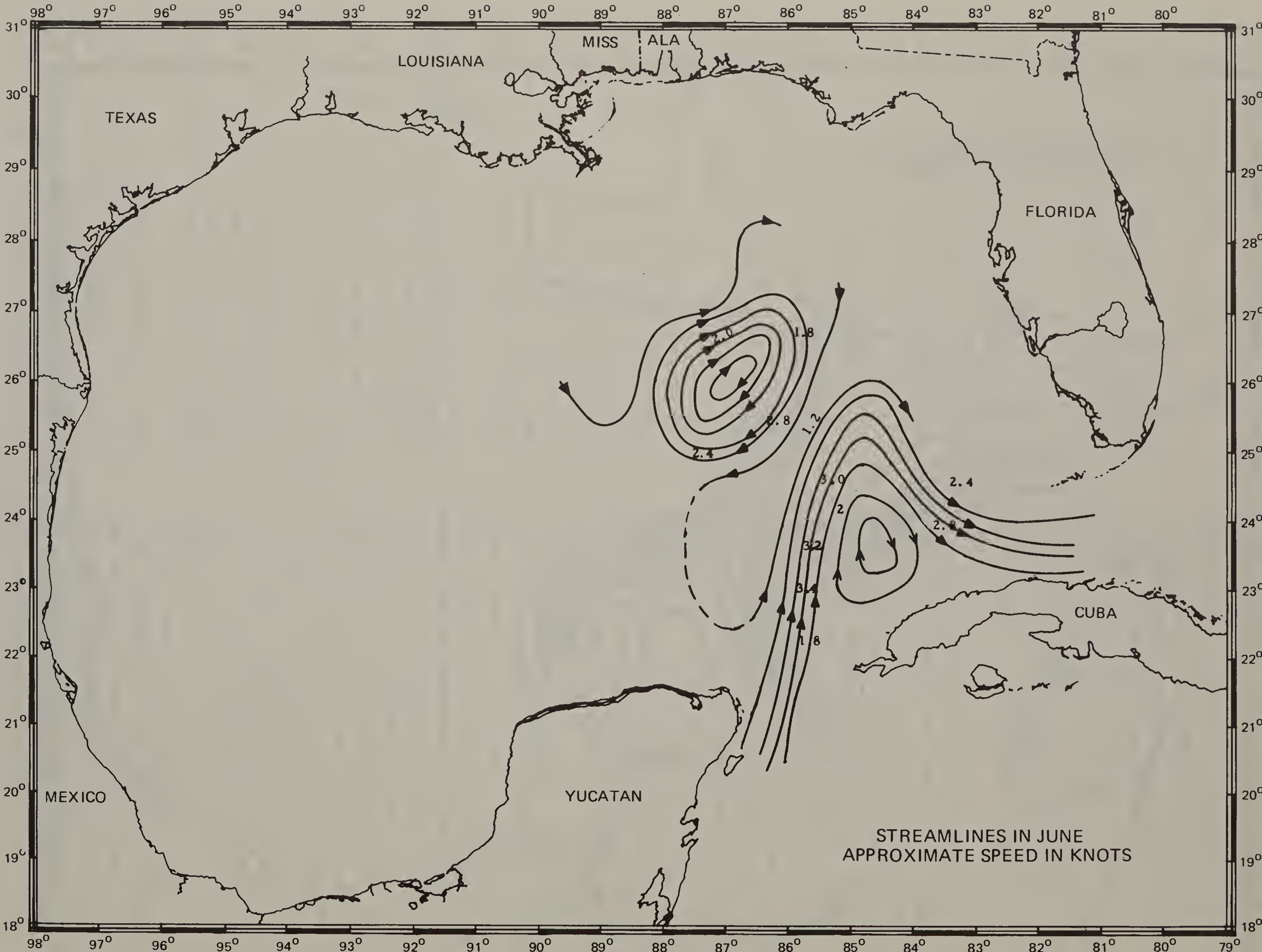


FIGURE II-10 Loop Current Streamlines, June, 1967. (Eleuterius, 1974)

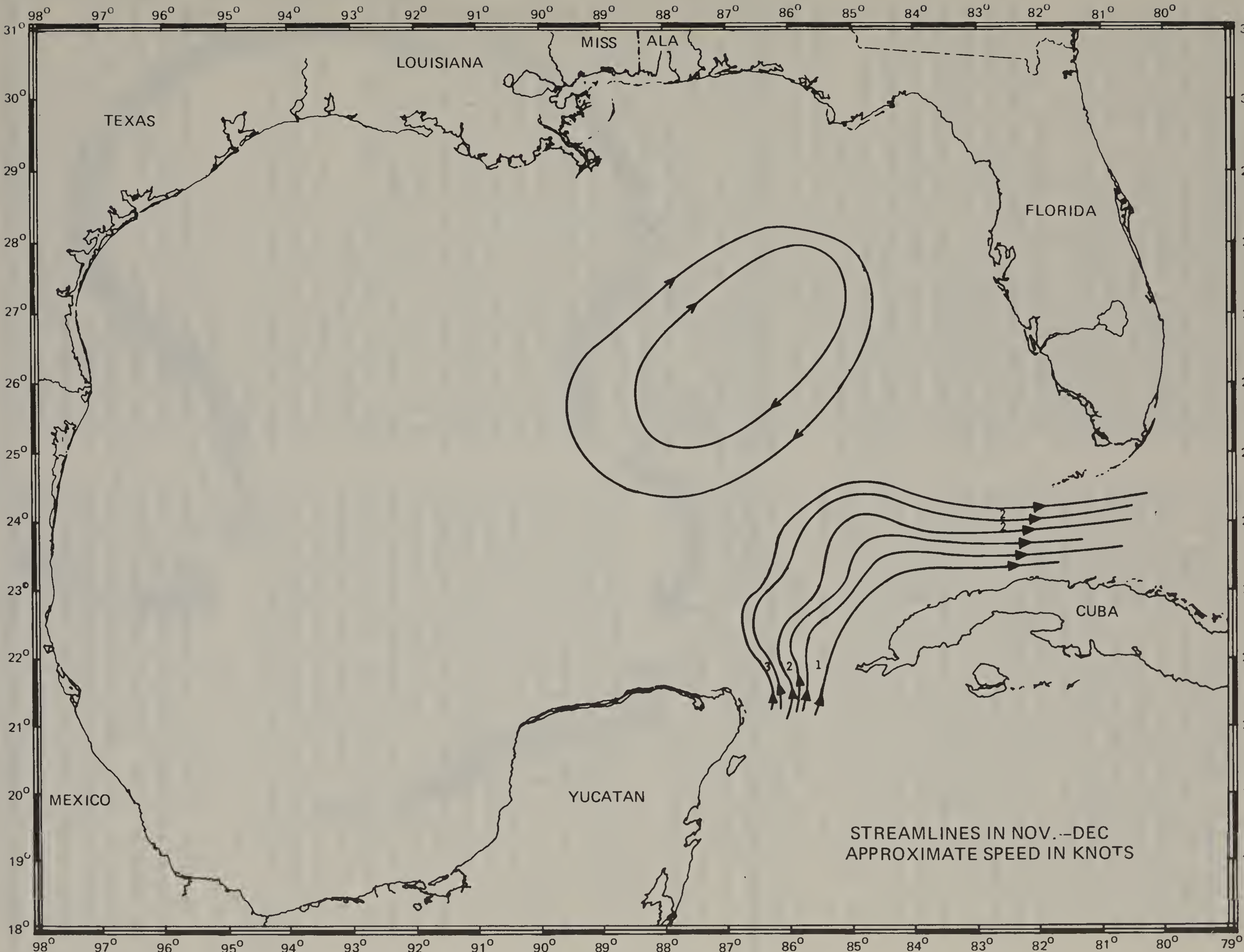


FIGURE II-11 Loop Current Streamlines, December, 1965. (Eleuterius, 1974)

Very little systematic knowledge of the continental shelf circulation of the eastern Gulf of Mexico exists. However, based on data by Nowlin (1971), Price and Mooers (1974a, b, c, 1975), Plaisted, et al (1975), and others, the eastern Gulf shelf from the Mississippi Delta to Cape San Blas is characterized by a very mixed current pattern reflecting influences of variable winds and fresh water inflow upon water mass movements resulting from the Loop Current. Eastward from Cape San Blas, the current directions reflect a semi-permanent counterclockwise gyre which flows northward along the west coast of Florida, swings westward south of Apalachee Bay, and turns south off Cape San Blas. This gyre appears to be more prominent in the winter months. (Fig. II-12)

Off the west coast of Florida in the vicinity of 26°N, Plaisted, et al (1975) found that the current tends to flow approximately parallel to the isobaths. Frequently in winter the mean flow over the inner shelf is nearly uniform witb depth and magnitude. In contrast, the mean flow over the outer shelf is typified by a system of surface currents and undercurrents.

b. Temperature

According to Leipper (1970), the main feature of the average winter sea surface temperature for the Gulf of Mexico is a gradual drop from approximately 24° C. in the south to 18° C. in the north in all parts of the Gulf. In the summertime, average temperatures are very nearly uniform at 29° C throughout the Gulf. In the colder months there is a strong onshore-offshore temperature gradient over the shelf area. Years of investigations have shown that considerable deviation from these average isotherms may occur at certain times. In shallow coastal waters and in estuarine and marsh areas, water temperatures approximate air temperatures, but without reaching the extremes exhibited by air temperatures on short term.

c. Tides

The tides of the Gulf of Mexico are weakly developed and usually their observed range does not exceed 0.7 m (Durham and Reid, 1967). Semidiurnal (twice daily) tides are small; and therefore, overall tides in the Gulf are considered diurnal (daily) in character. The diurnal tides of the Atlantic Ocean influence the tides in the Gulf through the Yucatan Channel. A single oscillating system with a nodal line extending from western Haiti to Nicaragua is formed by the Gulf of Mexico and the Caribbean Sea. This causes the tides of the Gulf to be simultaneous. The Gulf and the Caribbean Sea is viewed as a single oscillating body with a period of nearly 24 hours (Grace, 1932). Tidal regimes have been shown for the Gulf of Mexico as displayed by Eleuterius (1974) in Figure II-13.

In 1908, C. Wegmann (Defaunt, 1961) considered the resonance effect of the diurnal components of the Gulf tides and found the period of free oscillation for an east-west oscillation to be 24.8 hours. According to Grace (1932) the diurnal tide enters through the Florida Straits, progresses counterclockwise around the basin, is reflected by the northwestern and southern coasts and egresses through the Yucatan Channel.

When the moon is near its maximum declination, the tide is diurnal and has the greatest range. When the moon is over the equator, the tide has the least range and there may be several days having two highs and two lows. Although tides in the Gulf have a small range they do have important roles in modifying current and accelerating the movement of water through narrow passages.

Spring tides are slightly higher, but since the range is too small, meteorological effects can completely mask tidal fluctuations (U.S. Department of Commerce, Coast and Geodetic Survey, Environmental Science Services Administration, 1967). For instance, an onshore wind can pile-up water against the coast to a height of 1.2 m above mean sea level. Tides are diurnal (one high and one low per day), with maximum ranges recurring about every two weeks (Stone, 1972). Highest mean water level occurs during the period December through March.

Tidal currents do have some small effect on flushing rates in enclosed bays, but because tidal ranges are small, currents resulting from tides are also small.

d. Wind, Waves, and Swells

The coastline of the region of the proposed sale is characterized as a low energy area in terms of wave power (Stone, 1972). The annual average wave heights are 0.9 m (U.S. Department of Commerce, NOAA, 1972), with 75% of all waves being smaller in height than 1.5 m.

Direction and height of waves at an offshore station closely correlates with wind direction and

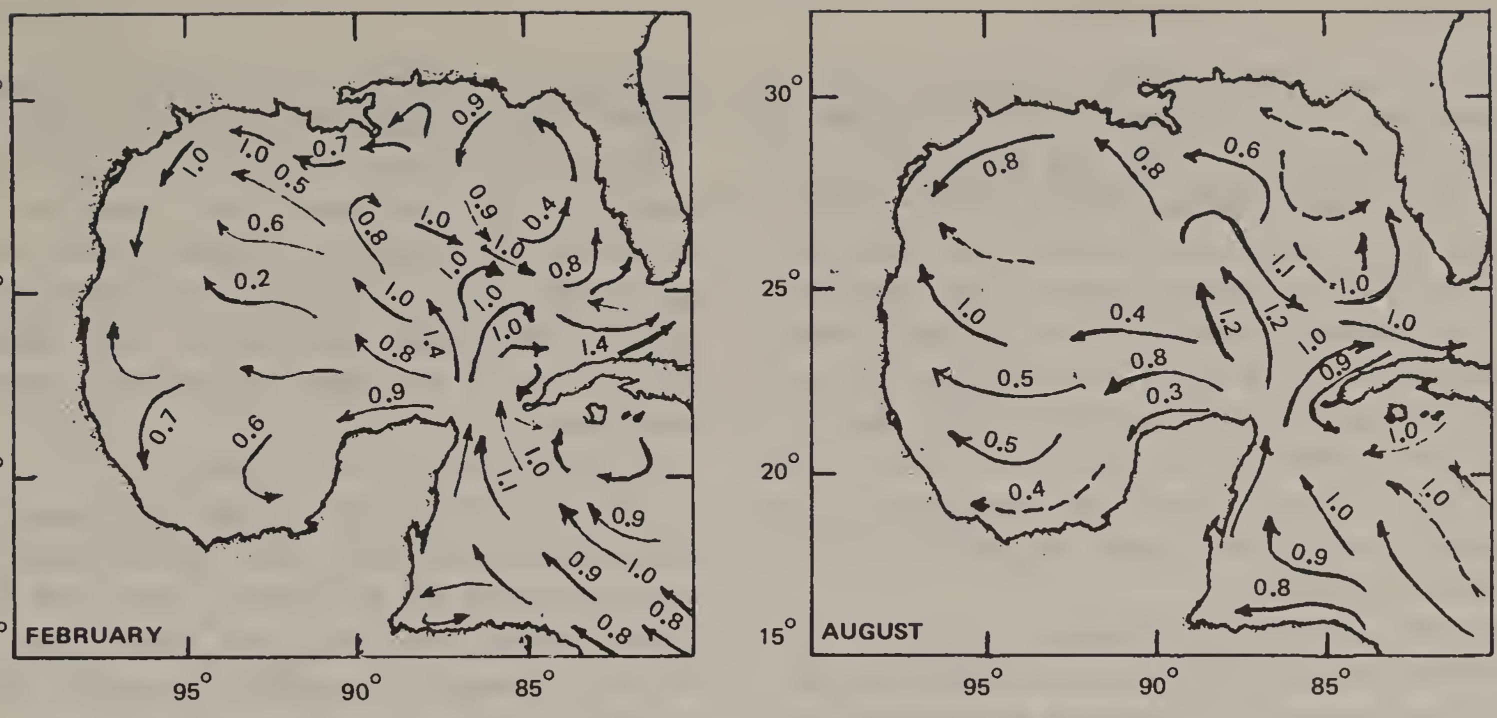


FIGURE II-12 Estimated Average Speed (Knots) of Surface Currents in the Gulf of Mexico from U. S. Naval Oceanographic Office Pilot Charts for February and August (After Nowlin, 1971)

FIGURE II-13

Gulf of Mexico Tidal Regimes.

From Eleuterius, C. K. 1974. Mississippi Superport Study, Environmental Assessment.

intensity. On an annual basis waves come out of the northeast, east, southeast, and south 70% of the time (Stone, 1972). July and September data reflect the strong influence of the southerly winds resulting from circulation around the Bermuda High. The shift to more northerly and northeasterly wave origin accompanies the change in wind direction in winter when it is dominated by continental air masses and ''northers''. From May to August 80% to 90% of the waves are 1.5 to 2.4 m in height. Waves from the northeast and southwest tend to have greater heights than those from other directions.

The wind velocity, the distance over which the wind blows (fetch), and the length of time that the wind blows (duration) all have a direct effect on wave growth. In general, any increase in one of these factors will result in larger waves. Sea is a term applied where waves are actively being generated. Swell refers to long period uniform waves some distance from the generating influence.

Prevailing winds during spring, summer and early fall are from the southeast and wave heights are generally less during this period. Waves associated with storms range considerably higher. During hurricane ''Camille'' in 1969, for example, waves 21 m high were reported offshore, with winds exceeding 324 km/hr. Table II-1 gives an estimate of high wave occurrences for three areas of the Gulf coast.

Due to the Coriolis effect, sea breezes rotate clockwise in the northern hemisphere during a 24-hour period. Usually the sea breeze will start around 1000 hours, reach a maximum at 1400 bours and afterwards be replaced by the nocturnal land breezes. To provide information on amplitude phase and frequency of responding waves, currents, and beach erosion and deposition, a fully instrumental project was undertaken on Santa Rosa Island, Florida, by Sonu, et al (1973). Their results demonstrated that sea breezes significantly affected the dynamic processes operating on the coast in the following summary:

(1) Meteorological parameters such as aerodynamic roughness, shear stress, and atmospheric stability exhibited definite coupling with the wind speed. A new relationship between the friction velocity and the wind speed at 10 m was found: this new relationship contrasts with conventional deepwater expressions. The aerodynamic roughness depended not only on waves, as was expected, but also on atmospheric stability mainly associated with land breeze.

(2) The sea breeze produced a high-frequency peak in the nearshore wave spectrum that dominated the background swell in the afternoon and evening. The response of the wind waves involved amplitude, frequency and direction, whereas that of the swell was primarily limited to amplitude.

(3) Nearshore currents responded with a lag of 3-5 hours to the onset of the sea breeze cycle with current amplitudes of up to 25 cm/sec. As a consequence of the proximity of the coast and the surface slope associated with wind setup, these currents flowed essentially parallel to the shoreline and had only minor onshore-offshore components.

(4) Wave-induced currents around and inside the inner bar underwent systematic diurnal variations in response to offshore wave breaking and incident angles of the diurnal wave field, changing from closed circulations (early afternoon), to meandering currents (late afternoon), to weakly curved parallel currents (night and early morning).

(5) The beach system acted as a low-pass filter to input waves, so that both swash and groundwater fluctuations underwent high-frequency attenuation. The cutoff frequency varies as a function of the combined effects of the tide and diurnal wave field.

(6) Topographic response exhibited dependence on the scale of topography and excitation frequency. Whereas small-scale features such as ripples, megaripples, and beach cusps changed within an hourly or shorter time scale, large features such as crescentic bars and rhythmic shorelines on the order of 120 m in wavelength remained unresponsive for over three weeks.

4. Chemical Oceanography

a. Nutrients

In the marine ecosystem phytoplankton constitute primary producers and, as such, are dependent on an adequate supply of three essential nutrients: nitrogen, phosphorous, and silica. The primary sources of supply of these nutrients are upwelling of deep waters, advection, and discharge from land sources (rivers and industrial and domestic sewerage). The primary process depleting the concentration of nutrients in the surface water is rapid uptake by phytoplankton and subsequent removal of the phytoplankton by

Table II-1 High Wave Occurrences in the Gulf of Mexico

	Maximum* Significant Wave Height (Meters)			
Mean Recurrence Interval	5 yr.	10 yr.	25 yr.	50 yr.
Southwest Pass Area (28°-30° N, 88°-91° W)	9.5	10.4	11.9	13.1
Mobile-Pascagoula Area (29°-31° N, 87°-90° W)	9.5	10.4	11.9	13.1
Panama City Area (28°-31° N, 84°-87° W)	9.5	10.4	11.9	13.1

Source: U.S. Department of Commerce, NOAA, 1972. Environmental Guide for the U.S. Gulf Coast.

* Significant Wave Height indicates the approximate height of one-third of highest waves observed. There may be higher waves in the wave field called extreme waves that can be estimated by applying a 1.8 factor to the significant wave height. However, in most cases extreme wave heights are limited to a value of one-half the water depth.

predation or by sinking. As a result, only low concentrations of nutrients are normally found in surface waters except in local source areas.

Major source areas of turbidities are the rivers and bay outlets into the Gulf of Mexico, principally the Mississippi River. Nutrient analyses of waters in the eastern Gulf of Mexico have recently been completed for the MAFLA baseline study (Fanning, 1974). He reports on five of the most common dissolved nutrients (nitrate, nitrite, silica, phosphate, and arsenate). Results show low surface and intermediate values and high bottom enrichment. Fanning 974) rejects upwelling as the cause of the bottom enrichment and favors this enrichment from release of the nutrients from bottom sediments through diffusion or seepage. Manheim (1974) points out that the intermediate and surface nutrient values could be caused by uptake by benthic algae.

b. Salinity

The salinity patterns of the Gulf of Mexico (Fig. II-14) are principally determined by: inflow of ocean waters through the Yucatan Strait, precipitation and inflow of fresh water from land sources, evaporation, circulation and mixing, and outflow through the Straits of Florida. In the northern Gulf, runoff from the Mississippi, Atchafalaya, and from smaller rivers to the east and west gives rise to a band of low-salinity water (Nowlin, 1972). Seasonality is known to strongly influence nearshore-offshore salinity gradients.

In the upper 50 m, water in the central Gulf of Mexico typically has a salinity of very near 36.0 parts per thousand (ppt) (Leipper, 1954b). The distribution of surface salinities in the water is generally lower. A similar distribution pattern, but with generally higher salinities because of high evaporation rates, is found for summer conditions. In the eastern Gulf these distributions are modified by the seasonally dependent Loop Current (Sackett, 1972).

c. Trace Metals

The trace metals that usually occur in the marine environment include cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, iron, uranium, and zinc. These occur in concentrations normally less than one part per million (ppm). These metals can enter the marine environment through weathering of rocks or by pollution discharge caused by human activities.

A most intensive study of trace metals in the Gulf was completed by Corcoran (1972) for six trace metals: Cd, Pb, Cu, Cr, An, and Mg. Except for copper, the concentration of the five other metals was ten times the concentration typically observed in open ocean waters. Also, manganese was higher than concentrations reported by Rona, et al (1962). This seems to indicate enrichment of trace metals by the Mississippi River and from Escambia and Perdido Bays. The most complete data on Alabama's coastal area was compiled by May (1973a) from water samples collected in Mobile Bay and Gulf waters within six miles of offshore Alabama.

Trace metals were most recently determined in conjunction with MAFLA investigations for the central and western Gulf of Mexico (Florida Board of Regents, 1976). Results are summarized in Table II-2. Areas IV and V represent findings on metal concentrations offshore from Alabama and Mississippi. These studies along with those by Hood (1963), Rona, et al (1962), Moritas (1961), and Slowey and Hood (1969) indicate that coastal waters have an order of magnitude greater concentration than open ocean waters.

When adequately sampled, it appears that trace metal data can complement or reinforce circulation information and indicate dynamic characteristics. Evidence of this is discussed in A Summary of Knowledge of the Eastern Gulf of Mexico (Jones, et al., 1973) as follows:

An examination of the distribution of trace metals in ESCAROSA (Escambia-Santa Rosa counties) indicates that water movements are complex. There seems to be a general movement of surface waters from east to west. Salinity, silicate, and manganese data indicate a surface flow of water out of the bays, yet the trace metal data show an offshore enrichment with no apparent surface connection. This would indicate that the trace metals are carried below the surface upon their entrance into the Gulf, only to rise again a few miles away in small divergent areas, or they are entrapped within the bays and their offshore enrichment comes from the Mobile Bay and Mississippi River sources, or the surface waters are enriched by wind-carried aerosols. Possibly all three processes contribute. Sediment studies seem to indicate bay entrapment, but it is also well known that trace metals are released from sedimentary particles upon contact with saline water, and it is also well known that trace metals (especially lead) are constituents of the aerosols.

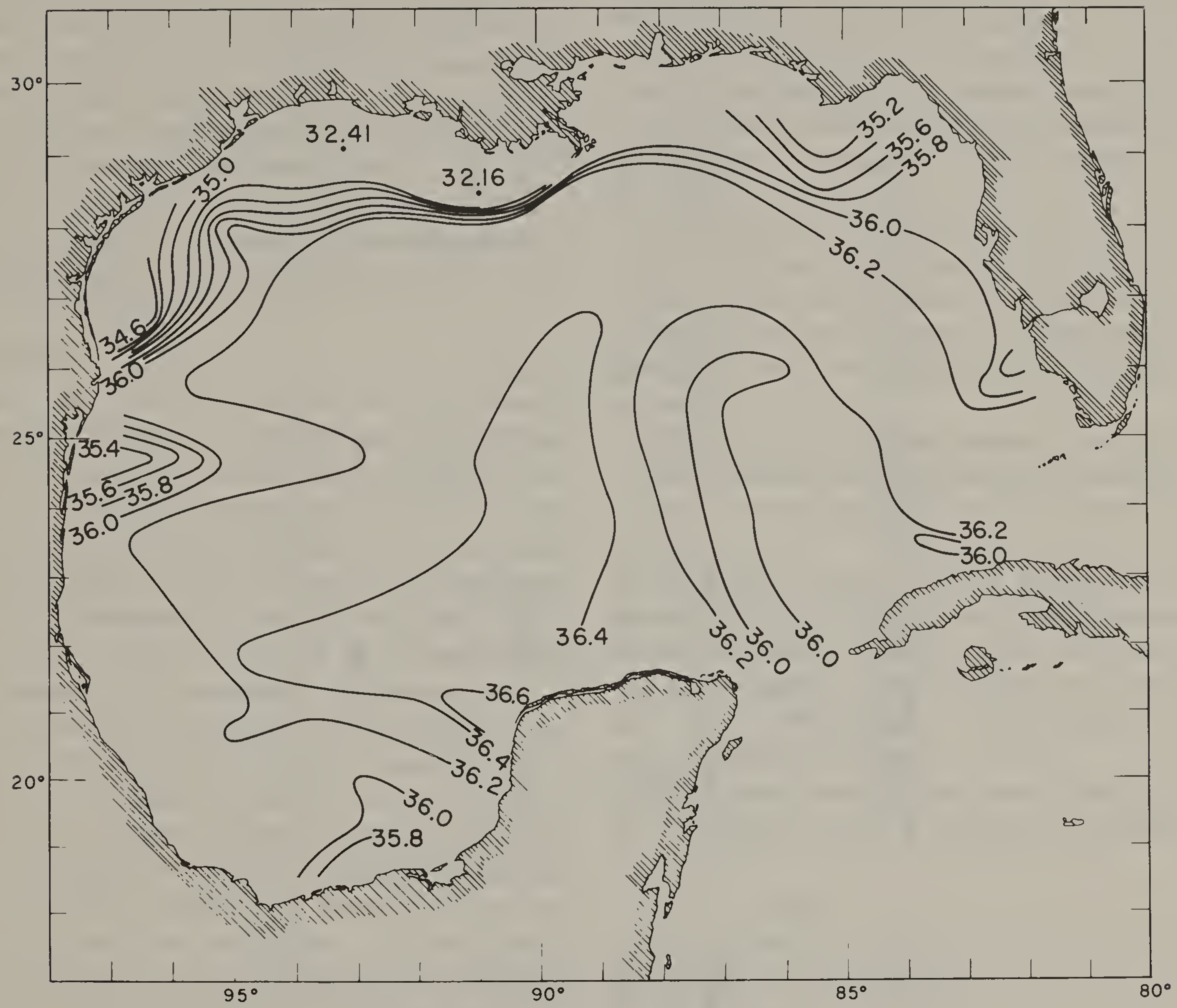


FIGURE II-14 Typical surface salinities (parts per thousand) in the Gulf of Mexico (Nowlin, 1972).

Table II-2. Sediment heavy metal concentrations (from Presley, et al.). N - number of samples. Standard deviation in parentheses.

Area	N	Fe (%)	Cd (ppm)	Cu (ppm)	Cr (ppm)	Ni (ppm)	Pb (ppm)	V (ppm)	Ba (ppm)
I	9	.16 (.04)	<.05 (0)	4 (.6)	18 (5.4)	2 (2)	6 (1.3)	5 (1.5)	49 (15)
II	8	.16 (.08	<.07 (.02)	4.4 (1.3)	13 (6.8)	3 (1.5)	3.5 (1.8)	6 (4.5)	46 (12)
III	20	.52 (.19)	<.09 (.05)	4.9 (2.7)	19 (7.5)	4.5 (1.9)	6 (1.6)	10 (4)	68 (31)
IV	10	.66 (.51)	<.08 (.03)	4.5 (3.8)	16 (20)	4 (2.7)	7 (2.7)	13 (7)	76 (39)
V	10	2.01 (1.11)	<.2 (.08)	10.5 (7.1)	39 (23)	17 (13)	13 (6.5)	56 (37)	339 (213)
Carbonate rocks		.4	0.0	14	11	12	8	15	150
Nearshore sediments		3.5	0.0	48	100	55	20	130	750

Source: Florida Board of Regents, 1976.

Slowey and Hood (1969) have reported high trace metal content at intermediate depths in Gulf water. They found this metal content at intermediate depths to decrease as the water moved through the Gulf of Mexico and concluded the metal origin to be from outside the Gulf, either from residual sub-Antarctic intermediate water, or from a continual rain of decaying organisms with their resultant release of metals during the northward transit of water. The outside origin of high metal content of intermediate water seems reasonable and feasible. However, the conclusion is based on the resemblance of copper, manganese, and zinc distributions in the Gulf to those found at one station taken from Cuba.

A further discussion of the occurrence of heavy metals in coastal regions can be found in Appendix 9, OCS Sale No. 40, Final EIS, Vol. 3, pp. 662-669 (USDI, BLM, 1976a).

5. Air Quality

Multiple or massive use of air for waste disposal (emissions) in a limited area temporarily degrades the quality (defined as availability for general use of the air. Evaluation of the potential impact of a proposed additional use of air involves knowledge of the restrictions on additional impacts, the capability of the air to receive additional impacts, and the extent of the proposed additional impacts. The remainder of this section examines the first two factors in terms of legal constraints involved and the existing air quality.

Interstate air quality control regions (AQCR) define areas in which specific controls and standards are applied but which are administered by Federal and State jurisdictions. Table II-3 lists the Federal ambient air standards. All individual states are required to adopt standards as stringent as or more stringent than the Federal standards.

Estimates of air pollution emissions for each AQCR and for coastal counties have been compiled by EPA Region IV in Atlanta, Ga. These data are compiled in Tables II-4 through II-6.

The emissions data give quantities of pollutants being emitted into the air, and the air pollution potential gives some indication of the likelihood that the emissions will not be satisfactorily dispersed. However, the data that is presented is not a true picture of the air quality of a given AQCR or county; most of the data available are from urban centers. This might seem to indicate that there is a region wide problem where in fact it is only an urban problem. Measurements are being inititated in non-urban areas but data has not yet been obtained from these areas.

Table II-7 indicates the counties and the point sources responsible for the highest emission for particulates, SOx , NOx, hydrocarbons, and carbon monoxide. It is generally noted that: 1) particulate emissions result from industrial processes such as mineral and wood products, area burning, fugitive dust, and paved roads; 2) the SOx, and NOx result from fuel combustion of coal, oil, or natural gas; 3) the use of gasoline for transportation is responsible for carbon monoxide emissions; and 4) hydrocarbons may indicate petroleum storage, refining, or other petroleum related activities.

The general air quality in the study area is good; however, the counties with major urban areas indicate high pollution concentrations. This indicates that an increase in pollutants directly correlates with the increase in population of an area.

Offshore oil operations generate a small but significant amount of air pollutants resulting from stationary combustion or from venting produced gas.

The major source of total hydrocarbon emissions is the oil storage on the production platform (136×10^3 mg/yr) and from gas processing vents (93×10^3 mg/yr). These account for over 70% of the total non-methane hydrocarbons (29,403 mg/yr) emitted offshore.

Power generation during production operations is the largest source of continuous emissions of:

NO_x 36.3×10^3 mg/yr

SO_x 1.7×10^3 mg/yr

non-methane HC 3.12×10^3 mg/yr

CO 9.0×10^3 mg/yr

particulate 1.1×10^3 mg/yr

There are several methods and control technologies for major emissions sources, combustion modification, waste heat utilization, dilution, stack vapor recovery systems, and smokeless combustion flares. The best method for emission control is waste heat utilization which totally eliminates emission sources from direct-fixed heaters.

Table II-8 indicates the total emissions from offshore facilities in 1985 and shows the amount by which the total emissions can be reduced by using control methods.

Table II-3. FEDERAL AMBIENT AIR QUALITY STANDARDS

Parameter	Standard Primary	Standard Secondary
Particulate Matter:		
Annual geometric mean	75 ug/m^3 1/	60 ug/m^3
24-hour maximum	260 ug/m^3	150 ug/m^3
Sulfur Oxides:		
Annual arithmetic mean	80 ug/m^3	
24-hour maximum	365 ug/m^3	
3-hour maximum	---	1.300 ug/m^3
Carbon Monoxide:		
8-hour maximum	10 mg/m^3 2/	10 mg/m^3
1-hour maximum	40 mg/m^3	40 mg/m^3
Photochemical Oxidants:		
1-hour maximum	160 ug/m^3	160 ug/m^3
Hydrocarbons:		
3-hour maximum	160 ug/m^3	160 ug/m^3
Nitrogen Dioxide:		
Annual arithmetic mean	100 ug/m^3	100 ug/m^3

1/ ug/m^3 = micrograms per cubic meter
2/ mg/m^3 = milligrams per cubic meter

Source: Adapted from US EPA, 1976.

Table II-4. Air Pollution Emissions Estimates for Alabama Coastal Counties

Counties	Particulate	Emissions in tons/yr SO_x	NO_x	HC	CO
Mobile	*11870	*10366	*18860	*33911	*140107
Baldwin	1454	1183	5287	12336	43388

* Highest Recorded

Source: US EPA, 1977a.

Table II-5. Air Pollution Emissions for Mississippi Coastal Counties

Counties	Particulate	SO_x	NO_x	HC	CO
	Emissions in tons/yr				
Amite	751	93	1207	1869	7696
Hancock	622	61	1050	2922	13268
Harrison	5607	*75265	*22141	*14975	*67228
Jackson	*7446	14193	8343	25173	58197
Marion	1202	96	1486	2912	12947
Pearl River	971	112	1921	3205	14746
Pike	653	197	2291	4184	17299
Walthall	203	53	1067	1193	4727
Wilkinson	165	74	863	1002	3510

* Highest Recorded

Source: US EPA, 1977a.

Table II-6. Air Pollution Emissions for West Coast Florida Coastal Counties

		Emissions in tons/yr			
Counties	Particulate	SO_x	NO_x	HC	CO
Bay	11699	57664	15133	9367	53873
Charlotte	846	113	843	4337	13990
Citrus	8905	49917	18307	3861	12336
Collier	4328	126	1946	9679	45290
Dade	14185	47493	47067	*77940	100687
Dixie	296	94	712	1387	3857
Escambia	15208	125166	36215	16704	38078
Franklin	360	31	245	2180	7733
Gulf	6644	14037	4114	2250	50155
Hernando	740	148	1122	2309	9292
Hillsborough	*27302	*243982	*69004	61409	*289877
Jefferson	148	39	718	997	4051
Lee	2596	16078	20907	16884	79057
Levy	1501	1003	2323	3256	11868
Manatee	2254	7483	19627	10952	51875
Monroe	717	770	5639	10011	42160
Okaloosa	1982	467	5371	10775	47716
Pasco	1187	3277	5856	8268	35896
Pinellas	6350	34072	37691	56028	264505
Santa Rosa	7559	32100	13799	17951	33217
Sarasota	1315	472	7095	15313	69008
Taylor	9418	3588	4005	4441	18145
Walton	446	78	1469	3672	15716

* Highest Recorded

Source: US EPA, 1977a.

Table II-7. Point Source Emissions for Selected Gulf of Mexico Coastal States and Counties

State	County	Emission	Source
Florida	Hillsborough	particulate	fuel combustion - bituminous coal
		SO_x and NO_x	gasoline - land vehicles
		CO	gasoline - land vehicles
	Dade	HC	
Mississippi	Jackson	particulate	industrial processing - wood products
	Harrison	SO_x and NO_x	fuel combustion - bituminous coal
		HC and CO	gasoline - land vehicles
Alabama	Mobile	particulate	industrial fuel
		SO_x and NO_x	commercial and industrial fuel
		HC and CO	gasoline - land vehicles

Source: US EPA, 1977a and b.

Table II-8.

ESTIMATES OF TOTAL EMISSIONS FROM OFFSHORE FACILITIES, 1985
(Mg/Yr)

	Offshore Texas, Louisiana and Gulf of Mexico (Federal)					
	NO_x	SO_x	HC	CO	Particulates	H_2S
DRILLING (average of nine years)						
Power Generation	2,580	173	87	377	unk	-
Mud Degassing	-	-	932[a]	-	-	-
Oil-Based Muds	-	-	43	-	-	-
Blowouts	-	-	unk	-	-	-
Fuel Storage	-	-	9	-	-	-
PRODUCTION						
Power Generation	25,955	1,274	2,549	7,046	956	-
GAS PROCESSING						
Dehydration	56	neg	1,126	-	6	-
Compressor Seals	-	-	unk	-	-	-
Vents	-	-	93,000[a]	-	-	149
Valve Seals	-	-	2,814[a]	-	-	-
OIL PROCESSING						
Direct-Fired Heaters	242	1	19	48	26	-
Pump Seals	-	-	37	-	-	-
Valve Seals	-	-	15[a]	-	-	-
Oil Storage	-	-	136,524[a]	-	-	233
WATER TREATING	-	-	unk	-	-	-
TOTAL UNCONTROLLED EMISSIONS	28,833	1,448	237,155 (27,162)[b]	7,471	988	372
Reduction from Pollution Control						
Waste Heat Utilization	298	1	19	59	32	-
Combined Cycles Operation	9,084	446	892	2,466	335	-
Vapor Recovery	-	-	206,572[a]	-	-	335
TOTAL REDUCTION	9,382	447	207,483 (21,568)[b]	2,525	367	335
TOTAL CONTROLLED EMISSIONS	19,451	1,001	29,672 (5,594)[b]	4,946	621	37
PERCENT REDUCTION	33	31	87 (79)[b]	34	37	90

a Primarily methane; non-methane hydrocarbon content approximately 10 percent.
b Non-methane hydrocarbons shown in parentheses.
Source: US EPA, 1977c.

6. Water Quality

The Gulf states - Texas, Louisiana, Mississippi, and Alabama are presently developing Water Quality Management Plans pursuant to Section 303e of the 1972 Amendments of the Federal Water Pollution Control Act (P.L. 92-500). The purpose of these plans are twofold: to provide an analysis and assessment of the present environmental conditions and stresses within basins; and to provide a qualification of the waste waters. The basin plans may affect local water pollution control activities by identifying polluted waters; establishing maximum pollution loads which may be discharged into waters; indentifying waste water treatment plants which are discharging more BOD (Biochemical Oxygen Demand) than the waters can safely accept; and suggesting measures which would correct local water pollution problems. The 1972 amendments to the Federal Water Pollution Control Act also requires that, for every "point source" discharge of pollutants, the discharger must obtain a permit which specifies the allowable constituents and amounts of its effluent (US CEQ, 1974). Those with ocean outfalls are required to comply with criteria set out in the Marine Protection, Research, and Sanctuaries Act of 1972. This permit program is administered by EPA or by authorized states that have met certain requirements. EPA limitations for petroleum refining point sources may be found in 40 CFR 419.

Each state is divided into hydrological units (basins). These are further divided into sub-basins. The segments of each basin have been analyzed in detail for water quality, and the existing state standards and classification of surface water and segment categorization are evaluated for each segment.

The sub-basins are classified as either water quality or effluent limited. The water quality segments require a significant point source or non-point source to be controlled beyond the best practical treatment or secondary treatment to achieve standards. The effluent limited segment is and will continue to meet water quality standards by the "best practicable control technology" or secondary treatment for publicly owned facilities.

Some of the types of pollutants that enter the water from non-point sources include soil particles, nutrients, organic matter, microscopic organisms, inorganic matter, heavy metals, chemicals, and pesticides. The erosion of soil particles is a major single pollution source. The majority of non-point pollution can be attributed to erosion areas, intense agricultural practices, and construction in highly populated areas.

In implementing the plan for waste load allocation, effluent discharge parameters for individual point source discharges have been established. These effluent limitations are quantities, rates, and concentrations of chemical, physical, biological, and other constituents that are discharged into navigable waters, waters of the continguous zones, or the ocean. In determining the maximum allowable wasteloads of BOD, an analysis of the assimilative capacity of the receiving stream is calculated. The reasonable background values are defined as: DO (dissolved oxygen) 85% saturation, TKN (total Kjeldahl nitrogen) 1.3 mg/l maximum; BOD 4 mg/l. Significant point source discharges are any discharges that have effluent of 100,000 gallons per day or more and/or discharges that are associated with a significant water quality violation problem. Since each state presents water quality data differently they are considered separately. The preceding information was largely taken from the water quality basin plans for the Gulf of Mexico Coastal basins. These plans were submitted in accordance with the 1972 Federal Water Pollution Control amendments (P.L. 92-500, Sec. 303e). Information concerning effluent limitations for petroleum refinery point sources can be found in 40 CFR (Petroleum Refinery Point Category).

Alabama and Florida have data available for each water quality basin. There is little data available for the water quality basins in Mississippi. Water quality management plans have been prepared in compliance with the 1972 amendments to the Federal Water Pollution Control Act (P.L. 92-50).

Alabama

Mobile River Basin

The Mobile River basin has a major urban area that is oriented toward trade, transportation, and manufacturing.

There are substantial water quality problems throughout the Mobile River Basin. The most persistently occurring violations are for dissolved oxygen and coliform bacteria. Pesticides and heavy metals (mercury) have also been recorded in Mobile Bay. Water quality degradation is attributed to domestic waste. The tremendous increase in population from tourism in the summer months places a heavy burden on waste treatment facilities. Industrial sources account for 95% of the total waste discharges measured on oxygen demand. The major contributing industries are paper and pulp, oil production, and the chemical industry.

Perdido-Escambia River Basin

Water quality in this basin is generally degraded. Although some problems are caused by natural swamp and forest drainage, agricultural, urban, and industrial areas contribute a large portion of the deleterious substances.

Florida

Florida has extensive data for each water quality basin, and it has been requested from the State of Florida Water Quality Board.

B. Biological Environment of the Gulf of Mexico Area

1. Phytoplankton

Phytoplankton sampling in the northern Gulf of Mexico has been sparse intermittent, and mostly unquantitative. Much of the information on species is from Balech (1967) and Steidinger (1973). Information on the eastern Gulf may be found in Curl (1959), Davis (1950), Dragovich (1963), and Saunders and Glenn (1969). These studies describe only the presence of certain species in certain areas, and thus it is difficult to recognize seasonal fluctuations or geographic shifts in species abundance or succession (Pequegnat et al., 1976).

El Sayed (1972) used measurements of chlorophyll *a* to calculate estimates of the phytoplankton standing crop for the Gulf of Mexico. Surface chlorophyll *a* showed higher concentrations (high standing crop) during the winter than at any other season; these were followed by a decrease in the standing crop of phytoplankton during spring, and a gradual increase in summer and fall. In terms of chlorophyll *a* (at the surface and integrated for the euphotic zone) the Gulf of Mexico is no different from other tropical or subtropical bodies.

The levels of gross primary production (total quantity of green plant protoplasm produced per unit time in a specific habitat) in different geographic localities in the Gulf of Mexico resemble the distribution of the phytoplankton standing crop. As with chlorophyll *a*, the surface and integrated (with the euphotic zone) primary productivity values in the inshore water were higher than those values for offshore waters (El Sayed, 1972).

Simmons and Thomas (1962) sampled phytoplankton from the eastern Mississippi Delta and described two assemblages associated with different salinity regimes. A low salinity regime of river water has an assemblage dominated by two species each of the genera *Cyclotella*, *Melosira*, and *Navicula*. A higher salinity regime of Gulf waters had an assemblage composed of *Nitzschia seriata*, *Thalassiothrix frauenfeldii*, *Thalassionema nitzochioides*, *Skeletonema costatum*, *Asterionells japonica*, and three species of *Chaetoceros*. This Gulf water regime near the fresh water plume has higher diversity due to mixing of fresh water and marine genera. Seasonality of species (presence and abundance) was more variable in the Gulf regime than in the river regime. In both areas, the lowest standing crop was noted in November. Dinoflagellates were minor constituents of the phytoplankton observed near the delta.

Dinoflagellate distribution was reviewed by Steidinger (1973). Species diversity of dinoglagellates was found to be higher offshore (where it occasionally exceeds diatom diversity) than nearshore, while dinoflagellate abuandance was higher nearshore than offshore. While the dinoflagellates are more diverse in the open Gulf, they do not necessarily dominate the standing crop.

Steidinger (1973) summarized data for phytoplankton of the eastern Gulf and stated that:

(a) There appear to be four types of phytoplankton distribution: estuarine, estuarine/coastal, coastal/open Gulf, and open Gulf, with diatom and dinoflagellate species characteristic of each category.

(b) Species and composition of year-round coastal residents fluctuate in dominance. Periods of seasonal peaks vary year to year and area to area. Studies to date in eastern Gulf of Mexico waters indicate that succession and seasonality are difficult to interpret but maximum production is in spring and summer.

(c) Data indicate that diatoms dominate inshore coastal areas while dinoflagellates, particularly with regard to species diversity, can often dominate open Gulf waters.

(d) It is important in all species composition evaluations to realize that even though diatoms and dinoflagellates are used as indices because of their identifiable nature, microflagellates (5-15 μ) numerically dominate in eastern Gulf coastal and estuarine environments. These microflagellates are rarely identified to species.

(e) Areas of upwelling and those influenced by river drainage are the most productive while the least productive areas are open Gulf waters. Eastern Gulf of Mexico estuaries, particularly Tampa Bay, show higher primary productivity and standing crops than many similar temperate or tropical estuaries, while coastal and open Gulf waters are comparable to nutrient rich tropical waters, but less productive than similar temperate regimes.

(f) Various phytoplankton researchers have mentioned that the eastern Gulf of Mexico needs further study with more sampling, preferably synaptic. Most data is derived from stations occupied too infrequently or only once.

(g) The basic known ecology of red tides is outlined and suggests that *Gymnodinium breve*, the causative organism, blooms annually in selected parts of coastal Gulf waters, but that many interrelated parameters must be optimal for the bloom to be supported and develop into a major red tide outbreak.

(h) Nutrients, particularly chelated trace metals, have been implicated with the initiation of red tides in Florida waters following heavy rainfall and land runoff. Using iron as an index, researchers suggest that monitoring of certain river discharges can be used to predict major red tides.

(i) Red tides appear to have their severest effects on local and state economy in the form of reduced tourism and the expense of dead fish removal. Commercial fisheries are reportedly not affected while isolated sports fisheries, i.e., reef fishing, are affected in a red tide area.

(j) Controlling *Gymonodinium breve* red tides after they have developed is considered unfeasible at the present time for reasons outlined in the text, e.g., vast area and volume of saltwater to be treated as well as the prospect of recruitment of other *G. breve* populations by physical forces from surrounding areas. *Gymnodinium breve* blooms are not a surface phenomenon and the organism can be found throughout the euphotic zone. Presently, red tide research continues and covers such salient points as life history of the causative organism and varying degrees of susceptibility among different fishes and invertebrates.

Steidinger goes on to discuss problems in plankton methodology and their implications in data interpretation. For instance, it is difficult to make geographic comparisons without standard methods, methods which are currently available may not be accurate, and the estimates derived should be used with caution, particularly in fisheries harvest projections.

Also considered a part of the phytoplankton are the large algae of the genus *Sargassum*, the most common of which are *S. fluitans* and *S. natans*. ''Sargassum weed'' communities provide shelters and food for a large number of organisms which would otherwise not be found at the surface in the open Gulf, at least not at such a high density, such as bryozoans, molluscs, coelenterates, crustaceans, and fishes, especially juveniles. Larger fish, and sea turtles, may be attracted to such communities to feed. Little is known of the extent of sargassum communities in the open Gulf.

Phytoplankton are important as the primary producers of the marine environment. As such they are the starting points in the marine food web, providing food for zooplankton, which in turn provide food for larger marine carnivores; man, as a harvester of a variety of marine fish and shellfish, is one of several animals at the ''top'' of the food web. In addition, phytoplankton play a significant role in the world's oxygen/carbon dioxide budget and, in ways as yet incompletely understood, also serve to detoxify (biodegrade) many pollutants found in the Gulf.

Unfortunately it is impossible to generalize regarding the distribution of phytoplankton in the Gulf of Mexico. It is clear from the data that have been collected to date that concentrations of phytoplankton are distributed in patches of various sizes which move with the prevailing winds and currents. Other factors, poorly understood, affect the size and distribution of the patches, including availability of nutrients and grazing pressure. Thus predictions regarding specific location of a patch or species at any given time simply cannot be made.

2. Zooplankton

Zooplankton comprise a major link between producers (phytoplankton) and higher trophic levels in the Gulf. The most abundant groups are the copepods (Raymont, 1963), and they and other planktonic crustacea seem capable of ingesting both phytoplankton and detritus particles, and thus are important in the marine food web, as other animals prey on them (LOOP, 1975). Ichthyoplankton (fish eggs and larvae) make up a portion of the zooplankton. Like all plankton, the distribution and abundance of the zooplankton fluctuates seasonally.

Common copepod species found in neritic Gulf waters include the calanoid copepods *Euchaeta marina*, *Neocalanus gracilis*, *Scolecithrix dana*, *Candacea pachdactyla*, *Unidinula vulgaris*, *Eucalanus attenuata*, and *Acartia tonsa*, as well as the cyclopis copepods *Copilia mirabilis* and *Corycaeus* spp. *Euchaeta* and *Corycaeus* differ from the rest in being carnivorous (organisms which depend chiefly or solely upon catching animals for their food). *Acartia tonsa* is a dominant nearshore form in bays and estuaries, and is found less commonly offshore (Gillespie, 1971).

Euphausiid crustaceans are also prominent members of the zooplankton assemblage. Major species found in the Gulf are *Euphausia americana*, *E. mutica*, *E. brevis*, and *Stylocheiron carinatum*.

Possibly the most significant carnivores in the zooplankton are the chaetognaths (arrow worms). Copepods dominate their diet but this may be an artifact based on relatively high copepod abundance (Raymont, 1963). They also feed on fish and barnacle larvae. The genus *Sagitta* is common worldwide; Gulf species include *S. setosa*, *Pterosagitta* spp., *Krohnitta* spp., and *Eukrohina* spp.

Other common carnivores in the zooplankton include the ctenophores (*Pleurobrachia* and *Beroe*), medusae of various species, ostracods, cladocerans (*Podon* and *Evadne*), mysid and amphipod crustaceans, heteropods (*Atlanta leseuri*), petropods, salps, and pyrosomes. Another significant group of carnivores are the various larval and immature forms, both holoplanktonic (planktonic at all states of the life cycle) and meroplanktonic (organsisms which have planktonic reproductive stages), from several phyla. These include most of the crustaceans mentioned, the tunicates, echinoderms, cephalopods, ectoprocts, sponges, and annelid and nemertean worms. Fish larvae are important carnivores, and the survival of larvae of commercial fish has an obvious economic impact.

Hopkins (1973) summarized data for zooplankton of the eastern Gulf and stated that:

(a) The principal hydrographic factors regulating zooplankton distribution in the eastern Gulf of Mexico are the Loop Current, Mississippi River, and local runoff into Gulf coastal areas.

(b) The copepod *Acartia tonsa* is the principal plankton species in terms of biomass in estuaries of the eastern Gulf.

(c) Zooplankton diversity in Gulf coast estuaries increase with increasing salinity.

(d) The meroplankton constitutes a signficant portion of the zooplankton biomass in estuaries, especially during the summer months.

(e) Zooplankton diversity in east Gulf coast estuaries is generally greater in summer than in winter.

(f) One of the principal regulators of seasonal patterns of zooplankton in Gulf coast estuaries may be predators such as ctenophores and scyphomedusae which graze heavily on the plankton population in winter.

(g) Zooplankton biomass appears to reach a maximum in eastern Gulf estuaries and on the southwest section of the Florida shelf in summer and on the northeastern shelf and central Gulf in winter. No significant seasonal changes in biomass seem to occur within the Loop Current.

(h) Upwelling generated by the Loop Current is responsible for the summer biomass maximum on the southwestern Florida shelf while river discharge and cool meteorological conditions are primarily responsible for the winter peak on the northern Gulf shelf.

As noted above in Section II.B.1., floating patches of sargassum provide food and habitat for a large variety of animals, many of which may not be normally associated with the surface waters of the open Gulf.

As with the phytoplankton, it is impossible to generalize about specific location and extent of concentrations of zooplankton due to this extreme patchiness. Much of this patchiness is no doubt due to the patchiness of the phytoplankton, on which many zooplankters feed.

3. Nekton

Nekton for the offshore waters are represented by five major taxonomic categories - marine mammals, reptiles, fishes, cephalopod molluscs (octopuses and squid), and certain crustaceans (shrimp and swimming crabs) (Visual No. 5). Individuals of this group commonly, but not always, range over broad areas. However, most nekton are limited in geographic and vertical ranges by the same environmental conditions as less mobile organisms, i.e., temperature, salinity, and available food. Marine mammals and marine reptiles (turtles) are discussed in Sections II.B.6. and II.B.7. and will not be treated here.

Nekton can be categorized two ways: vertically (position in the water column) and horizontally (distance from shore). Vertically, the nekton is usually separated into pelagic and demersal components. The horizontal categories are coastal and oceanic (high seas) nekton.

The most conspicuous nekters are probably the fishes. Table II-9 lists the aforementioned categories and some representative species in the categories. Many of the coastal fishes are estuarine dependent; that is, estuaries or coastal marshes are a critical habitat during some phase of their life cycle, usually as a nursery. The classic example is that the adult animal spawns in the ocean and the young migrate to the estuaries, which serve as nursery areas. As post-juveniles or sub-adults the animals emigrate back to the open ocean. Some prime examples of this are croaker (*Micropogon undulatus*) and pink, brown, and white shrimp (*Penaeus*). Rodgers (1977) postulated a similar net inshore-offshore movement for many demersal shelf fishes.

Most of the northern Gulf fishes are temperate with incursions of Caribbean faunas, and exhibit seasonal distribution and abundance fluctuations, which are probably largely related to oceanographic conditions.

Less is known about offshore than inshore fishes, although offshore species seem less diverse and seasonally varible.

The ichthyofauna associated with offshore platforms in the northeastern Gulf have been studied by Hastings, et al. (1976). They found that the platforms supported diverse and abundant fish populations not normally characteristic of the open sandy bottoms found in the area. Sonnier, et al (1976) studied the fish fauna associated with oil platforms and natural reefs on the Louisiana Outer Continental Shelf. They found more species associated with natural reefs than with oil platforms although some were common to both.

The fishes of the Florida Middle Ground have been reported on by Smith and Ogren (1974) and further by Smith (1976) in his paper concerning distribution of reef fishes in the eastern Gulf. Smith (1976) states: "Comparison of the eastern Gulf and other western Atlantic reef ichthyofaunas revealed greater intra-Gulf homogeneity and the Caribbean-West Indian affinity than previously suspected. Eastern Gulf reefs harbor a progressively more tropical ichthyofauna with increasing offshore distance and depth. Reef fish species composition and relative abundance changed most dramatically between 18 and 30 m depths and probably correspond to the transition from inshore, coastal to offshore, Gulf water masses. Preliminary observations at the Florida Middle Ground, a region of high-relief reef structure on the outer West Florida Shelf, indicate a diverse and abundant resident tropical ichthyofauna diverse and abundant resident tropical ichthyofauna including numerous insular (West Indian) elements rare or absent at other studied Gulf reefs. In many respects, however, the Middle Ground ichthyofauna resembles those inhabiting offshore banks in the northwestern Gulf of Mexico (e.g., Flower Garden Reefs)."

The Gulf of Mexico is a critical habitat for the Atlantic stock of the bluefin tuna (*Thunnus thynnus*). The bluefin tuna spawns only in the Gulf of Mexico and the young migrate out to the Atlantic through the Florida Straits. King mackerel (*Scomberomorus cavalla*) are also known to migrate through the straits, as do many other fishes. The Florida Straits is part of the migration route of many fishes, and is also the route of larval transport (via the Gulf Stream) for many nektonic and benthic species which are recruited into the populations along the Atlantic Coast. It can be considered a critically important area of these vast routes because it is a bottle-neck and could be a point of vulnerability of many of the stocks which must pass.

4. Benthos

The benthic communities for the OCS can be divided into shallow, intermediate, and deep shelf assemblages and slope assemblages.

Collard and D'Asaro (1973) indicate that there are no clear-cut faunal boundaries for the Florida portion of the eastern Gulf. They further state that the distributional limits of nearshore benthic invertebrates are influenced by temperature and salinity minima, but these factors are less important in deeper offshore waters. Defenbaugh (1976) in his study of the benthic macroinvertebrates from offshore Pensacola, Florida to Brownsville, Texas found that communities were broadly dis-

Table II-9. Representative Fishes in the Nektonic Category.

	Coastal	Oceanic
Pelagic	King mackerel	Billfish
	Chub mackerel	Mako sharks
	Butterfishes	Frigate mackerel
	Scaled sardine	Bluefin tuna
	Menhaden	
Demersal	Flounders	Snappers
	Croaker	Grouper

tributed according the substrate type and water depth. Defenbaugh (1976) listed 12 assemblages in the northern Gulf, these are shown on Figure II-15.

Smith (1976) studied the reef fishes on the West Florida shelf offshore the St. Petersburg, Florida area, and described the benthos as well. His observations probably apply to the Florida Shelf north of the study area at least to the Big Bend area, and probably to the DeSoto canyon area. The following discussion is taken from his work. The shallow reefs (12-18 m) are limestone ledges of low relief, generally less than one meter, and run parallel to the shoreline. Benthic invertebrate zonation of these reefs is characterized by an extensive overlay of small stony corals (*Cladocora arbuscula*, *Solenastrea hyades*, and *Oculina diffusa*), scattered soft corals (*Eunicea calyculata*, *Muricea elongata*, *M. laxa*, and *Pseudopterogorgia acerosa*), sponges including the loggerhead *Sphecíospongia vesparia*, and the siphonaceous green algae *Halimeda*, *Udotea*, and *Penicillus* on the back reef, 5-20 m shoreward of the reef ledge. The fore reef, 5-10 m shoreward of the reef ledge is typically covered with a luxuriant "forest" of soft corals which, at first glance, seem to exclude nearly everything else. A small ophiuroid echinoderm,*Ophiothrix suensoni*, associated with the dominant soft coral, *Muricea elongata*, is rather characteristic of this reef segment. The reef ledge is generally encrusted with the boring sponge *Cliona*, tunicates, serpulid and sabellid polychaetes, the fire coral *Millepora alcicornis*, and the green alga *Caulerpa racemosa*. Sand-shell substrates peripheral to rocky reefs are relatively barren except for scattered patches of the green algae *Caulerpa prolifera* and *C. ashmeadii* and, at shallow reefs, the seagrass *Thalassia testudinum*.

Conspicuous decapod crustaceans at shallow Gulf reefs include the arrow crab *Stenorynchus seticornis*, spiny lobster *Panulirus argus*, and, seasonally, the stone crab *Menippe mercenaria*. In addition to those echinoderms already mentioned, the echinoids *Arbacia punctulata*, *Lytechnius variegatus*, and *Encope michelini*, the ophiuroid *Astrophytan muricatum*, and the asteriods *Echinaster spinulosus*, *Oreaster reticulatus*, and *Luidia* spp. dwell on or in close proximity to reefs.

The deeper reefs (22-24 m) are characterized by broad expanses of limestone rock marred with crevices, shallow basins, and solution holes. No well-defined ledges were detected. A rich invertebrate fauna is associated with these in regular limestone bottoms. Many species of stony corals rare or absent at shallower reefs are common, but alcyonarian coral assemblages are depauperate by comparison. Both spiny lobster and Spanish lobster (*Scyllarides nodifer*) are common throughout the area, especially in the deeper solution holes. The thorny oyster *Spondylus americanus* first begins to appear at these depths.

Deeper reefs (29-33 m) off Sarasota, Florida are characterized by numerous discontinuous, low-relief limestone terraces. A diverse invertebrate and fish fauna is associated with these bottom irregularities. Diagnostic bioindicators of this deep reef community include the decapod crustacean *Stenopus hispidus*, the pelycepod mollusk *Lima scabra*, and the echinoid echinoderm *Diadema antillarum*.

The Florida Middle Ground is distinct from other Gulf patch reefs. Unlike most eastern Gulf reefs, the Middle Ground is typified by 10-15 m high limestone irregularities rising to within 24 m of the surface. Certain physical, chemical, and biotic features have favored development of a diverse and abundant biota, dominated by tropical species, at the Middle Ground (Smith and Ogren, 1974).

The shallow shelf benthic communities exhibit Carolinian affinities which gradually grade into communities with predominately West Indian affinities on the deeper shelf.

Shipp (1977) reports a faunal change offshore the Perdido Bay area. Shipp has also been conducting research on a reefal area on the rim at the head of the DeSoto Canyon, which apparently supports a diverse ichthyofauna with many tropical representatives. The Mississippi-Alabama shelf area is known to have "live bottom" areas containing alcyonarians, sponges, bryozoans, etc., but the extent and location of these areas are not well known at this time.

5. Birds

The eastern Gulf Coast region is inhabited by several colonial nesting and wading bird species such as herons, egrets, ibis, etc. (Table II-10). The beaches and coastal marshes of this region are inhabited by migrant and non-migrant shore bird species such as plovers, sandpipers, curlews, rails, etc. Seabird rookeries of the gull-billed, Forster's, least royal, sandwich, and Caspian terns and also black skimmers occur in several

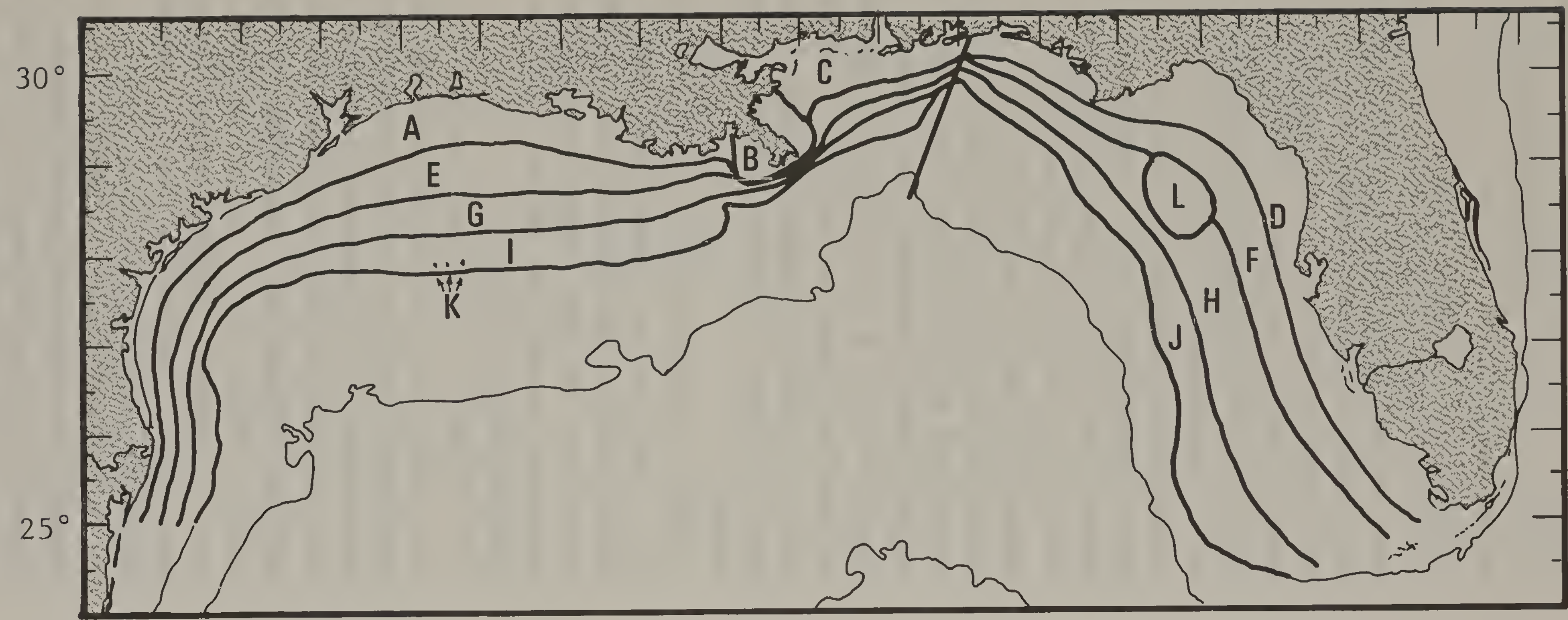


FIGURE II-15 Faunal assemblages of the northern Gulf of Mexico. Bathymetric limits semi-diagrammatic, not necessarily drawn to fit the actual contours.

A. Inner shelf assemblage, Texas-Louisiana Shelf.
B. Pro-delta fan assemblage.
C. Pro-delta sound assemblage.
D. Inner shelf assemblage, West Florida Shelf.
E. Intermediate shelf assemblage, Texas-Louisiana Shelf.
F. Intermediate shelf assemblage, West Florida Shelf.
G. Outer shelf assemblage, Texas-Louiaiana Shelf.
H. Outer shelf assemblage, West Florida Shelf.
I. Upper slope assemblage, Texas-Louisiana Shelf.
J. Upper slope assemblage, West Florida Shelf.
K. Submarine bank assemblages, Texas-Louisiana Shelf.
L. Florida Middle Ground assemblage.

(Defenbaugh, 1976)

areas on the beaches and nearshore islands of the eastern Gulf of Mexico.

Pelagic birds listed in Table II-10 (jaegers, shearwaters, terns, petrels, etc.) all occur in the eastern Gulf of Mexico region (Murphy, 1967). However, the majority of these species are rarely observed from land and their numbers are unknown.

Several species of waterfowl (wigeon, teal, Florida duck, wood duck, greater scaup, redhead, Canada geese, etc. - Table II-10) utilize the Atlantic and Mississippi Flyways as they migrate into or through the eastern Gulf of Mexico region. Migrant waterfowl overwinter in this region especially in upper Mobile Bay, Apalachicola and Suwannee rivers area, and the coastal area between Apalachicola and Tarpon Springs, Florida (Florida bend area). Approximately one million ducks and 25,000 geese overwinter in this northeastern Gulf region.

Three endangered bird species occur within the region of this proposal: the eastern brown pelican, red-cockaded woodpecker, and southern bald eagle (See Visual No. 3 and Table II-10).

Brown pelican nesting areas occur at several coastal sites in west-central Florida. Pelicans usually feed nearshore by diving into the water after food fishes.

Red-cockaded woodpecker habitat occurs at several sites inland from the Mississippi, Alabama, and Florida Gulf Coast. Six major sites occur inland from the coast in the vicinity of Gulfport, Mississippi and Allentown, Niceville, Wewahitchka, Odessa, and Punta Gorda, Florida.

Southern bald eagles have several nesting territories along the western Gulf coast of Florida. Two major coastal nesting areas are from Cedar Key southward to St. Petersburg and from Naples southward to Key West.

6. Marine Mammals

The marine mammal fauna of the Gulf of Mexico consists mostly of cetaceans (whales, dolphins, and porpoises). Pinnipeds (seals and sea lions) are found infrequently in the area. Sirenians (Florida manatees) are found inhabiting the warm coastal waters of Florida. Table II-11 lists the species and primary food in the Gulf of Mexico.

The Marine Mammal Protection Act of 1972 was established to protect all marine mammals in territorial waters of the U.S. (including imported marine mammals and products).

Schmidly and Melcher (1974) have documented 16 species of cetaceans near the Texas coast. The most common smaller cetaceans are the bottlenosed dolphin (*Tursiops truncatus*) and spotted dolphin (*Stenella plagiodon*). The sperm whale (*Physeter catadon*) and pilot whale (*Globicephala macrorhyncha*) are the most common larger cetaceans.

The Bottlenosed dolphin is the most widely studied marine mammal. Areal surveys and population counts of these mammals have been extensively conducted in the Gulf of Mexico. Findings indicate that this population is stable and it is estimated that the offshore Texas population is stable and is approximately 1,000-5,000. There is also an estimated population of 772 dolphins in the Chandeleur Islands and Breton Sound and approximately 4,076 dolphins from the Mississippi River Delta to Grand Isle, Louisiana (Orr, n.d.). There seems to be two groups of *Tursiops:* one that inhabits the coastal areas maintaining small discrete populations and an offshore population that congregates in larger numbers. This, however, is only conjecture and is presently being researched. It has also been suggested that larger dolphins move offshore during the winter, whereas, smaller dolphins are more common offshore during the summer.

Some of the larger whales occur far offshore in deep water and are seldom seen inshore. Some whales found in the Gulf are on the endangered list such as the blue whale, black right whale, humpback whale, sei whale, and fin whale (Federal Register, 1975a).

No dolphins or pinnipeds known to occur in this region are considered endangered. Some whale species such as the sperm whale are on the endangered list. The blue whale is endangered and rare, probably because their numbers have been severely reduced by commercial whaling. The smaller whales such as the Antillean beaked whale is generally classified as ‘rare’ because few have been observed at sea or stranded on beaches.

The Florida manatee population is increasing in Florida. The major area where these animals congregate are in warm waters. It is believed that manatees migrate offshore and avoid the extremely shallow flats and waterways near coastal inlets. They travel through the complex of sand bars, oyster reefs, and limestone shelves (Hartman, 1969). The primary food source of the Florida manatee is aquatic vegetation.

TABLE II-10 Selected Bird Species of the Gulf of Mexico Region

Common Name	Scientific Name
White pelican	*Pelecanus erythrorhynchos*
Brown pelican*	*P. occidentalis*
Olivaceous cormorant	*Phalacrocorax olivaceus*
Double-crested cormorant	*P. auritus*
Anhinga	*Anhinga anhinga*
Great blue heron	*Ardea herodias*
Little blue heron	*Florida caerulea*
Louisiana heron	*Hydranassa tricolor*
Black-crowned night heron	*Nycticorax nycticorax*
Yellow-crowned night heron	*Nyctannassa violacea*
Great egret	*Casmerodius albus*
Cattle egret	*Bubulcus ibis*
Reddish egret	*Dichromanassa rufescens*
Snowy egret	*Leucophoyx thula*
White-faced ibis	*Plegadis chihi*
White ibis	*Eudocimus albus*
Wood ibis	*Mycteria americana*
Roseate spoonbill	*Ajaia ajaja*
Mississippi sandhill crane*	*Grus canadensis pulla*
Whooping crane*	*G. americana*
American oystercatcher	*Hematopus palliatus*
Piping plover	*Charadruis melodus*
Wilson's plover	*C. wilsonia*

TABLE II-10 (continued)

Common Name	Scientific Name
Great black-beaked gull	*Larus marinus*
Ring-billed gull	*L. delawarensis*
Laughing gull	*L. atricilla*
Gull-billed tern	*Gelochelidon nilotica*
Forster's tern	*Sterna forsteri*
Common tern	*S. hirundo*
Sooty tern	*S. fuscata*
Least tern	*S. albifrons*
Royal tern	*Thalasseus maximus*
Sandwich tern	*T. sandvicensis*
Caspian tern	*Hydroprogne caspia*
Black skimmer	*Rynchops nigra*
Pomarine jaeger	*Sterocorarius pomarinus*
Parasitic jaeger	*S. parasiticus*
Gannet	*Morus bassanus*
Audubon's Shearwater	*Puffinus iherminer i*
Sooty Shearwater	*P. griseus*
Blue-faced booby	*Sula dactylatra*
Brown booby	*S. leucogaster*
Frigate bird	*Fregata magnificens*
Wilson's storm petrel	*Oceanites oceanicus*
Mallard	*Anas p. platyrhynchos*
Gadwall	*A. strepera*

TABLE II-10 (continued)

Common Name	Scientific Name
American wigeon	*A. americana*
Green-winged teal	*A. crecca carolinensis*
Blue-winged teal	*A. discors*
Northern shoveler	*A. clypeata*
Pintail	*A. a. acuta*
Mottled duck	*A. fulvigula maculosa*
Wood duck	*Aix sponsa*
Canvasback	*Aythya valisineria*
Lesser scaup	*A. affinis*
Ringnecked	*A. collaris*
American Coot	*Fulica americana*
Lesser snow goose	*Anser c. caerulescens*
Canada goose	*Branta canadensis*
Southern bald eagle*	*Haliaceetus leucocephalus leucocephalus*
Osprey	*Pandion heliaetus*
Florida everglade kite*	*Rostrhamus sociabilis plumbeus*
American peregrine falcon*	*Falco peregrinus anatum*
Arctic peregrine falcon*	*F. peregrinus tundrius*
Attwater greater prairie chicken*	*Tympanuchus cupido attwateri*
Ivory billed woodpecker*	*Campephilus principalis*
Red-cockaded woodpecker*	*Dendrocopos borealis*
Cape Sable sparrow*	*Ammospiza maritima mirabilis*
Dusky seaside sparrow*	*A. m. nigrescens*

*Listed as endangered by the U.S. Fish & Wildlife Service

Source: Bellrose, 1976; Roberts, 1974; and Murphy, 1967.

Table II-11. Species of Marine Mammals Known to Occur in the Gulf of Mexico.

Common Name	Scientific Name	Primary Food Source
*Sperm Whale	*Physeter catodon*	squid, shark, and bony fish
Pygmy Sperm Whale	*Kogia breviceps*	squid
Dwarf Sperm Whale	*K. sinus*	squid
*Black Right Whale	*Balaena glacialis*	zooplankton-copepods
*Humpback Whale	*Megaptera novaeangliae*	
*Sei Whale	*Baleanoptera borealis*	krill, schooling fish; copepods
*Fin Whale	*B. physalus*	krill, squid, and small fish
False Killer Whale	*Pseudorca crassidens*	squid and large fish
Killer Whale	*Orcinus orca*	squid, sea turtles, sea birds and fish
Short-finned Pilot Whale	*Globicephala macrorhyncus*	squid and fish
Pygmy Killer Whale	*Feresa attenuata*	squid
Goose-Beaked Whale	*Ziphius cavirostris*	squid
Antillean Beaked Whale	*Mesoplodon europaeus*	squid
Risso's Dolphin	*Grampus griseus*	squid and small fish
Rough Toothed Dolphin	*Steno bredanensis*	squid
Spotted Dolphin	*Stenella plagiodon*	squid and small fish
Gray's Dolphin	*S. coeruleoalba*	squid and small fish
Bridled Dolphin	*S. frontalis*	squid and small fish
Spinner Dolphin	*S. longirostris*	squid and small fish
Saddleback Dolphin	*Delphinus delphis*	no data
Atlantic Bottle-Nose Dolphin	*Tursiops truncatus*	fish, squid and crustaceans
*Blue Whale	*Balaenoptera musclus*	euphausiids
Minke Whale	*B. acutorostrata*	euphausiids and small fish
Bryde's Whale	*B. edeni*	euphausiids and small fish
*West Indian (Florida) Manatee	*Trichechus manatus*	aquatic vegetation

* Endangered species according to the Federal Register, 1975.

Source: Lowery, 1974 and Department of Commerce, NOAA, 1976.

The majority of the population now survive in the coastal waterways of Florida. The main enemy of the Florida manatee is man's activities. Many animals are lost each year as a result of increased use of waterways by commercial ships and pleasure boats. Their slow rate of reproduction, one calf per adult female every three years, also handicaps the population. Those that survive are often left with scarred backs from wounds inflicted by the propellers on boats.

Further work is being conducted regarding population densities and habitat of manatees at the University of Miami, and F&WS in Gainesville, Fla.

7. Marine Turtles

Five species of marine turtles occur in the Gulf of Mexico: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), Atlantic ridley (*Lepidochelys kempii*), hawksbill (*Eretmochelys imbricata*), and Leatherback (*Dermochelys coriacea*). Of these five species, the loggerhead and the green were recently designated as "endangered" (November 1976) by the Convention on International Trade in Endangered Species of Wild Fauna and Flora; the Atlantic ridley, hawksbill, and leatherback were already on this list. In addition, the loggerhead and green turtles have been proposed for "threatened" status by the F&WS and NMFS, while the Atlantic ridley, hawksbill, and leatherback are listed as "endangered" by F&WS under the Endangered Species Act of 1973.

Loggerhead turtles nest on beaches in the Gulf of Mexico during summer months. Ogren (1976) observed this species in nesting activity on Errol and Chandeleur Islands. He also reported nesting observed by others on Cat, Ship, and Horn Islands. Nesting has also been observed on St. Joseph Peninsula and St. Vincent and St. George Islands in northwest Florida.

Green turtle nesting sites have been reported in the vicinity of Sanibel Island, Florida and along the mid-eastern Atlantic coast of Florida.

The Atlantic ridley is truly an endangered species. The number of nesting females has declined from over 40,000 in the 1940's to about 400-500 in 1976. Any unnatural mortality of the surviving reproductive unit should be avoided. Although they nest in abundance only in Tamaulipas, Mexico, it is apparent that the northern Gulf of Mexico coastal area (i.e. the shrimping grounds) is a primary forage area for this species which can be considered a "Gulf of Mexico" sea turtle.

Although a tropical nesting species, the leatherback ranges widely throughout the Gulf of Mexico and western north Atlantic as far north as Nova Scotia. Leatherback turtle nesting sites have been reported in the vicinity of Santa Rosa Island, Destin, and Apalachicola, Florida. Many observations have been made of large numbers of leatherbacks feeding on jellyfish in inshore waters during the summer season (Ogren, 1976).

8. Other Wildlife

Other wildlife species (fishes, reptiles, amphibians, and mammals) inhabit the eastern Gulf of Mexico region. The following discussion will be limited to a few representative species which inhabit the coastal counties located within the region of this proposal.

The endangered okaloosa darter (*Etheostoma okaloosae*) inhabits five small streams which originate on Eglin Air Force Base and empty into the northwest corner of Choctawhatchee Bay, Okaloosa County, Florida.

The American alligator (*Alligator mississippiensis*) inhabits most of the fresh and brackish water marshes and swamps of the Gulf of Mexico. It depends upon well established marsh habitat for its supply of food (mostly fishes, reptiles, and small mammals) and for successful nesting. The endangered species status of the alligator has been changed to threatened status in all of Florida and in certain coastal areas of Georgia, Louisiana, South Carolina, and Texas. The alligator remains classified as endangered throughout the remainder of its range (except for Cameron, Vermilion, and Calcasieu Parishes in Louisiana (Federal Register, 1977a).

The endangered American crocodile (*Crocodylus acutus*) inhabits the coastal marsh areas of south Florida. A critical habitat established for the crocodile includes portions of the Everglades National Park and keys in Biscayne and Florida Bays. Its food and nesting habits are similar to those of the alligator.

The Fish and Wildlife Service has proposed endangered status and critical habitat designation for the Florida population of the pine barrens treefrog (*Hyla andersonii*) (Federal Register, 1977e). This treefrog inhabits an upland site in Okaloosa County, Florida.

Sightings of the endangered Florida panther (*Felis concolor coryi*) have been reported for eight Gulf coastal counties in Florida (see Visual No.

3). Most confirmed records are limited to upland areas of the state.

The endangered key deer (*Odocoileus virginianus clavium*) inhabit the area of Little Pine to Cudjoe Keys in Monroe County, Florida. The deer have a very small range and population.

9. Biologically Sensitive Areas

There are two types of areas in the eastern Gulf OCS that are considered particularly sensitive from a biological point of view. These are the Florida Middle Ground reefs and live (or hard) bottom areas (see Visual No. 4).

a. The Florida Middle Grounds represent the northernmost extent of coral reefs and their associated assemblages in the eastern Gulf of Mexico (Bright and Jaap, 1976). The Middle Grounds are, like the Flower Garden Banks off Texas, typical Carribbean reefal communities, although somewhat depauperate in terms of number of species present, probably because they are considered to be at the northern limit of viable existence for these types of coral communities (Bright, 1975; Hopkins, et al, 1977). Coral reef communities are exceedingly complex and have been treated at length elsewhere (for an entry into the literature, see Bright and Jaap, 1976). Suffice it to say here that in general, hermatypic (reef building) coral require temperatures of 18° to 30° C with the optimum at about 26° C; salinities from 36 ppt to 40 ppt (ppt = parts per thousand) with the optimum at about 36 ppt; little pollution; and adequate light (i.e., little turbidity). In the Carribbean they may grow as deep as 80m while in the Gulf they seem to be limited to a depth of about 40m Bright and Jaap, 1976). The Florida Middle Grounds are located at 28°35′N, 84°29′W, about 137 km southwest of Apalachicola Florida. The reefs rise essentially from a depth of 35m, and the shallowest portions are about 25m deep. It should be noted that the reefs have not been extensively mapped, but BLM has plans to obtain precision mapping of the area during 1978. Fortunately, none of the tracts being considered in this proposal are very close to the Middle Grounds; the nearest tract is some 72 km to the east of the reefs.

b. Live bottom areas, sometimes also referred to as "hard bottoms", are defined as those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occuring hard or rocky formations with rough, broken, or smooth topography; or whose lithotope favors the accumulation of turtles and fishes. These areas are sparsely distributed on the West Florida Shelf in depth of 10m to 60m over a wide area (Bright and Jaap, 1976). While again there are no highly precise maps of these areas currently available, apparently live bottoms are typically hard, rocky outcrops rising out of the surrounding sandy bottom to a height of one or two meters. The hard substrate provides a habitat for a large number of invertebrates, including corals, sponges, molluscs, and crabs, as well as leafy and encrusting algae. The flora and fauna in turn attract other animals, including fish, which feed and use the outcrop for shelter. Thus, the live bottom and the associated organisms, including the predator species, constitute a highly dynamic, diverse, and productive mini-ecosystem.

10. Mangroves

Three species of mangrove trees, red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*) occur in this region. Buttonwood (*Conocarpus erecta*), although not a true mangrove, is important in the transition zone between the swamp and upland vegetation (Davis, 1940).

The different species of mangrove trees sometimes grow in randomly mixed associations, but usually different species dominate certain bands or zones which are clearly delimited from the others. This characteristic zonation pattern results from differences in rooting and growth of seedlings and from various competitive advantages which each species has in the several gradients present from below the low water to above the high water lines.

Red mangrove seedlings sprout in marl soil below the low tide level and these form the most seaward band. This species may be easily recognized by its arching prop roots and by the long slender seeds which germinate before dropping from the tree. Prop roots are the most important attachment surfaces for sessile organisms in the intertidal region. On slightly higher intertidal peat soil is the red mangrove zone; the prop roots of these trees are inundated by almost every high tide. The zone inland is composed of black mangrove trees growing on flat areas flooded by the higher tides. Black mangrove has characteristic pneumatophores. Large numbers of these slender appendages grow up from the main roots until they emerge from the mud. Still further inland, buttonwood swamps and blackrush marshes form the transition band between the mangroves and either the tropical forest trees or the sawgrass (*Mariscus jamaicensis*) plants that are unable to survive significant amounts of salt. White mangrove is found in all zones but usually not as the dominant species. It is often most abundant near the brackish marshes between the black mangrove and buttonwood zones.

The mangrove trees themselves are certainly the dominant producers in the swamps. Algae are also important, especially because their production may be much more quickly consumed by the mangrove fauna than the woody materials produced by the trees. In Florida, open shoal areas below mean low water are often covered by tropical species such as *Caulerpa*, *Acetabularia*, *Penicillus*, *Gracilaris*, *Halimeda*, *Sargassum*, and

Batophora. Above this region, on the intertidal muds one may find a thick growth of *Vaucheria* or *Cladophoropsis*. There is also a subterranean algal flora composed of unicellular and filamentous blue-green and green algae. The prop roots of the red mangrove have several zones of algae attached to them. In Puerto Rico, the permanently submerged portions of the roots often have rich growths of *Acanthophora*, *Spyridia*, *Hypnea*, *Laurencia*, *Wrangelia*, *Valonia*, and *Caulerpa;* the intertidal zone may be covered by species of *Murrayella*, *Centroceras*, *Polysiphonia*, *Enteromorpha*, and *Rhizoclonium;* finally, there may be species of *Catenella*, *Caloglossa*, and *Bostrychia* at the upper limit of high tide.

Many kinds of animals are found in mangrove swamps, in sharp contrast to the low diversity of plant species. The most important benthic marine animals are probably crustaceans and mollusks and most of these can be classified as either deposit or filter feeders. Fiddler crabs (*Uca* spp.) in Puerto Rico frequently are dominant in terms of biomass. The crabs on intertidal flats of mangrove islands in Florida bay include *Uca pugilator*, *U. speciosa*, *U. thayeri*, and *Eurytium limosum*. Other species, *Aratus pisonii*, *Sesarma curacaoense*, and *S. reticulatum* are abundant in mangroves above high water. Barnacles such as *Balanus eburneus* attach to roots and stems where they can filter their food from the water at high tide. Coon oysters (*Ostrea frons*), also important filter feeders, are abundant on mangrove roots in Florida. The weight of their shells may eventually cause the root to break off. The dead shells and undigested food of these barnacles and oysters contribute to the sediments of the swamp. Several kinds of snails (*Cerithium*, *Melogena*, *Cypraea*, and *Littorina angulifera*) feed on material deposited on the roots or on the mud surface. Some vertebrates of the Florida swamps include turtles, crocodiles, alligators, bears, wildcats, puma, and rats.

Other important consumers in Florida swamps are amphipods, isopods, the crab *Rhithropanopeus harrissii*, and fishes, especially *Cyprinodon variegatus*, *Mollinesia latipinna*, and *Floridichthys carpio*.

Birds are abundant, conspicuous, and probably important in mangrove swamps. Approximately half of the species utilize the swamp for nesting activities and the others feed there or congregate there in large communal roosts. The food resources of the birds are varied. Many (egrets, herons, ibis, ducks, kingfishes, crab hawks, stilts, and pelicans) feed on estuarine fishes and invertebrates; other (fly-catchers, woodpeckers, wrens, swallows, and warblers) feed on insects in the forest; and a few (doves and blackbirds) feed on seeds outside the swamps but return for roosting or nesting. The mangroves themselves and their fruits, however, do not supply nutriment directly and the food supply for birds, like that of the other animals, comes predominantly from marine life in the channels or on the mud flats. The dense nesting colonies in some areas may harm the trees physically, but the excreta is of some nutritive benefit.

Florida mangrove swamps also serve as nursery grounds for many animal species of economic importance-- menhaden, black mullet, spotted sea trout, snook, tarpon, red drum, mangrove snapper, pompano, and pink shrimp. Edible oysters growing on the bottoms of shallow bays or on the mangrove prop roots are also harvested in some places.

For a map of the distribution of mangroves in the area of this proposed sale, see Visual No. 3.

11. Salt Marsh

Salt marsh habitat has been mapped by Davis (1967) and is presented on Visual No. 3. As can be seen, the most extensive areas of salt marsh occur from Tarpon Springs to the Port St. Joe area.

According to Humm (1973), vegetation consists primarily of three grass species, one rush, and several species of forbs.

Salt marsh grass (*Spartina alterniflora*) comprises the most seaward of the vegetation zones where it endures the deepest and longest inundation by salt water. Black rush (*Juncus roemerianus*) inhabits the next zone inland and therefore occurs on slightly higher ground. This species forms almost pure stands to heights of six to seven feet and functions to slow down tidal penetration. The third zone inland is dominated by salt grasses (*Distichlis spicata* and *Spartina patens*). This zone is rarely inundated except during high tides.

Annual production of dry organic matter by marsh plants is very large, probably about 2000 g/m or roughly 20,000 lb/acre) (Odum, 1961; Teal, 1962). The production of a salt marsh is mostly decomposed by bacteria and the released inorganic nutrients recycled either in the marsh or in the sea. Some is preserved in the form of salt marsh peat or organic soil. As decomposition by bacteria takes place, some salt marsh organic matter is converted to detritus and a small portion of this is fed upon by small animals before decomposition is complete. This productivity is either dissipated into the marine environment or moves into a variety of food chains. Very few animals feed directly on the salt marsh grasses, but this does not diminish their importance to the ecosystem as a whole, in which they are extremely important.

It is important to note that these areas act as a buffer, storing the tidal waters along with the aperiodic storm waters, dispersing much of the energy before it can reach areas of human habitation. They also act as a catch basin for runoff and pollutants from the upland.

Salt marshes also support considerable populations of rails, sparrows, ducks, numerous shorebirds, and a few reptiles. The area also functions as a hatchery for fish and invertebrates which are essential to the maintenance of the higher vertebrates.

12. Seagrasses

Humm provides the most recent data on seagrasses of the eastern Gulf. The following narrative is presented verbatim because it best describes the situation applicable to this proposed sale area.

"The inner part of the great continental shelf along the Florida Gulf coast supports the most extensive seagrass beds of the continent of North America. A major stand of these seagrasses occurs from Tarpon Springs northward to Port St. Joe of the Florida panhandle in sub-region C of Earle (1969), an area in which the seagrass beds are essentially continuous for a distance of about 250 miles. The gentle slope of the inner shelf in this area is such that these seagrass beds are more than ten miles wide in many places, extending from the intertidal zone out to depths of six to eight meters or more" (Humm, 1973).

Three species make up about 99 percent of the biomass of these seagrass beds: *Thalassia testudinum*, *Syringodium filiforme*, and *Halodule wrightii*. The relative abundance of these three species is presumed to be in the order given above, based upon general observations of the beds and of the quantity of leaves washed ashore. Quantitative data are available from only a few small areas and are not adequate for interpolation to large areas.

A fourth species, *Halophila engelmanii*, occurs in the beds mixed with *Thalassia*, presumably in relatively small quantity. Here again, the presumption may be erroneous as no quantitative data are available. A fifth species, *Halophila baillonis*, is known only from deeper water north of Tampa Bay and apparently does not occur in the beds. It forms, presumably, small patches at depths of eight to thirty meters but apparently no one has studied it in the Gulf of Mexico.

A sixth species, *Ruppia maritima*, is present off river mouths, especially in beds of *Halodule wrightii*, but also mixed with *Thalassia*. It is not a true seagrass as its normal habitat is freshwater; however, it extends into the sea in places because it can tolerate considerable salinity.

The seagrass beds between Tarpon Springs and Port St. Joe are probably the most important community of the inner shelf in terms of basic productivity. Apparently they far exceed the basic productivity of phytoplankton in the area they occupy, perhaps several thousand square miles of inner shelf bottom. Their ecological importance, however, is not only their basic productivity; they also provide what may be an essential environment for many species of invertebrates and fishes, including some of economic value in both sport and commercial fisheries.

Humm (1973) also noted that seagrasses exhibited significant environmental functions in the eastern Gulf:

(a) They serve as a sediment trap and a stabilizer of bottom sediments from the waters edge to a depth of six to sixteen meters or more.

(b) They carry on basic productivity that in the eastern Gulf, may considerably exceed that of benthic algae or phytoplankton in the same area.

(c) They serve as a direct food source (fresh) for a few animals, including sea urchins, sea turtles, manatees, certain herbivorous fishes. Partially decomposed leaves in the form of detritus serve as a food for a wide variety of detritus-feeders, especially invertebrates but also some fishes.

(d) They serve as a place of refuge, and a source of food organisms as well, for juveniles of many species of seafood organisms including shrimp, crabs, bay scallops, and fishes.

(e) They provide a habitat for a certain assemblage of invertebrate species that burrow or grow attached to the leaves-organisms that may be uncommon or absent from habitats that lack seagrasses.

(f) They provide an important substrate for attachment of scores of species and a significant biomass of benthic algae that otherwise would be rare or absent in an area.

Specific concern was expressed by the State of Florida over the potential existence of extensive seagrass beds in tracts 89 through 93 in the Tarpon Springs Area. This area was surveyed by BLM personnel and a team of diving scientists from Florida State University and found to contain patchily distributed, sparse beds of *Halophila* mixed with the algae *Caulerpa* and *Udotea*. A complete report of this survey is presented in Appendix F.

13. Estuaries and Embayments

Lyons and Collard (1974) reported on the estuarine habitat for the eastern Gulf of Mexico. What follows is largely from their report.

The single category "estuary" contains much of the first four of Collard and D'Asaro (1973), i.e., "low salinity communities"; "oyster reef communities"; "oyster, mangrove, and hard substrate communities"; and "bays, channels, and sounds". The authors also recognized various subdivisions within most categories, based on salinity, temperature, vegetation, and substrate.

It is sufficient here to state that these areas, located along most of the eastern Gulf coast, are characterized by salinity gradients generally ranging from 0 to 34 ppt, with broad fluctuations caused by rainfall (or lack thereof), tides, and other factors. Temperature fluctuations are usually much greater than in other marine environments. Substrates may vary considerably, both within a single estuary and between estuaries. Nutrient values are generally higher than in other marine environments.

Of these factors, perhaps temperature and salinity fluctuation and high nutrient values are most characteristic in separating estuaries from other marine communities. However, substrate and vegetation are just as important in determining composition of communities. All factors are, to some degree, interrelated.

A remarkably high n umber of benthic invertebrates are adapted to exist under the rigorous conditions of east Gulf estuaries. Menzel (1971) noted some 500 estuarine species in the Alligator Harbor Florida area. More than 600 species occur in the Tampa Bay estuarine system (Taylor, 1971). Much of the Florida West Coast may be considered "ecotonal" between temperate and tropical zoogeographic provinces. Such areas, generally high in species diversity, result from occurrence of hardier types from each province. There is also a small Gulf endemic element. Broadly fluctuating salinities and, to a lesser extent, temperatures are characteristic of these habitats.

The low salinity communities include marshes, deltas, and mangrove swamps, each of which is characterized by low salinity and organically rich sediments. Mangrove communities are dominant in the south but entirely absent in the north, primarily due to low temperature intolerance. *Spartina-Juncus* marshes occur extensively in the north, but much less so in the far south. Both occur south of Cedar Key, but with mangroves increasingly dominant to the south.

The oyster reef-hard substrate community is the major sessile invertebrate community of eastern Gulf estuaries. It is based upon *Crassostrea virginica* throughout the region, but widely diverse temperatures and salinities dictate different species associations at different localities.

Bay, channels, and sounds, though still characterized by broadly fluctuating salinities and temperatures, tend to have overall mean values higher than that of the previously mentioned areas. These factors are still important in determining local species composition, but substrate, vegetation, and depth are also major factors.

Substrates may vary from muds and terrigenous sands and mixtures thereof in the north to vegetable debris and calcareous sands in the far south. Terrigenous sands are not important south of Cape Romano. Quartz sandshell mixtures dominate most of west Florida, but muds become important west of the Apalachee Bay area.

Pure or mixed stands of seagrasses occur in estuaries throughout the region. Species include *Thalassia*, *Syringodium*, *Halodule*, and *Ruppia*. Two species of *Halophila* are less common. Most of these grasses reach their greatest densities in estuaries, but in this area are generally limited to depths less than two meters because of poor light penetration. This leaves greater estuarine depths as non-vegetated substrate inhabited by species not tied to a "grassbed" existence.

Generally, estuaries are herein considered as coastal invaginations, often separated from the Gulf of Mexico by barrier islands. However, certain shallow areas of low wave energy display typical estuarine characteristics. These include extensive shorelines from Apalachee Bay to the Anclote Keys and, further south, the Ten Thousand Islands area from Cape Romano to Cape Sable. These seem to represent estuaries intergrading directly into shallow shelf communities.

14. Beaches and Barrier Islands

Beautiful white sandy beaches are often the resource most closely identified with Florida. Such beaches also occur along the Alabama coast. The following is a brief description of these beaches as well as the beaches of the many barrier islands found off the coast of the northeastern Gulf.

Barrier islands of this area are found from Cape Sable to Anclote Key and from Lighthouse Point westward. These beaches consist of fine white sand composed of white quartz and bleached shell fragments. Along the Gulf coast the continental shelf is considerably wider than on the Atlantic coast. The wider shelf results in flatter beach slopes.

A perspective of the general vegetative complexes of beaches has been provided by Davis (1967). Generally, the beaches of the Florida coastline consist primarily of coastal strand vegetation which is composed of various species of forbs, dune-grasses, and shrubs. Trees and shrubs dominate further inland. On better drained soils, stands of sand pine occur on the inland dune areas.

Wildlife use is dominated by shore and wading birds and small mammalian species. The islands of Florida also provide the primary habitat for nesting sites of the loggerhead turtle in the Gulf though the extent of use is unknown.

Many of the islands also provide essential habitat for shore and wading bird rookeries.

Collard and D'Asaro (1973) reported on the faunal components of high energy beaches. Organisms inhabiting these areas are adapted to survive the scouring force of wave action by burrowing into the sand. The beach flea *Emerita* and the bivalve *Donax* are able to bury themselves almost instantaneously which enables them to survive in the surf zone.

Away from the surf-swept sandy beaches a trough generally occurs where benthic animals are partially protected from wave action during normal tide and wave action. In this area representative species include the common whelk, *Busycon;* olive shell, *Oliva;* sand dollar, *Mellita;* and certain starfish, *Astropecten*. At the seaward edge of shallow troughs where sand bars are located, *Donax-Emerita* communities are prevalent. Seaward of this area as the water deepens, large cockles, *Dinocardium;* sand doll, *Encope;* sea pansy, *Renilla;* and the common starfish, *Luidia* are found.

15. Endangered and Threatened Species

The Fish and Wildlife Service has designated a critical habitat for several endangered species. The notice pertaining to critical habitat designation (Federal Register, 1975b) states that "critical habitat" for any endangered species could be the entire habitat or any portion thereof, if, and only if, any constituent element is necessary to the normal needs or survival of that species. The following vital needs are relevant in determining "critical habitat" for a given species:

(1) Space for normal growth, movements, or territorial behavior;

(2) Nutritional requirements, such as food, water minerals;

(3) Sites for breeding, reproduction, or rearing of offspring;

(4) Cover or shelter; or

(5) Other biological, physical, or behavioral requirements.

Pursuant to Section 7 of the Endangered Species Act of 1973, all Federal agencies must take such action as is necessary to insure that actions authorized, funded, or carried out by them do not result in the destruction or modification of this critical habitat area.

The Bureau of Land Management maintains frequent contact with F&WS and NMFS in meeting its responsibilities under Section 7 of the Endangered Species Act. Also resource reports are requested from F&WS and NMFS prior to the preparation of each environmental statement and liaison is maintained during the review process of each EIS, S.O. 2974 consultations, and preparation of environmental stipulations.

Several federally designated endangered species occur, either on a permanent or on a transitional basis, within the geographic area being assessed for this proposal. With many of these, no definitive range is identified, thus it is difficult to portray the species accurately for environmental assessment purposes.

Table II-12 lists the federally endangered and threatened species that occur in the eastern Gulf of Mexico region. In lieu of attempting to depict all of these on Visual No. 3, a brief description of the habitat and range of the species will follow:

Key deer: Distribution is limited to an area in the Florida Keys from Little Pine Key to Cudjoe Key, Monroe County, FL.

West Indian (Florida) manatee: The majority of the population now survive in isolated pockets in Florida. Their primary food source is aquatic vegetation. The Fish and Wildlife Service has established critical habitat areas for the Florida manatee (Federal Register, 1976).

Florida panther: The Florida panther is primarily restricted to Florida. Large, unmolested habitats that support abundant deer populations favor the panther.

Whales: The population status and migration patterns of these species in the Gulf of Mexico is unknown.

Mississippi sandhill crane: Distribution limited to Jackson County, Mississippi. The Fish and Wildlife Service has designated a 26,000 acre critical habitat for this crane (Federal Register, 1977b).

Southern bald eagle: The primary breeding population of eagles for this analysis area is located in Florida (Visual No. 3). Reduction of the bald eagle in Florida is mainly due to heavy use of pesticides and to development which has destroyed the longleaf pine which are used as nesting sites. The bald eagle is primarily riparian, associated with the coast or lake and river shores, and feeds on rodents, ducks, coots, rabbits, and fish.

Peregrine falcon: The occurrence of this species in the assessment area results mainly from migrating individuals. However, Florida serves as an important wintering habitat. The primary migration routes are located along the high energy beaches of the south Atlantic states.

Florida everglade kite: This subspecies of kite occurring in the United States is confined strictly to Florida. Kites require freshwater marshes with a distant horizon and low vegetative profiles. Almost permanent flooding of the marsh is needed to sustain an adequate food supply which is exclusively the freshwater Apple snail.

Brown pelican: This species nests in large colonies on sandy beaches and in trees and shrubs along the Florida Gulf Coast (Visual No. 3). They feed mainly on menhaden and other fish. Since the establishment of refuges, increased law enforcement, and the decreased use of DDT, this species appears to have a chance to increase its population.

Bachman's warbler: The species in this area is known only from observations (1950) in three localities in Alabama. However, its habitat of river swamp forests does not preclude it from occurring in other areas within the assessment region.

Red-cockaded woodpecker: The geographic distribution of this woodpecker is primarily coastal plain pinewoods in the southeastern United States. Presently, South Carolina, Georgia, and Florida are believed to have the highest populations. This species is associated exclusively with mature to overmature southern pines. Historically, longleaf pine has been the most utilized with loblolly, shortleaf, slash, and pond pine used with varying degrees of frequency.

American Alligator: The alligator in this geographic region occurs all along the Gulf coast. It occurs primarily in the fresh water environment (rivers, swamps, marshes, etc.) from the coastal area inland. The alligator has been reclassified as a threatened species in all of Florida and in certain coastal areas of Georgia, Louisiana, South Carolina, and Texas (Federal Register, 1977a).

American crocodile: Occurs mainly in Southern Florida, in the fresh water environment from the coastal area inland. The Fish and Wildlife Service has established a critical habitat for the American crocodile in southern Florida (Federal Register, 1976).

Sea turtles: These species are inclusive of those listed in Table II-12 plus the loggerhead and green sea turtles which are currently proposed for a classification of ''threatened'' under the U.S. Fish and Wildlife Service criteria. The areas of concern in the analysis area are the high energy beaches occurring along the Gulf coast which the turtles utilize for nesting.

Red Hills salamander: Distribution limited to Alabama.

Pine barrens tree frog: A small population has been found in Okaloosa County, FL.

Bayou darter: Distribution limited to certain fresh-water streams in Mississippi.

TABLE II-12. Endangered and Threatened Species Occurring in the Eastern Gulf of Mexico Region

Common Name	Scientific Name
Key deer	*Odocoileus virginianus clavium*
West Indian (Florida) manatee	*Trichechus manatus*
Florida panther	*Felis concolor coryi*
Blue whale	*Balaenoptera musculus*
Finback whale	*Balaenoptera physalus*
Humpback whale	*Megaptera novaeangliae*
Right whale	*Eubalaena spp.* (all species)
Sei whale	*Balaenoptera borealis*
Sperm whale	*Physeter catodon*
Birds:	
Mississippi sandhill crane	*Grus canadensis pulla*
*Southern bald eagle	*Haliaeetus leucocephalus leucocephalus*
American peregrine falcon	*Falco peregrinus anatum*
Arctic peregrine falcon	*Falco peregrinus tundrius*
Florida everglade kite (snail kite)	*Rostrhamus sociabilis plumbeus*
*Brown pelican	*Pelecanus occidentalis*
Bachman's warbler (wood)	*Vermivora bachmanii*
*Red-cockaded woodpecker	*Dendrocopos borealis*
Reptiles:	
American alligator	*Alligator mississippiensis*
American crocodile	*Crocodylus acutus*

TABLE II-12 (continued)

Common Name	Scientific Name
Atlantic ridley turtle	*Lepidochelys kempii*
Hawksbill turtle	*Eretmochelys imbricata*
*Leatherback turtle	*Dermochelys coriacea*
†Red Hills salamander	*Phaeognathus hubrichti*
Fishes:	
†Bayou darter	*Etheostoma rubrum*
*Okaloosa darter	*Etheostoma okaloosae*
Watercress darter	*Etheostoma nuchale*
Clams:	
Alabama lamp pearly mussel	*Lampsilis virescens*
Fine-rayed pigtoe pearly mussel	*Fusconaia cuneolus*
Pale lilliput pearly mussel	*Toxalasma (-Carunculina) cylindrella*
Pink mucket pearly mussel	*Lampsilis orbiculata orbiculata*
Shiny pigtoe pearly mussel	*Fusconaia edgariana*
White warty-back pearly mussel	*Plethobasis cicatricosus*
Orange-footed pimpleback	*Plethobasis cooperianus*
Insects:	
†Bahama swallowtail butterfly	*Papilio andraemon bonhotei*
†Schaus swallowtail butterfly	*Papilio aristodemus ponceanus*

*Depicted on Visual No. 3
†Threatened species

Source: Federal Register, 1977c.

Okaloosa darter: Distribution of this species is limited to five small streams which originate on Eglin Air Force Base (northwestern Florida) and empty into the northwest corner of Choctawhatchee Bay, Okaloosa County, FL.

Watercress darter: Distribution limited to certain freshwater streams in Alabama.

Clams: These species of mussels are distributed in fresh-water streams of Alabama.

Bahama swallowtail butterfly: Distribution limited to a small area in southeast Florida.

Schaus swallowtail butterfly: Distribution limited to a small area in southeast Florida.

C. Social and Economic Environment of the Gulf of Mexico Area

1. Resource Utilization

a. GENERAL WATER/LAND USE

Coastal land use information for the states adjacent to the proposed sale area is variable in age, detail, and scale of treatment. Visual No. 6 presents a highly generalized compilation from currently available land use maps.

Current land uses in the coastal areas of the states adjacent to the proposed sale include virtually all possible mixes. Predominant land uses are urban uses, public area uses, wooded area uses, and wetlands. Coastal areas are often highly urbanized. Large urban concentrations have developed in the Tampa/Saint Petersburg area, Pensacola, Mobile, and virtually the entire Mississippi Gulf Coast.

In all three states in the coastal area of this proposed sale, the largest percent of undeveloped lands are used as timber or other woodland resources utilized by pulpwood and lumber industries. Developed uses are intense or moderate urban (residential, commercial, and industrial) and public and semi-public areas such as public beaches and parks, forests, preserves, and wildlife areas administered by all levels of government. ment.

In Section b, following, in-depth discussion of various forms of commercial and industrial uses are presented. These land and water uses which would be most closely associated with the possible oil and gas development consequent to proposed Sale 65 are commercial fishing, dredging, solid waste disposal, general petroleum development, and transportation. Other land and water uses presented in c., d., and e. of this section also interrelate with offshore oil and gas development activity and they are military uses, recreation, and historical/cultural values and uses.

b. COMMERCIAL/INDUSTRIAL USE

(1) COMMERCIAL FISHING

A representation of the Gulf fisheries is shown on Visual No. 5. Locations of royal red shrimp grounds, crabbing areas, oyster beds, and calico scallop beds are shown. Shell dredging areas are also identified. In addition, the NMFS statistical grid zones are delineated and each contains a pie-diagram depicting the mean percentage composition by weight of the major species caught during the time period 1968-1974. Also, the mean total weight of all the fisheries products caught in each zone are shown.

By far the most productive fishery region of the northern Gulf of Mexico in terms of pounds caught is the area off Atchafalaya Bay, Louisiana. The adjacent grid zones to the west are the next most productive areas in the northern Gulf. These 3 grid zones accounted for nearly 66% of all poundage caught in the northern Gulf during the 1968-1974 period. The total U.S. commercial lands for 1976 were 5.3 billion pounds (U.S. Department of Commerce, NOAA, 1977) valued at a record $1.4 billion to the fishermen. Landings in the Gulf waters of the U.S. accounted for 33% or 1.75 billion pounds and 29% or $389 million of the total U.S. landings.

The Gulf fishery is dominated by the shell fisheries: shrimp, crabs, and oysters (with smaller amounts of clam and scallops), usually worth three or four times more than the much greater volume of finfish. The shrimp fishery in the Gulf area includes brown (*Penaeus aztecus*), white (*P. setiferus*), and pink shrimp (*P. duorarum*). These are taken almost exclusively by trawl fishing, in depths ranging from 2 to 73 meters. Other shrimp taken commercially are the sea bobs (*Xiphopenaeus kroyeri*) and royal reds (*Hymenopenaeus robustus*).

Shrimp are the most valuable fishery off Alabama and Florida, whereas menhaden (*Brevoortia* spp.) are the most valuable off Mississippi. The Tortugas grounds off the southern tip of Florida is an extremely productive shrimping area, inhabited almost exclusively by pink shrimp. Moving up the coast, brown and white shrimp begin showing up in the catches in substantial numbers off the Big Bend area of Florida and replace the pink shrimp in dominance west of Pensacola. In the northeastern Gulf, rock shrimp (*Sicyonia* spp.) are becoming an important additional shrimp fishery.

Blue crabs (*Callinectes sapidus*) are the mainstay of the fishery in grid zone 6 (See Section II.B.4). Spiny lobster (*Panulirus*) is the most valuable fishery in the Florida Keys.

For most of Florida, the finfishery is mainly for food fishes, snapper, grouper, and mullets. Offshore Alabama and Mississippi the finfishery is primarily an industrial one, croakers (*Micropogon undulatus*) and menhaden respectively. The fishes are used in the production of animal feeds and oils and solubles.

Table II-13 is a summary of selected commercial information by states.

Gunter (1967) indicated that 97.5% of the total commercial fisheries catch of the Gulf states is made of estuarine dependent species, that is, fishes or shell fishes that spend all or part of their lives in estuaries. A few species, such as the commercial oyster *Crassostrea virginica*, may live their entire lives in estuarine waters.

On the Gulf coast as a whole, the usual ranking of the most important commercial finfishes is as shown below:

By weight:	By value:
Menhaden	Menhaden
Mullet	Red Snapper
Croaker	Mullet
Groupers	Croaker
Spanish Mackerel	Groupers
Spotted Seatrout	Pompano
Red Drum	Spanish Mackerel
Flounders	Red Drum
Black Drum	Flounders
King Whiting	King Mackerel
White Seatrout	Black Drum
Sheepshead	White Seatrout
	Sheepshead

(2) Dredging and Solid Waste

Dredging

The marine transport of huge tonnages of materials has led to the development of ports and navigable waterways that can accommodate deep draft vessels. The development and maintenance of these ports and waterways requires extensive dredging of large volumes of sediments each year. The principal responsibility for dredging operations is vested with the U.S. Army, Corps of Engineers. EPA, however, having responsibility for water quality, has designated a number of "Dredged Material Sites", the locations of which are contained in the Federal Register of January 11, 1977 (Vol. 42, No. 7, pages 2462-2490). These areas are all inshore in the vicinity of the Intracoastal Waterway or dredged channels and harbors. None of the tracts of this proposed sale are near these sites, and there will be no mutual interference.

Dredging entails the excavation of bottom material. The types of dredging devices fall into two classifications, hydraulic and mechanical. Mechanical dredges pick up material by various types of buckets. Hydraulic (or suction) dredges utilize a centrifugal pump which moves a slurry of water and material through a pipeline either into the hold of hoppers or to a distant discharge point.

The mechanical dredges, discharge either alongside the place of excavation, or into barges. This type of dredge is used extensively around breakwaters, docks, and piers in maintenance dredging. It is mostly applied to excavating soft and cohesive subaqueous materials such as silts and stiff muds.

The hydraulic dredges all have a suction line through which the excavated material is diluted with water and pumped to the disposal site either on shore, alongside the barge, or into the hold of the dredge. The hopper dredge is an example of this type and is suitable for all except very hard materials. This type is generally used for maintenance and improvement of harbors, rivers, and bays where near-by dumping grounds are not available. The cutter dredge is another example of the hydraulic type. This type is used in excavation and maintenance, and is used to dredge rock-like formations such as limestone without blasting and rock after blasting.

Each year dredging operations are carried out in major harbors and along the intracoastal waterways. The disposal of the dredged material varies from open ocean dumping sites, diked areas near shore, and onshore dumping sites. Following is a brief summary of some of the major dredging operations that occur along the Gulf coast.

Alabama and Mississippi

The U.S. Army Corps of Engineers, Mobile District has jurisdiction over both Alabama and Mississippi. There are two types of dredging operations along the coast: pipeline and hopper dredging. There are three areas that are maintained with a hopper dredge: Gulfport, Pascagoula, and Mobile. This material is disposed of in ocean dumping sites to the west.

Table II-13. Selected Commercial Information by States

A. Total Fulltime and Part-time Fishermen, 1974.

State	Number of fishermen
Florida (West Coast)	7,766
Alabama	1,766
Mississippi	1.925
Louisiana	11,380
Texas	6,587
Gulf total	25,489

B. Value of Processed Products by State, 1974.

State	Thousand dollars
Florida (West Coast)	94,532
Alabama	31,176
Mississippi	63,075
Louisiana	156,526
Texas	88,741
Gulf total	434,050

C. Processing and Wholesale Establishments, and Employment, 1974.

State	No. of Plants	Employment Average	
		Season	Year
Florida (West Coast)	265	4,030	3,468
Alabama	60	1,641	1,131
Mississippi	56	1,643	1,168
Louisiana	211	4,685	3,311
Texas	150	3,657	2,023
Gulf total	742	15,656	11,101

Source: US Department of Commerce, NOAA, 1977.

Pipeline dredging is also used to maintain ship channels as in the Mobile Bay area. The dredged material from this operation is mostly sandy silt and clay that is high in organic material. This material is disposed of alongside the operation into the open water. The major problems arising from this operation are mainly turbidity plumes, and the mud flow at the bottom.

Florida

Information for the western coast of Florida has been requested.

Solid Waste

Solid waste management is considered a state and local problem. The Federal government has no jurisdiction over disposal practices at other than Federal installations. It does provide grants for research and the development of new methods of collection and disposal and purchases recycled materials. It has, in the past, funded demonstration projects for new technologies and has tried to eliminate discriminatory interstate transportation rates.

Most states require regional or county management plans specifying conditions and future alternatives. Regions and counties are urged to cooperate so as to share the financial burden and maximize the use and efficiency of disposal facilities. The problems are most acute in population centers where density is high, waste volumes are large, and disposal sites are scarce.

Estimates of the amount of solid waste generated per person range from 3.3 lb/day to 6 lb/day (Snyder, 1974; US CEQ, 1974). The 3.3 lb/day figure includes wastes generated in households, commercial and business establishments, and institutions. Higher figures include those generated by industrial processes, agriculture, construction, demolition, and sewage wastes.

More than 90% of the solid wastes are directly disposed of on land, in open and burning dumps, or sanitary landfills. Other methods of disposal are incineration, use of materials to build such things as artificial reefs, and collection and recovery. Sanitary landfilling, the preferred method, involves the disposal of solid waste on land by spreading in thin layers, compacting to the smallest practical volume, and covering with soil. This method is employed by a majority of communities.

There are acute problems that have resulted from solid waste disposal. In landfill operations, ground waste pollution has resulted because of the high water table. This is caused by leaching material entering the ground water aquifer.

(3) Petroleum Development

Some further discussion of the petroleum industry of the states adjacent to the Gulf of Mexico is appropriate since crude petroleum and natural gas production developed as a result of exploration and production activity on the Outer Continental Shelf will probably be a source of raw material for initial processing within the coastal portions of these states.

The production of oil and gas may be classified as a primary industry; the further processing of oil and gas in refineries, natural gasoline plants, and petrochemical plants may be considered as secondary industries; and the increased development of tertiary industries may be expected to develop as a result of the economic activity undertaken by the primary and secondary industries.

The coastal region of the states bordering the Gulf, including both onshore and offshore areas, have been productive of oil and gas for many years. The production of these hydrocarbons has led to the extensive development of a system of production, transportation, refining, and other manufacturing facilities based on the availablity of crude and refined petroleum products in the region.

Oil and gas resources include substances classified as crude oil, condensate, natural gas, and natural gas liquids. Crude oil is a mixture of hydrocarbons that exists as a liquid in the natural underground reservoir and continues to exist as a liquid on the surface at atmospheric pressure. Condensate is a substance that exists as a gas in the natural underground reservoir and exists as a liquid under atmospheric conditions. Natural gas plant liquids are hydrocarbons extracted from streams of natural gas processed at plants. The American Petroleum Institute and American Gas Association statistical data include as crude oil small amounts of hydrocarbons recovered from oil well gas that exist as gases in the reservoir but become liquid at atmospheric pressure. All other liquids, including condensate, are reported as natural gas liquids.

(a) Historical Data of Gulf of Mexico OCS Operations

A tabulation of new well and completion activity on the Federal domain in the Gulf of Mexico was obtained from data published by U.S.G.S. (see Table II-14).

The number of acres held under active lease in the Gulf of Mexico has increased from 3.9 million acres in 1969 to 7.8 million acres as of March 23, 1977. Approximately 42 percent of this acreage was classified as included in producing leases, compared to 58 percent so classified in 1968.

The amounts of oil, condensate, and gas that have been produced from Federal leases in the Gulf of Mexico are published in Outer Continental Shelf Statistics, (USDI, GS, 1977a).

The amounts of oil and gas produced from these leases is tabulated on Table II-15.

The term "offshore" describes marine drilling and production activities on state, as well as Federal leases.

Offshore gas well footage drilled during recent years is summarized on Table II-16. During 1976, the most important region for development drilling of gas wells was offshore Louisiana, but exploratory drilling for gas in the offshore Texas area increased in 1976, compared to the year 1975, and exploration footage for gas off Texas has been higher than the gas exploration footage assigned for Louisiana during the past five years.

Crude Petroleum Production

During the year 1975, approximately 65 percent of the total U.S. production of crude petroleum occurred in the states of Alabama, Florida, Louisiana, Mississippi, and Texas. The quantities produced in the coastal area of Louisiana and Texas, as well as the total production from Alabama, Florida, and Mississippi, are shown in Table II-17. A significant fact revealed by these statistics is a decline in the production of crude oil and condensate in this region. Production of crude petroleum in three of the five areas in this region decreased between 1972 and 1975, reflecting the national trend. The increases recorded in the other two were not sufficient to offset the decline in the region.

Natural Gas

The Minerals Yearbook (USDI, Bureau of Mines, 1975) and other publications of the Department provides statistical detail concerning the source and use of natural gas.

Natural gas produced in the Gulf region was used to satisfy the demand for gas by individuals and organizations within the region and in other areas of the United States. During the year 1975, natural gas was also imported from Canada and Algeria. Some volumes of natural gas produced in other states were transported into the region during the year.

Approximately 96 percent of the natural gas withdrawn from the wells was marketed. The balance was used for repressuring and a small amount was vented to the atmosphere or flared. The marketed production of natural gas, augmented by volumes obtained from other areas, was delivered to interstate pipelines for transmission to other areas, consumed in the region, or added to storage. Some amounts of gas were lost in transmission.

Some of this gas was used for lease and plant fuel and pipeline fuel, but approximately 73 percent was delivered to consumers, including residential and commercial users, electric utilities, and industrial establishments. The industrial uses of the natural gas included fuel for refining operations, feedstock for the chemical industry, and as material for the manufacture of carbon black.

(b) Petroleum Refining and Petrochemicals in the Coastal Zone

On January 1, 1977, the crude oil capacity of the operating petroleum refineries in the United States amounted to 15,861,735 barrels per calendar day. An additional 255,155 BCD of refining capacity was located in Puerto Rico and the combined crude oil capacity in these operating refineries amounted to 16,116,890 barrels per calendar day. The total operating refinery capacity in the refining districts along the coast of the Gulf of Mexico on January 1, 1977 amounted to 6,010,023 BCD or approximately 37% of the total U.S. capacity (Table II-18).

Additional crude oil refining capacity amounting to 348,800 barrels per day was under construction in the coastal area of the Gulf of Mexico. This capacity amounts to approximately 58% of the capacity under construction in the United States (Table II-19).

Comments concerning the refining and petrochemical industries in the various states, pertaining to the existing industrial development, follow. Petroleum Refining Industry of Texas, Louisiana, Mississippi, and Alabama.

Table II-14. Gulf of Mexico OCS Drilling Activity

Year	Oil & Gas New Well Starts	Oil & Gas Well Operations	Zone Completions Producible Oil and Gas Zones Oil	Gas	Total
1968	931	410	524	166	690
1969	826	363	448	125	573
1970	827	535	611	266	877
1971	806	379	357	240	597
1972	839	335	303	180	483
1973	816	418	302	288	590
1974	808	305	221	155	376
1975	863	390	218	277	495
1976	1023	427	259	258	517

Source: USDI, GS, 1977a.

Table II-15. Oil and Condensate (000 barrels)

Year	Louisiana	Texas	Total
1968	263,825	3,111	266,936
1969	300,159	2,760	302,919
1970	333,411	2,247	335,658
1971	385,760	1,685	387,445
1972	387,591	1,733	389,324
1973	374,197	1,618	375,815
1974	342,435	1,382	343,817
1975	313,593	1,340	314,933
1976	301,887	1,054	302,941

Natural Gas MMCF

1968	1,413,468	109,911	1,523,379
1969	1,822,468	127,097	1,949,641
1970	2,273,147	133,300	2,406,447
1971	2,634,014	127,358	2,761,372
1972	2,881,365	147,156	3,028,521
1973	3,055,628	148,674	3,204,302
1974	3,349,171	159,979	3,509,150
1975	3,332,169	122,573	3,454,742
1976	3,499,866	92,582	3,592,448

Source: USDI, GS, 1977a.

Table II-16.

Offshore Exploratory Gas Well Footage
(Thousand feet)

	1972	1973	1974	1975	1976
Texas	77.7	150.9	89.8	70.5	83.1
Louisiana	60.6	18.2	16.2	94.9	29.6

Offshore Developmental Gas Well Footage
(Thousand feet)

	1972	1973	1974	1975	1976
Texas	51	34	77	42	41
Louisiana	1,467	2,314	1,552	1,771	2,123

Source: US Federal Power Commission, 1977.

Table II-17. Production, Producing Wells, Average Production Per Well

	1973	1975
Alabama		
Crude Petroleum Production 1/	11,677	13,477
No. Producing Oil Wells	586	608
Average Production Per Well 2/	56.6	62.1
Average Value Per Barrel	$3.58	$10.13
Florida		
Crude Petroleum Production	32,695	41,877
No. Producing Oil Wells	147	143
Average Production Per Well	619.9	822.4
Average Value Per Barrel	$4.59	$11.71
Louisiana (Gulf Coast area only)		
Crude Petroleum Production	791,760	613,502
No. Producing Oil Wells	13,086	12,535
Average Production Per Well	162.4	132.4
Average Value Per Barrel	$4.00	$ 7.10
Mississippi		
Crude Petroleum Production	56,102	46,614
No. Producing Oil Wells	2,901	2,237
Average Production Per Well	50.4	56.9
Average Value Per Barrel	$3.81	$ 6.66
Texas (Gulf Coast area only)		
Crude Petroleum Production	253,296	234,365
No. Producing Oil Wells	14,199	14,108
Average Production Per Well	46.6	45.3
Average Value Per Barrel	$4.11	$ 7.96
United States (Total)		
Crude Petroleum Production	3,360,903	3,056,779
No. Producing Oil Wells	497,378	500,333
Average Production Per Well	18.3	16.8
Average Value Per Barrel	$3.89	$ 7.56

1/ Thousands of barrels
2/ Average production per well per day (barrels)

Source: USDI, BOM, 1977b.

Table II-18. Crude Oil and Condensate Production for Texas and Louisiana Offshore Areas (thousands of barrels)

	1972	1976
Louisiana		
Offshore		
State	58,327	39,978
Federal	387,594	316,480
Total Offshore	445,921	346,076
Texas		
Offshore		
State	740	353
Federal	1,733	426
Total Offshore	2,473	779
Gulf of Mexico Offshore		
State	59,067	40,311
Federal	389,327	316,906
Total	448,394	357,217

Source: USDI, BOM, 1977b.

Table II-19. Additional Crude Oil Refining Capacity Under Construction on January 1, 1977

Operator	Location	Additional Crude Capacity Barrels per day
Texas Gulf Coast Refining District		
Texas City Refining	Texas City	46,000
Tipperary Corp.	Ingleside	5,000
Exxon	Baytown	250,000
Sub Total (Texas Gulf Coast)		301,000
Louisiana Gulf Coast Refining District		
Alabama		
Marion Corp.	Theodore	1,900
Louisiana Gulf Coast		
La Jet, Inc.	St. James	15,000
Tenneco Oil Co.	Chalmette	29,000
Sub Total (Louisiana Gulf Coast)		44,000
Sub Total (Louisiana Gulf Coast District)		45,900
Total Gulf of Mexico		348,800

Source: USDI, BOM, 1977a.

As of January 1, 1974, according to the annual refining survey published in the Oil and Gas Journal (Cantrell, 1974), there were twenty-four operating petroleum refineries in the Texas coastal region with a combined capacity of more than three million barrels per calendar day.

The Texas Gulf coast refining district is the largest domestic refining district, measured in crude oil throughput capacity, and has accounted for approximately twenty-three percent of the total operating crude oil throughput capacity of the United States (including Puerto Rico) (USDI, BOM, 1977a). The Louisiana Gulf coast refining capacity accounts for fourteen percent of the total U.S. refining capacity.

The raw material received at refineries in the Texas Gulf coast refining district includes crude oil from domestic and foreign sources, natural gas liquids, and other hydrocarbons. The products produced by refineries include gasoline and other fuels, lubricating oils, wax, coke, asphalt, and feedstock for petrochemical plants.

Refineries in Texas receive crude oil from other states for processing, and some of the crude oil produced in Texas is shipped to other states for refining.

During the year 1975, a total of 1,053 million barrels of crude petroleum were received at refineries in the Texas Gulf Coast District. Approximately 753 million barrels were obtained from sources within the United States, and an additional 300 million barrels were obtained from foreign sources. This level of imports is approximately equal to 822 thousand barrels per day (USDI, BOM, 1977b). An additional 126 million barrels of imported crude was processed in refineries located in the Louisiana Gulf Coast District.

Since approximately eighty-seven percent of the operating crude oil refining capacity of Texas is located in the Texas Gulf Coast District, the following statement referring to the total Texas refining industry is applicable to the Gulf Coast area. The data was obtained from a paper prepared by the Texas Office of Information Services on January 2, 1974.

The importance of the petroleum refining industry to the Texas economy is partially demonstrated by the dollar value of sales, employment, and household income generated directly by its operations. In 1972, the industry's total sales f.o.b. ("free on board") the refinery were $7.7 billion. The industry employed approximately 33,700 workers and paid an estimated $481 million to Texas households in wages, salaries, and other payments. In addition, the petroleum refining industry provides input for production processes in many other industries--most notably the petrochemical industry. It is estimated that approximately seven percent or $577 million of the Texas refineries' production was used by the petrochemical industry in 1972. The total production of the petrochemical industry in Texas in 1972 was estimated at $5.8 billion f.o.b. the plant.

Petrochemical Industry of Texas

The importance of the chemical industry to Texas was evaluated by Ryan (1973). Chemical production is Texas' top-ranking industry as measured by value added by manufacture (the difference between the cost of raw materials and the value of products). In 1973, more than 61,000 workers were employed in chemical plants. The output value in 1970 totalled $4.8 billion. The most important group is industrial organic chemicals, the basic materials from which synthetic fibers and plastics, rubber, and lubricants, and hundreds of other products are made.

In addition to the onshore economic effects due to the refining of crude oil, additional economic activity would result from the further processing of fractions of the crude oil, natural gas, and petroleum liquids in petrochemical plants. The following description of the petrochemical industry of Texas was obtained from Whitehorn (1973).

The petrochemical industry in Texas is large, complex, and integrated. It exerts a strong influence on industrial activities and provides a tremendous economic impact upon the state's economy. Petrochemicals were defined by Whitehorn for his report as those chemicals derived from petroleum and/or natural gas, but excluding all fuel and energy products such as gasoline, fuel oil, natural gas for fuel, kerosene, lubricating oils, as well as asphalt, wax, and coke.

A 1972 survey, cited by Whitehorn, identified eighty-two firms operating 139 petrochemical manufacturing plants in Texas. While there were plants located in every part of the state, more than sixty-seven percent by number and eighty-eight percent by capacity were located in the coastal zone.

By volume, the Texas Gulf Coast has the greatest United States concentration of chemical plants, producing more than forty percent of every basic petrochemical, eighty percent of the synthetic rubber, and sixty percent of the nation's sulfur. By conservative estimates, the total production of petrochemicals in Texas in 1971 was between 75 and 85 billion pounds. Ethylene is produced in greatest quantity, with propylene and benzene next. Texas' petrochemical industry began during the 1920's. The 1950's and early 1960's marked the industry's greatest growth, ranging annually from ten to nearly twenty percent. Although it dipped in the late 1960's, the growth rate for the next few years appears to be good with estimates between seven and eight percent annually (Whitehorn, 1973).

Table II-20 presents a ranking of factors given by industry leaders as deterrents to the growth of petrochemical firms or plants within Texas or in portions of the state.

These ten factors are selected as the principal deterrents to growth. Other factors mentioned by Whitehorn include inadequate fresh water supply, urban population growth, construction costs, and depressed sulfur market.

Representatives from sixty-eight petrochemical firms also ranked those economic factors which could change the future level of activity in their operations. Table II-21 presents the economic factors ranked in order of importance.

A similar ranking of technological factors that could change the future level of petrochemical activity in Texas include new and improved processes, new or improved product development, environmental control technology, and the development of alternative fuel (energy) sources.

Late in the year 1972, a survey revealed that 622 petrochemical plants were operating within the United States. Of this total number of plants, approximately twenty-two percent were located in Texas. More than two-thirds of the plants representing almost ninety percent of the producing capacity were located in the coastal zone of Texas. In this zone, during the period 1950-59, twenty-one plants commenced operations; during the period 1960-69, seventeen plants went on stream.

The most important reason cited for the growth of the petrochemical industry in Texas is nearness to raw materials. Other factors influencing the development of this industry have included the availability of an existing facility; the availability of transportation, labor and land; and nearness to markets.

Petroleum-Related Industries in Louisiana

The following description of some of the important industries in the Louisiana coastal zone was published by the Louisiana Advisory Commission on Coastal and Marine Resources (LACCMR, 1973). The following description of the more important industries in the coastal zone parishes by the Louisiana Department of Commerce and Industry was presented in a report to the Commission in February, 1972.

Industry in the coastal region is dominated by petroleum refining, petrochemical production, ship and boat building, food processing, and primary metals. Apparel making, metal fabrication, and pulp and paper making are also important industries. Petroleum refining and petrochemicals are by far the largest. More than $5 billion has been invested in these industries in the coastal region since World War II and most of the 32,000 plus workers employed in these industries work in the coastal parishes. There are approximately 100 major petroleum and petrochemical plants in Louisiana making the state one of the principal producers in the United States. A number of the facilities are among the largest of their kind in the world. Over the last ten years Louisiana has attracted about ten percent of all new investment in chemical and petroleum refining expenditures in this country.

Ship and boat building continue to be a mainstay in the state's industrial economy. A shipyard is the single largest employer in Louisiana, with a work force ranging upward to ten thousand at times. The Avondale yards and other smaller yards specialize in supplying the needs of the offshore oil and gas industry with drilling platforms, tugs, barges, crewboats, and other specialized vessels that are constructed in Louisiana. Boats for commercial fishing and pleasure use are built in small yards scattered across the coastal region.

Baton Rouge, the capital of Louisiana, is a major center of petroleum and chemical industries. It is situated on the Mississippi River two hundred miles from the Gulf of Mexico at the head of navigation for ocean-going vessels. The total value of industrial investment along the banks of the Mississippi River in Water Resource Plannning Area 8 (10 Louisiana parishes and 1 Mississippi county) since 1946, has been $1.9 billion ($0.6 billion between 1946 and 1960, and $1.3 billion between 1961 and 1971). In 1967, East

Table II-20. Deterrents to Growth in Texas

Factors	Rank
Shortage of feedstocks	1
Remoteness from main market area	2
Energy (fuel) availability and cost	3
High state and local taxas and inequity in taxes	4
Transportation costs including high rail rates	5
Raw material costs	6
Saturation of some type of processing plants	7
Labor costs	8
Pollution abatement laws too stringent	9
Land transportation to markets	10

Source; Whitehorn, 1973

Table II-21. Economic Factors Which May Change the Future Level of Petrochemical Activity in Texas

Factors	Rank
Availability and cost of feedstocks	1
Availability and cost of energy sources	2
Product demand and prices	3
Labor costs	4
Foreign imports and competition	5
Government regulations (safety, environment, price, etc.)	6
Transportation costs	7
Tax levels	8
Environmental costs	9
Product distribution costs	10

Source: Whitehorn, 1973

Baton Rouge Parish accounted for eighty-one percent of the area's $564.1 million value added by manufacturing. Petroleum refineries, the industrial base of the city, are supplied by nearby oil fields in south Louisiana. Many plants in the city either supply refinery needs, further process refinery products, or are engaged in related work.

Water Resources Planning Area 9 includes a fourteen parish area extending from the border with Texas to the basin of the Atchafalaya River, bordering the Gulf of Mexico. WRPA 9 is rich in oil, natural gas, salt, sulfur, sand and gravel, and clays. The development of oil and natural gas resources has contributed more than any other factor to the progress of the area and to the rapid strides made in the raising of living standards and industrial growth. Oil and gas fields are located throughout the area as well as offshore in the Gulf of Mexico. Salt deposits are located on the eastern and western borders, and sulfur is mined in Calcasieu Parish.

Sand and gravel are produced in nine parishes, and clays are mined in two. The total value of mineral production in WRPA 9 in 1969, was $1.57 billion, or thirty-three percent of the Louisiana total of $4.7 billion.

A combination of varied natural resources, water access, geographical location, and road and rail connections has made WRPA 9 an attractive location for industrial firms. The extent and quality of these resources are attested to by some of the nation's major chemical producers having developed a multi-million dollar petrochemical complex around Lake Charles. Natural resources have also been of great importance to Lafayette, Louisiana, as it has become the area headquarters and service center for the oil and gas industry. Industrial growth has also been enhanced by the existence of the deepwater port of Lake Charles.

Water Resource Planning Area 10 includes the New Orleans Standard Metropolitan Statistical Area (Jefferson, Orleans, St. Bernard and St. Tammany parishes). Due to the presence of varied natural resources and its location on crossroads of internal and foreign commerce, WRPA 10 has experienced remarkable industrial development. A vast complex of petrochemical plants has been developed in recent years along the Mississippi River. Other industries have grown up around such native resources as sulfur, salt and sugar. Imported products such as bauxite, gypsum, and coffee have also contributed to industrial development.

The 1977 Worldwide Petrochemical Directory contains a listing of petrochemical facilities under construction. Of the 45 plants under construction in the states adjacent to the Gulf of Mexico, 29 were proposed for Texas, 13 for Louisiana, 2 for Alabama, and 1 for Mississippi (Petroleum Publishing Company, 1976).

Transportation Systems

During 1975, refineries in the Gulf Coast region received crude oil from producing wells in the same state as the refinery location, from producing wells in other states, and imported crude oil from foreign nations (Table II-22).

(4) Transportation

(a) General

The Gulf Coastal Zone is served by all forms of transportation. An extensive network of highways and rail lines connect all major ports with inland areas. Transportation throughout the coastal counties is primarily via roads and highways. Because of their geographic location, the coastal counties are also served extensively by waterborne transportation systems. See Visual No. 7 for a generalized portrayal of airports, ports, the Intracoastal Waterway, and major highways and railroads.

(b) Mississippi

The principal reference for the following text is the draft Interim Report on Permissible Land and Water Uses in the Mississippi Coastal Zone (Mississippi Marine Resources Council, 1977).

Highway Transportation

Highways form the backbone of the transportation system serving the land areas within the coastal zone. Mississippi has 17,561.6 km of highways, with 2,798.6 km within the coastal zone (Mississippi State University, 1974). The Mississippi Gulf Coast is principally served by U.S. Highway 190 and Interstate Highway 10, both of which parallel the coastline in an east-west direction.

Rail Transportation

The Mississippi coastal area is served by three railroads: the Louisville and Nashville, Illinois Central Gulf, and the Mississippi Export. The state contains a total of 5,867.2 kilometers of railroad track. The Louisville and Nashville generally follows the coastline connecting the coastal communities with New Orleans and Mobile and all connecting points. The Illinois Central Gulf is

Table II-22. Transportation of Crude Oil in 1975
(all figures shown are in thousands of barrels)

Area	Pipelines	Tank Cars & Trucks	Tankers & Barges
Alabama			
Domestic crude	10,835	741	1,120
Foreign crude	---	---	671
Louisiana			
Domestic crude	368,189	6,451	88,281
Foreign crude	---	---	89,159
Mississippi			
Domestic crude	58,143	1,746	---
Foreign crude	---	---	38,600
Texas			
Domestic crude	807,292	15,285	81,235
Foreign crude	5,258	---	303,361
Totals	1,249,717	24,223	602,427

Source: USDI, BOM, 1977b.

located in Harrison County (Gulfport) and extends northward to the Hattiesburg, Jackson areas. The Mississippi Export serves the Jackson County areas connecting Pascagoula and Moss Point with Lucedale in Stove County and interconnecting with the Gulf Mobile and Ohio Railroad near Lucedale (Mississippi Marine Resources Council, 1977).

Air Transportation

Three types of airport facilities occur in coastal Mississippi: air carrier facilities, general aviation facilities, and military installations. Air carrier airports are located to serve large concentrations of populations and/or commerce. The only air carrier airport in coastal Mississippi is located at Gulfport.

General aviation airports may and frequently do serve smaller population centers or industrial or recreational areas. General aviation airports in coastal Mississippi include Stennis International Airport, Diamondhead Airport in Hancock County, the Gulf Park facility east of Ocean Springs, and the Jackson County Airport. The only major military installation is Keesler Air Force Base (Mississippi Marine Resources Council, 1977).

Pipeline Transportation

There are currently no pipelines moving offshore crude oil or gas into Mississippi (University of Southern Mississippi, Department of Geography and Area Development, 1976).

Port Facilities and Water Transportation

In 1973, the ports of Pascagoula, Biloxi, and Gulfport handled a total of 15,112,000 short tons of freight traffic. Of the total, 3,787,000 short tons were in foreign trade (USDI BLM, 1976).

The major navigation channel in coastal Mississippi is the Gulf Intracoastal Waterway which provides a protected channel 12 feet deep and 150 feet wide. The waterway links all ports along the Mississippi Gulf Coast with inland waterway systems emptying into the Gulf of Mexico. Other major waterways include the Pascagoula River, Wolf River, Jourdan River, East Pearl River, Pearl River, and the Bayou Portage Channel (Mississippi Marine Resources Council, 1977).

Principal Mississippi Gulf Coast ports are Pascagoula Harbor and Gulfport. Descriptions of these ports were taken from a publication by the U.S. Department of the Army (USD Army, COE, 1973a).

Pascagoula Harbor

Pascagoula Harbor has an authorized 40′ x 350′ entrance channel about two miles long from the Gulf of Mexico through Horn Island Pass, a 38' x 350' channel through Mississippi Sound and about two miles up the Pascagoula River, and a branch channel 38' x 225' from the ship channel in Mississippi Sound to Bayou Casotte and the Bayou Casotte Channel and turning basin.

Gulfport Harbor

Gulfport Harbor has an authorized channel from the Gulf of Mexico across Ship Island Bar 32 feet deep, 300 feet wide and about 8 miles long; a 30' x 220' channel through Mississippi Sound, an anchorage basin at Gulfport 30 feet deep, 1,320 feet wide, and 2,640 feet long. Maintenance of an existing small boat harbor and channel is also authorized.

(c) Alabama

The principal reference for the following text is the ''South Alabama Regional Transportation System'' (South Alabama Regional Planning Commission, 1972).

Highway Transportation

Coastal Alabama is served by six U.S. highways, two Interstate highways, and a secondary road system consisting of state and county roads. Major U.S. highway routes include U.S. 98, 45, 43, 31, and 90. Interstate highways 10 and 65 serve the area from east-west and north-south directions respectively.

Rail Transportation

Railroads serving coastal Alabama include the Gulf-Mobile and Ohio, the St. Louis-San Francisco, the Louisville and Nashville, and the Southern Railways. In Mobile County, railroad lines radiate from the Port of Mobile and from the major industrial centers. The Alabama State Docks Terminal Railway connects these railroads to portside tracks and other marine terminal facilities and industrial locations near Alabama State Docks property.

Air Transportation

Commercial air transportation in coastal Alabama is available at municipally owned Bates Field. Three airlines serve the region. Additionally, there are 15 public airfields, three private airfields, and seven military airfields in Baldwin and Mobile Counties.

PIPELINE TRANSPORTATION

There are currently no pipelines moving offshore crude oil or gas into Alabama.

PORT FACILITIES AND WATER TRANSPORTATION

Alabama's only coastal port is the Port of Mobile. Mobile is served by a 42' x 600' channel about 1 1/2 miles long across Mobile bar, a main channel with minimum dimensions of 40' x 400' extending about 35 miles from the Gulf of Mexico through the bay into the lower reaches of Mobile River and several branch channels and basins (US Department of the Army, COE, 1973a).

The Mobile-Tombigbee-Black Warrior River system, which accommodates barge traffic, extends northward from the Port of Mobile to Port Birmingham. The Gulf-Intracoastal Waterway traverses the southern extremity of the state in an east-west direction.

(D) FLORIDA

Principal references for the following text are the Florida Statistical Abstract, 1975 (University of Florida), the Department of the Army Report on Gulf Coast Deep Water Port Facilities (1973), and Florida 10 Million (Florida Department of Natural Resources, Division of State Planning, 1973).

HIGHWAY TRANSPORTATION

The state of Florida has an extensive highway network, most of which is located within coastal counties. In all, Florida has approximately 155,742 km of urban and rural roads and highways. As is the case in most areas, highway traffic densities are higher in urban areas as opposed to rural areas. Only about 20% of Florida's current highway system is considered adequate for present and anticipated traffic volumes.

RAIL TRANSPORTATION

Florida is served by an extensive railway network containing approximately 6667.5 km of track miles utilized by 8 railroad companies and three terminal companies.

In 1971, Florida's rail network hauled 92 million tons of revenue freight and carried 215,000 passengers.

AIR TRANSPORTATION

There are sixteen general service airports in Florida, including two Air Force bases. Together, 13,082,110 passengers enplaned at these airports in 1974. At least five of the state's major airports are operating at levels where demand exceeds capacity.

PIPELINE TRANSPORTATION

There are currently no pipelines moving offshore crude oil or gas into Florida.

PORT FACILITIES AND WATER TRANSPORTATION

Major Florida Gulf Coast ports, in fiscal year 1973-74, handled a total of 45,985,871 short tons. Gulf ports in 1973 exported 26,064 million pounds and imported 14,728 million pounds.

The major coastal navigation channel on the Florida Gulf Coast is the Gulf Intracoastal Waterway which links all ports on the state's west coast with Gulf coastal ports of Alabama, Mississippi, Louisiana, and Texas, as well as the Atlantic Ocean via a cross-state navigation channel.

Principal Florida Gulf ports include Tampa Harbor, Port St. Joe, Panama City, and Pensacola.

TAMPA HARBOR

Tampa harbor is served by an authorized channel from the Gulf to Port Tampa and Tampa, 36 feet deep and 600 feet wide on Egmont Bar, 34 feet deep and 500 feet wide in Mullet Key Cut, 34 feet deep and 400 feet wide in Tampa and Hillsborough Bays and in Port Tampa, Sparkman, and Ybor Channels, and 30 feet deep and 300 feet wide in Seddon and Garrison Channels. Additionally, there are two 34-foot deep turning basins and several smaller channels. The channels total 67 miles in length. Enlargement of many Tampa channels is planned pursuant to the 1970 River and Harbor Act.

PORT ST. JOE

Port St. Joe has an entrance channel 37 feet deep by 500 feet wide for about 3 1/2 miles from the Gulf across the bar, a main channel 35 feet deep by 300 feet for 10 1/2 miles around St. Joseph Point and through St. Joseph Bay to Port St. Joe, and a turning basin and two branch channels.

PANAMA CITY

Panama City Harbor has an entrance channel from the Gulf across Lands End Peninsula to deep water in St. Andrew Bay, 34 feet deep by 150 feet wide in the Gulf, and 32 feet deep and 300 feet wide across Lands End and in the Bay, 700 foot protective jetties on the Gulf side of Lands End and a larger channel in Watson Bayou. Additional improvements are planned.

Pensacola Harbor

Pensacola Harbor has an authorized 35 by 500 foot entrance channel about 5 miles long from the Gulf to lower Pensacola Bay and a 33 by 300 foot channel from there to Pensacola. The entrance is actually dredged to 37 by 800 feet for the Navy Department to a 1,200 acre mooring basin 35 feet deep opposite the Naval Air Station to accommodate aircraft carriers.

c. Military Use

The Gulf of Mexico is used rather extensively by the U.S. Navy and Air Force for conducting military training, testing, and research activities. These current activities consist of missile testing, ordnance testing, drone recovery operations, pilot training, and electronic counter measure (ECM) activities by the Air Force. Mine research activities are conducted by the Department of Navy. Most of this activity takes place in areas designated for these purposes (Fig. II-16). However, live ordnance testing by the Air Force occasionally involves emergency release of ordnances outside designated bombing areas. This ordnance ranges from small munitions to 544 kilogram bombs. The occurrence of unexploded munitions on the ocean floor in the proposed sale area is a possibility in certain locations. The following tracts of this proposed sale are located within these military operating areas:

WARNING AREA W-151 De Soto Canyon Area Block Numbers: 436, 437, 480, 481 Florida Middle Ground Area Block Numbers: 358, 359, 397, 398, 399, 400, 401, 402, 403, 404, 405, 441, 442, 443, 444, 445, 446, 447, 486, 487, 488, 489, 490, 491, 531, 532, 533, 534, 535 Destin Dome Area Block Numbers: 473, 474, 518, 519, 562, 563 WARNING AREA W-155 Pensacola Area Block Numbers: 926, 970 Destin Dome Area Block Numbers: 2, 3, 4, 313, 314, 357, 358 WARNING AREA W-168 The Elbow Area Block Numbers: 696, 697, 739, 783, 827, 871 Saint Petersburg Area Block Numbers: 661, 662, 705, 706, 753, 754, 797, 798 NG 16-6 Area Block Numbers: 258, 259, 302, 303, 609, 610, 611, 653, 654, 697 Charlotte Harbor Area Block Numbers: 143, 144, 145, 187, 188, 221, 231, 265, 266, 627, 628, 671, 672, 715, 716

The U.S. Navy has conducted no munitions dumping in water less than 914 m in depth since 1945. Additional information received from the Office of the Oceanographer of the Navy indicates other sites are located off the Atlantic and Pacific coasts and no sites are utilized in the Gulf of Mexico.

d. Recreation

The eastern Gulf of Mexico and associated shoreline area from the Pearl River delta in Mississippi to the Florida Keys is a continuous outdoor recreation environment where many recreational pursuits are focused on the waterfront. Visuals No. 1 and 4 depict the major state and nationally recognized public interest areas. Included are publicly owned areas like parks, beaches, and wildlife lands as well as specially designated sites such as national natural landmarks and historic register properties. Some specially designated sites are in private ownership and not always accessible to the public. The beach areas noted on the visuals were derived from the Corps of Engineers National Shoreline Study (U.S. Dept. of the Army, Corps of Engineers, 1973b) and include private as well as public beach areas. A general discussion of the different categories of areas found along the Gulf Coast which provide recreation opportunities are included in the following descriptions followed by a discussion of the major recreation activities taking place in the coastal waters and nearshore areas of the eastern Gulf of Mexico.

(1) Coastal Recreation Resources

The areas described below include the traditional managed resources perceived by the general public as recreation destination areas. All of the areas referred to are depicted on Visual No. 4.

National Parks

The National Park Service administers 5 diverse areas along the eastern Gulf of Mexico. Areas in the National Park System were set aside by the National Congress specifically to preserve recreational, natural, and cultural resources of national significance and to systematically devise management schemes which will maximize public appreciation without endangering the resources.

Included is Gulf Islands National Seashore, a developing recreational area composed of extensive islands in Mississippi and Florida. Annually well over a million people enjoy the park's natural and historic assets which are closely tied to the Gulf of Mexico and its shoreline. Everglades National Park and Big Cypress National Preserve are two immense natural areas at the southwest tip of

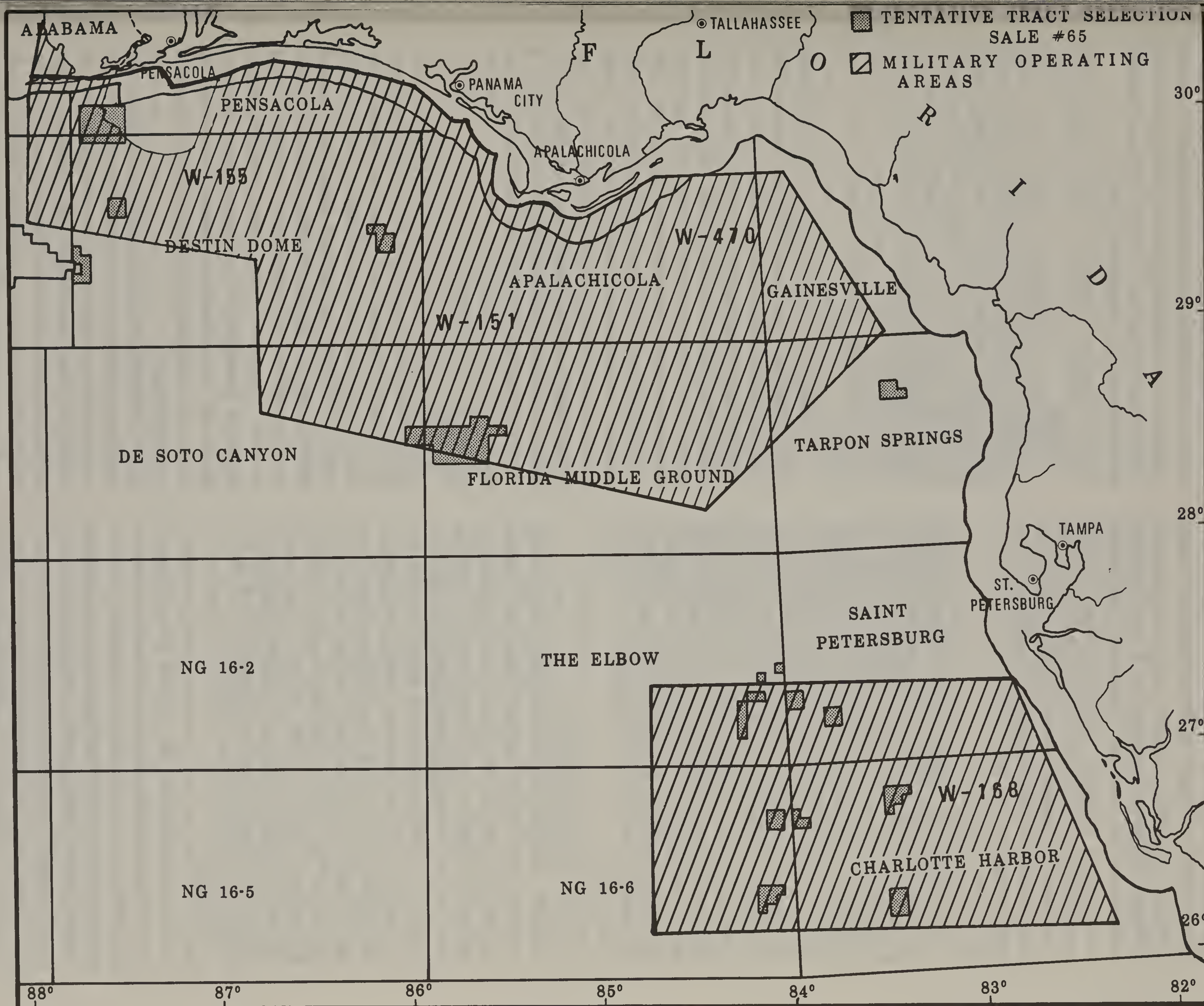


FIGURE II-16 MILITARY OPERATING AREAS-EASTERN GULF OF MEXICO the Florida Peninsula. The areas are most noted for subtropical fauna and flora which are closely tied to a complex water circulation system. DeSoto National Memorial is a small coastal historic site in southwest Florida and Fort Jefferson National Memorial, an isolated island fort almost 70 miles west of Key West in the Dry Tortugas islands, comprise the remaining units of the National Park System located around the eastern Gulf of Mexico.

NATIONAL FORESTS

Mississippi and Florida contain national forests in their coastal regions. All national forests present a forest based recreation environment managed by the U.S. Forest Service under the multiple use principle for wood, water, forage, wildlife, and recreation. The two national forests found in the eastern Gulf coastal region have specifically designated recreation sites accommodating the recreation needs of campers and picnickers; however, the greatest public use stems from dispersed recreation use throughout the forest environment. Opportunities for hunting, camping, freshwater fishing, hiking, and sightseeing attract most visitors to national forests in the coastal zone.

NATIONAL WILDLIFE REFUGES

Fifteen national wildlife refuges are located along the coast of the eastern Gulf. Most tend to be oriented towards the protection of waterfowl, endangered species, and other wetland wildlife; however, all encourage public visitation and accommodate those recreational activities that are compatible with the primary wildlife mission of the refuges. A few of the refuges like Chassahowitzka allow waterfowl hunting but all encourage nature study, photography, and wildlife observation. Many of the Florida west coast refuges are noted for isolated beaches. The Jay N. "Ding" Darling Refuge on Sanibel Island is nationally renowned for shell collecting.

STATE PARKS

As noted on Visual No. 4, over 30 state parks are strung out along the eastern Gulf coastal region with most of them located in the State of Florida. These recreational areas vary in size and function, from multi-activity recreational areas to sites managed specifically for historical appreciation. Similar to the National Park System, some states have established classifications for their state parks which distinguish between recreational areas, historical areas, preservation or natural areas, and demonstration areas. Many of the state parks found along the eastern Gulf focus primary attention on their Gulf shorefronts.

STATE WILDLIFE REFUGES AND MANAGEMENT AREAS

Although management goals may differ somewhat from state to state, these areas serve primarily to maintain habitat and breeding space for wildlife, and to provide wildlife-oriented recreation under closely controlled conditions. There are 16 such areas in the coastal area of the eastern Gulf.

LOCAL OUTDOOR RECREATION AREAS AND FACILITIES

In addition to Federal and State recreation areas, there are numerous City and County park and recreation areas in the coastal zone. These facilities are generally found in and around the major population centers where the demand is greatest. In addition, numerous private and commercial recreational facilities exist along the eastern Gulf Coast. The list could include resorts, marinas, tennis clubs, amusement and theme parks, water access sites, and many others. Due to the large number, small size, and difficulty in obtaining comparable data for the entire area, a complete mapping or listing of these facilities and areas was not attempted.

SPECIALLY DESIGNATED AREAS

This subsection was included to briefly describe those classification systems which designate certain natural resources of state and national significance. Such areas are usually so identified in order to proclaim the value of their innate natural qualities and to foster the preservation of these same qualities for educational, aesthetic, and scientific purposes. These same areas either by design or happenstance accommodate a selected range of recreational activities. The different classes of areas described below are also depicted on Visual No. 4.

The National Natural Landmark Program administered through the National Park Service has as its primary objective to encourage the preservation of sites illustrating the geological and ecological character of the United States. Publicly or privately owned, a Registered Natural Landmark is a selected portion of America's land and waters. Five registered natural landmarks occur in Florida's coastal zone and six additional areas are under consideration in Mississippi, Alabama, and Florida.

The National Wilderness System was established in 1964 to assure preservation of portions of our Federal resource lands in as near a pristine condition as possible. All or portions of six of the National Wildlife Refuges located on Florida's west coast have been included in the system (Cedar Key, Passage Key, Ding Darling, Key West, St. Marks, and Island Bay). Many of the wilderness refuges are small barrier islands. A small portion of the Apalachicola National Forest has been so designated and Petit Bois and Horn Islands, portions of Gulf Island National Seashore, are under consideration for wilderness designation.

The State of Florida as well as the Federal Government have established marine preserve systems. Florida owns many square miles of submerged tidal land which support biological, aesthetic, and natural features important ecologically and for outdoor recreation. To set aside certain exceptionally valuable and representative areas for perpetual public enjoyment and to preserve important natural systems, a statewide system of aquatic preserves was established in 1969. Sixteen aquatic preserves have been designated along Florida's west coast, most being located in lagoons behind the barrier islands which extend along the shoreline of the eastern Gulf. Rookery Bay, a state aquatic preserve, has been nominated for a Federally-supported marine preserve under state sponsorship. No national marine sanctuaries have been established in the eastern Gulf; however, interest in designating new marine sanctuaries has increased and it is likely that some of the unique areas in the eastern Gulf such as some coral reef areas may soon be nominated.

There are no nationally designated wild and scenic rivers in the coastal areas of the three states influenced by this proposed sale. The states have established or have under consideration state systems of river classification designed to recognize and protect the scenic and recreational qualities of many waterways. Twenty-three rivers in the coastal region of Florida have been designated canoe trails. All of Florida's canoe trails as well as special rivers in Mississippi and Alabama coastal regions are highlighted on Visual No. 4.

Many special areas under private control can also be found in the coastal region of the southeastern United States. Major ornamental gardens and Audubon Society Sanctuaries are also depicted on Visual No. 4.

Recreation Beaches and Barrier Islands

Wherever they are accessible for recreational use the sandy beaches and barrier islands along the edge of the eastern Gulf are of major recreational importance. As is apparent in Table II-23 and on Visual No. 4, almost two-thirds of the ocean/gulf shoreline bordering the eastern Gulf is composed of sandy beaches. With the exception of the Pascagoula area most of Mississippi's shorefront is composed of readily accessible shorefront beach area. The entire beachfront between Waveland and Biloxi is a popular recreation area for residents and tourist alike. Additionally, six islands in and around the Mississippi Sound have no road access but are popular recreation resources. Besides the three islands which are components of Gulf Islands National Seashore, Deer Island, Cat Island, and Round Island are recreation attractions of the Mississippi Sound.

Of Alabama's two coastal counties, Baldwin is noted for its beach frontage extending from Mobile Bay to Perdido Bay in Florida. Dauphin Island, a major barrier island accessible by causeway through Mobile County, is a primary destination area with major recreation activities focused on the island's beaches.

Florida's northwest coastline is continuous beachfront and barrier islands from the Alabama state line to Apalachee Bay. Santa Rosa Island, part of the Gulf Islands National Seashore, and other beaches in the vicinity of Pensacola, Panama City, and Fort Walton support major concentrations of beach recreaters, especially in the spring and summer. A long stretch between Apalachee Bay and just north of the Tampa-St. Petersburg area, known as the Big Bend, has little beachfront to offer. But beaches and barrier islands continue as prominent attractions for intensified recreation on the shorefronts of Pinellas County to southward of the Ten Thousand Islands just below Naples. Famous beaches at Clearwater, St. Petersburg, Sarasota, Sanibel Island, and Charlotte Harbor attract tourists and residents all year long.

Table II-23

Eastern Gulf of Mexico
Selected Shoreline Ownership Information (miles)

State	Total Shoreline	Sandy Beaches	Ownership		
			Federal	Non-Federal Public	Private
			Ocean/Gulf		
Mississippi	33	27	15	1	17
Alabama	47	47	1	5	41
Florida	673	403	114	110	449
Total	753	477	130	116	507
			Bay/Estuary		
Mississippi	214	70	18	42	154
Alabama	302	180	2	8	295
Florida	3276	507	416	134	2726
Total	3795	757	436	184	3175

Source: USD Army, COE, 1973b.

The Gulf of Mexico becomes less turbid off the Gulf Coast of Florida; consequently, the water is clearer and beaches are whiter. The inviting character of its shorefronts along with its mild climate has contributed significantly to making recreation-tourism the primary industry in Florida's economy. Florida's Statewide Comprehensive Outdoor Recreation Plan identifies beach activities as the state's most popular recreation activity. Nearly half of its residents and two-thirds of its tourists are known to enjoy the beachfront (Florida DNR, Division of Recreation and Parks, 1976).

(2) Coastal Recreation Activities

The diverse environments found in areas where water and land converge present an interesting setting for leisure pursuits. Along the extensive shoreline from the mouth of the Mississippi to the Florida Keys one finds barrier islands, coastal beaches, estuarine bays and sounds, and tidal marshes contributing to an atmosphere supportive of water-dependent and water-enhanced outdoor recreation activities.

Beach Use

Traditionally the shoreline of the eastern Gulf has provided residents of coastal states and tourists with an opportunity to enjoy and participate in a wide range of beach related activities. A precise accounting of the scope of this public use is difficult, however some investigators have addressed the subject (Stursa, 1973). No comparable data regarding user activities in the immediate coastal area are available for the three states adjacent to this proposed lease sale. All states, however, show swimming, fishing, picnicking, and boating as some of the most popular forms of outdoor recreation statewide. As mentioned previously, Florida's recreation plan rates beach activity as its most popular form of outdoor recreation. With nearly nine million residents and over 27 million annual visitors, demand for beachfront recreation opportunities continues to grow. Tourist rates have been increasing at approximately 3.5% a year. The only major interruption to a steady increase in out-of-state visitation rates since 1970 was attributed to the energy crunch of early 1974 (Florida Department of Commerce, Division of Tourism, 1976).

The states of Mississippi and Alabama have a limited marine exposure in comparison to Florida; consequently, their statewide participation rates do not reflect as strong a dependence on beachfront recreation activities for satisfying instate recreational demand. As would be expected however, planning regions in the coastal sections of both states show high use and demand especially from out-of-state visitors for beach recreation activities (Alabama Dept. of Conservation & Natural Resources, 1971 and King, 1971). Besides swimming and beach use, all three southeastern states indicate widespread participation in recreational boating and salt water fishing. Waterfowl hunting is another recreation activity popular in coastal wetland areas.

Recreational Boating and Sport Fishing

The area most directly influenced by offshore oil and gas development is the marine environment itself or, for purposes of this discussion, the neritic zone. The nearshore and offshore waters of the eastern Gulf serve as the basis for the two major marine outdoor recreation activities common to the three states-boating and recreational fishing. Likewise, participation in SCUBA diving is increasing rapidly, especially off Florida's Gulf Coast.

A 1973 National Marine Fisheries Service study provides a general overview of recreational boating in the U.S. and its subdivisions, including the states bordering the Gulf of Mexico. As of October, 1973, there were 8,008,000 privately owned recreational fishing boats in the U.S. and some 1,010,000 of these boats were used in saltwater recreational fishing activities (Ridgley, 1975). It was further estimated that commercial recreation fishing boats in the U.S. numbered 2,496. Table II-24 provides more detailed data for the Gulf of Mexico Region. In the Gulf 349,000 private recreation boats were estimated to be used in saltwater. Most of these boats were under 26 feet in length. There were also 473 commercial recreational fishing boats (charter and head boats), predominantly in the 40'-65' length class. The 1976 Boating Statistics (US Department of Transportation, CG, 1977) indicates almost 700,000 power boats are registered in the States of Mississippi, Alabama, and Florida. Almost two-thirds of those registrations are Florida boats which are much more likely to be utilized in saltwater because of the state's extensive exposure to the marine environment. In fact, the Florida Recreation Plan (Florida DNR, Division of Recreation and Parks, 1976) shows twice as many saltwater

Table II-24. Recreational Boating Activity in States Bordering the Gulf of Mexico
November, 1972 - October, 1973

	Less than 16'	16-26'	Greater than 26'	Total
Estimated No. of Private Recreational Boats	988,000	389,000	31,000	1,408,000
No. of Private Recreational Boats that Fished in Saltwater	190,000	141,000	18,000	349,000
	Less than 40'	40-65'	Greater than 65'	All Classes
Estimated No. of Commercial Recreational Fishing Boats	85	310	42	473

Major Species of Fish Sought By:	Open Ocean	Rivers, Sound, and Bays
Private Recreational Boaters	Groupers, Red Snappers, Trouts, Snook	Spotted Sea Trout, Red Drum, Snappers
Fishermen on Commercial Recreation Boats	Red Snappers, Snappers, Groupers, King Mackerel, Kingfishes	Red, Snapper, Spotted Sea Trout, Sand Sea Trout

Source: Ridgely, 1975.

boating user-occasions annually as freshwater boating (42,000,000 vs. 18,000,000). Sailing, or nonpower boating, is a very popular form of recreational boating in the inland bays, sounds, and nearshore Gulf waters of the southeastern United States. Although no figures are available on the number of sailboats utilizing the eastern Gulf, it is generally accepted the number is significant and increasing with major concentrations of sailboats near the population centers.

The National Marine Fisheries Service published the results of a comprehensive saltwater angling survey indicating the intensity and productivity of marine recreational fishing nationally and on a regionwide basis (Deuel, 1973). The results of that survey (Table II-25) showed almost one and half million fishermen catching 188 million fish in the eastern Gulf in 1970. Deuel's study also showed seatrouts, croakers, catfishes, drums, snapper, groupers, mackerels, porgies, grunts, and flounders as the fish most likely to be harvested by sport fishermen. Other investigators (Fable and Saloman, 1974; Sutherland, 1977; Daniel and Seward, 1975; and Wade, 1976) have studied efforts, catches, and values relating to recreational fishing in individual locations along the eastern Gulf. These studies and others have demonstrated that sport fishing is increasing in popularity, is very productive and rewarding to participants, and has a significant affect on coastal economies.

Most recreational or sport fishing in the eastern Gulf is confined to nearshore waters, inland bays, and sounds. People most commonly fish from beaches, jetties, piers, abandoned bridges, and boats. Deuel's 1970 survey attempted to demonstrate the relative importance of the different fishing platforms and locations. The results (Table II-26) indicate that boats are by far the favored fishing platforms in the eastern Gulf with twice as many people fishing from private boats as from chartered boats. Even though the inland waters are more favored, two out of three fishermen will fish directly in the Gulf of Mexico.

A significant commercial recreational fishing enterprise has developed over the years in the eastern Gulf. Coastal locations such as Biloxi, Dauphin Island, Pensacola, Ft. Walton, Destin, Panama City, and Tampa-St. Petersburg are noted for their charter fleets as well as their beautiful beaches. Charter boats are composed of very large head or party boats which generally carry from 10-50 fishermen and anchor or drift fish. Catches might include snappers, groupers, and mackerel. Natural fishing banks and artificial structures such as shipwrecks and artificial reefs are favored locations for charter and private boats seeking bottom fish offshore in the eastern Gulf. Visual No. 4, Undersea Features, depicts many of the major artificial and natural fishing areas attractive to offshore fishermen. The other type of charter boat is usually in the 25′-40′ class and caters to small groups, usually less than eight people. Although this type of commercial recreational fishing vessel is likely to pursue bottom fish, it is just as capable of joining the growing number of private yachts seeking billfish or pelagic sport fish throughout the offshore waters of the eastern Gulf. Some of the most popular big game fish caught include sailfish, marlin, tarpon, dolphin, and tunas (Beardsley, 1977). Interest in big game fishing is increasing annually with more boats trying new methods and areas every year. Additionally the number of big game fishing tournaments has increased over the past few years.

The ''Red Tide'' and ''Jubilee'' are two natural phenomenon affecting sport fish in the eastern Gulf. The Red Tide is most often noted off the west coast of Florida and the Jubilee is associated with the coast of Alabama. Both phenomena are infrequent and cause fish die-offs; however, the Jubilee does not directly influence the food quality of the fish, thus, such an occasion generally results in a short term bonanaza for recreational fishermen (Hughes, 1972 and May, 1973b).

Several other recreation activities are associated with harvesting marine creatures of the eastern Gulf and, like sport fishing, have commercial counterparts. Crabbing, shrimping, shell collecting, and fishing for spiney lobsters are some examples.

SCUBA diving and snorkling are other recreational activities deserving special mention in this section. Clear, temperate water is a primary environmental requirement for enjoyment of these recreational pursuits. Unlike the central and western Gulf, warm water with visibility from 25′-50′ is common in nearshore waters all along the west coast of Florida throughout most of the year. Favored SCUBA destinations are shipwreck sites and natural reefs.

Although on the southern limits of the planning region for this proposal, the area south of Cape Romano encompassing the Florida Keys and Dry

Table II-25 Estimated Number of Saltwater Anglers and Their Catches in the Eastern Gulf of Mexico (Fla. West Coast to Mississippi River) with Relationship to the Total U.S. Sport Fishermen and Their Catches for 1970.

	No. of Anglers (000)	% of U.S. Total	No. of Fish Caught (000)	% of U.S. Total	Weight of Fish Caught (000 lbs)	Weight of Fish Caught (000 kg.)	% of U.S. Total
Eastern Gulf of Mexico	1,478	16	188,888	23	334,120	151,557	21
Total U.S.	9,392		817,317		1,576,823	715,247	

Source: Deuel, 1973.

Table II-26

Saltwater Fishermen and Their Catches 1/
by Principal Area and Method of Fishing - 1970

	Principal Area of Fishing		Principal Methods of Fishing			
Region	Gulf	Sounds, Rivers, and Bays	Private or Rented Boats	Party or Chartered Boats	Bridge, Pier, or Jetty	Beach or Bank
Eastern Gulf of Mexico	- - - - - - - - - - - -	- - - - - Thousands	- - - - - - - - - -	- - - - - - - -	- - - - - - - -	- - - - - -
Number of fishermen	633	915	607	323	413	266
Number of fish caught	42,352	146,536	87,328	39,892	40,735	20,933
Total Weight (lbs.)	111,177	222,943	167,875	75,638	69,793	20,814
Total Weight (kg.)	50,429	101,127	76,148	34,309	31,658	9,441

1/ The number of fish caught and the weight of fish caught in the two principal areas of fishing are equal to the total catch for a particular region, and the number and weight caught by the four methods of fishing are equal to the total catch for a particular region. However, the number of anglers is not additive as some anglers fished in both areas and by more than one method for certain species groups in a particular region.

Source: Deuel, 1973.

Tortugas is deserving of special emphasis in the description of recreation environments and activities in the eastern Gulf. The onshore, nearshore, and offshore environments are relatively unique and best described with superlatives. Approximately the western half of the southern tip of Florida is under management schemes designed to maintain the natural condition. The vast expanse of semiaquatic land includes the Big Cypress National Preserve and Everglades National Park. The western border of the park lands is made up of thousands of islands and waterways forming an irregular shoreline covered by mangroves, saltmarsh, and seagrass. Rich in wildlife, especially avian fauna and tropical vegetation, the parks attracted over a million people in 1976. The saltwater environment from Florida Bay west to the Dry Tortugas is a tropical marine ecosystem unique to the continental U.S. Coral reefs, tropical fish, historic shipwrecks, and plentiful sportfish contribute to making the south Florida marine ecosystem and associated landforms a very special recreation environment.

e. Historical/Cultural Values

(1) Procedures Used to Identify Cultural Resources

An analysis of cultural resources information relating to the marine environment indicates the Outer Continental Shelf is a mysterious submerged graveyard concealing vestiges of ancient maritime travelers and potentially harboring secrets of civilizations yet to be described. Consequently the Department of the Interior contracted with Coastal Environments, Inc. (CEI), to make a general evaluation of the cultural resources in the northern Gulf of Mexico and asked that they attempt to predict broad areas where historic and prehistoric resources are most likely to be located.

In their report, Cultural Resources Evaluation of the Northern Gulf of Mexico, (CEI, 1977), Coastal Environments, Inc. identifies two types of cultural resources likely to be encountered within the proposed lease area: (a) historic cultural resources or the relics of maritime wreckage, mainly shipwrecks and (b) prehistoric cultural resources or potential traces of heretofore undescribed human civilizations. Much of the information in this section is borrowed from CEI's report.

The State of Florida has an active underwater archaeology program and has done extensive work in inventoring and describing cultural resources in nearshore waters. Figure II-17 provides a graphic illustration of the numerous shipwreck concentrations and a few other submerged sites of cultural interest in Florida coastal waters. Florida has inventoried 77 nearshore sites and almost 4,000 onshore sites within Gulf of Mexico coastal counties.

Additionally, the National Register of Historic Places (Federal Register, 1977d) was consulted along with the State Historic Preservation Officers in Mississippi, Alabama, and Florida in order to identify significant cultural resources which might be affected by an offshore oil and gas lease sale in the eastern Gulf region. Visual 4 depicts the location of National Register sites in the coastal areas of the eastern Gulf as well as indicating the general location of reported shipwrecks on the Outer Continental Shelf.

(2) Cultural Context

There are good reasons to believe that man has been in the eastern Gulf Coast area for 50,000 years or more. Even a conservative estimate of this first possible arrival in the general area would be 20,000 years before present (B.P.). Archaeological evidence from such areas as the Skelly Site establishes that prehistoric people lived in the area around Dothon, Alabama, as long as 20,000 years ago. The Fish creek site has dated prehistoric man in the Tampa Bay area at least 12,000 years ago. Recent news reports of investigations by Clausen in Florida sinkholes noted the discovery of preserved portions of early man himself.

During the thousands of years that man has occupied the eastern Gulf area, a great many changes have occurred, both on a worldwide scale and locally, which have brought about major changes in the landscape. Among the most important of these changes was the fluctuations of sea level due to the waxing and waning of continental glaciers. As indicated in Figure II-18 the level of the sea has been significantly lower during much of the period of human occupation. As a result of sea level changes and some tectonic movements, former land areas are now covered by water and lie on the continental shelf. Therefore it is possible that some of the proposed lease area was at one time inhabited by human beings.

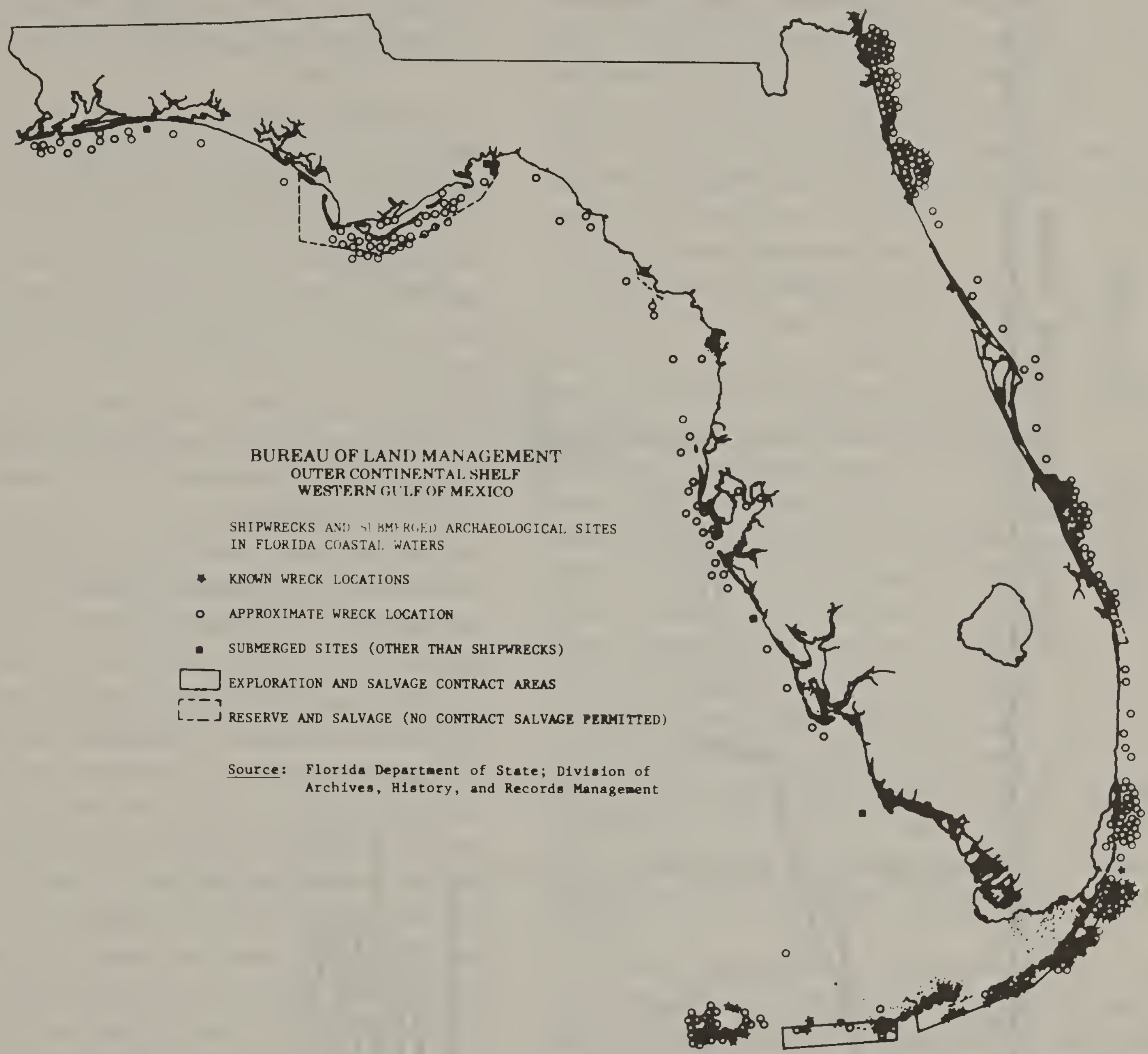
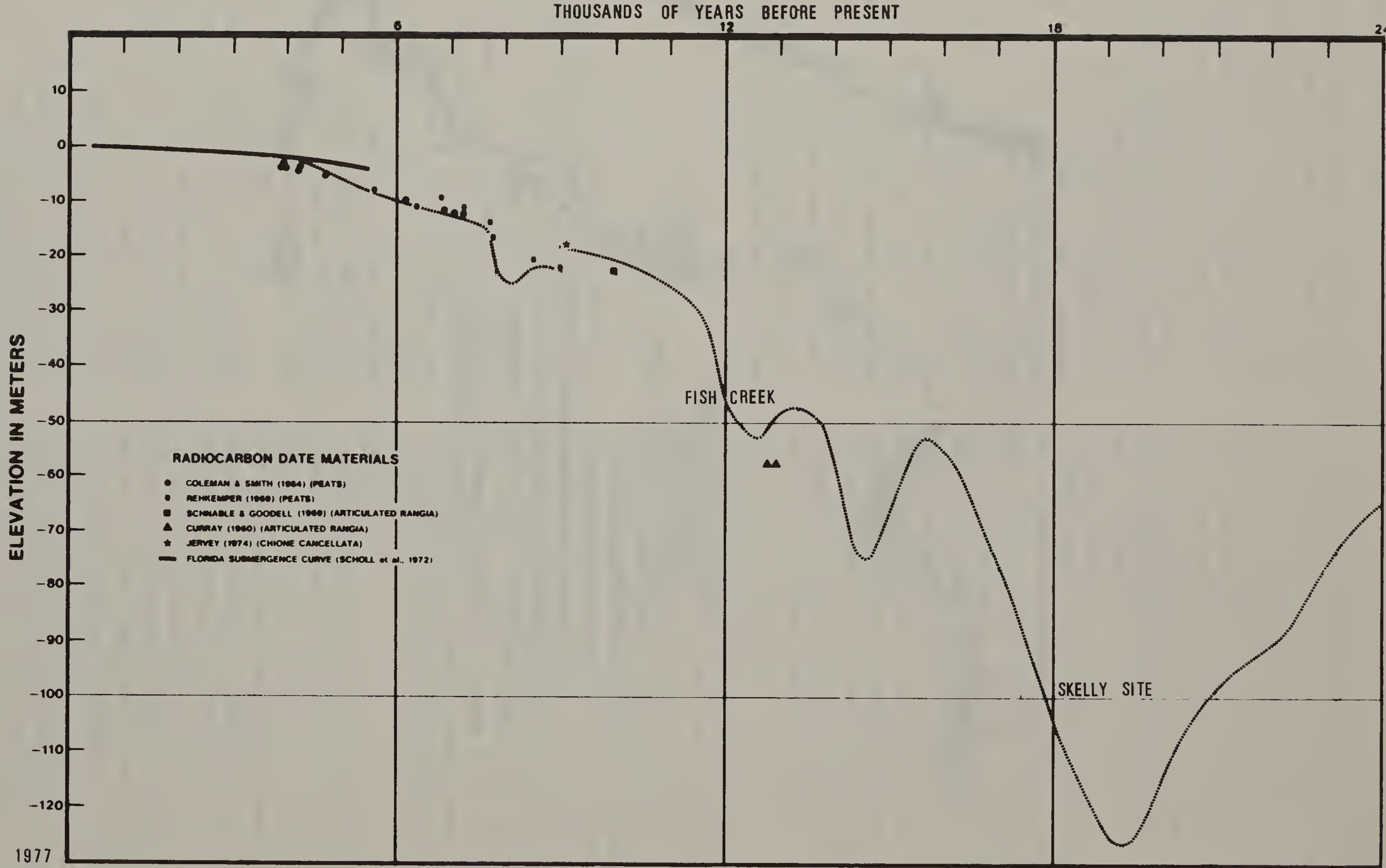

BUREAU OF LAND MANAGEMENT
OUTER CONTINENTAL SHELF
WESTERN GULF OF MEXICO
SHIPWRECKS AND SUBMERGED ARCHAEOLOGICAL SITES
IN FLORIDA COASTAL WATERS
KNOWN WRECK LOCATIONS
APPROXIMATE WRECK LOCATION
SUBMERGED SITES (OTHER THAN SHIPWRECKS)
EXPLORATION AND SALVAGE CONTRACT AREAS
RESERVE AND SALVAGE (NO CONTRACT SALVAGE PERMITTED)
Source: Florida Department of State; Division of Archives, History, and Records Management

FIGURE II-17

CURVE OF RELATIVE CHANGE

OF LAND - SEA LEVEL



SOURCE: CEI, 1977

FIGURE II-18

Volume I of CEI's report provides a synthesis of the known archaeological record for the entire Gulf Coast region and relates coastal artifact traditions and cultural sequences to geological times and events. CEI's study goes on to provide an interpretation of Quaternary sea level fluctuations relating to geomorphology of the Outer Continental Shelf and forms the basis for establishing the seaward limits for the most probable area of former human habitation sites. The cultural resource demarcation line depicted on Visuals 1 and 4 is a reflection of those "high probability" limits.

Shipping, and hence shipwrecks, in the waters of the eastern Gulf has been ongoing for at least five centuries. Probably the greatest early concentration of shipping and shipwrecks is along the Florida coast (see Figure II-17) related to the movement of early Spanish expeditions. Early explorers, colonizers, and marine merchants sailed to major ports from New Orleans to Tampa and crisscrossed the mid-Gulf, traveling between Southern Florida and Mexico.

As settlement and economic development progressed during the nineteenth century, shipping increased considerably, and the waters of the region contained numerous international trading ships and some fishing vessels. During the age of sail, when ships were more at the mercy of the elements than the powered ships of today, wrecks along the coast were frequent. The Civil War increased the number of wrecks throughout the offshore area due to hostile naval operations along with increased commercial traffic. Finally World Wars I and II added numerous wrecks from natural and combat (mostly submarine) related activities. It should be noted that some obsolete and derelict ships of former and recent times were disposed of routinely by intentionally sinking them in the Gulf of Mexico.

The entire eastern Gulf offshore area covered by this statement has the potential for holding shipwrecks, however the number of known wrecks decreases very rapidly with distance from shore. The entire coastline and its associated shallow waters has a high potential for containing shipwrecks but the largest concentrations of historically significant wrecks appear to be in the Florida Keys area and around major ports such as Tampa Bay, Mobile Bay, and the mouth of the Mississippi River.

(3) Summary of Known Cultural Resources

CEI's Volume II presents a comprehensive report on the occurrence of historic shipwrecks in the northern Gulf of Mexico. The period of consideration extended from 1500 A.D. through 1945 A.D. Sources included published and unpublished reports of losses and locations of known wrecks. It is estimated that the total number of historic wrecks in the eastern Gulf area is around 750 ships. Even though approximately 750 ships are reported lying somewhere in the eastern Gulf, only about 200 ships have reported locations somewhat indicative of their probable resting place. Of the total shipwreck population in the eastern Gulf, approximately 65 percent date from the 19th and 20th centuries. The remaining 30 percent of known lost ships are wrecks from the 16th, 17th, and 18th centuries.

It has been estimated that approximately two-thirds of the total number of wrecks in the northern Gulf are within 1.5 kilometers of the coast. Another 15 percent lie between 1.5 and 10 kilometers out and for the most part are associated with approaches to seaports, straits, shoals, or reefs and along well established sailing routes. Therefore only a very small percentage of known shipwrecks occur on the Outer Continental Shelf where the Federal government leases mineral development rights. Visual 4 shows shipwrecks within the leasing area where some type of specific locations have been reported. Two known underwater shipwreck sites, the Tecumseh, a Civil War vessel resting near the mouth of Mobile Bay and the San Jose, a Spanish Galleon in the vicinity of Plantation Key, have been included on the National Register of Historic Places.

Although shoreline archaeological sites have been identified in every county bordering the eastern Gulf, known submarine archaeological sites are extremely rare. A number of onshore springs near south Florida's west coast have produced Paleo-Indian artifacts and bones of extinct Pleistocene animals. Among the most important of these are Warm Mineral Springs and Little Salt Spring, where systematic underwater excavations have been conducted. Similar springs, sometimes called sinkholes, are known to occur offshore.

The first prehistoric submarine archaeological site investigated in the Gulf of Mexico is located in shallow waters near Venice, Florida. A systematic archaeological investigation of a subsea shell midden by Ruppee produced, among other things, pottery from an early ceramic period. Numerous artifacts and facial bones have been dredged up in Florida coastal bays and additional submarine archaeological sites have been identified off Sarasota, Franklin, and Wakulla Counties. No archaeological sites have been identified to date in Federal offshore leasing areas.

In addition to known shipwrecks and submerged archaeological sites, the coastal shoreline of the eastern Gulf displays historic relics of our early American heritage. Prominent among such historic resources are lighthouses and forts, many of which are included on the National Register of Historic Places.

(4) Summary of Unknown Cultural Resources

Except for the small percentage of shipwrecks with reported locations on the OCS, very little is known of the location of numerous other vessels sunk somewhere in the eastern Gulf. Earlier vessels, lacking communications equipment, sunk without specific information as to the location of the wreck. Vessels were often abandoned before sinking, leaving the ship to finally go down after drifting, in an unknown location. A knowlege of the location of a sinking is frequently not the location of the wreck, which may float beneath the surface for some time, or which may slide along the bottom due to the effects of storms or currents. Many ships are buried not only by the sea but by layers of marine sediment as well. Of the estimated 750 ships known to have been lost in the eastern Gulf almost 550 of those ships have no definite sinking locations and are merely associated with a proposed destination site or the nearest port where survivors may have reported a loss. Additionally, other shipwrecks have been located but not identified or classified into a historical period. Approximately 175 known ships in the eastern Gulf fall into this category.

Although the plausibility for the former existence of Paleo-Indian sites on the Outer Continental Shelf has been demonstrated by Coastal Environments, Inc., little direct evidence has been produced to substantiate the hypothesis.

2. Other Social/Economic Factors

Introduction

The acreage to be offered in proposed Sale No. 65 is located on the Outer Continental Shelf in the northeastern portion of the Gulf of Mexico. The largest portion of the acreage lies off the Florida coast and a number of tracts lie off the coasts of Mississippi, Alabama, and Louisiana.

The areal extent of the industrial and economic effects that may result from this sale are difficult to delineate, due to the fact that the Gulf of Mexico area is a major supplier of crude oil, petroleum products, and natural gas to other regions of the United States. The following discussion pertains to Gulf of Mexico areas since the initial economic effects may be assumed to impinge mainly on this sector.

Additional discussions of the economy in the states adjacent to the Gulf of Mexico have been published in the following Environmental Statements:

OCS Sale No. 32, OCS Sale No. 41, OCS Sale No. 44, and Programmatic OCS Oil and Gas Leasing Increase (USDI, BLM 1973, 1976(b), 1976c, and 1975).

The economic activity that has occurred in the areas bordering the Gulf of Mexico has been a significant part of the total economic activity of the nation.

The states bordering the Gulf of Mexico include Texas, Louisiana, Mississippi, Alabama, and Florida. For the purpose of this discussion, the coastal area of Texas can be considered to be the western Gulf of Mexico region; the coastal portion of Louisiana can be considered to be the central Gulf of Mexico region, and the coastal portions of Mississippi, Alabama, and the western part of the coastal region of Florida can be considered to be the eastern Gulf of Mexico.

The historical changes that have occurred within the economies of the states bordering the Gulf of Mexico are summarized in the following paragraphs. These descriptions were based on statistical data prepared by the Research Department of the Federal Reserve Bank of Atlanta (1976) supplemented by additional information relating to current economic conditions.

An article by Patricia Faulkinberry (1977) recently discussed shifting population trends within various regions of the United States. The author notes that the population factor is perhaps the basic ingredient of any economy since changes in demographic patterns have a far-reaching impact on the social and economic characteristics of a region including culture, composition, geographic dispersion, income levels, wealth, occupations, and economic demands of its people. Changes in an area's population occur through natural increases (births minus deaths) and net migration.

The South, defined as a 16 state area extending from the District of Columbia to Texas, accounted for more than half of the nation's population growth in 1970-75 compared to less than one-third in the 1965-70 period.

One of the reasons for this change has been the increase in migration to the South. The principal in-migration has been from the Northeast and North Central regions. Out-migration has been to the West and North Central regions.

The explanation for this change in population may be due to many factors. Aggregate migration may be a response to higher income levels, but the country's largest interregional migration flows have been into the South, the region where per capita income is lowest. Some consideration should be given to cost-of-living differences, and it may be that lower price levels in the South may compensate for lower per capita income levels. Expectations of future income may be a factor and, if so, the changes in per capita income may be the significant factor.

The best single explanation of the acceleration of migration to the South was considered to be the effect of lower prices and wages, abundant labor, and available natural resources. Possible effects of the easily accessible energy sources in the southern petroleum states, and the milder climate, offered energy savings to all kinds of businesses.

In the 6 state area of Alabama, Florida, Georgia, Louisiana, Mississippi, and Tennessee, the population growth rate during 1970-75 amounted to 11 per cent, and for individual states ranged from 4.25% in Louisiana to 23.64% in Florida. The growth rate in this group of states was more than twice the growth rate in the South as a whole.

Some pertinent measures of economic activity in the southeastern states are presented in the following paragraphs.

A recent article by James T. Fergus reviews the energy requirements, particularly of oil and gas of various sectors of the economies within selected states. The procedure utilized a determination of major U.S. industries which are heavy energy users, and then noted the relative importance of these industries in the southeastern states, and sketched the implications of this relationship for the southeastern states. See Table II-27 for this relationship.

The above-referenced chart shows relatively high reliance on petroleum and natural gas in the non-fuel mining, non-durable goods manufacturing, and agricultural industries.

Compared to the total United States economy, employment shares in both agriculture and non-durable goods manufactured in the southeastern region are higher, indicating a greater regional dependence on these industries, indicating that this region may be subject to a greater degree to energy-induced cost increases.

The implications of this relationship vary from state to state, depending on the composition of the economy.

a. Population

Between the years 1965 and 1975, the population of the United States increased from 193,526,000 to 213,121,000 persons, an increase of 19,595,000 persons, approximately 10.1 percent of the 1965 population. See Table II-28 for these percentage changes in the five Gulf of Mexico states.

Additional data, provided from the OBERS projections, applicable to the coastal areas are provided on subsequent tables. The population of the 5 states as estimated for the year 1980 are shown on Table II-29.

Comparison of Tables II-28 and Table II-29 indicate that the population in three of the states is above the 1980 level projected by OBERS.

The coastal portion of Louisiana and part of Mississippi, comprising the central Gulf of Mexico region, is included with Bureau of Economic Analysis (BEA) economic areas 138 and 193.

The coastal portions of Alabama, a portion of Mississippi coastal area, and the major portion of the western coastal area of Florida are included in BEA economic areas 037, 038, 039, and 137. This area is referred to as the eastern Gulf of Mexico region.

The coastal portions of Texas are included within BEA areas 140, 141, 143, and 144, and are included within the western Gulf of Mexico region.

Table II-27.

Industry	Input cost in cents per dollar of output Petroleum & Natural Gas	Total Energy
Mining (excluding fuels)	3.3	5.9
Nondurable goods	3.5	4.8
Agriculture	3.6	4.3
Durable goods	2.0	3.9
Transportation and trade	2.5	3.5
Construction	2.1	2.9
Services	1.5	2.4

Note: All values estimated from table.

Source: Fergus, 1977.

Table II-28.

State	Population (thousands) 1965	1975	Difference	Percent
Alabama	3,443	3,614	171	5.0%
Florida	5,594	8,357	2,403	40.4%
Louisiana	3,496	3,791	295	8.4%
Mississippi	2,246	2,346	100	4.5%
Texas	10,388*	12,237	1,849	17.8%

* Estimated from 1960 and 1970 figures.

Source: Federal Reserve Bank of Atlanta Research Department, 1976.

Table II-29.

State	Projected Population (thousands) 1980
Alabama	3,747
Florida	8,926
Louisiana	3,744
Mississippi	2,328
Texas	12,167

Source: Federal Reserve Bank of Atlanta Research Department, 1976.

A comparison of the population, employment, and personal income of the inhabitants of these regions with the total United States population, employment, and personal income is shown in Table II-30.

Perhaps the most significant relationship revealed in Table II-30 is that employment and personal income in all 3 regions is a smaller percentage of national employment and personal income than is the percentage of population to the total U.S. population.

The BEA economic regions included within the classification of western, central, and eastern Gulf of Mexico form only a portion of the various states bordering the Gulf of Mexico.

b. Housing

The housing situation for most of coastal Florida is one of increasing demand while southern Mississippi and Alabama have a comparatively lower growth rate. Table II-31 demonstrates that expected growth for those areas most likely to be impacted by the proposal. The social-economic environment is estimated for 1980 because the impact of the proposal would not be felt before that time.

Panama City is in Bay County which is a part of Florida's Planning District 2. Port Manatee is in Manatee County, part of Florida's Planning District 8. Mobile is in Mobile County, Alabama. Pascagoula is in Jackson County, Mississippi.

Florida coastal growth is largely the result of in-migration of retirees and the growing economy of the area. The Mississippi and Alabama increases are largely caused by expanding industry and other commerce.

The growth of influx of population also creates a demand for housing which must be met by the local housing industry. Increasing demand on housing leads to rising prices and short term under-supply. It is expected that the existing housing industry can provide houses to meet the expanded need in the long run.

The projected rapid growth of northwest Florida in planning District 2 may lead to severe short-term housing shortages. However, it should be remembered that the last completely accurate census was in 1970 and that any area which is experiencing rapid growth may be subject to inaccurate population projections.

c. Employment and Income

(1) Alabama

Selected portions of the economic activity for Alabama are presented in Table II-32.

During 1970, approximately 29 percent of the civilian employment in Alabama was in the manufacturing category. Approximately half of the employment in manufacturing was in the production of durable goods, particularly in the metal industries. The largest percentage of employment in the manufacturing of nondurable goods was in the category of textiles and textile products.

A recent review of the economy of Alabama by Gunther (1975) stated: "Certainly a strong note for the future is the presence of vast coal deposits and potential oil reserves in and off the coast of Alabama. The industrial mix of the state should prevent any serious declines in employment in the near future with the expected strengths of the steel, paper, mining, chemical, and petroleum industries serving as a floor on future unemployment in the state. Construction, one of the most severely depressed industries in the state, has probably seen the worst in the current slump and should begin regaining strength this year."

During 1977, the Alabama unemployment rate is slightly better than the national average. During 1976, the Alabama unemployment rate was 6.8% and in May, 1977 it had fallen to 5.5%.

Projections for the economy in Alabama in the near future indicate that 1977 could be a record year for investment spending in the state, and that employment opportunities in the manufacturing sector should be quite favorable in coming months.

The total value of construction activity in March, 1977 was greater than March, 1976 by about 100%. On a three month average basis, during the first quarter of 1977, construction contracts were 33% above the same quarter of 1976.

Alabama (as well as Tennessee) have large shares of nondurable goods manufacturing employment and above average shares of jobs in agriculture. These industries are heavily dependent on petroleum and natural gas inputs, and may be somewhat sensitive to higher prices of oil and gas (Fergus, 1977).

(2) Florida

Selected portions of the economic activity for Florida are presented in Table II-33. During 1970, approximately 54 percent of the employment in

Table II-30. Population and Employment By Income Regions Compared to Total U.S., 1970

	Total U.S.	Gulf of Mexico Western	Gulf of Mexico Central	Gulf of Mexico Eastern
Total Population	203,857,864	4,883,064	2,900,230	3,267,717
% of U.S.	---	2.4%	1.4%	1.6%
Total Employment	79,306,527	1,816,283	963,028	1,138,419
% of U.S.	---	2.3%	1.2%	1.4%
Total Personal Income 1/	$708,583,931	$15,059,700	$7,973,192	$9,150,233
% of U.S.	---	2.1%	1.1%	1.3%

1/ Total personal income in thousands of 1967 dollars.

Source; USD Commerce and USD Agriculture, 1974.

TABLE II-31 Population and Housing, Selected Areas

County or Area	1970 (1) Population1/	(2) Housing Units2/	(3) Households2/	(3)/(2) = (4) % Occupied
Florida District 2	123,617	111,051	99,520	89.6%
Florida Bay County	75,283	26,652	23,403	87.8%
Florida District 8	1,185,700	469,497	438,900	93.5%
Florida Manatee County	97,115	41,829	38,488	92%
Alabama Mobile SMSA	376,690	121,244	109,769	90.3%
Alabama Mobile County	317,308	99,441	91,769	92%
Mississippi Jackson County	87,975	27,584	24,584	89%

Sources:

1/ USD Commerce, Bureau of the Census, 1972.
2/ University of Florida, College of Business Adminstration, BEBR, 1976a.

TABLE II-31 (continued)

1980 Estimates

County or Area	Population	Housing Units 6/	Households 5/	% Growth From 1970
Florida District 2	455,100 2/	456,044	366,300	260%
Florida Bay County	104,700 2/	40,463	32,500	39%
Florida District 8	1,784,200 2/	822,198	660,400	50%
Florida Manatee County	150,600 2/	74,308	59,685	55%
Alabama Mobile SMSA	416,500 3/	154,878	124,400	13%
Alabama Mobile County	345,400 3/	124,376	99,900	9%
Mississippi Jackson County	99,800 4/	34,735	27,900	13%

Sources:

2/ University of Florida, College of Business Adminstration, BEBR, 1976a.
3/ University of Alabama, Graduate School of Business, CBER, 1975.
4/ Personal Telephone Conversation with Dr. H. Biggs, Mississippi Research & Development Center, 1977.
5/ Estimated using 1970 population to household ratios.
6/ Using a national ratio of housing units to households of 1.245 from USD Commerce, Bureau of the Census, 1974.

Table II-32. Economic Activity for Alabama

	1965	1975	
Per capita personal income	$1,987	$4,557	
Total personal income	$6,840	$16,469	(million)
Total cash farm income	$ 684	$ 1,397	(million)
Cash farm receipts from crops	$ 254	$ 545	(million)
Cash farm receipts from livestock and products	$ 394	$ 840	(million)
Farm employment	120	91	(thousand)
Coal production	14,832	19,834 1/	(thousand short tons)
Petroleum production	8,064	13,469	(thousand bbls)
Non farm employment	886	1,150	(thousands)
Value added: manufactured goods	2,954	5,841	(million) 2/
Value of construction	$ 679	$ 1,845	(million)
Manufacturing employment	277	320	(thousand)
Construction employment	52	68	(thousand)

Source: Federal Reserve Bank of Atlanta Research Department, 1976.

1/ 1974
2/ 1973

Table II-33. Economic Activity for Florida

	1965	1975	
Per capita personal income	$ 2,402	$ 5,517	
Total personal income	$14,299	$46,105	(million)
Cash farm receipts from crops	$ 737	$ 1,809	(million)
Cash farm receipts from livestock and products	$ 250	$ 624	(million)
Petroleum production	1,464	41,887	(thousand bbls)
Value of construction	$ 1,890	$ 3,622	(million)
Manufacturing employment	252	328	(thousand)
Construction employment	135.7	171.1	(thousand) 1/

Source: Federal Reserve Bank of Atlanta Research Department, 1976.

1/ Construction employment in Florida continued to increase until it reached a level of 277.3 thousand workers in 1973. In 1974, the employment was 267.2 thousand, and in 1975, 171.1 thousand. The decline since 1973 amounts to 106.2 thousand workers, approximately 38 percent of the 1973 total. A similar effect was evident in the value of construction contracts awarded. The decline from 1973 to 1975 amounted to 53% of the 1973 value.

manufacturing was in the category of durable goods. Approximately 11 percent of the manufacturing employment occurred in the metal industries, and an additional 11 percent of the employment occurred in the electrical machinery industry. An important industry in the nondurable goods manufacturing category is the production of food and kindred products. Approximate 4.5 percent total civilian employment in Florida was in the category of wholesale trade, and approximately 19 percent of the civilian employment was in the category of retail trade. During 1967, total retail sales in Florida amounted to $10,280 million.

The economy of Florida reflected the downturn noted in the national economy, and, during the last three quarters of 1974, the unemployment rate increased from 5.1% during the second quarter to 7.3% during the fourth quarter. During the same period of time, nonagricultural employment declined from 2,776.7 thousands to 2,741.3 thousands of workers. Farm employment remained during October and November at about the same level as during the previous year, and farm cash receipts during October, 1974 were higher than the previous year.

The main source of Florida's unemployment has been in the building trades, due to the decrease in the amount of building. "Motels and condominiums are in considerable oversupply in many areas; bankruptcies and foreclosures have already occurred and more are likely to follow" (Jackson, 1975).

During the period 1967 to 1972, the most rapidly growing manufacturing industry in the state in terms of value added was textile mill products. Other fast-growing groups are petroleum and coal products, apparel and other textile products, printing and publishing, and furniture and fixtures.

Much of Florida's major manufacturing is resource-oriented: food, tobacco, lumber and wood products, paper, chemicals, and stone, clay, and glass products (Thompson, 1975).

The importance of Florida as a recreational and tourism center is well known. Estimates of visitors to Florida range from 25.5 million in 1973, 24.5 million in 1974, to 27.3 million during 1975. In January, 1976, there were 983 licensed hotels, 5,311 motels, and 22,216 licensed food service establishments. During 1973, an average of 75 thousand persons were employed at hotels, motels, and lodging places, with a total wage and salary bill of $427 million.

Compared to other southeastern states, Florida's share of employment in both agriculture and nondurable goods manufacturing is low, and this might indicate that the economy of Florida would be less sensitive to increases in prices for oil and gas. However, since a sizable part of Florida's service business is tourism-related, the volume of tourist business could easily be eroded by higher costs of auto and air transportation.

(3) Louisiana

Selected portions of the economic activity for Louisiana are presented in Table II-34. During 1970 approximately 40 percent of the manufacturing employment in southern Louisiana was in the durable goods industries, and approximately 60 percent of the employment in manufacturing was in the nondurable goods category.

Approximately 10 percent of the manufacturing employment in southern Louisiana during 1970 occurred in the metal industries, and almost 19 percent of the total manufacturing employment was in the category of chemicals and allied products.

Employment in retail trade in the city of New Orleans, and including a portion of the adjacent area of the State of Mississippi, amounted to approximately 76 thousand persons during 1967, and an additional 31 thousand were employed in wholesale trade in the same area.

Louisiana's economy is similar to Florida's economy in that important sectors of the economy, such as transportation, services, trade, and construction have relatively low direct requirements for petroleum and natural gas. However, portions of these industries are dependent on tourism which could be affected by higher prices for oil and gas (Fergus, 1977).

(4) Mississippi

Selected portions of the economic activity for Mississippi are presented in Table II-35. During August, 1977, approximately 57 percent of the manufacturing employment in the southern half of the state occurred in the manufacture of durable goods. The balance of employment within the category of manufacturing was in the production of nondurable goods, principally the production of fabricated textile products, and food and kindred products.

During the month of August 1977, total nonagricultural wage and salary employment in Mississippi amounted to 762,900 persons, 30,500

Table II-34. Economic Activity for Louisiana

	1965	1975	
Per capita personal income	$2,134	$ 4,729	
Total personal income	$7,461	$17,928	(million)
Total cash farm income	$ 507	$ 1,102	(million)
Cash farm receipts from crops	$ 296	$ 770	(million)
Cash farm receipts from livestock and products	$ 189	$ 314	(million)
Petroleum production	595	655	(million bbls) 1/
Value of construction	$1,190	$ 1,851	(million)
Manufacturing employment	158	182	(thousand)
Construction employment	77	90	(thousand)
Farm employment	121	68	(thousand)

Source: Federal Reserve Bank of Atlanta Research Department, 1976.

1/ Louisiana's petroleum production continued to increase until 935 million barrels were produced in the year 1971. Since that time, production has declined to the figure shown above, a decline of 280 million barrels, approximately 30 percent of the 1971 production.

Table II-35. Economic Activity for Mississippi

	1965	1975	
Per capita personal income	$1,684	$4,041	
Total personal income	$3,783	$9,481	(million)
Total cash farm income	$ 846	$1,395	(million)
Cash farm receipts from crops	$ 485	$ 708	(million)
Cash farm receipts from livestock and products	$ 334	$ 667	(million)
Farm employment	179	92	(thousands)
Petroleum production	56,183	46,587	(thousand bbls)
Value added: manufactured goods	$1,206	$3,477	(million) 1/
Value of construction	$ 489	$1,042	(million)
Manufacturing employment	153	198	(thousand)
Construction employment	29	36	(thousand)

Source: Federal Reserve Bank of Atlanta Research Department, 1976.

1/ 1973

more than during August 1976. Unemployment during September 1977, amounted to 55,300, a decrease of 6,100 from the August, 1976 figure.

Part of the increase in employment was due to increases in manufacturing, trade and finance, and mining. Employment in construction, services, and transportation-communications-public utilities recorded small decreases.

A possible impact on the future of the Mississippi economy was noted recently in the Economic Review published by the Federal Reserve Bank of Atlanta. Increased energy costs may be expected to have an impact in those economies containing industries dependent on petroleum and natural gas inputs. The agricultural character of Mississippi's economy makes the state vulnerable to cost increases (Fergus, 1977).

(5) Texas

Selected indicators of economic activity in Texas are presented in Table II-36. During 1972, approximately 398,000 workers were employed in the manufacture of durable goods, and approximately 343,000 were employed in manufacturing nondurable goods.

Employment in wholesale and retail trade amounted to approximately 951,000 persons in 1972. Employment in water transportation amounted to approximately 21,000, and employment in pipeline transportation amounted to approximately 5,000 during 1972.

The recent changes in the economy of the State of Texas have been summarized by Stockton (1975).

Comparison of business activity in Texas with measures of business activity on the national level indicated that the Texas economy has shown much greater resistance to the depressing forces present within the national economy than has the nation as a whole; however, the Texas economy did not maintain a normal growth rate.

The most depressed segment of the Texas economy has been the building industry. For the first two months of 1975 the amount of building construction authorized declined 29 percent from the same period in 1974; however, much of the construction authorized in earlier periods was still providing jobs and the employment in contract construction was 1.7 percent higher in February 1975 than in February 1974. However, the decline in authorized construction may indicate future unemployment as workers are released when current projects are completed. The number of building permits issued for repairs, additions, and alterations has increased.

Employment in the manufacture of durable goods has declined from approximately 451,000 during February 1974 to about 437,000 during February 1975, and employment in the manufacture of non-durable goods has decreased from 364,000 to 350,000 workers.

The influence of the increased level of petroleum exploration both within the state, and in other areas, was reflected in various sectors of the Texas economy. "Employment in machinery manufacture (excluding electrical) was 8.0 percent higher in February 1975 than in February 1974, reflecting largely the increase of 17.5 percent in employment in oil field machinery manufacture. This is the result of the recent increase in oil exploration. Employment in the manufacture of instruments and related products, which also reflects the effects of oil exploration, increased 5.1 percent over the past year" (Stockton, 1975).

During the first six months of 1977, permits for new construction in Texas amounted to $3.1 billion, 29 percent aove the comparable figure for 1976. Residential construction was 48 percent higher than in the 1976 period and amounted to $1.8 billion. Industrial buildings amounted to $1.38 million, 83 percent above the 1976 period (Cannon, 1977).

The increase in domestic oil prices has led to a reevaluation of the oil and gas reserves of Texas. The wellhead price of Texas oil increased from an average of $3.28 per barrel in 1970 to $8.02 per barrel in 1976. Since the state tax on oil and gas production is an ad valorem tax, these higher prices have resulted in additional revenues to the state of Texas. Energy tax revenues rose from $553 million in 1970 to $1,224 million by 1976, amounting to 25.4 percent of the state's entire 1976 revenues.

The effect of the price increases on drilling activity has been substantial. During the year 1973, 8,031 wells were drilled, and during the year 1976, 13,884 wells. Energy industry employment amounted to 45,400 additional jobs (Askari and Creasy, 1977).

Employment within Texas in activities related to the oil and gas production and processing industries has also been affected during recent years as discussed by Stockton (1975):

Table II-36. Economic Activity for Texas

	1962	1972
Per capita personal income	$ 2,027	$ 4,045
Total personal income	$20,518	$47,121 (million)
Total cash farm income	$ 2,575	$ 3,722 (million) 1/
Cash farm receipts from crops	$ 1,352	$ 1,132 (million)
Cash farm receipts from livestock and products	$ 1,075	$ 2,122 (million)
Petroleum production	943	1,301 (million bbls)
Value of construction	1,132	1,751 1/
Manufacturing employment	497	741 (thousand)
Construction employment	---	238 (thousand)

Source: Ryan, 1973.

1/ 1971

"Currently oil production in February, 1975, decreased 7.0 percent compared with February, 1974, as the Texas fields have apparently reached their full capacity for the present. But higher prices of crude oil can be expected to continue; they will undoubtedly support exploration and will add substantially to the economy. Texas employment in oil and gas extraction in February, 1975, showed an increase of 10.5 percent over the February, 1974, figure, in spite of the fact that the total production of crude oil declined over the same period. The decline in gasoline consumption over the past year is reflected in the 15.1 percent decline of employment in refining. Some of the decline in refining has been offset by increased activity in chemicals, which are mainly petrochemicals. In spite of the decline in refining, oil and gas continue to be among the major supporting factors for the Texas economy."

d. Local, State, and Federal Government Plans, Policies, and Restrictions

Local

Municipalities and counties in the eastern Gulf Coast area have been granted broad powers by their respective states to control human activities within their geographical jurisdictions. In exercising this authority, local governments have typically enacted various programs and ordinances often including comprehensive land use plans, zoning ordinances, subdivision regulations, flood plain management ordinances, building codes, noise standards, air quality emission regulations, health regulations, performance standards for industrial operations, and the siting of utility lines including pipelines, and public review and approval requirements prior to the initiation of specific activities.

Local capital and operating budget processes and procedures may also function as de facto land use controls by influencing the location and scheduling of road and sewer construction, the availability of public water supplies, and other infrastructural elements.

Federal OCS activities per se occur in federal waters and therefore, outside of local areas of jurisdiction. However, secondary activities resulting from OCS leasing, such as the location and operation of service bases, pipelines, terminals, processing plants, and other facilities are subject to local laws and regulations. Industrial siting location is often significantly influenced by local government policies and restrictions such as zoning regulations, local taxation, educational policies, and other governmental attitudes of an economic nature or those affecting the "quality of life" of company employees and their families.

State

The three states within the proposed sale area have or are formulating numerous plans, policies, or restrictions which may relate either directly or indirectly to federal OCS leasing and related activities. State programs may include Coastal Zone Management programs; statutes governing shoreline uses; 208 Water Quality Management plans; highway programs; oil and gas transmission regulations; flood plain management; air and water quality standards; tax inducements to attract labor intensive industries; fisheries management and propogation programs; regulations governing common carriers; waste disposal regulations; and other plans and regulations for the protection of natural resources. Alabama also has a tentative plan for the development of a deep water offshore oil port. A more detailed discussion of state government programs, existing regulations, and agency responsibilities appears in Section I.C.1. and 4.

Federal

Federal plans, policies, and restrictions include programs and regulations relative to drilling and production activities; offshore structures; pipeline construction and safety; air and water quality pollution, emissions, and discharges; the transfer of oil from vessel to vessel and between onshore and offshore facilities and vessels; and protection of marine mammals and endangered species. These policies, programs and regulations are discussed in more detail in Sections I.C. and IV.

Additionally there are various federal programs providing technical and financial assistance to states and local governments. These programs principally involve planning and construction activities and land acquisition.

D. Future Environment Without the Proposal

The addition of the oil and gas produced as a result of this sale to the quantities of oil and gas currently being produced on the Outer Continental Shelf in the Gulf of Mexico can be expected to continue the use of facilities installed for the transportation and processing of oil and gas reserves developed from previous state and federal offshore lease sales.

Production developed in onshore areas prior to, concurrent with, and subsequent to production developed in the offshore areas also requires production, transportation, and processing facilities. In the event that this sale is not held, it is considered probable that the skilled and unskilled labor, specialized equipment, and other facilities that would be employed in the development of leases awarded as a result of proposed Sale 65 would be employed in the specialized activity of exploring for, producing, processing, and transporting oil and gas in an alternate area.

The resultant economic and environmental impact of these activities in other areas cannot be known at this time, as it would be necessary to delineate these areas in a precise fashion in order to estimate these impacts. It is possible that the resources would be employed in the onshore areas adjacent to the offshore areas, in which case, the economic impact would be similar to the impact anticipated to result from this sale.

Given the extensive development of industries supporting the offshore production of oil and gas, and the extensive development of industries related to the processing of oil and gas, additional supplies of oil and gas from any source in the Gulf of Mexico area are likely to be processed within existing facilities in the area.

It is probable that industry interest in the OCS indicates that larger quantities of oil and gas may be obtained for a given investment dollar. If this speculation is valid, it suggests that Outer Continental Shelf production is efficient in the economic sense, in that a larger return can be anticipated from a smaller expenditure of scarce resources.

A further observation governing the continued operation of the refining industry, and industries utilizing the products of refineries may be in order. It is probable that existing refineries within the Gulf of Mexico coastal area will continue to operate as long as demand for the products continue. In the event that sufficient feed stock is not available, imported crude oils will be utilized.

The environmental effects of additional onshore production and/or additional crude oil imports to the existing refining centers must be considered in determining the status of the future environment of the Gulf of Mexico region in the event that this proposed lease sale is not implemented.

Section III

Environmental Impacts of the Proposed Action

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

BLM
NEW ORLEANS OCS

A. Basic Assumptions Utilized in the Analysis of Environmental Impacts

1. Aspects of Oil and Gas Operations Primarily Affecting Offshore Environments

a. Cuttings and Drilling Fluids

Exploratory drilling operations are basically the same regardless of mobile rig type (jack-up drilling rigs, drillships, and semi-submersibles). Initially, a drive casing is installed along with a blowout preventer. The casing is either jetted into place or driven into the bottom with a pile driver. Drill mud is circulated through the drill stem and casing to contain subsurface pressures and remove rock cuttings. Cuttings are screened and discharged overboard where they settle to the bottom. Some mud remains attached to the cuttings when they are discharged. As the cuttings cascade down through the water column, the mud is washed free and creates a turbid plume trailing with the prevailing surface current. The volume of drilling cuttings generated and drilling muds is listed in Table III-1.

Otteman (1976) has considered the problem of drill cuttings and muds which result from offshore drilling and has presented the following analysis which is based upon experience in the Gulf of Mexico.

"The first 150± feet will be drilled or jetted with seawater. The resulting seawater mud will be returned directly to the sea floor without being pumped to the rig. While drilling the hole to 1,000 feet, typically only seawater will be used as drilling fluid; and it will be discharged overboard. When the formation clays do not make a viscous enough mud, some natural bentonitic clay will be added to the system. The discharged water amounts to approximately 7,000 barrels (for a typical 10,000 ft. well), and it will contain mostly natural mud generated while drilling the hole. Before running the conductor pipe to 1,000 ft., approximately six tons of bentonite clay will be added to the 1,000-barrel saltwater system. When the conductor pipe is cemented, this volume of bentonite clay in seawater will be discharged overboard.

"While drilling the remainder of the hole, the mud is continuously cycled back through the mud system. Some mud is discharged with the drill cuttings; and periodically drilling mud is discharged overboard to make room for natural mud made while drilling the hole. The maximum discharge will not exceed 200 barrels a day while drilling to 5,000 feet and 50 barrels a day from 5,000 to 10,000 feet. During approximately 20 days of drilling to 10,000 feet, some 2,000 barrels of bentonite clay and lignosulfonate treated mud would be discharged overboard. We would possibly begin converting the mud system from a seawater gel mud to a lignosulfonate treated freshwater mud at around 6,000 feet. This decision would be based on the relative economics of hauling freshwater from shore versus the higher maintenance cost of saltwater muds. During the additional 70 days operations while drilling from 10,000 to 18,000 feet, the discharge rate will not exceed 50 barrels a day; approximately 4,000 barrels of lignosulfonate drilling mud would be dumped overboard. When the well is completed, the mud remaining in the surface system is discharged overboard; and this can amount to as much as 800 barrels."

The typical composition of gelled seawater and lignosulfonate treated muds are listed in Table III-2.

b. Formation Waters

Produced water or liquid associated with the extracted oil and gas must be removed and disposed of. Produced water is relict sea water but with anomalous ion ratios. The median concentrations of trace metals found in produced formation waters are listed in Table III-3.

The following discussion of produced water is taken largely from Koons, et al (1975).

Produced waters generally contain appreciable concentrations of dissolved inorganic salts in which the principal cations are sodiums, magnesium, and calcium. The principal anions are chloride, sulfate, carbonate, and bicarbonate. The concentrations of total dissolved constituents can vary over a wide range such as from a few milligrams per liter to as much as 350,000 mg/liter. Collins (1974, 1975) reviewed the composition of many oil field waters and found that the majority contained high chloride concentrations. Hydrocarbons and some organic compounds may be present in produced waters at part per million levels. Dissolved oxygen may be present at low concentration in produced waters.

Typical sodium concentrations range from 23,000 to 57,000 mg per liter. Typical calcium concentrations are between 2,500 to 25,800 mg per liter and those for magnesium are from 100 to

Table III-1 VOLUME OF DRILL CUTTINGS GENERATED AND DRILLING MUDS

WELL TYPE	HOLE SIZE		CUTTING VOLUME		WEIGHT OF CUTTINGS REMOVED FROM HOLE		TOTAL MUD VOLUME (INCL. HOLE VOLUME)		DRILLING MUD TYPE
	INCHES 10,000 FT	INCHES 18,000 FT	YD^3 10,000 FT	YD^3 18,000 FT	TONS 10,000 FT	TONS 18,000 FT	BBLS 10,000 FT	BBLS 18,000 FT	
INTERVAL BELOW MUDLINE (FT)									
0-150	36	36	39	39	72	72	As required		Seawater and natural mud
150-1,000	25	32	108	176	203	332	As required		Seawater-gel natural mud
1,000-4,500	18	20	229	283	448	534	1800	2200	Seawater-gel Lightly treated mud
4,500-10,000	11	-	135	-	272	-	1600	-	Seawater/fresh-water - ligno-sulfonate mud
4,500-12,000	-	15	-	342	-	690	-	2800	Seawater/fresh-water - ligno-sulfonate mud
12,000-18,000	-	10	-	121	-	262	-	2000	Freshwater lignosulfonate mud
		TOTAL	511 YD^3	961 YD^3	995 TONS	1890 TONS			

Source: Otteman, 1976.

Table III-2. TYPICAL MUD COMPOSITION - SEAWATER GEL MUD

This type mud is typically used to drill from the base of the conductor casing to the surface casing point. Generally, the seawater gel system will be used from less than 1000 feet to a maximum of 4500 feet. The components used to make up and maintain the required characteristics of this mud system are:

Mud Components	Lbs/Bbl of Mud
1. Drilled Solids	48-60
2. Bentonitic Clay	30-40
3. Caustic - Sodium Hydroxide	0.5-1.5
4. Mica Flakes (Lost Circulation Material)	0.0- .5
5. Cellulose Polymer	0.0-.25
6. Seawater	As required - approx. 10#/bbl salt from the seawater

LIGHTLY TREATED LIGNOSULFONATE SEAWATER/FRESHWATER (6,000-8,000 ppm Cl^-) MUD

As the hole is deepened below surface casing it becomes necessary to start adding additional materials to maintain the desired mud characteristics. Slowly fresh water is substituted for sea water as the depth and temperature increase. A typical 10.0-10.5 pound per gallow lightly treated lignosulfonate system used to about 10,000 feet would include:

Mud Components	Lbs/Bbl of Mud
1. Drilled Solids	55-70
2. Bentonitic Clay	20-30
3. Barium Sulfate - Weight Material	45-60
4. Caustic - Sodium Hydroxide	1.0-2.0
5. Lignosulfonate	4-6
6. Lignite	0.0-3.0
7. Cellulose Polymer	0.0-.25
8. Seawater/Freshwater	As required - approx. 5# bbl salt from 50/50 seawater-freshwater

LIGNOSULFONATE FRESHWATER (3,000-4,000 ppm Cl^-) MUD

The deep portion of a typical well (below approximately 10,000 ft) would require a freshwater lignosulfonate mud system in order to maintain the mud properties as desired for proper hole maintenance. A typical 10.0-11.0 pound per gallon lignosulfonate treated mud system would include:

Mud Components	Lbs/Bbl of Mud
1. Drilled Solids	65-80
2. Bentonitic	20-30
3. Barium Sulfate - Weight Material	55-150
4. Caustic Sodium Hydroxide	1-2
5. Lignosulfonate	4-8
6. Lignite	3-8
7. Defoamer/Detergents	0.5
8. Fresh water	As required

Source: Otteman, 1976.

Table III-3. CHEMICAL CONTENT OF REPRESENTATIVE OFFSHORE BRINES 1/

Offshore Louisiana

Component		High Solids		Average Solids		Low Solids	
		mg/1 2/	%	mg/1	%	mg/1	%
Iron	FE	153	0.057	15	0.011	139	0.226
Calcium	Ca	17,000	6.287	4,675	3.294	772	1.254
Magnesium	Mg	2,090	0.773	1,030	0.726	152	0.247
Sodium	Na^+	84,500	31.250	49,120	34.612	22,651	36.800
Bicarbonate	HCO_3	37	0.014	100	0.070	933	1.516
Sulfate	$SO_4^=$	120	0.044	0	0	188	0.305
Chloride	Cl^-	166,500	61.575	86,975	61.287	36,717	59.652
Total Solids		270,400	100%	141,915	100%	61,552	100%

1/ USDI, GS, 1975a.

2/ mg/1 is equivalent to part per million.

5,000 mg per liter. There are occasional waters in which values either much higher or lower than the averages are observed.

It is important to note that the metal ions present in highest concentrations are those which are common either to seawater or many terrestial deposits and are not considered hazardous at the low concentrations observed except very close to the discharge (see below). Those metals generally considered as toxic are present at very low concentrations, often below the level of detection of even the sensitive methods used. The metals which would be of greatest concern in the environment are those which are toxic in concentrations of parts per million or less. To consider any possible hazards in discharging produced waters containing toxic metals into the marine environment, it is necessary to consider the following three factors:

(1) Concentration of trace metals in produced waters,

(2) Concentration of trace metals in normal seawater, and

(3) Toxicity levels of toxic metals. With the exception of Cu, Cr, Mn, and Sr, the concentration of trace metals in produced waters is not much different from that found normally in seawater.

The six most toxic elements for marine organisms are considered to be mercury (Hg), cadmium (Cd), silver (Ag), nickel (Ni), selenium (Se), and lead (Pd). Produced waters do not normally contain concentrations of these six elements greater than those found in seawater. Recently, attention has been paid to the determination of the two most toxic elements (Hg and Cd) in effluents from a number of crude oil offshore production units. In essentially all samples examined, values were below the levels of detection which were 50 parts per billion Cd and 0.5 part per billion for Hg. Of lower toxicity, but still of concern, are copper (Cu), chromium (Cr), arsenic (As), zinc (Zn), and manganese (Mn). There seems to be no damage caused by the low levels at which these trace elements are present in produced waters.

In order for a heavy metal to be toxic it apparently must be in the ionic state. In most natural waters much of the free metal ions would probably be bound to organic substances, naturally present in the water, decreasing the relative percentage of the ionic species. There is indirect evidence that organically chelated heavy metals in aqueous solutions do not have as great an effect upon organisms as do solutions of the metal salts. This could be due either to the fact that the organo-metallic complex is too bulky to enter a biological system or it could be due to the lack of availability of the metal for reaction with enzymes within the cells.

In addition to the possible environmental effects of trace elements in offshore produced waters, there are some additional components and properties of produced waters which have potential for minor environmental effects. These are salinity, dissolved oxygen, organic compounds other than hydrocarbons, and temperature.

Salinity -- Many offshore produced waters have higher concentrations of dissolved solids than the waters surrounding the platforms. The average total dissolved solids content for produced formation waters from offshore Louisiana production facilities is approximately 110,000 mg/liter (ppm), compared with 35,000 mg/liter for normal seawater. Since we are dealing with dissolved components, dilution occurs quite rapidly when the produced waters are discharged into the waters surrounding the platform. Any environmental effects will be extremely localized near the point of discharge. Mackin (1973) states, "This dilution in large water bodies and comparatively deep water is almost instantaneous, and dilutions of 1,000 parts of seawater to one of brine can be effected in even comparatively shallow water in distances of from 8 to 50 feet. In offshore waters in the Gulf or elsewhere, there is no brine problem for that reason."

Salinity measurements were made at 180 different sampling stations offshore and in Timbalier Bay (Louisiana) in the Offshore Ecology Investigation conducted in the northern Gulf of Mexico by Gulf Universities Research Consortium (GURC, 1974). Variations were correlatable with season and geography of sampling sites and all variations were within the ranges reported by season.

Dissolved oxygen -- Since oxygen is also a dissolved molecular species, the above comments about dilution certainly apply here as well. Also, the GURC (1974) study found that natural processes (tides, floods, droughts, etc.) completely overshadowed any changes in dissolved oxygen content which might have been caused by the discharge of production waters. No significant depletion of oxygen was observed at platform sites and what small reduction was noted could be explained by the generally rich biota living on the platform legs.

Organic compounds, other than hydrocarbons -- Other organics found in platform production waters will usually be present in even lower concentrations than the petroleum hydrocarbons associated with these waters. These other organics would likely be in the few ppm range and dilution would rapidly disperse them below the limits of any adverse environmental effects.

In the GURC study, measurements were made of the organic carbon content in the waters around two producing platforms and a control area some six miles away. Typical organic carbon contents measured around the platforms were 5.8 and 5.0 mg/liter (ppm), respectively, and 5.1 mg/liter (ppm) for the control area. Since these values are all within the sampling variability, it was indicated that there was no significant build-up of organic compounds in the vicinity of the producing platforms.

Temperatures -- Production waters tend to be somewhat warmer than the water surrounding the platforms, but here again, the differences are not likely great. As with dissolved species, dilution would almost instantaneously diminish any temperature gradients. In the GURC study, temperature measurements were also made at some 180 different sampling stations offshore and in Timbalier Bay. As was found with salinity, the temperature variations correlated with season and nearness to shore, and no impact of the platforms and their discharges on the water temperature was noted.

c. Platforms and Structures

The number of platforms which will result from this sale has been estimated to be from 5 to 25. The number of underwater completions which will result from this sale has been estimated to be from 0 to 1.

2. Aspects of Oil and Gas Operations Primarily Affecting Onshore and Offshore Environments

a. Development of Onshore Support Facilities

Portions of the Louisiana and Texas coast have developed a nearly self-contained gas and oil related infrastructure in the form of service, support, production, transportation, storage, processing, etc., facilities. The existing petroleum related infrastructure in Mississippi, Alabama, and Florida is not as completely developed or as oriented toward offshore operations as that of Louisiana and Texas.

The extent of the existing facilities in the Gulf of Mexico area has been described in Section II.C.1.b.(3).

It is assumed that the location of sale-induced support facilities is only loosely correlated with specific offshore points, and that they will tend to locate in areas presently committed to and experiencing like facilities and inducements. In general, the types and extent of existing land development are strong determinants in setting the pattern for future land development.

For example, previous exploration activities in the OCS region adjacent to the states of Florida, Mississippi, and Alabama utilized existing port facilities for the establishment of onshore operating bases. Of five major oil companies operating in the eastern Gulf region, three used publicly owned facilities at Panama City and Port Manatee, while two operated from privately owned facilities at Pensacola and Panama City (Florida State University and University of South Florida, 1975).

In particular, existing land development and activities related to the processing of crude oil and gas are expected to be factors influencing the destination of sale related production. Areas presently committed to a highly developed gas and oil related infrastructure are expected to have a greater tendency towards, and land use precommitment to, continuation of these activities than will those areas with a low or non-existent level of development. Should new incremental requirements be induced by this proposed sale, they will be essentially an expansion of the present capabilities. Exceptions to this general statement are noted in later portions of this section.

Sale inducements are not generally expected to overload this existing or historic capacity. Should the sale cause incremental increases in any segment of the infrastructure, such increases are likely to occur in presently industrialized areas.

Using the preceding estimates and general assumptions, the following development scheme and general land use requirements have been addressed: transport from production areas to shore; gas and oil pipeline development; oil transhipment; refinery construction; and onshore support facilities. Each of these activities has not been developed in detail because of widely varying economic conditions, the unknown production characteristics of the wildcat acreage, and the wide range of development alternatives available to the producers.

Although the most likely method for the transfer of crude oil from marine production facilities to onshore storage facilities is by pipeline, certain environmental and economic factors could suggest that crude production be transported by surface vessel from the production site to refining areas under some circumstances.

The most likely results of proposed Sale No. 65 are believed to be pipeline transportation to crude oil terminals located onshore, and shipment from these terminals by tanker or barge to existing refineries.

The USGS estimates that there will be 0 to 2 terminal storage facilities constructed as a result of proposed Sale No. 65. These sites will most likely fall in the Mobile to Panama City area and the Tampa/Manatee area.

In the event productive tracts are located off the coast of Florida, the construction of additional offshore and onshore facilities may be required. The following comments concerning additional gas pipeline construction in the state of Florida were obtained from an attachment to a letter dated January 3, 1975 sent by the Chairman of the Federal Power Commission and addressed to the Bureau of Land Management. The attachment was entitled Federal Power Commission Staff Comments on Possible Sale of Oil and Gas Leases Offshore Florida.

In order to utilize any new gas supplies discovered in the area of the possible sale, new offshore pipeline construction will be required. As to additional onshore pipeline facilities, this will depend upon which pipelines transport the gas and whether their systems are being utilized. However, it is unlikely that extensive additional onshore facilities would be required unless the development of the Florida area greatly exceeds expectations. To the extent that one of the interstate pipelines supplied from this area is currently curtailing deliveries, there should be spare onshore pipeline capacity to deliver part, if not all, of the new supplies resulting from the development to be included in the proposed sale (US, FPC, 1975).

If profitable quantities of oil are found in any of the tracts, it is assumed that oil pipelines will be developed offshore to connect new fields with new onshore terminals. No new overland pipelines are probable, but an additional onshore crude oil line has been considered in one of the scenarios. The USGS estimates 400-700 miles (644-1127 km) of pipeline construction may occur both onshore and offshore as a result of proposed Sale 65. These oil and gas lines would generally come ashore in the Mobile/Panama City area and the Tampa/Manatee area.

It is considered most likely that all oil production will be piped to shore, stored in tank farms, and finally transferred to existing refineries by means of tanker or barge facilities. A weekly trip by a 25,000 DWT tanker from the onshore storage facility to the refinery would be required to transport the production attributed to this proposed sale.

As discussed in Section III.D.1.b. production from offshore areas will tend to offset declining onshore and offshore production. The total refinery and petrochemical capacities in the Alabama, Mississippi, Texas, and Louisiana coasts has been and will continue to be in response to the region's need to supply oil products to adjacent regions and to meet its own needs, and this total will be derived independently of this lease-sale's possible contribution. Since this current capacity processes, and will probably continue to process, a combination of locally produced (onshore and offshore) and imported (domestic and foreign) crude oil, that produced by this sale is perceived to be inclusive of this total rather than constituting an additive factor.

By ''support facilities'' is meant a wide variety of supply and service industries having capabilities to support the exploration, production, and transportation of gas and oil. It includes companies dealing with tools, wireline, gas lift, cement, boats, etc., as well as machine and welding shops, trucking firms, wellhead and mud suppliers, supply stores, etc. Such capability is present in many industrialized areas within the Louisiana and Texas coastal areas, and to a lesser extent, in Mississippi, Alabama, and Florida. Capabilities exist in virtually all sectors which will be stimulated and utilized by sale related demands. It is not anticipated that the sale will create substantial demand for land dedicated to these uses. Specifically, the USGS estimates that there will be no new direct service base needs as a result of proposed Sale 65. It is assumed then, for the purpose of discussion in this section, that two of the previously used support base areas (publicly owned), Port Manatee and Panama City, are likely areas for support base set-up as a result of this proposed sale.

The individual and total sale induced acreage is assumed to be very small, and these requirements may be widely dispersed over large portions of the coastal zone. It can be assumed that the region has many site alternatives to those indicated which could host the modest acreage requirements, should development of the sale be different from that assumed.

Industrial development was used as the basis for land use requirements, as its site demands are most relevant to sale related activities. However, in doing so, it is understood that this land use represents only one component of a balanced land use/population ratio. Industrial development induces new employees and activities into the general sale area, and these will be distributed to more specific areas. This suggests land use implications beyond these specifically addressed because of requirements for residential, commercial, recreation, and other land use categories.

Any population or industrial inducement can be perceived as creating environmental stress for a localized area or general region. Conversely, shifting of developmental pressure to such areas can be perceived as relieving stress in other areas. Whether the result is a net gain or loss of total environmental stress is partially dependent on the relative stresses experienced in the areas which gain or lose population. It is axiomatic that stress induced into an area can often be mitigated by rationally developed, goal-oriented policies, and land use plans. Subsequent allocation of land in response to these demands remains a responsibility of state, regional, and local governments. Because of the time lag between the lease sale and the resulting land use impacts, there is sufficient lead time for these entities to develop responsive land use plans and policies.

In summary, the USGS estimates that a maximum of two onshore support facilities may be needed in direct response to this proposed sale and they would be oil terminal storage facilities. Possible locations for these facilities are one in the Tampa/Manatee area and one in the Mobile/Pensacola/Panama City area. It is further assumed for the purpose of this impact assessment that there will also be oil and gas pipeline landfalls and gas processing plants in these same two areas.

b. Employment fluctuations

"The Florida Coastal Policy Study: Impact of Offshore Oil Development," a report prepared by the Department of Urban and Regional Planning, Florida State University, and the Department of Geography, University of South Florida, considered the impacts that might be expected to occur in Florida as a result of exploration and production activities in the Gulf of Mexico adjacent to Florida.

The report contains a detailed analysis of impacts that might be anticipated in the Tampa Bay region with specific focus on Manatee County.

For the purpose of that study, it was assumed that support facilities in the Port Manatee area could support operations on OCS leases located off the Tarpon Springs-Tampa areas. The peak daily production was estimated to be 136,000 barrels of oil and 215 million cubic feet of natural gas, considerably above the production levels estimated to result from proposed OCS Sale No. 65. The estimated number of exploratory wells to be drilled amounted to 120, and would utilize a maximum of 12 rigs. Development drilling was projected from 32 platforms with 15 producing wells from each platform, for a total of 480 development wells. The design and construction of pipelines and onshore facilities was hypothesized to begin approximately two and one half years after the first discovery.

The peak direct employment figure developed by this study amounted to 2,270 workers, allocated to the following facilities, at a time 8 years after an assumed sale date.

Facility or activity	Employment
Development rigs	1,064
Production platform	320
Maintenance and workover	385
Transportation and galley	92
Support base	55
Pipeline and tanker terminals	38
Gas processing plant	48
Onshore service companies	260
Pipeline maintenance	8
	2,270

After the completion of drilling activities and an increase in maintenance and workover employment, the employment level was anticipated to stabilize at 1,505 persons (Florida State University and University of South Florida, 1975).

After allowance is made for employees that would not be expected to reside locally, the peak employment effects in Manatee County, Florida, were estimated to amount to 2,055 persons.

In order to develop total employment, a multiplier of 1.68 of basic employment resulted in an estimate of 3,452 total employment. Multiplying total employment of 3,452 by 2.45 yielded a population impact estimate of 8,457.

Additional estimates of the socioeconomic impacts resulting from production on the Outer Continental Shelf have been prepared by the New Orleans Outer Continental Shelf Office. These estimates have been developed by incorporating the following assumptions into base cases and hypothetical OCS development cases computed by Dr. Curtis Harris of the University of Maryland with the use of his Multiregional, Multi-industry Forecasting Model.

The rationale adopted for these estimates incorporated the following assumptions:

1) Domestic production of oil and gas would decline and be replaced by imported oil and gas.

2) New production of oil and gas would displace an equivalent volume of imports at existing processing centers.

3) Processing centers located closest to new OCS production would be ultimate destination points for crude oil and natural gas processing.

Three impact scenarios were developed to provide estimates of the economic effects that might result from proposed Sale No. 65. The assumptions incorporated into Scenario B most resemble the scenario developed as the "most likely case" in the discussion of impact further on in Section III and thus the discussion of impacts in Section III is based on Scenario B. See Table III-4. Scenarios A and C are discussed in the Alternative Section.

3. Aspects of Oil and Gas Operations Potentially Affecting Onshore and Offshore Environments

a. Transportation of Products Produced

Figures III-1, III-2, and III-3 depict natural gas movement by pipelines in 1974, crude oil movement by water in 1974, and total petroleum movement in 1974 respectively. These figures are included here in order to place the following discussion into perspective.

(1) Pipelines

Because of a lack of pipelines within reasonable proximity to the tracts offered by this proposed sale, it has been assumed that 700 miles of oil and/or gas pipeline would be installed as a result of proposed Sale 65. It is further assumed that two pipeline landfalls will occur, one in the Mobile, Alabama area, and one in the Manatee, Florida area. The assumed pipelines would connect producing fields to oil storage/terminal locations and gas processing plants at Mobile and Manatee.

It should be noted that the need for pipelines, and their ultimate construction, would be contingent upon the discovery of feasibly recoverable hydrocarbons from newly-leased areas and whether, as a result of previous sales, pipelines are constructed which will have sufficient capacity to accommodate production from proposed Sale 65. USGS resource estimates indicate a probable minimum of 400 miles of pipeline.

Should sufficiently productive tracts be located off the Florida coast, offshore pipeline construction would be required. Whether additional onshore pipeline facilities will be needed, however, will depend upon which pipelines transport gas and the extent to which existing systems are being utilized. It is unlikely, however, that extensive additional onshore facilities would be required unless the development of the Florida area greatly exceeds expectations. To the extent that one of the interstate pipelines supplied from this area is currently curtailing deliveries, there should be spare onshore pipeline capacity to deliver part, if not all, of the new supplies resulting from this proposed sale.

For impact assessment purposes then, a scenario has been developed which assumes that 700 miles of oil and/or gas piepline will be constructed and that landfalls will occur in the Mobile and Manatee areas.

(2) Barges and Tankers

Because of the anticipated production characteristics, it is assumed that little or no barging will occur between offshore production sites and onshore receiving facilities. It has been assumed that pipelines would most likely be constructed early in the development phase and would be functional at the time of production thus reducing or eliminating the need for barging.

The USGS resource estimates, however, do assume that tanker operations will occur from oil storage and terminal facilities in the Manatee and Mobile areas to existing refineries in Alabama, Mississippi, and Louisiana. The volumes range from 2,500 to 24,000 barrels per day and could be accommodated by a weekly trip by a vessel ranging in size from a single barge to a 25,000 DWT tanker.

Table III-4.

<u>Scenario B</u>: High Discovery Mobile and Pascagoula

A. Resource Estimates
   1. Crude Oil: 150 million barrels
   2. Natural Gas: 175 billion cubic feet

B. Facility Location
   1. Exploratory wells: 75 (27 off Jackson Co. Miss., 48 off Mobile, Alabama)
   2. Platforms: 25 (9 off Jackson Co. Miss., 16 off Mobile, Alabama)
   3. Development wells: 225 (82 off Jackson Co. Miss., 143 off Mobile, Alabama)
   4. Pipelines: 700 miles
   5. Operating bases: 1 (Mobile Co. Alabama)
   6. Oil terminals: 2 (Mobile Co. Alabama; Jackson Co. Miss.)
   7. Gas Processing: 2 (Mobile Co. Alabama; Jackson Co. Miss.)
   8. Well drilling employment: Jefferson, Orleans, and Plaquemines Parishes, Louisiana)

Table III-4. (continued).

Scenario B. OCS Related Employment (High Resource Estimates)

Year	Exploration Drilling	Development Drilling	Platform	Support Facilities	Oil Terminal	Gas Processing	Pipeline	Total
1977								
1978								
1979								
1980	377			64				441
1981	583		44					627
1982	753	65	110					928
1983	753	260	220			635	350	2218
1984	377	2600	550		66	60		3654
1985			550					740
2008			550	64	66	60		740

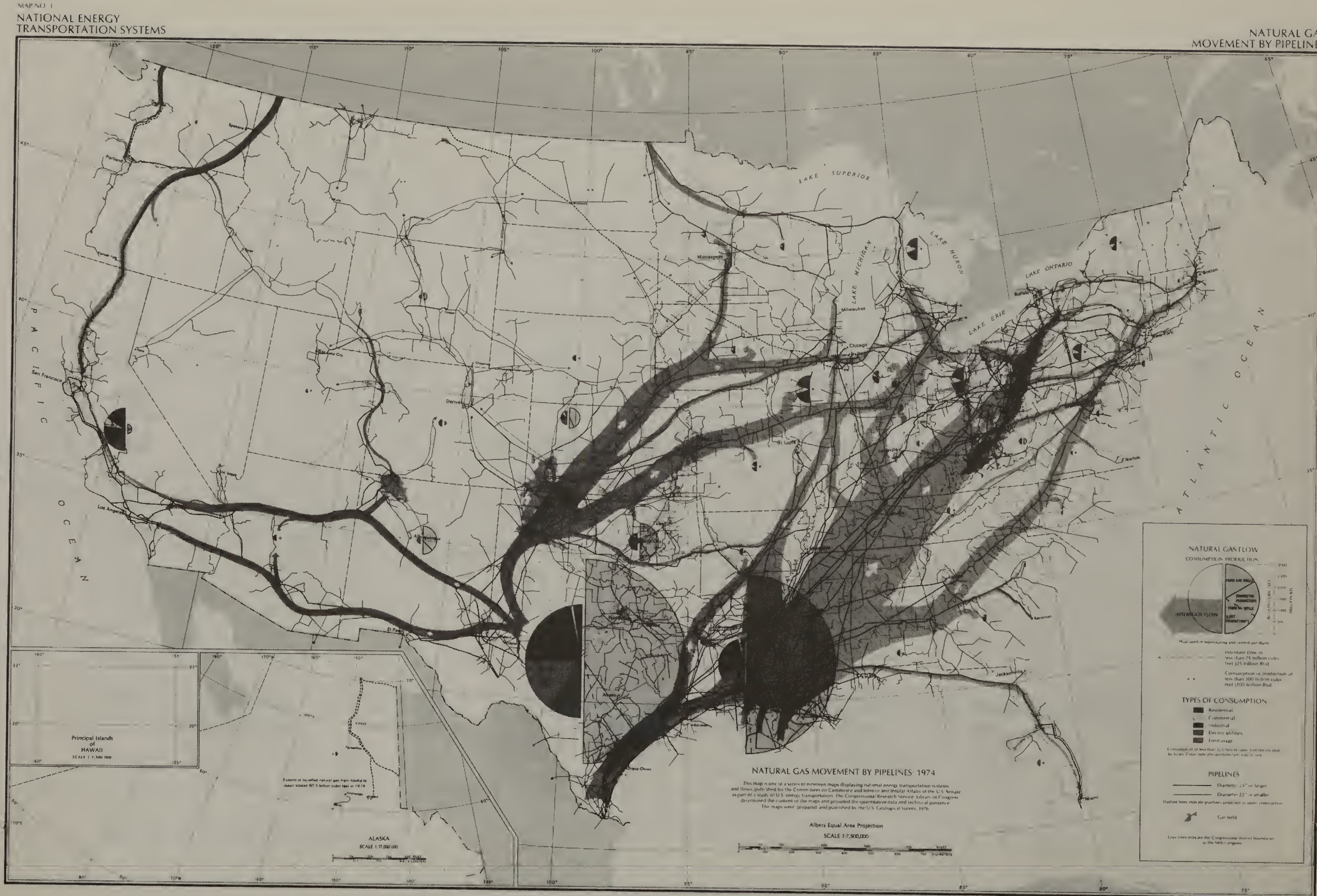


FIGURE III-1

NATURAL GAS MOVEMENT BY PIPELINES: 1974

SOURCE: CONGRESSIONAL RESEARCH SERVICE AND U. S. GEOLOGICAL SURVEY, 1977

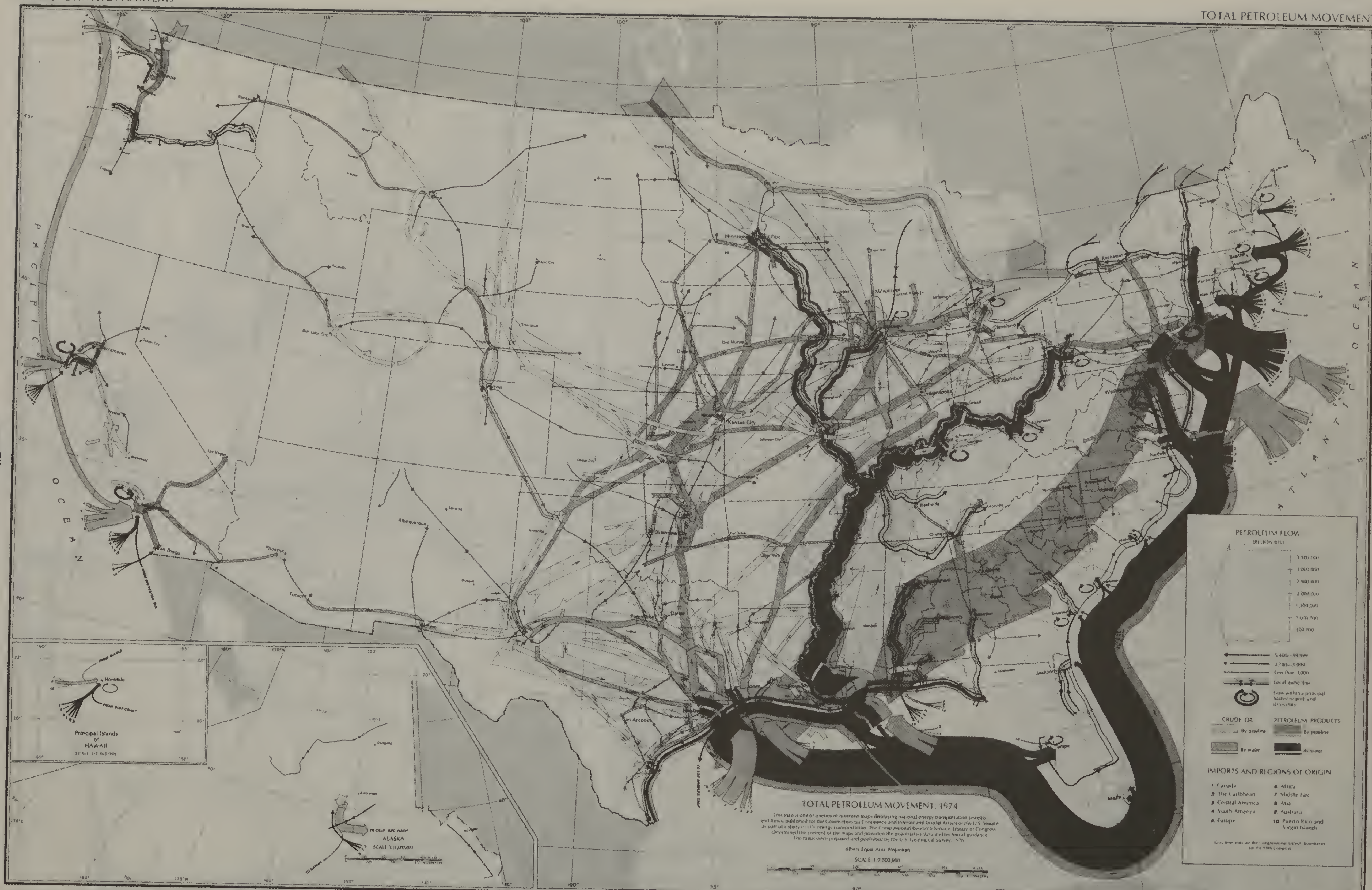
MAP NO. 8
NATIONAL ENERGY
TRANSPORTATION SYSTEMS

CRUDE OIL MOVEMENT
BY WATER

CRUDE OIL MOVEMENT BY WATER 1974 SOURCE: CONGRESSIONAL RESEARCH SERVICE AND U. S. GEOLOGICAL SURVEY, 1977

FIGURE III-2

MAP NO. 11
NATIONAL ENERGY
TRANSPORTATION SYSTEMS



TOTAL PETROLEUM MOVEMENT 1974   SOURCE: CONGRESSIONAL RESEARCH SERVICE AND U. S. GEOLOGICAL SURVEY, 1977

FIGURE III-3

b. Transportation of People and Supplies

Transportation of supplies and personnel between onshore facilities and offshore rigs and platforms is accomplished through the use of boats and helicopters, both of which have differing requirements with respect to the mode of transportation and the commodity transported.

(1) Boats

Boats of varying sizes ranging from 60 feet to over 200 feet in length are used to transport personnel and equipment and supplies from onshore locations to offshore rigs and platforms. Typical cargoes include drilling fluids, cement, fresh water, tubular goods, fuels, food, tools, and parts. Boat operations require all-weather harbors with minimum dockside depths between 15 and 20 feet and adequate turning area. It is assumed that crew and work boats will be moved and supplied at the service base locations discussed in Section III.A.2.a. The discussion of service base requirements in that section should be referred to since impacts related to the use of crew and workboats are primarily of a land use and economic nature derived from service and supply requirements.

The proposed Sale 65 scenario assumes that three supply boats and one crew boat (NERBC-RALI, 1976) are required to service each drilling rig during the exploratory drilling phase, although, in reality fewer boats may suffice since one boat can service more than one rig at a given time provided that the rigs are reasonably close together.

During production drilling four supply boats and one crew boat are needed to service each platform under this scenario (NERBC-RALI, 1976). During actual production and workover, one supply boat would be required for each two platforms; no crew boats would be required.

(2) Aircraft

The helicopter is the primary aircraft vehicle used for support of oil and gas exploration and production activities. These craft are used to transport personnel and, in some cases, supplies between onshore and offshore locations.

It is assumed that two helicopters will be required to service each rig or platform (New England River Basins Commision and the Resource and Land Investigations Program, 1976, p. 1.29); therefore, ten helicopters would be in operation during the exploratory phase and 50 would be in operation during the production drilling phase. During production and workover, the helicopter requirement will be approximately 25. It is further assumed that helicopters will be based at either existing airports in proximity to service bases, or at the service bases themselves. Helicopter facilities requirements at service bases are discussed in Section III.A.2.a.

c. Accidents

(1) Natural Phenomenon with the Potential for Causing Accidents

As outlined in the "Description of the Environment," natural phenomenon with potential for causing accidents are hurricanes, karst topography, unstable slopes, and faulting.

Hurricanes have caused considerable damage to platforms as the result of massive mud slides along the Mississippi Delta area. However, due to the absence of massive delta lobes in the eastern Gulf of Mexico, no damage to unstable bottoms are expected.

Karst topography mapped on a regional basis as shown in Figure II-3 would not normally be a problem since all porous zones are "cased off" during drilling operations to prevent the loss of drilling mud.

Unstable slope areas as mapped by SUSIO (1976) are all found along the West Florida Escarpment, well outside any tracts offered for this proposed lease sale.

Although faulting has been mapped in the general vicinity of the proposed lease area, faulting is expected to be at a minimum.

In summary, no natural phenomenon which might cause accidents are expected in the area of the proposed lease sale.

(2) Oil Spills

All phases of petroleum development from exploration to processing have the potential for contributing to oil spills. Oil spills are recognized as the most common cause of environmental damage associated with offshore petroleum development. The following discusses the causes and effects of oil spills.

The most important feature of oil spill statistics as reported by US CEQ (1974) is the size of individual spills which range from a fraction of a barrel to over 15,000 barrels. Most spills are at the low end of this range. In 1972, 96% of spills were less than 24 barrels (100 gallons). A few very large spills account for most of the oil spilled (the Torrey Canyon accident of 1967 in Great Britain spilled twice as much oil as was reported spilled in the United States in 1970). In 1967 and 1972, a total of four spills accounted for 75% of all oil spilled in the U.S. as a result of offshore operations. Because amounts spilled per incident can vary by a factor of one million, it is meaningless to estimate average amounts of oil that might be spilled during development. Data supplied by the Geological Survey for the period of 1964-1976 indicate a total of 27 major oil spill incidents connected with Federal OCS oil, gas, and condensate (Table III-5). The estimated total volume of oil spilled during this period as a result of these incidents is at least 327,659 barrels (13.8 million gallons). Table III-5 compares oil spill incidents to total production for the years 1964-1976.

(a) Causes

Pipeline Accidents

There have been 17 reported pipeline breaks and leaks of greater than 50 barrels each in the Gulf of Mexico: 1967-1976. The total volume of oil spilled due to these accidents is approximately 202,588 barrels. This volume amounts to .007% of the total Gulf of Mexico OCS production since 1967. Assuming this historically developed ratio and the USGS estimates of recoverable resources for this proposed sale of 15-150 million barrels, from 1,050-10,500 barrels could be spilled from pipelines as a result of this proposal.

Since 1971, information on pipeline leaks of all sizes has been maintained. Figure III-4 illustrates principal causes of pipeline and pump spills of 1-50 barrels by year and volume for the Gulf of Mexico (USDI, GS, 19756).

Since 1970, 72.9% of the total volume of oil spilled by pipelines is the result of ship anchors dragging across the pipelines, causing them to rupture. Other causes of pipeline damage include movement due to wave action during storms, impact of trawl boards of commercial fishing boats, and corrosion of the pipe due to formation water that is produced with the oil.

Blowouts

It is possible for oil or gas wells to blow out of control during drilling operations, completion, and production. Blowouts may be prevented during drilling by increasing mud weight and activating blowout preventers. When a well is completed, a subsurface safety device is installed to prevent the well from blowing out if surface control is lost.

A gas well blowout will cause little or no environmental damage because the gas will either burn or dissipate into the atmosphere. An oil well blowout can release large quantities of drill muds and cuttings, as well as oil, into the marine environment.

Gulf of Mexico OCS statistics indicate that an average of one blowout occurs for every 245 wells drilled, spilling approximately 1,294 barrels of oil each. Not one pollution incident by blowout, greater than 200 barrels, has occurred since 1971 (USDI, GS, 1976). Most blowouts causing spillage result from producing oil wells, not wells being drilled. Producing oil well blowouts are normally a result of equipment malfunctions, workover procedures, human errors, storms, and collisions.

It is estimated that between 30-225 development wells will result from this proposed sale. Based on past Gulf of Mexico statistics, it is estimated that up to two blowouts could result from exploratory drilling, production, or completion.

Recently (November 1976) a gas well blowout occurred in High Island Area, South Addition 563. The following discussion is based on the final report of the incident by Brooks and Bernard (1977). The blowout occurred during drilling at about 1,830 m (6,000 ft). The platform was lost and a crater 137 m (450 ft) deep and 487 m (1,600 ft) wide was created. This was the fifth well drilled from the same platform, and some of the previous wells had penetrated to near 3,048 m (10,000 ft), apparently with no problems. At the time of this writing the cause of the blowout had not been determined, but a wet, oil-related gas, deeper than the biogenic gas noted at the crater some four months after the blowout, was the most likely cause. The bulk of the "several million tons" of sediment resuspended by the blowout was redeposited within 600 m (1,970 ft), but redeposited sediment was detected up to 2,440 m (8,000 ft). Five months after the blowout, a gas "seepage" of about 400,000 cu ft per day continued causing a visible plume of suspended sediment from the crater. Certainly such a blowout could cause extensive damage to any nearby area of high biological productivity, such as a coral reef or live bottom areas.

Explosions and Fires

Combustible hydrocarbon liquids or vapors making contact with arcing electrical or overhead

TABLE III-5 +MAJOR OIL SPILL INCIDENTS - GULF OF MEXICO OCS: 1964-1976

Calendar Year	Incidents	Oil Spilled	Number of Fixed Structures	Annual OCS Production
1964	5	14,928 barrels	1,100	123 million barrels
1965	2	2,188 barrels	1,200	145 million barrels
1966	0	None	1,325	189 million barrels
1967	1	160,639 barrels	1,450	222 million barrels
1968	1	6,000 barrels	1,575	269 million barrels
1969	4	10,624 barrels	1,675	313 million barrels
1970	3	83,895 barrels	1,800	361 million barrels
1971	1	450 barrels	1,891	419 million barrels
1972	0	None	1,935	412 million barrels
1973	4	22,175 barrels	2,001	395 million barrels
1974	2	22,046 barrels	2,054	361 million barrels
1975	1	Unknown	2,079	328 million barrels
1976	3	4,714 barrels	2,102	320 million barrels
	27	327,659 barrels		*3,859 million barrels

*Estimate
+Includes spills of over 10,000 gallons (238 bbl)

Source: USDI, GS, 1977c.

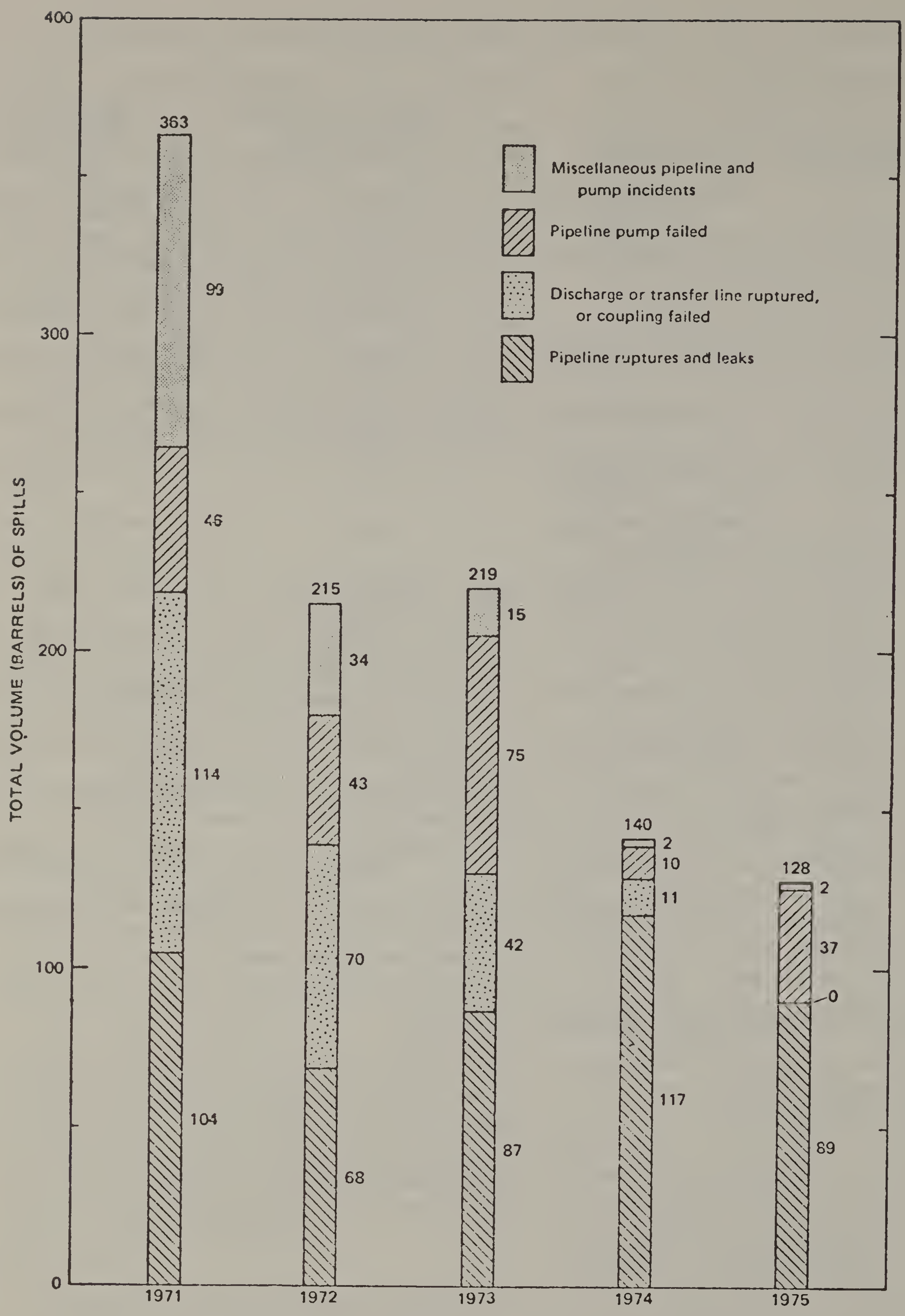


FIGURE III-4 Principal causes of pipeline and pump spills of 1-50 barrels, by year and volume of spills, 1971-75, Gulf of Mexico Outer Continental Shelf. (USGS Circular 741).

mechanical devices are thought to cause most platform fires. More rarely they are ignited by lightning or static electricity. Sometimes platform fires involve the accidental ignition of fuel, solvent, or heat exchanger fluids.

If producing wells are damaged to the extent that oil flows freely and ignites, they are ususally allowed to burn while remote control operations are underway. In this way, most hydrocarbon liquid expelled by the well burns, reducing the fire hazard during relief operations and lowering the volume of oil dispersed into the ocean. If a blowing well is releasing mostly natural gas, ocean pollution is minimal. However, personnel and the platform or drilling structure are imperiled in the event of a fire.

From 1956 to 1977, many platform fires of varying sizes occurred during OCS production. Most were extinguished without causing serious damage or pollution. Of 199 recorded explosions and fires, nine had oil spills totalling 87,141 barrels. When the amount spilled is compared to total production of 3,537 million barrels, the annual spillage rate is 0.0025 percent. Assuming a 25-year life of discovered fields and a 150 million barrel total production, approximately 148 barrels of oil may be spilled per year as a result of the proposal.

Every fire and/or explosion that occured on a platform in the Gulf of Mexico is recorded by USGS. However, on Visual No. 7, only 65 of the 199 recorded incidences has been identified; these are the ones that resulted in a major or serious occurance. Two of the accidents that are considered serious resulted in spilling a total of 83,500 bbl of oil.

Tanker Accidents and Operations

Accidents, carelessness, or mismanagement releases almost 36.5 million barrels of oil annually into the world's ocean (Charter et al., 1973). Figure III-5 shows the percentage of total overflow from various polluting sources (Porricelli and Keith, 1973).

About 98% of all of the oil spilled by vessels is from incidents involving over 1,000 barrels. Most large tanker spills occur nearshore (within 80 km of land) when the vessel runs aground, rams a fixed structure, or collides with another vessel.

During 1973, approximately 1,404 billion tons of oil were transported by tankers; about 1,355 billion tons of crude were similarly transported during 1971 (National Academy of Sciences, 1975).

From 1969 to 1973, a total of 950,000 long tons of oil were spilled by tankers (Card et al., 1975); average annual spill volume was 190,000 long tons (13.5 million barrels). A ratio of volume transported (10 billion barrels) to volume spilled (1.35 million barrels) results in a spillage rate of 0.013%. The CEQ (1974) report lists a spillage rate for tankers of 0.016%. The above spillage rate calculations reflect 10 billion barrels. Tankers probably will not be used to transport production from offshore to onshore facilities as long as pipelines are technically and economically feasible. Pipelines will carry the production from offshore platforms to onshore storage facilities.

(b) Oil Spill Risk Analysis

Offshore oil and gas development in the eastern Gulf of Mexico, as a result of this proposal presents the probability of at least one oil spill greater than 1,000 bbl occurring during the projected 25 year fieldlife. Oil spills on the ocean surface are usually described in terms of spreading, drifting, and weathering. A combination of many factors control oil spill movement and composition: original composition of the oil, age, solubility, volume spilled, concentration, dilution, evaporation, photo oxidation, absorption on suspended particulates, microbial degradation, mechanical or chemical treatment, water salinity and temperature, waves, winds, currents, season, and geographical location.

In order to assess the probability of oil spills from offshore locations reaching shore sites, a variety of computer simulations have been conducted. It should be remembered that two separate and distinct probabilities are involved in this type of analysis. The first is the probability of a spill occurring and the second is the probability of a spill impacting environmentally sensitive areas.

One of the first trajectory studies for offshore oil spills was made at the Massachusetts Institute of Technology by Stewart, et al (1974) for the Council on Environmental Quality. The study consisted of a computer simulation of the environment (wind and currents) affecting movements of hypothetical oil spills. Parameters obtained from the analysis included minimum time to shore, average time to shore, and probability of the spill reaching shore.

A recently developed oil spill risk analysis model was used by the Department of the Interior

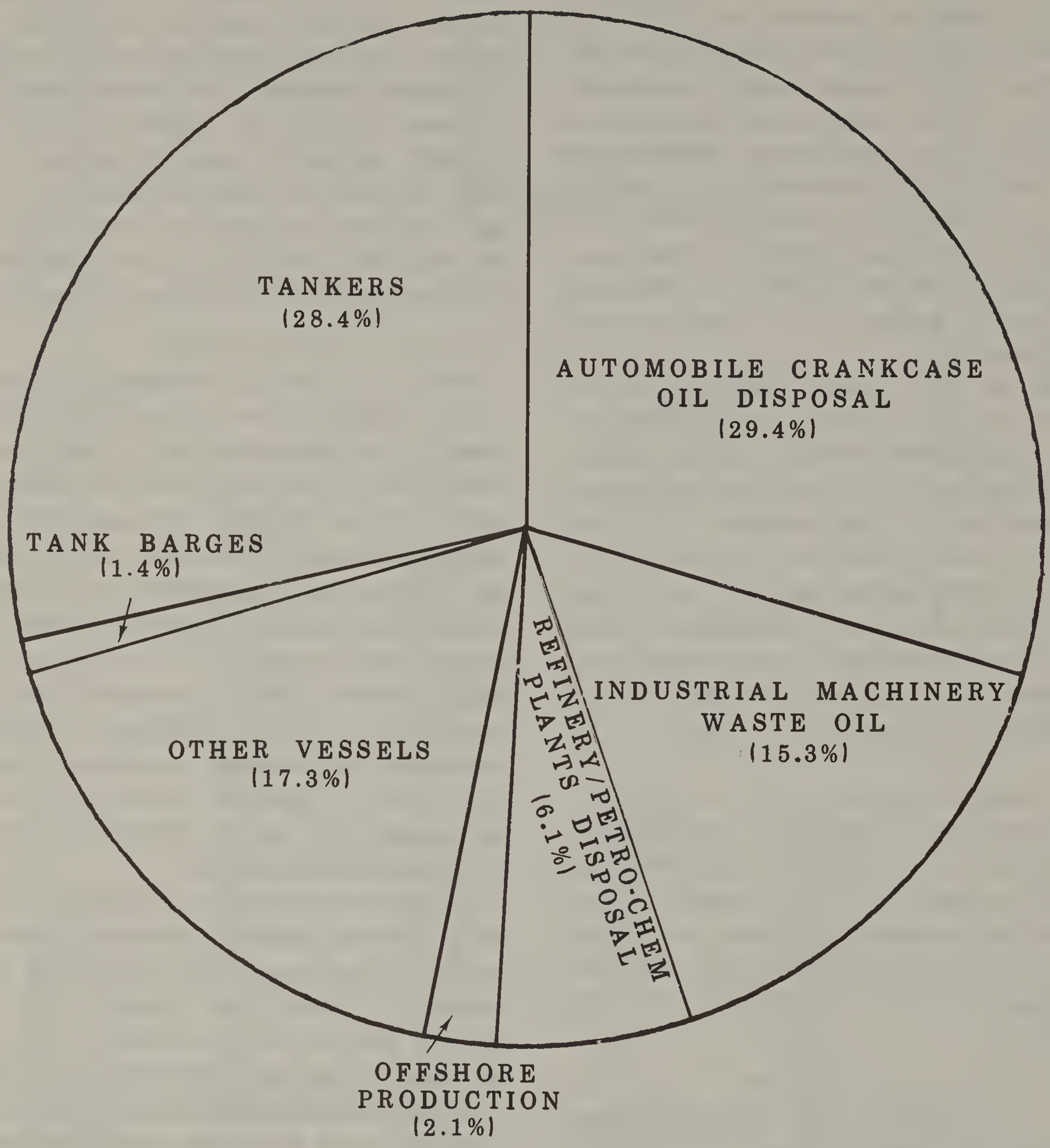


FIGURE III-5 Sources of Oil Pollution to the Oceans.

Source: Porricelli and Keith, 1973

to develop an analysis of probable impacts associated with OCS oil and gas development within the proposed lease sale area. A description of the model, details of methodology, and a summary of probable risks are provided in Appendix H.

Utilizing available oceanographic and meteorological data in conjunction with the location of biological, recreational, and other resources specific to the eastern Gulf of Mexico, the model provides a means of (1) analyzing the probabilities of OCS-related oil spills occurring, and (2) evaluating possible drilling sites within the proposed sale area in relationship to potential impacts on the environment in case of an OCS oil spill. Additionally, the model determines the average time that it would take for a hypothetical spill to reach an environmentally sensitive area. This analysis could facilitate determination of further significant trade-offs for possible alternative selection of tracts that may be offered for lease.

Representative spill sites were selected for analysis from proposed leases (P1-P14), existing leases (E1-E12), and transportation routes (T1-T3) (Figure III-6) based on the estimated petroleum resources for individual prospects within those areas (U.S. Geological Survey, proprietary data). The risk analysis model distributions permitted separate estimates of platform, pipeline, and tanker spill frequencies which could then be combined to estimate the risk from production, transport of crude to shore, and transshipment of some of the crude within the Gulf of Mexico. Spill frequency estimates were further categorized for spills less than 50 barrels, between 50 and 1000 bbl, and greater than 1000 bbl in size. The size grouping is somewhat arbitrary but important in considering the significance of weathering and the impact of oil spills.

Using available wind and current data, an oil spill trajectory model was constructed and used to analyze movements of hypothetical oil spills on a digital map of the area. The area that might be affected was defined as the region between 22 1/2° to 30 1/2° N latitude and about 77 1/2° to 90° W longitude.

The spatial disposition of the trajectory simulations is given in Table III-6. The final location of each trajectory was recorded and the results for each spill site were averaged. Figure III-7 shows the locations of the land segments referred to in Figure III-8.

Oil spill trajectory simulations were conducted keeping track of the frequency with which trajectories intersected the locations of biological, recreational, and other resources. Trajectories were recorded as impacting a resource only in cases where the resource was listed as being vulnerable to oil spills in the month the impact took place. Figure III-9 gives the probability of impact of each of the 30 categories of biological, recreation, and other resources for a spill originating at the 25 spill sites within the eastern Gulf region (Figure III-7). The likelihood that a given spill trajectory from a proposed lease would beach at the location of a specific land based resource during critical months is generally less than 16% within 60 days.

The probability of at least one spill greater than 1,000 bbl occurring during the 25 year production life of the field and impacting the various biological, recreational, and/or other resources (Figure III-10) is used as the basis for assessing the impacts discussed in Section III. There is a tendency for resources that occupy a large area of the shoreline or continental shelf to exhibit higher probabilities of impact. In reality the impacts of a particular spill may only affect a small portion of that resource population or habitat.

(3) OCCUPATIONAL HAZARDS

Although precautions are taken accidents still occur. Table III-6 indicates the number of personnel fatalities and injuries that occurred from 1970-1976. It is noted that in view of the number of personnel that work offshore, the number of accidents is extremely low.

Based on 1976 figures it is estimated that 6 fatalities will result from this proposed sale for 150 million barrels of oil produced.

B. Impacts on the Physical Environment of the Gulf of Mexico Area

1. Impact on the Gulf Seafloor

Impacts to the seafloor resulting from the proposed sale would be in the form of physical disturbance resulting from construction activities. There are 25 platforms, 1 underwater completion, and 700 miles of pipelines estimated to result from this proposed sale. In the case of platforms and the subsea completion, bottom disturbance would occur only in the immediate vicinity of the structure. For pipelines, bottom disturbance would result from trenching activities utilized in burial of the pipelines in a zone approximately 9

FIGURE III-6 Map showing potential starting points for spills from proposed leases (P1-P14) existing leases (E1-E12), and transportation (T1-T3).

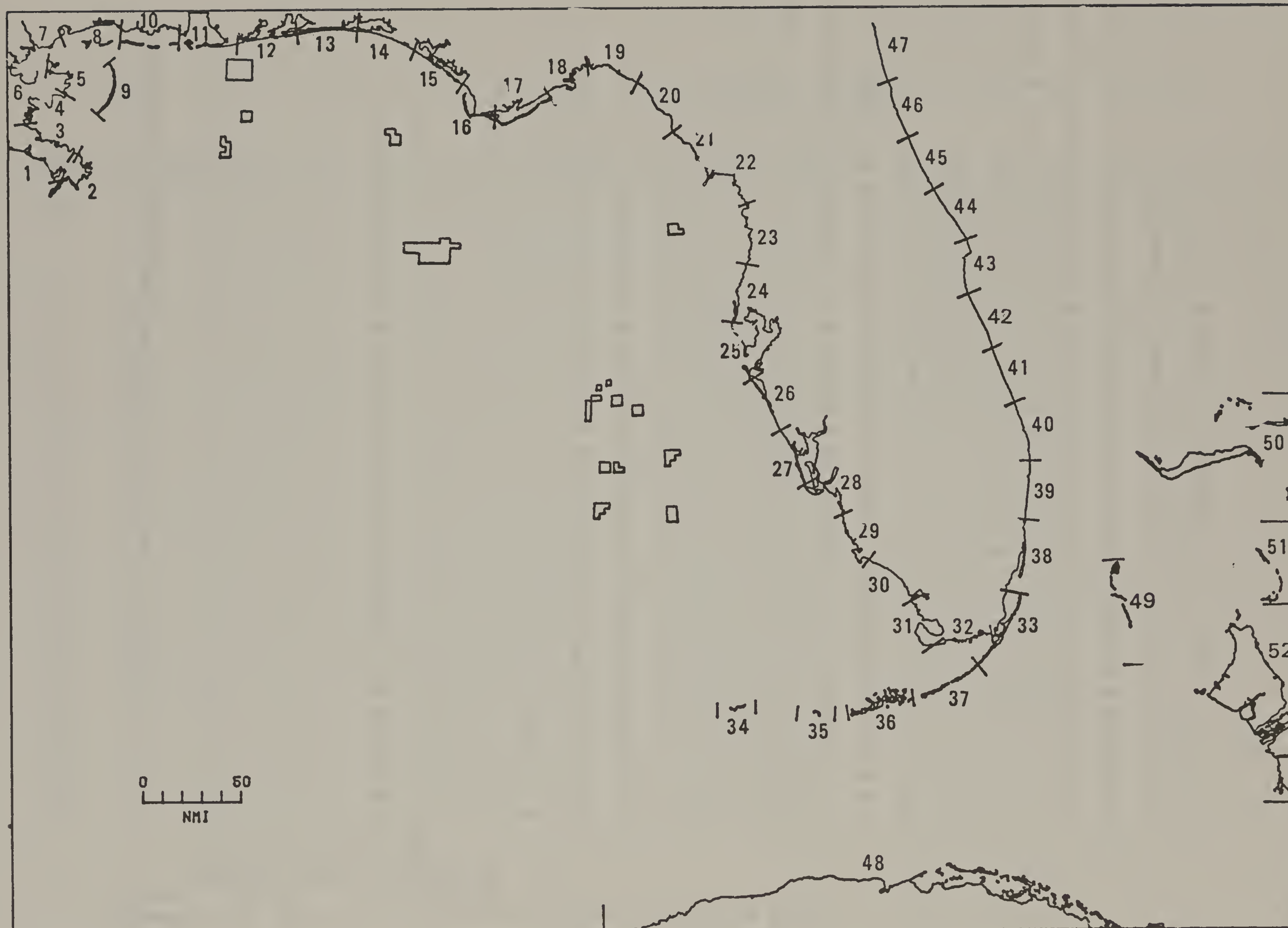


FIGURE III-7 Map of land segment numbers.

FIGURE III-8 Probabilities (in percent) that an oilspill starting at a particular location will reach a certain land segment in 3 days.

Land Segment Number	Hypothetical spill location P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	27	n	n	n
2	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	2	26	11	40	26	n	n	n
3	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	5	11	n	2	n	n	n	n
4	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	3	3	n	n	n	n	n	n
5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	2	n	n	n	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
9	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	5	34	7	4	3	n	n	n	n
10	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
11	7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	5	n	n	n	n	n	n	1
12	10	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
13	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
14	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n
15	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	2	n	n	n	n	n	n	n	n	n
16	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
17	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
18	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
19	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
20	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
21	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
22	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
23	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
24	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n
25	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n
26	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
27	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
28	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
29	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
31	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
32	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
33	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
34	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
35	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
36	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
37	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
38	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
39	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
40	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
41	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
42	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
43	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
44	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
45	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
46	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
47	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
48	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
49	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
50	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
51	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
52	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent.

FIGURE III-9 Probabilities (in percent) that an oilspill starting at a paticular location will reach a certain object in 3 days.

Object	P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
	Hypothetical spill location																								
Land	18	n	1	n	n	n	n	n	n	n	n	n	n	n	n	3	6	51	47	15	45	53	2	n	1
1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	50	n	n	n	n	n	n	n	n	n	n
2	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
3	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
4	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	8	9	n	1	6	n	n	n
5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	14	n	n	n	n	n	n	n	n	n	n	n	n	n	n	3	6	37	7	4	3	n	2	n	1
9	15	n	n	n	n	n	n	n	n	n	n	n	n	n	n	3	n	4	n	n	n	n	n	n	1
10	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	10	39	11	42	42	n	n	n
11	2	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
12	n	n	n	n	n	8	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	7	n	n
13	n	n	n	n	n	1	1	n	1	10	32	n	n	2	34	n	n	n	n	n	n	n	n	n	n
14	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
15	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	28	n	n
16	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	41	n	n
17	2	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	15	43	14	44	*	n	n	n
18	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
19	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
20	6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	2	n	n	n	n	1	n	1
21	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
22	22	1	n	n	n	n	n	n	n	n	1	n	n	n	n	5	1	7	n	n	n	n	6	n	2
23	3	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
24	1	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	6	45	48	17	39	n	n	n	n
25	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	6	40	16	5	4	n	n	n	n
26	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
27	3	n	n	n	n	n	n	n	n	n	3	n	n	n	n	n	n	n	n	n	n	n	11	n	n
28	4	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
29	11	1	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	4	n	n	n	n	n	n	n
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent

* - greater than 99.5 percent

FIGURE III-10 Probabilities (in percent) of one or more spills and most likely number of spills greater than 1,000 barrels occurring and contacting objects over the (remaining) production life of the lease area.

Object	Within 3 days						Within 10 days						Within 30 days						Within 60 days					
	Proposed Leases		Existing Leases		Both		Proposed Leases		Existing Leases		Both		Proposed Leases		Existing Leases		Both		Proposed Leases		Existing Leases		Both	
	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode
Land	2	0	95	3	95	3	7	0	99	4	99	4	13	0	99	5	99	5	16	0	*	5	*	5
1	n	0	n	0	n	0	n	0	n	0	1	0	1	0	n	0	2	0	2	0	2	0	5	0
2	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
3	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
4	n	0	17	0	17	0	1	0	24	0	25	0	2	0	37	0	38	0	2	0	43	0	44	0
5	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
6	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
7	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
8	1	0	18	0	19	0	4	0	52	0	54	0	6	0	65	1	67	1	8	0	68	1	71	1
9	1	0	n	0	1	0	2	0	27	0	29	0	4	0	45	0	47	0	5	0	51	0	54	0
10	n	0	93	2	93	2	2	0	96	3	96	3	4	0	97	3	97	3	5	0	97	3	97	3
11	n	0	n	0	n	0	1	0	4	0	5	0	2	0	26	0	27	0	2	0	35	0	37	0
12	1	0	n	0	1	0	1	0	n	0	2	0	2	0	n	0	2	0	2	0	n	0	2	0
13	n	0	n	0	n	0	2	0	n	0	3	0	5	0	1	0	6	0	8	0	10	0	17	0
14	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
15	2	0	n	0	3	0	4	0	n	0	5	0	5	0	n	0	6	0	6	0	n	0	6	0
16	3	0	n	0	4	0	4	0	n	0	5	0	6	0	1	0	6	0	7	0	1	0	7	0
17	n	0	98	3	98	3	3	0	99	4	99	4	5	0	99	4	99	4	6	0	99	4	99	4
18	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	1	0	n	0	1	0
19	n	0	n	0	n	0	1	0	3	0	5	0	2	0	21	0	23	0	3	0	29	0	31	0
20	1	0	n	0	1	0	1	0	19	0	21	0	3	0	41	0	43	0	5	0	48	0	51	0
21	n	0	n	0	n	0	n	0	n	0	n	0	1	0	n	0	1	0	3	0	1	0	4	0
22	2	0	n	0	2	0	3	0	30	0	32	0	5	0	54	0	56	0	6	0	60	0	62	0
23	n	0	n	0	n	0	n	0	2	0	3	0	1	0	11	0	11	0	1	0	12	0	13	0
24	n	0	35	1	85	1	4	0	91	2	91	2	6	0	92	2	93	2	7	0	93	2	93	2
25	n	0	25	0	25	0	3	0	42	0	43	0	3	0	45	0	46	0	4	0	45	0	47	0
26	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
27	1	0	n	0	1	0	2	0	1	0	3	0	3	0	3	0	5	0	3	0	4	0	7	0
28	n	0	n	0	n	0	1	0	7	0	8	0	2	0	27	0	29	0	3	0	36	0	37	0
29	1	0	n	0	1	0	1	0	8	0	9	0	2	0	23	0	25	0	3	0	28	0	29	0
30	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0

Notes: Prob is the probability (in percent) of one or more spills contacting the object.
Mode is the most likely number of contacts.
n - less than 0.5 percent.
* - greater than 99.5 percent.

Table III-6. Gulf of Mexico Outer Continental Shelf Summary of Blowouts, Fires, and Explosions and Miscellaneous Accidents

Year	Blowouts		Fires and Explosions		Miscellaneous		Total	
	Fatalities	Injuries	Fatalities	Injuries	Fatalities	Injuries	Fatalities	Injuries
1970	4	27	17	31	12	0	33	58
1971	0	0	1	16	10	0	11	16
1972	0	0	0	9	10	0	10	9
1973	0	3	2	9	7	3	9	15
1974	0	0	0	15	9	7	9	22
1975	0	1	10	11	7	2	17	14
1976	0	0	0	14	13	14	13	28
Grand Totals	4	31	30	105	68	26	102	162

Miscellaneous includes - falls, falling objects and drowning.

Source: USDI, Geological Survey, 1977a.

meters wide. Assuming all of the pipelines are buried, which is unlikely, for the worst case resulting from the installation of 700 miles of pipelines, 25 platforms, and one undersea completion, a maximum of 1,100 hectares (2,717 acres) of seafloor could be impacted as a result of this proposed sale.

In summary, impact to the seabottom resulting from this sale is expected to be minimal.

2. Impact on Sandy Beaches

Beaches and shoreline areas could receive impacts from pipeline construction onshore, from oil spills, and from the placement of onshore facilities (such as production terminals or transfer facilities). Additionally, minor impacts from debris washup can result from OCS construction efforts, well support activities, and from recreational fishermen who will be attracted to the additional platforms.

Two to four pipelines are projected to be brought ashore as a result of this proposed sale. In Manatee County, Florida and Mobile County, Alabama, recreational beaches will likely be involved in the event of any pipeline landfalls. The area of beach disturbed by construction would be fairly small (9 meters wide) and high tides following burial of the pipeline would soon serve to restore the beach terrain. Restoration of the beach would take longer, most likely requiring a storm tide or high winds to obliterate the effects of excavation. Should a pipeline enter a marsh shore, there would be little beach activity affected; however, there could be long lasting visual impacts due to vegetative and drainage disturbance in the laying process. Likewise, a pipeline crossing a shore backed by forest vegetation will produce an obvious corridor which may be noticeable for many years. Physical interference with recreational activities will be minimal and short-lived.

If production terminal facilities are located in or near a beach there will be an adverse impact from disruption during the construction phase and the intensive use and elimination of about 16 hectares per terminal plant from recreational uses. This latter impact would be long-term and restoration of the area, if attempted at all, would have to await the depletion the offshore production which the plant would be designed to serve. These impacts may tend to diminish quality of the area for recreational enjoyment. It is anticipated this proposed sale would generate a maximum of 2 onshore terminal and storage facilities to accommodate oil and gas production from this sale. A maximum of 480 hectares (1200 acres) of surface area would be intensively disturbed, or kept from other uses.

As calculated by Wyant & Slack's "Oil spill Risk Analysis for the Eastern Gulf of Mexico Lease Area" (Appendix H) the probability of a major oil spill greater than 1000 bbl reaching the beach during the 25 year life of the proposal is 1% within 3 days and 48% within 60 days.

For this proposed action plus existing leases now being held, the probability of a major oil spill reaching the beach is 1% within 3 days and 51% within 60 days. The maximum cumulative impact for this proposed action is 3%.

Considering the above and the fact that the spill point has the most influence on the probabilities of oil spill hits on a beach resource, the long range impact to the beach shoreline is expected to be slight.

3. Impact on Air Quality

Degradation of offshore air quality will occur in cases of oil spills, oil and gas blowouts, pipeline breaks, and the normal exhaust of platform generators and service vessels.

An average composition (Levorsen, 1967) of natural gas from an onshore field (an offshore field would be similar) in Texas is as follows: methane 92.5%, ethane 4.7%, propane 1.3%, butane 0.8%, and pentane and heavier gases 0.6% (small amounts of sulfur are usually present).

If a blowout should occur at a gas well and did not burn, the above gases in a comparable ratio would be released into the air. A typical Texas offshore well produces approximately one million cubic feet of gas per day, so a blowout could reasonably be expected to release at least this much gas into the atmosphere. However, if the gas well were burning, combustion would be essentially complete and the emissions would consist almost entirely of carbon dioxide (CO_2), water, and any sulfurous gases which would be oxidized to SO_2. It is impossible to predict the probability of this occurrence.

If a blowout at an oil well occurred and released crude oil into the water, the resulting impact would be substantially greater. If the oil does not burn, some of it would evaporate. During the Chevron 1970 spill, it was estimated that approximately 15% of the 30,000 barrels spilled evaporated. At an average density of 310 lb/bbl, this incident would have introduced approximately 1.4 million lbs of hydrocarbons into the air. Some oil spills in the past have resulted in fires, however, the chance of this occurring is minimal. In fact, if this were to occur, emissions from the crude oil would be relatively low in reactive compounds.

A reasonable estimate of the ranges of emission, assuming complete combustion, that an oil well fire could produce per 1,000 bbl burned, might be as follows (Levorsen, 1958): CO_2, 340,000-47,000 lbs; SO_2, 620-4,000 lbs (SO emission would be less for Gulf of Mexico crude oil, which ranges from 0.1 to 0.5% sulfur); and NO_2, 660-10,000. However, combustion of oil would be incomplete; therefore, the emissions would contain a smaller amount of the above compounds, and would include such materials as volatilized petroleum, particulate carbon, carbon monoxide, nitrous oxide, sulphur monoxide, along with other altered or partially oxidized matter. There is no reliable way to predict in advance the relative volumes of each of these possible emissions because it would depend among other things, upon moisture content of air, wind speed, pattern of oil spray from wild wells, number of wells involved, chemical content and physical character of the oil itself, and types of equipment and materials other than oil that might also burn. Some areas - Mobile Alabama and Tampa Florida, have a photochemical oxidant problem. A large oil spill combined with a prevailing onshore wind affecting these areas could cause severe air quality problems.

Massive spills from wild wells are not the only source of spilled oil. A number of minor spills during the first nine months of 1972 released over 800 barrels of oil. The net result is that a small amount of spilled oil is floating somewhere on the waters of the Gulf of Mexico almost continually. The evaporation of this oil may cause elevated levels of hydrocarbons in the sea breeze coming off the Gulf. At the present time there is no evidence as to the source of these materials.

Offshore operations generate a small but significant amount of air pollutants resulting from stationary combustion or from venting produced gas. The major source of total hydrocarbon emissions is from oil storage or surge tanks and venting during gas processing. Even though there is a significant amount of emissions from offshore facilities, the use of control technology such as waste heat utilization can decrease the amounts of emissions.

Onshore air pollution resulting from offshore production would not be significantly increased as a result of this proposed sale. The major factors that could result in onshore air quality degradation are transportation (usually freight) increases, population increases, and construction of roads and refineries. However, no significant increases of this nature are expected as a result of this proposed sale.

If there was an increase in natural gas production it would have a positive effect on air quality in the market area. Natural gas is a complete burning fuel which does not create particulate matter, virtually no sulfur compounds, and less nitric oxides than any other common fuel.

Oil produced as a result of this proposed sale is not expected to create the need for increased refinery capacity and other petrochemical industries. Instead, it may take the place of imported oil or oil that will not be furnished from domestic sources due to declining production or other factors in the general Gulf of Mexico area.

In summary, air quality will not be severely degraded as a result of this proposed sale. The largest amount of emission offshore would result from oil and gas well blowouts. Emissions from electric generators on the platforms would only add minimal pollutants to the air. Since there will not be any increased refinery development, there will not be any increase in onshore air quality degradation as a result of this proposed sale. For the same reasons, this proposed sale is not expected to have any cumulative effect on air quality due to any future sales that may take place since any such future sales will probably continue the pattern of Gulf of Mexico oil and gas operations of replacing existing production rather than adding to it.

4. Impact on Marine Water Quality

During drilling and oil production the water quality of the Gulf of Mexico may be altered and degraded in several ways. Many of the chemical and physical factors which will be transferred to the Gulf during various phases of oil production will represent potential hazards of degraded water quality and may be found to be insignificant in some cases or significantly adverse in others. The magnitude of these potential hazards should be answered by future research. Those that might have an adverse effect are produced water and drill muds.

Several methods of treatment technology for waste water from produced waters may be employed to achieve final limitations. It is also noted that drilling muds and cuttings may be discharged if they are water based and their discharge does not result in free oil on the surface waters. Muds and cuttings that are oil based may not be discharged. Presently a drilling mud report is required when submitting for a Plan and Development Permit from USGS, this covers both water based and oil based muds. The requirement for this can be found in OCS Operating Order No. 7. The Environmental Protection Agency has proposed effluent limitations which would apply to the discharge of formation waters and are broken down into 3 basic categories: the best practicable control technology currently available (BPCTCA), the best available technology economically achievable (BATEA), and new source performance standards (NSPS). The BPCTCA and BATEA regulations apply to existing sources and take effect in July 1977 and 1983 respectively. The proposed NSPS are identical to the BATEA regulations and are applicable to new sources, the construction of which is commenced after the promulgation of the regulations. These have been developed for two subcategories of installations: the "near offshore" which is within 3 miles of the coastal basin and the "far offshore" which is beyond 3 miles of the coastal baseline. For the near offshore category BPCTCA is an average of 48 mg/l for oil and grease in produced water and BATEA calls for no discharge to surface waters. For the far offshore category, BPCTCA is also 48 mg/l but BATEA is 30 mg/l average discharge of oil and grease in produced water.

Bottom sediments would be put in suspension during exploration and development by emplacement of blowout preventors, drilling platforms, sea-bottom equipment, pipeline burial, and disposal of drilling muds and cuttings. Pollutants that are entrapped in the bottom sediments would be dispersed into the water column. A turbidity plume may be created; the duration and size depends upon the size, shape, and density of the suspended material, and the turbulence of the water.

The disposal of drilling muds and cuttings also results in a turbidity plume. It is estimated that in drilling to 10,000 feet approximately 995 tons of drilling muds and 511 yds^3 of cuttings are disposed overboard during 20 days of drilling. A turbidity plume from a drilling rig can extend well over a mile in length. The exact extent of these plumes will be determined primarily by currents. The prevailing currents and winds will allow for mixing and dispersion of the turbidity plume. Zingula (1975) reports a rapid decrease in suspended solids, no appreciable change in pH, and undetectable changes in soluable barium and chromium during drilling activities offshore Louisiana.

While no definite conclusions have been drawn on the manner in which drilling mud chemicals and drill cuttings may contribute to pollution in the marine environment, research in this area is in progress. Possible pollutant characteristics include: acute toxicity to fish; high immediate dissolved oxygen demand; and high concentrations of organic carbon, total nitrogen, phosphorous solids, chemical oxygen demand, and chromium.

The production and discharge of formation waters (oil field brines) has been discussed earlier. Three components or properties of formation waters contribute to water quality degradation when released into the Gulf. These include: entrained liquid hydrocarbons, dissolved mineral salts, and absence of dissolved oxygen. In a study done by Chevron on hydrocarbon dispersions it was found that emulsified oil concentration in water at the platforms ranged from 2-60 ppm but decreased to 1 ppm at a distance of 1 mile (Koons, et al, 1977). It was also found that crude oil lost essentially all components of C_2 in 24 hours. Most toxic compounds are present in this fraction and evaporative losses, therefore, quickly reduce oil toxicity (Kreider, 1971).

Within the proposed lease area, the maximum oil production is estimated to be 15-150 million barrels of oil. This would be extracted over a twenty year period. The expected annual production of oil will be from 3.6 to 9.1 million barrels. Considering the maximum amount of formation water production (0.6 barrels of formation water per barrel of oil produced), approximately 2.2-5.5 million barrels of formation water per year will be produced as a result of this proposed sale, providing that all the tracts are leased and developed.

In the Gulf of Mexico many platforms are disposing of treated formation waters where the treatment equipment puts out an effluent less than 25 ppm oil content, but many older platforms are not accomplishing this. The range of oil concentrations discharged from surveyed production platforms in the Gulf is from 6-827 ppm (US EPA, 1975).

Due to many factors which will contribute to the physical and chemical characteristics of formation waters, no reliable estimate can be made to the extent of the impact from these waters. The characteristics of formation water can change during the oil production period as more reservoirs are tapped or if accidental leakage occurs between reservoirs. Formation waters may contain significant concentrations of toxic materials; i.e., cyanide, cadmium, chromium, lead, and mercury (US EPA, 1975). Therefore, it is concluded that formation waters present a potential significant hazard which could degrade the water quality locally around 25 platforms and which may have adverse effects on the marine biota.

Water quality could be further degraded as the result of accidental oil spills. Part of this spilled oil would probably be dispersed into the waters of the Gulf where it would be reduced further by microbial degradation and weathering.

It is estimated (USGS Resource Report estimates) that from zero to two terminal storage facilities may be constructed onshore as a result of this proposed sale. These facilities could have a slight impact on the water quality in the terminal vicinity. The amount of effluent discharged and the area in which the facility is constructed is a major factor in determining the extent of the impact. These facilities would come under state jurisdiction in regards to effluent discharge. The Water Quality Management Plans (P.L. 92-500) for each state provide a baseline for the present water quality for each basin. Depending on the location of the terminal facilities, mathematical models would be calculated for the particular basin and the water quality of the area can be determined. Since these facilities are located onshore waste water discharge is regulated by state Water Quality Boards under EPA guidelines.

In summary, offshore water quality is most likely to be affected by drilling fluids and cuttings, accidental oil spills, and resuspension of bottom sediments.

As indicated, the turbidity that results from the discharge of drilling fluids and cuttings is localized and its persistency is short. Thus there would be no severe water quality degradation problems resulting from turbidity.

Oil spills present a more serious problem. Yet even in the case of spills, the diluting effect of the large volumes of Gulf waters and the microbial degradation of the hydrocarbons acting to reduce deleterious effects will depend on the amount of oil spilled and the depth of the water. In shallow waters the oil may become entrapped in the sediments to be released later when the sediments are resuspended during storms. Unfortunately, none of these effects can be quantified, partly due to our lack of precise knowledge of the fates and effects of oil on the environment, and partly because so much depends on the particular circumstances of a spill. See III.A.3.c.(2) and Appendix H for more discussion of the probabilities of oil spillage resulting from this proposed sale.

Judging from past experience in the Gulf of Mexico, oil and gas operations on the OCS do not have a significant long term effect on water quality, although the short term effects in the immediate vicinity of operations may be quite severe.

Since the activities resulting from this proposed sale are expected to replace existing operations in the Gulf of Mexico rather than add to them, no cumulative effects on water quality are expected. Since future sales in the Gulf of Mexico are likely to continue this pattern of replacement, this proposed sale should not contribute to future water quality degradation resulting from sales in the future.

5. Impact on Aquifers and Ground Water Quality

Although fresh water aquifers may be penetrated during drilling operations as a result of this proposed sale, standard drilling practices and regulations require the sealing off of all porous horizons to prevent the injection of drilling mud into them. No impact on ground water aquifers is anticipated.

C. Impacts on the Biological Environment of the Gulf of Mexico Area

1. Impact on Phytoplankton

The oil and gas exploratory phase will have a localized effect on the phytoplankton in the vicinity of each exploratory well by the presence of turbidity plumes created by the disposal of drill muds associated with the cuttings. If we assume that these operations create a plume 20 m wide and 800 m long (plumes of this approximate size have been observed in the Gulf of Mexico) then the euphotic zone will be reduced under 16 ha of sea surface for the duration of drilling (approximately 15 days). The residence time for any single phytoplankton within this reduced euphotic zone would depend on the vertical and horizontal transport to which it is subjected.

The field development phase will have similar impacts only with longer duration. Assuming that a maximum of 20 wells will be drilled from each platform, approximately 400 drilling days would be necessary and the turbidity plume would be present during this period. This would result in a cumulative duration of 10,000 days for 25 platforms throughout the proposed sale area. This turbidity may reduce the photosynthetic assimilation of the total marine system in the proposed sale area by an amount that is presently unquantifiable.

The production phase can impact phytoplankton through the disposal of formation waters which contain the soluble fractions of crude oil at an average concentration of 30 mg/l and relict sea water with trace amounts of certain heavy metals. As mentioned above, the resultant receiving water concentration of petroleum hydrocarbons is difficult to assess, but if we assume instantaneous mixing into one cubic meter of sea water, the concentration would be approximately 30 micrograms per liter (μg/l). Gordon and Prouse (1973) have observed stimulation of phytoplankton photosynthesis by Venezuelan crude in concentrations of 30 to 50 mg/l with inhibitions at higher concentrations in studies conducted off Nova Scotia. Shields et al (1973) found that very low concentrations of Prudhoe Bay crude stimulated Gulf of Alaska phytoplankton photosynthesis over a short incubation period during December, April, and June. The photosynthetic rate of June phytoplankton exposed to approximately 3 μg/l more than doubled the rate for phytoplankton in sea water containing no oil. Oppenheimer et al (1977) in their North Sea investigations found a tendency toward more organisms being associated with the most active oil fields. Mironov (1970), however, reports that cell division in phytoplankton was delayed or inhibited by crude oil concentrations as low as 1 μg/l. Thus minute petroleum hydrocarbon discharges from the production phase may cause local stimulation of phytoplankton photosynthesis for the duration of production (approximately 20 years) in the immediate area of production platforms. But if excessive concentrations are discharged, a local inhibitory effect can be expected.

The anomalous ion ratios present in formation water should cause minimal disturbance to phytoplankton due to dilution. Concentrations of trace metals contained in formation water may exceed background concentrations at the point of discharge.

However, Williams (1977) reports that his studies have shown that acute toxicity and much environmental degradation occur as a result of oil spills. He reports that the toxins are not from the oil itself but from ". . . apparently unsuspected high concentrations of some lipid soluble metals derived from the tolerant concentrations in the oceans". Williams further states that he found acute toxic effects on the nannoplankton downstream from oil rigs off Texas and Louisiana in 1975 and 1976 respectively. He does not, however, say how far downstream the effects are noted nor does he define "acute toxic effects". There is considerable controversy on this point, and the final word has not yet been written.

The transportation phase will affect the phytoplankton due to the pulse of turbid water created by pipeline burial operations. This pulse will temporarily stress phytoplankton in the immediate vicinity of the operations. If bottom areas high in heavy metals, pesticides, or other pollutants are traversed, the effects will be more severe and possibly of longer duration. Phytoplankton primary productivity will be temporarily impacted in an area approximately 50 meters wide throughout the length of the pipeline route.

Oil spills are always a possibility, although the oil spill risk analysis for this proposed sale predicts the probability of a spill of greater than 1000 barrels of oil to be very small (see Section III.A.3.c.(2) and Appendix H). However, the analysis also shows a very high probability that there will be over 250 spills of up to 50 barrels. Ray and Mills (1974) and Mills (1974) showed that phytoplankton exposed to water-soluble fractions of south Louisiana crude oil, Kuwait crude oil, No. 2 fuel oil, and Bunker C oil had reduced primary productivity. However, they noted that once the exposure to oil was terminated, the phytoplankton resumed a normal growth rate within a few days. They conclude that once a spill episode has passed, only a few cells need survive to repopulate a given area rapidly. Recruitment from nearby unaffected areas would also achieve a normal phytoplankton population quickly.

Our conclusion is that the plankton populations of the Gulf of Mexico ecosystem will probably be able to absorb the impact of a major oil spill and recover fairly rapidly. The greatest number of planktonic organisms directly killed from a spill greater than 50 barrels would be found in the neuston (the community in the upper five cm of the Gulf surface). Since annual biological productivity is greatest in spring and winter, especially along the coast in upwelling areas, a spill in this part of the year would do the most damage to phytoplankton productivity and standing crop.

Impacts to planktonic organisms from chronic low-level discharges include direct lethality, reduction in photosynthetic effeciency, interference with chemical communication, and general physiological stress.

In summary, there is little doubt that phytoplankton will be adversely affected by the oil and gas activities that will result from this proposed sale, should it be held. However, even in the worst case of an oil spill, it is clear that such adverse effects will be limited to the immediate vicinity of the operation or spill, and will be of short duration (see Section III.A.3.c. and Appendices G and H for discussions on the behavior and extent of oil spills). Thus small patches of phytoplankton may be killed by drilling operations or an oil spill, but such mortality will not significantly affect a species or even a population. Furthermore, once the affecting operation or substance is no longer present, it seems clear that phytoplankton populations in the area will quickly resume normality. Thus it is concluded that activities resulting from this proposed sale will have no significant nor lasting impact on phytoplankton.

There is current oil and gas activity in the eastern Gulf as a result of previous sales. The cumulative impact on phytoplankton resulting from this activity added to the impact from this proposed sale is still believed to be insignificant, for reasons given above. Likewise, the added impact from any future sales that may be held is not considered to be significant.

2. Impact on Zooplankton

Much of the information regarding the impacts of oil and gas operations on phytoplankton, discussed in the previous subsection, also apply to zooplankton.

Turbidity generated during the exploratory and development phases of OCS oil and gas operations may have an adverse effect on individual zooplankters in the immediate vicinity of the drilling rig. Zingula (1975) has shown that suspended solids concentrations in surface water near drilling discharges are of the order of 300 mg/l and are rapidly diluted to approximately 6 mg/l within 300 m of the discharge. An additional impact may be the temporary resuspension of bottom sediments during platform placement.

The dissolved components of crude oil present in production phase discharges may have a toxic effect on zooplankton in the immediate vicinity of the production platform. If we assume a local concentration of 30 parts per billion (ppb), direct lethality should not occur. However, Lee (1975) has shown that certain species of zooplankton can assimilate hydrocarbons from a seawater solution at low concentrations forming the necessary first step in food web concentration. Another potential effect involves the interference by petroleum hydrocarbons with chemically controlled behavior in zooplankton. The magnitude and importance of this potential impact is at present insufficiently known to allow prediction.

The use of pipelines in the transportation phase of OCS development should have a minor effect on the total zooplankton component of the marine ecosystem. Pipelaying may result in the temporary resuspension of bottom sediments and the resultant turbidity may have a severe effect on local zooplankton populations. In nearshore areas, the possibility of the liberation of adsorbed toxicants should be taken into consideration in pipeline routing since sufficient concentrations of heavy metals or chlorinated hydrocarbons to stress zooplankton may be present.

Important work by Mironov (1970) indicated that planktonic larvae of benthic and nektic animals (meroplankton) are more sensitive than permanent members of the plankton (holoplankton). Therefore, a threat to populations of various finfish and shell fish exists for oil prone areas.

In addition, coating by oil of various plankton species (i.e., large coelenterates) could have an adverse affect. Neuston (strictly surface dwelling plankton) are clearly threatened. However, active vertical migrators, in a worst case assumption, are also potentially threatened. (Again, see Section III.A.3.c.(2) and Appendices G and H).

Like the impact on phytoplankton, the impact on zooplankton will be local and short term. Also like the phytoplankton, past and proposed future Gulf sales will not add to the impact, but will only maintain a more or less constant level.

3. Impact on Nekton

With the use of non-explosive energy sources for seismic survey work, the pre-exploratory phase of oil and gas development should have minimal impact on the marine nekton. Faulk and Lawrence (1973) report that while explosive sources killed fish over an area of thousands of square feet, the nonexplosive source tested caused no direct mortality. Weaver and Weinhold (1972) reported no harmful effects from nonexplosive sources fixed at various depths. Explosive energy sources are still used for special applications approximately eight times per year in the Gulf of Mexico. The environmental impact of this limited use is considered to be insignificant.

The exploratory phase will have a localized temporary effect on the nekton due to the physical presence of the rig and the disposal of drill muds and cuttings during the drilling of exploratory wells. The attraction of nektonic organisms, especially fish, to submerged structures is a widely recognized phenomenon and since drilling rigs are well lighted, this attraction may be enhanced at night. Observations in the Gulf of Mexico indicate that fish are also attracted to the drill cuttings as they cascade down through the water column where they may be sampled as food items and rejected. No definitive bioassays have been conducted with drill muds and nektonic species found in the proposed sale area, however. Falk and Lawrence (1973) have indicated lethal concentrations of between 0.83 and 12.0% of drill mud with lake chub and rainbow trout. Experience in the heavily developed areas of the Gulf of Mexico indicates that no severe adverse effects upon nektonic populations will result from exploratory drilling.

The field development phase will entail the installation of semi-permanent (20 year average functional design life) platforms from which development wells will be drilled. The platforms, like the drilling rigs, will attract the larger organisms immediately; but due to their permanent nature, they also act as true artificial reefs with the establishment of a community of great diversity.

The production phase of offshore operations can impact the nekton through the disposal of formation waters which contain the soluble components of crude oil (30 mg/l) and trace amounts of certain heavy metals. The effects of these low-level chronic discharges are not quantifiable at present. However, due to the magnitude of dilution and the process of microbial degradation, no adverse effects upon nektonic populations have been noted in areas of intense oil and gas development in the Gulf of Mexico OCS.

The transportation phase, if by pipeline, will result in temporary, localized increases in pipelaying operations which can be easily avoided by the actively swimming nekton. No long term nor incremental adverse impacts are expected to occur to the nekton.

4. Impact on the Benthos

The exploratory phase effluents that may be expected to have an effect upon benthic organisms include drill cuttings and drilling muds (see Section III.A.1.a. and Appendix E).

These cuttings may form a low mound or may be worked into the surrounding sediments. Their disposition is dependent upon the nature of the cuttings, the nature of the local sediments, the depth of disposal, the benthic fauna capable of bioturbation and/or encrustation, and the physical forces acting upon the cuttings pile.

The drilling muds which are associated with the cuttings when they are disposed of overboard, are washed from the cuttings and eventually settle to the bottom after generally a wide dispersal through the water column. Also, muds are routinely discharged into the water during drilling operations as mud mixtures are changed, and, at the completion of drilling operations, some 800 barrels of mud are discharged (Otteman, 1976). The major impact of these discharges would be to smother benthic organisms in a small area immediately adjacent to the drilling platform. Experience in the Gulf of Mexico indicates that such effects are of short duration in a small area, and that there is no long term impact (Zingula, 1975). Jones and Williams (1973) found sediment barium concentrations to be above normal in areas of the Gulf of Mexico where intensive drilling has taken place. Barium sulfate is the major constituent of drilling fluids and the distribution of barium in the sediments suggest that the above-normal concentrations are due to the disposal of these fluids.

Barium sulfate is a highly insoluble, nontoxic salt which is present in seawater at a concentration of approximately 0.05 mg/l and in certain localities concretions and nodules of barium sulfate are found naturally in bottom deposits (Horne, 1969). Therefore, no direct toxic effects on benthic biota are expected from the disposal of drilling fluids during the exploratory and development phases. The U.S. Environmental Protection Agency is presently conducting research which addresses the problem of drill mud toxicity to marine organisms, and BLM is continuing research into the ultimate fate of the muds.

The field development phase will require the placement of platforms and the drilling of an average of 9 wells at each of a maximum of 25 platforms. The initial platform placement and anchoring may temporarily disturb the benthic biota in the immediate vicinity. Longer term effects may include a change in the benthic community to reflect the presence of an artificial reef.

The drilling of these average 9 wells from a platform will result in the disposal of approximately 27,000 yd^3 of cuttings which, in this area, are expected to be mainly carbonate in nature. This may result in the establishment of a different benthic community in the immediate vicinity of the cuttings pile.

The production phase will result in the introduction of the soluble components of crude oil at an average concentration of 30 mg/l. If these components become adsorbed to suspended particulates they may eventually be incorporated into the benthic environment. This will cause a shift in the sediment microflora to a community capable of utilizing petroleum hydrocarbons as an energy source. Those compounds which are not degraded may accumulate in the deeper sediment layers. No investigation that would determine if this is the case has been conducted to date in areas of offshore petroleum development.

If the transportation phase requires the installation of pipelines, certain impacts to the marine benthos will occur. In water depths of less than 61 m, new common carrier pipelines are entrenched by jetting away the sediment beneath the pipe and allowing the pipe to settle approximately one meter into the underlying trench. Partial burial takes place quite rapidly as the disturbed sediments slide and settle back into the trench.

The jetting process physically disrupts the sediments in its path, and also causes resuspension of large quantities of sediment. This process would have the effect of displacing benthic organisms and would result in direct mortality to softer life forms and indirect mortality to others through increased vulnerability to predators. Although recolonization would begin immediately, the native fauna could not be fully restored until seasonal reproduction cycles had been completed by representative species from adjacent areas; these would provide a supply of larvae to settle and enter the reworked substrate.

Turbidity resulting from resuspended sediment is capable of producing an adverse impact on filter-feeding molluscan and crustacean benthos populations by clogging the filter-feeding apparatus or blocking respiratory surfaces. This impact is temporary, occurs during burial operations, last from several hours to a few days, and would effect those populations adjacent to the pipeline. Observations indicate that ocean currents carry the sediment and redeposit it at various distances, depending upon the particle size of the sediment. Moreover, these same factors along with the rate of burial operation determine the length of time in suspension.

As previously mentioned (Sec. I.A.), the expected length of pipeline from this proposed sale is 644-1127 km. Locations of these pipelines are presently unknown. We expect that the area impacted would be localized within 50 m of the particular operations throughout the water column. However, this area may decrease or increase because of the following variables: water currents, sea conditions, water depths, natural bottom sediment, and dispersion rate of bottom sediments from the jetting operation.

Recovery rates would be dependent upon seasonal reproduction cycles and recolonization by indigenous and other species. Estimates for recolonization range from months to several years.

Twenty-five tracts of this proposed sale, tracts 1 through 20 inclusive, and 89 through 93 inclusive, encompass possible areas of biological significance, termed "live bottom areas." Stipulations on these tracts, as presented in Section IV.D.8., would ensure that measures are taken to protect these features from damage.

Thus it is believed that while drilling activities will have a severe effect on benthic organisms in the immediate vicinity of the activities, the overall impact on the benthos from this proposed sale will not be of any wide spread or long term significance, nor will the cumulative impact of previous and future sales be of any significance.

5. Impact on birds

The greatest impact on birds as a result of this proposal will be from accidental discharges of oil during drilling and production, from pipelines, and by intentional discharge from tankers.

Although mass fatalities are often observed after spills of crude and heavy fuel oils, it has been estimated only 5-15% of those birds are actually killed by oil that is washed ashore where the death toll is taken (Nelson-Smith, 1973). Nevertheless, estimates for spills include 3,686 bird fatalities for the Santa Barbara blowout (Straughan, 1972), 7,000 for the San Francisco spill of Bunker C (Chan, 1972 and Boesch, et al, 1974), and 10,000 to 31,000 for the Chesapeake Bay spill of 250,000 gals. of No. 6 fuel oil (Kiernan, l976). According to F&WS a loss of this magnitude in one locality should be considered significant on the affected population.

The immediate effect of oil on birds is the fouling of their feathers. Clark (1969) reports that feathers become matted together and the repellant and insulation properties are lost, as well as their buoyancy. Birds can lose their ability to fly (Erickson, 1963), diving ducks lose their ability to dive for food (Chubb, 1954), or they become so soaked they drown (Tuck, 1960). Hartung (1967) reports that heavily oiled ducks lose more than twice the normal amount of body heat due to the breakdown of the insulating properties of plummage. Ingested oil is lethally toxic to birds and often results in inflammation of the digestive tract or disturbs other physiological processes (Boesch, et al, 1974).

It is thought that some species of sea birds are more prone to oiling than others. Previous reports and observations have shown that diving birds suffer the most direct fatalities whereas others, such as gulls and shearwaters, suffer the least. Reports indicate that the vulnerable species are those that are attracted by slicks and consequently land on them.

Not all birds are equally vulnerable to oil slicks. Clark (1971) reports that in Western Europe, auks, puffins, razorbills, murres, and other sea ducks suffer the most fatalities as a consequence of spills. Boesch, et al (1974) report that from the Santa Barbara spills, loons and grebes, which account for 7-10% of the total bird population suffered 64% of the mortality. A main concern is that many sea birds are long lived and breed slowly which can make recovery of a population very difficult if populations are reduced to a small size.

The impact of oil on various species of birds is directly related to their behavior patterns and habitats on which they are dependent. Sea birds undeniably receive the greatest impacts, and mortalities can be high as previous cases have shown. Because of the location of proposed tracts for lease, these species would be most likely to receive impacts from an oil spill in the offshore area.

The treating of oil contaminated birds has met with only limited success with the survival record being very dismal. According to Boesch, et al, (1974), most birds perish soon after capture while others do not survive the cleaning procedures or the following recuperation period.

Along the eastern Gulf coast the bird groups that are considered most vulnerable are the diving ducks, pelicans, and pelagic birds. The pelagic birds believed to be most susceptible to contamination by oil at sea are: terns, boobies, petrels, etc. The probability of an oil spill reaching a wading and/or pelagic bird nesting area is zero to two percent as a result of this proposal and 17 to 44% cumulative probability from proposed and existing lease tracts.

Activities associated with pipeline installation, drilling, and construction of onshore facilities can affect bird populations in both offshore and onshore environments. If pipeline burial and drilling activities should resuspend toxic elements as heavy metals and pesticides, they can enter food chains to affect bird populations (Appendix G). Impacts from onshore activities are loss of habitat and other environmental disturbance for bird species that inhabit the coastal region. The extent of the impacts would depend on time of year and where they occurred. If the facilities are constructed in marsh areas the habitat destruction could effect such species as herons, egrets, ibis, etc. The change in air and water quality and noise level can also effect these bird species during construction and development.

If a major spill should occur as a result of this proposal, habitats utilized by shore birds in the eastern Gulf could be impacted. As Erickson (1963) reports, both habitats and food supply are greatly reduced by oil deposits. Many shore birds rely on intertidal areas which could be affected as a result of a spill. The long-term damage to bird habitats from chronic oil pollution at sea may exceed that caused by irregularly occurring major spills.

The time of day, season of the year, and sea conditions all play important roles in the bird species that occur in a specific area and the probability that they could be impacted by an oil spill. Spills occurring during the migration periods of spring and fall and wintering periods would probably impact the greatest numbers and species of birds. Migratory waterfowl are probably among the most susceptible due to their flocking habits. Large numbers of waterfowl which utilized the Atlantic and Mississippi Flyways winter along the northwestern coast of Florida and therefore would be susceptible during the winter. Since the sea conditions are most severe during the winter months this would be the most susceptible time for a spill to occur. If oil should impact these areas, bird populations can be reduced through loss of habitat or direct fouling. If an oil spill were to occur and wash ashore, the probability of it reaching the north western coast of Florida is less than 0.5%. If an oil spill occurred from an offshore platform, pipeline, or tanker, the probability of one or more oil spills reaching shore in the eastern Gulf of Mexico is 2% within 3 days and 16% within 60 days from the proposed leases. For both the proposed and existing leases, there is a 95 to 99.5% probability that an oil spill will come ashore.

If a spill occurred from a nearshore pipeline or tanker, the oil could wash ashore within a short period of time (1 to 5 days) reducing the effects of dispersion, evaporation, and biological degradation. This type of nearshore spill would affect a much larger number of bird species.

In summary, the 25 year estimated field life of this proposal and estimated 47% probability of about 5 spills of 50-1000 bbl of oil there could be a moderate impact on bird species within this eastern Gulf region. The number and species of birds affected is difficult to predict because of numerous environmental variables (i.e. location, volume, and type of spill; species present in area; weather conditions; seasons of year, etc.). The more significant affect would be from existing leases elsewhere in the Gulf Region. Activities associated with pipeline burials and construction of facilities can impact bird populations from disturbances these actions create and through loss of habitat. Disturbances associated with the construction stages are believed to be relatively short-termed and the extent of damage can vary. Loss of habitat due to placement of storage facilities (240-480 ha) is expected to be permanent.

6. Impact on Marine Mammals

Oil and gas development in the eastern Gulf of Mexico as a result of this proposal may impact marine mammals as a result of oil spills, and increased marine traffic. The direct effects of oiling on marine mammals could include the matting of pelage; irritation of skin and eyes; ingestion causing internal disorders; possible clogging or inflammation of respiratory passages; and fouling of baleen plates thus imparing the feeding efficiency of baleen whales. Increased marine traffic (drilling vessels, crew boats, barges, and/or tankers) could disrupt feeding and/or migration behavior. Also collisions involving marine mammals and shipping could increase. Secondary impacts may include a decrease or redistribution of food supplies.

There are approximately 24 species of cetaceans (Section II.B.6) including six endangered species (black right, humpback, fin, sperm, sei, and blue whales) which have been sighted in the Gulf of Mexico. The bottlenose and spotted dolphins and the sperm and short-finned pilot whales are the most common cetaceans sighted in the proposed sale region. However, there is little information on the population dynamics and migration behavior of cetaceans in this area.

There are no recorded cetacean deaths as a direct result of oil pollution. However, numerous dead animals were found after the Santa Barbara oil spill, including grey, sperm, and pilot whales, dolphins, and elephant seal pups. They were examined histologically and chemically for the presence of oil or pathological effects related to oil, but these mortalities could not be directly attributed to the oil spill.

Irritation of the eyes or exposed mucous membranes may also be common to petroleum-contaminated animals. A potential danger to cetaceans is absorption through the mucous membrane lining the blow hole distal to the nasal plug. This area remains open near the water surface and may become oiled. The ultimate outcome of oil exposure could be a thin oil film covering the lungs and respiratory passages which would have the same effect as pneumonia, including death.

As cetaceans forage for such organisms as copepods, euphausiids, and fish, localized decreases or redistributions of these organisms as a result of OCS activities could limit food availability for cetaceans. Ingestion of contaminated organisms as a result of an oil spill incident could occur. While young cetaceans might also ingest oil during their period of nursing, other effects of hydrocarbons upon mating implantation, pregnancy, and birth are unknown for cetaceans.

Because of the endangered species status of some cetaceans, and their apparent limited distribution or occurence in the Gulf of Mexico, any impact to individual cetaceans could have consequences on species populations or distribution.

Possible impacts to endangered marine mammals (i.e., whales and Florida manatee) as a result of this proposal are discussed in Section III.C.14.

Unfortunately, data are not available to adequately estimate the impact of offshore oil and gas development on marine mammals. However, the impact would appear to be a function of the probability of an oil spill, the population size, and the distribution of the species. In conclusion, there may be a slight incremental impact to marine mammals from oil spills as a result of this proposal.

7. Impact on Marine Turtles

Three endangered species of marine turtles (the Atlantic ridley, hawksbill, and leatherback) and two threatened species (the loggerhead and green) inhabit the eastern Gulf of Mexico.

Adult loggerheads seem to be attracted to ''treelike'' platforms offshore. Ogren (1976) has observed them sleeping under offshore platforms off Panama City, Florida. They probably use the platforms for feeding and resting areas. Turtles in the vicinity of platforms would be vulnerable to both oil spills and possible collision with boats.

Indeterminate turtle mortality could be expected should spills reach nesting beaches. The nesting season usually lasts from late spring through summer. Hatchlings emerge after an incubation period of about two months. Eggs or hatchlings could be oiled during this prolonged period. Death of egg embryos could occur through asphyxiation without oil contacting the eggs should the sand be covered with oil.

Turtle hatchlings are especially susceptible to oiling during the first six to nine months of development while they are pelagic in habits and prior to moving inshore to take up benthic habits (except the leatherback). During this period, they are frequently observed associated with mats of sargassum weed (Caldwell, 1969). Passive transport by ocean currents is the main dispersal mechanism for these turtles and is the same type of movement expected of oil spilled in the offshore area. Turtles surface at one to three minute intervals when actively swimming and at least 30-40 minute intervals when resting. They are, therefore, very vulnerable to oiling during an oil spill in their vicinity.

Hatchlings are disoriented by lights according to McFarlane (1963). Lights on the beach or at sea can affect turtles in their post-natal drive to reach open water and favorable currents. Therefore, refineries, docks, offshore platforms, and gas flaring would be expected to attract or disorient the hatchlings.

The population dynamics of marine turtles and the impact of oil and gas operations on their habitat have not been studied and therefore are difficult to evaluate. However, the endangered and/or threatened species status is an indication that any unnatural loss of marine turtles should be prevented.

According to the oil spill risk analysis (Appendix H) the probability of an oil spill reaching a marine turtle nesting beach as a result of this proposal is 1% within 3 days and 8% within 60 days of a spill. The cumulative oil spill impact probability from proposed and existing leases is 19% within 3 days and 71% within 60 days of a spill. In conclusion, there will be slight incremental impact on marine turtles as a result of this proposal.

8. Impact on Other Wildlife

Direct impact on terrestrial wildlife could occur through habitat encroachment and oil spills and secondary through potential oil spill contamination of food.

Direct impacts resulting from construction as a result of this proposal would be the greatest on the small animals, reptiles, and amphibians at construction sites. It is estimated that 240 to 480 ha will be required for onshore storage facilities. Currently the location of these facilities have not been determined, but probably they will be in areas which are already developed and thus will have a minimal impact on wildlife. Pipelines, if constructed, will have an impact on undeveloped wildlife habitat and pipeline management will have to be planned with care. The extent of the impact would ultimately depend on habitat recovery (revegetation of the area) but should be limited in magnitude and of short duration. Those individual animals having home ranges within or overlapping the zone of construction could be either destroyed or displaced and there could be a definite alteration of habitat.

Disturbance occurring due to local construction should have only a local and minor impact. This means that there should be little measureable indirect impact on the total system stemming from impact on small animals. It is possible that a population occupying a small area could be eliminated, causing a greater adverse indirect impact, but no such populations have been identified.

There could be direct, adverse, short-term impact on small animals (mammals, reptiles, and amphibians) anywhere that an oil spill reached shore or occurred onshore. The impact would depend on the location, the habitat, and the season of the year. It might range from minute to severe depending on the circumstances. There is insufficient information available to evaluate the long-term and indirect effects of oil spills upon small mammals. Shore areas most susceptible to spills would be along pipeline and tanker routes.

Through beach and marsh vegetation and carrion links in the food web, it is possible that oil production could affect terrestrial mammals which either constantly or intermittently use habitats subject to oil pollution. Intermittently, deer and other foragers and rodents utilize beach and intertidal zone plants exclusively and would thus be vulnerable to the threat. Ingestion of oil-covered carrion by foxes, skunks, and shrews would result in petroleum hydrocarbons being assimilated directly at the top of the food chain; however, the relative toxicity of crude oil to these mammals is not currently known.

The impact on beach-utilizing mammals of hydrocarbons that have become entrained in the marine ecosystems from chronic low-level sources is unknown. There is, however, evidence to suggest that chlorinated hydrocarbons which may be resuspended for a time in the water column could cause premature births in California sea lions with a resultant death of pups (Delong, et al, 1973). Additional chronic low-level data is presented in Appendix G.

Some mammals could die from ingesting oil from contaminated pelage while grooming (Alaska, 1971). Scavengers such as foxes and skunks could occasionally eat oil-killed animals, and foragers such as deer could eat oil contaminated vegetation thereby ingesting petroleum. It is difficult to estimate possible losses since the effects on animals ingesting hydrocarbons is not well-known at present.

In summary, impacts resulting from the burial of pipeline and construction activities will probably be of limited magnitude and of short duration. Species most affected by such construction would be those whose habitat would be destroyed by the construction. Oil spills reaching the shore will have an impact on wildlife, but this impact is expected to be minimal because of the time it takes the oil to reach the shore and because the probability of an oil spill reaching any areas of major wildlife habitat such as marsh and wetlands as a result of this proposal is zero within 3 days and 5% within 60 days. The cumulative probability of an oil spill reaching coastal wildlife habitat from proposed and existing leases is 95% to greater than 99.5% (Oil Spill Risk Analysis, Appendix H). Therefore, there would be a slight incremental impact on other wildlife as a result of this proposal, as existing leases offer the greater hazard.

9. Impact on Commercial Fisheries

This section will discuss only impacts to the organisms; impacts to the industry (ie. gear losses) are presented in Section III.D.1.a.

The results of the Oilspill Risk Analysis presented in III.A.3.6.(2)(b) and Appendix H, show that there is little probability, usually 5% or less, of an oilspill impacting a commercial fisheries resource.

Mangroves and tidal marsh in the Mississippi Delta have a 2% chance of being impacted by this proposed sale, but have a cumulative 96% chance of impact from both existing leases and this proposed sale. In the event of an oilspill, oysters and sessile molluscs in this area will probably become contaminated with oil and therefore be unavailable to the fishery for a limited time period. There may even be some heavy mortalities locally. However, it is believed that the oyster stocks as a Gulf region resource will not be reduced.

Shrimp is a major fishery in this area, fishing areas may be closed because of the possibility of contamination of the catch. Due to the size of the stock, its wide distribution, spawning duration, and fecundity, no stock reductions will be measurable.

Commercial fisheries in the coastal areas of Mississippi, Alabama, and Florida will probably not be impacted because of their ubiquity, spawning potential, and extended spawning duration.

And further, according to the Oilspill Risk Analysis, most of the oil spilled will remain in the open ocean.

This proposed sale will probably adversely impact some local fisheries for a season, but no stock depletions due to oil and gas operations are likely to occur. The cumulative impact from this proposed sale and previous sales will have the same effect as discussed above.

10. Impact on Shorelines

The activity which would affect shorelines in the proposed sale area, other than a major oil spill (see Section III.A.3.), may occur in the transportation phase of oil and gas operations. Two areas are considered to be the most likely locations for onshore facilities should significant production result from this proposed sale. These are the Mobile Bay area and the Tampa Bay area. (See also Section III.A.2.a.) If pipelines are used to transport any such production ashore the landfalls will most likely be in one or both of these areas, depending on where discoveries are made.

Both areas have extensive sandy beaches on their Gulf shore, either on barrier islands or on the mainland itself. Behind the barrier islands, shallow lagoons are generally present. Both the bays have large areas of wetlands in addition to significant stretches of sand beach. The precise location of any pipeline landfall cannot be determined at this time, so impacts cannot be assigned with any certainty. What follows is a brief discussion of impacts on beaches and on wetlands.

Beaches

There are some 767 km (477 mi) of sandy beaches on the Gulf shores of Mississippi, Alabama, and Florida, and another 1218 km (757 mi) of sandy beaches in the bays of those states. As a pipeline approaches the beach, there is a transition from burial by jetting to burial by dredge, either bucket, clamshell, or suction dredge. As this operation crosses the beach, it will disrupt and rework the sand for a width of 10 to 15 m, possibly killing the indigenous beach fauna. At least one year will be required for the disturbed intertidal zone to return to normal.

Above the high-tide line, devegetation will occur along the pipeline right-of-way. Small dunes appear to recover within a few years after the installation of pipelines. Large primary dunes will require much more time. These processes of dune reconstruction can be accelerated by planting dune vegetation, such that dune communities can be expected to recover within a few years to soil, plant, and animal conditions similar to an undisturbed small dune (Willingham, et al, 1975).

Wetlands

The transportation phase of development will affect the wetlands in the proposed area if the need for new shore based pipelines arises and the pipeline right-of-way crosses this ecosystem type.

There are two basic methods of traversing wetlands with a pipeline.

The ‘‘push’’ or ‘‘shove’’ technique is possible where the marsh is firm and with appropriate care where the marsh is soft. In this technique, a narrow, relatively shallow ditch is excavated by a dragline or clamshell digger from the bank. By using a marsh buggy base or by using runners or pads to spread the weight, the damage to the bank is minimized. The ditch may be 1 to 2 m deep by 2 to 3 m wide. The pipe sections are joined together at the point of origin of the ditch, the line given temporary buoyancy by strapped floats, and pushed or shoved down the ditch. A section as much as 24 km long can be installed in this fashion. After being floated into place the floats are removed and the line allowed to sink to the bottom of the ditch. Typically, there will be approximately 1 m of water above the pipe. The ditch may be left open but is more frequently backfilled. Even with firm marsh soils, there is generally sufficient subsidence and shrinkage that the spoil will not completely fill the ditch. However, there usually is no canal after completion. The shove technique is less costly than using flotation barges and is preferred where possible.

The second method of pipe laying utilizes a flotation canal to provide access for the pipelaying equipment. Such a canal may be 12 to 15 m wide and 2 m deep, and may have an additional trench in the bottom to provide 3 to 4 m clearance above top of the pipeline.

The pipeline is constructed on a series of lay barges, and passed over the stern of the train. The pipe is large and heavy, and massive equipment is needed to manipulate it. For example, a standard 12 m section of 1 m diameter pipe weighs approximately 3,629 kg. After the addition of a corrosion coating and 76 to 102 mm of concrete to give it negative buoyancy, a 12 m section weighs about 15,422 kg. Equipment to handle weights of this magnitude cannot be supported by the marsh.

This type of canal is excavated by a flotation dredge, which normally piles the dredged spoil upon each side to form a low levee. Characteristically, where this type of canal is utilized the marshes are soft and unstable, sometimes to the point of being near-floating marshes.

Generally, the dredged spoil is piled back some distance from the canal to leave a 9 to 12 m berm between the canal and the levee. The levees are characteristically low and flat. Depending upon the width and depth of the canal (which determines the quantity of the spoil) and on its stability, a levee may be 1 to 2 m high and possess a base width of 15 to 30 m. The high water content (50-80%) and the organic nature of the excavated spoil results in major shrinkage and subsidence when piled on top of marshland with similar properties. Height reductions of 50% are possible.

Because of these factors, there is never enough dredge spoil from the excavation to backfill a flotation canal. Where canals traverse State-owned land or wildlife refuges, very stringent conditions may be attached to the right-of-way grant with the objective of minimizing impact on the land, and these may include backfilling a flotation canal. In one recent example, nearly 3 km of flotation canal crossing a wildlife refuge were backfilled. However, as usual there was insufficient spoil material, and additional backfill (nearly 160,000 cubic yards) had to be dredged from a nearby bayou and lake. Backfilling with foreign material on a large scale is probably economically unfeasible, and the environmental impacts of the extensive additional dredging that would be required are unknown but probably are significant.

In the course of laying such a line through marshland, numerous bodies of open water will also be traversed. The same equipment may be used, although only a trench will be dredged, or the assembled line can be jetted into place. Hydraulic dredge spoil may be pumped to nearby land, dispersed over the nearby area, or piled up in spoil islands, depending on the particular situation.

Treatment of completed canals, whether "push" or "flotation" is a matter of negotiation between the pipeline owner and the owner of the land being traversed. Land owners may require bulkheads or plugs or dams wherever a canal intersects another waterway, in order to minimize erosion and to prevent navigational traffic, which is a prime cause of erosion.

As with any major engineering effort there are a number of actions and effects from the general pipeline construction operations irrespective of the type of canal constructed. Either type requires surveying and an alignment established and marked. Marsh buggies have normally been used for this operation; these may have a permanent effect on the marshes, especially some softer ones. Even though wide tracts are used, and the unit pressure on the soil is low, the weak marsh structure is compressed, and depressed tracks are left. These may not be self-repairing in some cases because of their depth, and may act as erosion foci.

Similarly, when back-supported draglines are used to dredge push canals, the berm may be damaged, even when pads are used, if the marsh is soft.

In the construction of a flotation canal and laying of a pipeline, there also can be erosion effects upon the canal from the ancillary boat traffic bringing men and materials to the site but this is a short term effect.

Gagliano, Light, and Becker (1972) identified several adverse impacts to marshes as a result of pipeline canal dredging. They include primarily the disruption of marsh vegetation, altered water flow patterns, salt-water intrusion, accelerated runoff, and increased tidal exchange. Altered water flow and salt-water intrusion are considered to have the most severe long term effects on wetlands. The affected states, which control the location and construction of pipelines onshore, have the major responsibility for protecting coastal zone areas from pipeline related impacts. Any of these impacts have the potential to reduce a marsh's productivity or alter the floral and faunal components. The duration can be expected to be short-term (less than one year) if the area is rehabilitated upon completion of the pipeline. However, impacts could last for several years if no effort at reclamation is made.

Oil spills can also present a major threat to shorelines. Because of the distance from shore of the tracts proposed for leasing, spills originating in these offshore areas themselves are not considered to pose any threat to shorelines. A very real threat is posed, however, by oil spills resulting from pipeline or tanker accidents. The likelihood of a major spill from such accidents is slight (see Section III.A.3.c.), but is real nonetheless. Certainly, beached oil is unpleasant aesthetically. More importantly oil at the shoreline kills some animals, such as diving birds, removes habitat from others, alters the behavior of others, and probably has long term, subtle sub-lethal effects on still others (Chan, 1976). The effect of spilled oil on living things depends primarily on two factors: the type of oil (crude or type of refined) and the length of time between occurrence of the spill and the time the oil reaches the shore. Many of the more toxic fractions of oil, especially refined oil, are also the more volatile, and apparently evaporate within a few days. Weathering tends to break up a slick within about four days; the remainder of the oil consists of discrete ‘‘blobs’’ of spongy emulsions of oil which are presumably less harmful to the biota then a slick which can penetrate into many more and smaller places. Thus it would seem that any spill which takes more than four days to reach a shoreline will have only a moderate deleterious effect on the biota of that shoreline. Unfortunately it is difficult to take this sort of analysis any further without knowing where and how much oil will be discovered as a result of this proposed sale or where and by what mode any oil produced will be transported to shore. However, based on production projections and the oil spill risk analysis (Section III.A.3.c.(2)) it appears that there will be very little risk to shorelines as a result of any oil and gas activity that might result from this proposed sale.

Existing leases in the eastern Gulf provide a much higher risk of damage from spills than does this proposal (Section III.A.3.c.(2)). In fact, this proposal does not significantly increase that risk.

11. Impact on Reefal Structures

None of the tracts offered in this proposed sale are nearer than 72 km to the hermatypic coral reefs of the Florida Middle Grounds; thus, no impacts whatsoever are foreseen on these reefs as a result of this proposal.

However, there are extensive live bottom areas in the eastern Gulf (Bright and Jaap, 1976; see also Section II.B.9.b.). Such areas may be even more widespread than as shown on Visual No. 4. Solitary corals and other reef-type organisms may be found on them, especially in depths of less than 60 m.

Oil and gas activities would certainly have an adverse affect on live bottom areas in several ways. These would include mechanical damage due to the placement of drilling rigs, anchors, and platforms; the drilling operation itself would destroy a small area. Pipeline construction would cause considerable damage in a narrow band along the right-of-way. Some adverse impacts might also be caused by the discharge of drilling fluids and cuttings, not only by smothering of benthic organisms, but also by toxic constituents that may be in the drilling fluid; see also Section III.A.1.a. and Appendix E. It is believed that such impacts, while locally very severe, will not cause a serious problem when considering the area of this proposal as a whole.

However, because of the paucity of knowledge of specific locations of live bottom areas, and the highly productive nature of these areas both in terms of biological production and their importance as fishing areas, BLM is proposing the adoption of a special biological lease stipulation for 25 of the tracts being offered in this proposed sale. It is felt that the application of this stipulation will minimize the impacts of live bottom areas in depths of water of less than about 50 m, and that the impacts to such areas in greater than 50 m of water will not be of any concern. This stipulation is discussed in full in Section IV.D.8.

In conclusion, it is believed that activities resulting from this proposed sale, with the suggested stipulation applied to the shallower live bottom areas, will not have a major long-term adverse impact of any significance to reefal areas. The short-term local impact will be severe to the organisms in the immediate area of platforms and pipelines but recovery is expected to be rapid.

12. Impact on Estuaries

Estuaries are highly productive ecosystems. Detrimental effects upon the primary productivity of these ecosystems would result in a decrease in the planktonic food supply of the menhaden, shrimp, and other fisheries in addition to direct toxic effects of crude petroleum on other fauna and flora. Ketchum (1973) cautions that while effects of petroleum depend upon proximity to and type of oil released, "Any release of oil into the environment carries a threat of destruction and constitutes a danger to world fisheries".

However, other authors believe the adverse effects of petroleum hydrocarbons on the biotc communities of the Gulf Coast are less significant. St. Amant (1973), speaking of the oil producing structures in the bays, offshore areas, estuaries, and marshes of his state, says:

"Louisiana's coastal areas with more than 25,000 producing wells, with some fields that have been in production for more than 40 years, and most of which has existed for 20 years, serves as a type area of high production and long-term pollution."

Yet St. Amant, aware of possible environmental damage which may result from "... chronic mismanagement of the environment...", states:

"Long-term exposure in Louisiana does not seem to have resulted in significant changes in the biotic productivity of the marine system and the presence of normally occurring hydrocarbons at levels of from 100 to 500 ppm. in bottom mud tend to confuse attempts to determine accumulative levels of petroleum hydrocarbons in the substrate"

While studies cited previously in this section indicate the retarding effect of petroleum on primary productivity, it is St. Amant's opinion based on his experience that there has been no decrease in overall productivity in Louisiana resulting from introduction of crude oils into the ecosystem (St. Amant, 1973).

The presence of oil consuming microbes which consume limited amounts of hydrocarbons as documented for Barataria Bay, Louisiana (Stone, 1972) may partially account for the reported lack of environmental damage.

Onuf (1973) studied the effects of petroleum in the field near refinery effluents, natural seeps, drilling operations, and in the laboratory. He cites a study in which the biological effects of oil production upon estuarine organisms were considered. In that study the yield of harvestable organisms from waters receiving oil field wastes in Texas was compared with nearby waters which were relatively unaffected by human activity and concluded that there was a serious detrimental effect to commercially important organisms due to oil field wastes. However, the high concentration of oil in the creek under study (16 ppm) and the effects of brine effluents concludes that "... demonstrable effects of long term pollution by oil are very local and often associated with concentrations that approach acutely toxic levels. Where more general effects have been suggested, confounding factors have not been satisfactorily discriminated". According to Onuf:

"The fact that a long period of large scale oil extracting activities has not reduced the productivity of major fisheries along the Gulf Coast of Louisiana suggests that many populations in offshore regions can accommodate long term, low level intrusions of oil. The case for estuaries cannot be so succinctly stated nor dismissed. No respectable field experiments (on estuaries) have been reported."

Onuf points out that lab experiments have revealed "... dislocations of normal behavior..." by organisms in concentrations of oil found in some polluted estuaries and that adverse synergistic interactions between low concentrations of oil and temperature/salinity stresses are of such dangerous magnitude that they warrant direct testing by field experiments. He feels that refinery effluents cause more environmental harm than drilling operations, although he maintains that no predictions are possible on how serious the damage may be.

Galtsoff (1959) noted that the major effects of industrial wastes and the soluble components of crude oil on oysters is a reduction in the rate of various physiological functions, principally ventilation of the gills. Specifically, these pollutants cause a reduction in the amount of time during which an oyster opens its valves for feeding and respiration, and also interferes with the coordination of the ciliary motion with the result that the pumping capacity of the gills is reduced. The reduction in feeding time (simultaneous with respiration) results in a lowered growth rate and poorer quality oyster meats. It is well known that oysters can become contaminated with oil (Ehrhardt, 1972 and Galtsoff, 1959), but there is still scientific debate as to whether oysters can cleanse themselves when returned to clean water.

Teal and Stegeman (1973) exposed two oyster populations, differing in fat (lipid) content, to oil and found that petroleum hydrocarbons were accumulated by both groups of oysters. The oysters with a higher lipid content collected the greater wet weight of hydrocarbons. When the two populations were returned to clean water, the hydrocarbon content was rapidly, though incompletely, discharged. These researchers also found that the petroleum contained in the oysters differed from the contaminating oil by showing a greater percentage of aromatics. This result suggested that a higher percentage of aromatic fractions of oil were more likely to be incorporated into the oyster's tissue. The possibility that the oysters were themselves modifying the oil could not be discounted, however.

A more recent study by Chan (1976) documents some of the effects of an oil spill on the biota of a number of shallow water communities. It is clear from this study that organisms show a wide range of reactions to stress due to oil pollution. The spill was of some 1,500 to 3,000 barrels of a crude oil emulsion 42 km from the Marquesas Keys, Florida. It took about three days for the oil to reach the shore. Floating seagrasses served as natural sorbents of floating oil and were stranded in the intertidal zone. A soluble component of oil leaching from this debris contributed to a mass mortality of subtidal echinoderms on the rocky platform. Oil penetrated sandy intertidal substrates to a depth of ten centimeters. Formation and erosion of a hard, tarry crust overlying the oil-saturated sand was noted. Several crab species were eliminated from the rocky shore, mangrove, and marsh communities for several months. Subtidal oysters from the grass flat community suffered extensive mortalities attributable to a soluble component of the oil. Red mangrove seedlings of the mangrove fringe and swamp sustaining greater than 50% oiling of their leaves were killed. Dwarf black mangroves with greater than 50% oiling of pneumatophores also perished. Lesser degrees of oil coating resulted in continued growth despite leaf loss and chemical burn scars. Elevated temperatures exceeding upper lethal limits of many intertidal organisms were reported for oil covered substrates. The result of clean-up attempts interferred with damage assessment in the mangrove swamp and marsh. No deleterious effects were observed on the submerged offshore coral reefs (Chan, 1976).

Because of the distance from shore of the tracts proposed for leasing, spills originating in these offshore areas themselves are not considered to pose any threat to estuaries. A very real threat is posed, however, by oil spills resulting from pipeline or tanker accidents. The liklihood of a major spill from such accidents is slight (see Section III.A.3.c), but is real nonetheless. The effect of spilled oil on living things depends primarily on two factors: the type of oil (crude or type of refined) and the length of time between the occurrence of the spill and the time the oil reaches the shore. Many of the more toxic fractions of oil, especially refined oil, are also the more volatile, and apparently evaporate within a few days. Weathering tends to break up a slick within about four days; the remainder of the oil consists of discrete ''blobs'' of spongy emulsions of oil which are presumably less harmful to the biota then a slick which can penetrate into many more and smaller places. Thus it would seem that any spill which takes more than four days to reach an estuary will have only a moderate deleterious effect on the biota of that estuary. Unfortunately it is difficult to take this sort of analysis any further without knowing where and how much oil will be discovered as a result of this proposed sale or where and by what mode any oil produced will be transported to shore. However, based on production projections and the oil spill risk analysis (Section III.A.3.c.(2)) it appears that there will be very little risk to estuaries as a result of any oil and gas activity that might result from this proposed sale. Existing leases in the eastern Gulf provide a much higher risk of damage from spills than does this proposal (Section III A.3.C.(2)). In fact, this proposal does not significantly increase that risk.

13. Impact on the Marine Food Web

Some concern has been expressed as to the possibility of food web magnification of petroleum hydrocarbons in marine ecosystems; that is, an increasing concentration of hydrocarbons per weight of tissue at successively higher levels of feeding. This phenomenon has been observed in birds with respect to chlorinated hydrocarbons such as DDT. However, partitioning across respiratory surfaces is considered to be the most likely means of uptake and release of hydrocarbons in marine organisms. The National Academy of Sciences has concluded that there is no evidence for food web magnification in the case of petroleum hydrocarbons in the marine environment; and that, on the contrary, evidence is strongest that direct uptake from the water or sediments is more important than from the food chain, except in special cases (NAS, 1975). For a complete review of the influence of petroleum hydrocarbons and heavy metals on marine food webs refer to Appendix G.

The NAS (1975) concluded that modest concern appeared to be justified regarding the effects of oil in the marine environment on human health. Although it is known that petroleum contains small amounts of carcinogens and possibly small amounts of other harmful materials, the amounts of carcinogens known to be in petroleum that could be ingested by eating marine organisms is estimated to be no greater than that acquired from eating any other foods.

14. Impact on Endangered and Threatened Species

The endangered and threatened species that could be affected and the characterization of their habitat are discussed in Section II.B.15. Those bird species are the brown pelican, red-cockaded woodpecker, and southern bald eagle. Adverse impacts may result to some individuals of these species in ingesting oil contaminated food. The probability of occurrence and the actual effects resulting from ingesting oil contaminated food are not currently known. If it occurs it would certainly not be beneficial. It is considered a remote possibility that there would be ingestion of marine forms which incorporated pesticides or trace metals resuspended during dredging, drilling and operations, or a significant reduction of food supply. Lacking experimental data or a direct relationship, it can only be stated that there could be a possibility of effect.

Another possible effect on these birds could be reproductive in nature. In experiments with mallard ducks, Hartung (1965) found that consumption of small amounts of oil disrupted egg laying activities and that eggs smeared with oil had a very low hatching rate. How much of this that could take place is not known.

Little, if any, of the habitat utilized by these species or other endangered species is expected to be lost as a result of this proposal. Most of the onshore operations will be restricted to very small areas. Little habitat of any type is expected to be lost to permanent installations (a minor portion of 240-480 ha). Locations are not yet site specific nor can they be until production planning is undertaken. No direct relationship establishing a reduction of endangered species habitat is demonstrable at this time. Possible problems that OCS-related facilities may create and possible impacts are discussed in Section III.A. and B.

The probability of an oil spill reaching a brown pelican rookery as a result of this proposal and/or existing leases is less than 0.5% (Appendix H).

Several colonies of the red-cockaded woodpecker have been identified in the coastal areas of the eastern Gulf with the most significant populations occurring in Florida. Since this species is a resident of mature pine forests, it is somewhat removed from coastal areas and clearly unrelated to oil spills. Any indirect impact from offshore leasing would result from habitat destruction caused by construction of onshore support facilities and this is not expected to occur in the red-cockaded woodpecker habitat.

The probability of an oil spill reaching a southern bald eagle nesting area as a result of this proposal and/or existing leases, according to the oil spill risk analysis, is less than 0.5%.

It is believed that the habitats of the other endangered and threatened bird species are not within the probable area of impact as a result of this proposal.

Critical habitat for the Florida manatee includes the majority of the larger freshwater rivers and their headwaters along both coasts of peninsular Florida. Manatees tend to concentrate in select estuarine and river habitats that provide adequate vascular vegetation, recourse to warm water, a source of fresh water, and proximity to channels of at least two meters in depth.

Increased ship transportation in harbors could result in injury to the manatee. From Past experience ship related injuries probably would result in a decline in the manatee population. Another adverse impact to the manatee that could occur from offshore leasing is that of habitat destruction through water pollution and possible pipeline laying or onshore operations. The oil spill risk analysis indicates a probability of less than 0.5% of an oil spill impacting manatee habitat along the eastern Gulf coast.

Alligators for all practicable purposes are coastal wide throughout the geographic area of this proposal. They are primarily a species of the fresh water environment, but occasionally inhabit brackish marshes. It is not expected that acute or chronic discharges of oil will reach their habitat. possibility. If it did occur, it is not expected that this would prove very detrimental for any length of time and would not affect the alligator population as a whole. The possibility of alligator habitat destruction by allowing salt-water intrusion into the fresh water environment is also possible. However, if this occurred it would be on a local basis and would not be expected to affect the total population of alligators to any significant extent.

Critical habitat for the American crocodile lies mostly in the Everglades National Park and keys in Biscayne and Florida Bays. The species depends on the quiet waters of Florida Bay and associated marshes for feeding and nesting. It is believed this area will not be impact by offshore or onshore development as a result of this proposal.

Endangered sea turtles in the eastern Gulf of Mexico include Atlantic ridley, leatherback, and hawksbill with the loggerhead and green being classified as threatened. The principal impact that may affect the turtles as a result of offshore leasing is oil washing ashore and possibly contaminating the eggs or hatchlings or onshore installations destroying nesting areas. There is approximately 555 km (300 miles) of beaches suitable for turtle nesting within this region, of this amount probably less than 10%·is utilized by marine turtles. Individual turtles could be coated with oil if they emerged into an oil slick. Since sea turtles nest from approximately the first week in May through September with hatchlings emerging after a 60 to 70 day incubation, a spill impacting a beach could affect sea turtles for up to seven months of the year. Sea turtles are air breathing animals and hatchlings frequently swim at the surface. Thus, an oil spill would undoubtedly affect them, as well as the forage items (jelly fish, small fishes, and crustaceans) that make up the major portion of their diet.

The oil spill risk analysis indicates a probability of 1% within 3 days and 8% within 60 days of an oil spill reaching a turtle nesting beach (19 to 71% probability for proposed plus existing tracts).

In conclusion, it is believed that impacts to endangered species as a result of this proposed sale would be a chance occurrence, temporary in nature, and confined to specific localized areas and a few individual animals so that only a small part of the population in question would be affected. Although, the loss of even a small part of the population of an endangered species can be of major consequence to the survival of that species, there is no way to further assess the probable effects of the proposal on these species in the region when the accidental nature of any potential occurrence is so uncertain and remote. We therefore judge the potential impact on endangered species to be remote possibilities only and without major potential for direct effect on any single specie.

D. Impact on the Social and Economic Environment of the Gulf of Mexico Area

1. Impacts on Resource Utilization

a. Impact on Commercial Fishing

Offshore oil and gas operations impact commercial fisheries in the following ways: removal of sea floor from use; underwater obstructions; oil pollution (chronic or accidental); and pipelines.

Since the majority of shrimp and many commercial bottom fish are caught by dragging large trawls across the sea floor, sites occupied by drilling or production platforms and attendant service boats and barges must be avoided. If the structures are jack-up drilling rigs or permanent production platforms, the area of the sea floor removed would amount to one to two hectares for each structure. In deeper waters (over 91 meters) a semisubmersible drilling rig with its anchoring system would occupy from 66 to 92 ha (assuming 457 to 637 m anchoring radius). Trawling depths range from approximately 9 to 91 m depth; therefore, structures positioned beyond the 91 m depth would have a minimal impact on trawling operations. The duration of exploratory drilling ranges from approximately 45 days for a single well to around 6 months for multiple well explorations. Permanent production platforms may remain in place for 10 to over 20 years.

Approximately one out of 4.6 tracts will require a platform. Using the actual dimensions of a platform, one would physically cover approximately 1 hectare of the sea floor. Taking into account a navigational safety zone around each structure, trawlers may be denied up to two hectares of the sea floor per platform. The number of new platforms expected from this sale ranges between 5 and 25; therefore, the maximum area denied fishermen would be 50 hectares for the duration the platforms are in place (20 years).

There is no indication that space competition between trawlers and platforms has decreased the catch or revenues of the fishermen. There is reason to expect that with an increase in the number of platforms, the chance for increased fishing boat collisions with these platforms will result; however, this is unquantifiable.

Underwater obstructions may cause problems to trawlers. The obstructions referred to here are submerged well heads, pipelines, underwater stubs, and large pieces of debris which, when snagged, may cause damage to trawl nets.

Pipelines permitted by the Bureau of Land Management are required to be buried 3 feet beneath the mudline out to a water depth of 61 m (200 ft). Pipeline burial is not required in greater water depths. The BLM has records of only two instances of shrimp trawl hangs on offshore pipelines. One of these was hung on a side tap valve of a buried pipeline, which became exposed. At the present time, with so few reports of trawls encountering pipelines, burial of pipelines in waters deeper than 61 m (200 ft) does not appear warranted.

As previously stated, Coast Guard regulations require that stubs be marked by a lighted buoy at the surface if there is less than 26 m of clearance. Stubs with clearance of between 26 and 61 meters must be buoyed; however, a lighted buoy is not required. These buoys are frequently missing despite regular maintenance and replacement. Also, in water depths of 26 to 61 m, if the stub is covered by a bonnet, then it need not be marked by a buoy.

Another safeguard has been the plotting of these stubs on navigation charts for vessels with accurate navigational equipment.

Large pieces of debris, such as equipment, piping, structural members, tools, and the like, may accidently be lost off a platform and may be located by divers and retrieved as specified in OCS Order No. 8. However, if it is lost from a boat or barge underway, the location may not be known accurately enough to allow its subsequent recovery. Presently under development by National Ocean Survey and BLM is a program to chart all major offshore pipelines and flow lines. Several charts for regions of the Gulf of Mexico have now been issued.

An oil spill could cause the closure of areas to fishing, therefore compelling fishermen to fish in other areas where normally they don't. Only one major spill over the field life is assumed likely and even here the probability is low (2:1 against). If it occurred, this could increase the operating costs to the affected individuals, and be inconvenient as well. However, this probably would not be discernable in the industry as a whole.

The addition of platforms could have a beneficial effect on commercial fisheries as well as recreational fisheries, in providing an artificial reef.

Fishermen on a local scale may be impacted by this proposed sale. Loss of catch due to mortalities or area closure could cost them some revenue. Some benefits could also accrue to fishermen because the platforms provide some additional reef habitat (artificial) and concomitant catches.

Trawlers would probably be effected by this proposed sale by loss of revenue due to equipment and time losses due to encounters with underwater obstructions associated with the oil and gas industry.

The cumulative effects of this sale plus previous and future sales would increase fractionally. Each additional sale would probably only fractionally increase the chances for adverse impacts on the commercial fishing industry. This fractional increase of adverse impacts might affect individual fishermen but it is doubtful that it will be observable in the fishery Gulf wide.

b. Impact on the Oil and Gas Industry

The principal effect of this sale on the industrial environment of the coastal areas of the Gulf of Mexico is believed to be the resulting tendency to preserve the existing industrial and economic activity in the region.

This conclusion is based on several factors as stated below:

(a) The extensive industrial development in the area. These industries have developed over a period of many years, and have been based on existing reserves of oil and gas in the area.

(b) The current decline in crude oil and condensate production in the coastal area of the Gulf of Mexico.

(c) The importation of crude petroleum for refining in facilities located in the coastal zone.

The extensive existing refinery capacity and petrochemical production facilities have been described in the section of this statement concerned with the existing petroleum development in the Gulf of Mexico area (Section II.C.1.b.(3)).

The extent to which crude oil and condensate produced from tracts leased as a result of this sale will displace imported crude oil and condensate will probably be dependent, in part, on the relative prices of domestic crude oil and imported crude oil.

The following is based on USGS Federal Energy Administration, 1977. Approximately 40 percent of the domestic crude oil production was valued at the wellhead at $5.16 per barrel. This oil is referred to as ''Lower Tier'' oil. The remaining 51 percent of the total domestic crude oil production is referred to as ''Upper Tier'' or ''Stripper'' and is sold at prices ranging from $10.92 to $13.28.

A preliminary estimate of the average cost for all domestic crude petroleum delivered to refiners during June, 1977 was $9.30 per barrel. The refiner's cost of imported crude petroleum was estimated to be $14.54 per barrel during June, 1977, or approximately $5.24 more than the refiner's average cost of domestic crude. A comparison of refiner acquisition cost of new oil with the landed cost of imported crude is difficult, due to the necessity of adding transportation costs to the wellhead price of new oil in order to arrive at a comparable cost to the refiner, but 86 cents per barrel represents an average cost; and therefore, new domestic production may cost the refiner $11.78, approximately $2.76 or 19 percent below the cost of imported crude petroleum.

It is assumed that the additional production from tracts leased as a result of this sale will displace imported crude oil production. This effect would not be anticipated to initiate an increase in refining capacity, but rather to continue the operation of the existing refineries located in the Gulf of Mexico region.

Although federal legislation influencing land use and refinery siting is presently under consideration, the federal government presently has little direct control over the spatial distribution of onshore activity induced by offshore production. This function, to the extent that it might exist, remains a state, regional or local responsibility. The Coastal Zone Management Act is designed to aid in coordinated planning between state, regional, and local governments combined with Federal cooperation and funding. Florida is well along in the planning process and Mississippi and Alabama are showing progress in their planning.

The incremental onshore effects attributable to this sale are difficult to identify and quantify because: (1) the proposed sale represents only a small portion of a continuing activity in the coastal areas adjacent to the Gulf of Mexico and (2) the potential offshore production and onshore inducements resulting from this sale will occur in association with potentially more dominant and overriding externalities, such as, the importation of foreign crude and the level of exploration and production activity onshore and in state waters. These activities might induce onshore activities similar to the onshore effects induced by activities on the Outer Continental Shelf.

The quantities of crude oil and condensate currently produced from the various onshore and offshore areas have been included in the description of the petroleum industry in the Gulf of Mexico area.

After consultation with the Geological Survey and representatives from industry, an estimated timetable and development sequence was used to determine the projected daily and annual production rate, and other aspects of the sale's impact. This timetable is shown as Table III-7, and incorporates the following assumptions.

(1) The number of movable rigs utilized would increase to the maximum of 10 during the third year following the sale, maintain this rate for two years, and then be reduced to zero at the end of the fifth year.

(2) After a discovery has been made, the final platform design is completed, fabrication is completed, and the platforms are installed during the second to fifth year.

(3) At this time, development drilling started and between 30 and 225 wells on platforms are drilled during the third through fifth years. Platform oil, gas, and water treating facilities are installed after the wells are completed. With this schedule, the first platform is installed during the second or third year and the last one installed during the fifth year.

(4) Production can be started approximately four years after the first discovery if pipelines are installed with the first platform. The most likely case assumes that pipelines would be used with production separated and treated onshore. Production was then modeled to begin during the fourth year and at the completion of development drilling leveling off at the maximum value in the tenth year. A summary of the anticipated develop-

ment scheme with further assumptions are shown in Tables III-8 and III-9.

Given the existing activity and location of oil and gas industry and infrastructure in the Gulf of Mexico area, proposed Sale No. 65 may change the physical location of some of the oil and gas industry activity if oil or gas in sufficient quantities are found in the eastern Gulf.

As producing areas onshore and in the western Gulf decline, activity will shift to newer, more productive areas. The eastern Gulf of Mexico may contain these more productive properties and proposed Sale No. 65 may contribute to the shift. To summarize, from the viewpoint of the world wide activity of the oil and gas industry, the shift of capital and labor from the western to the eastern Gulf will be comparatively slight.

c. Impact on Transportation

The discussion of impacts of OCS activities on transportation can conveniently be divided into three areas: marine transportation, air transportation, and ground transportation. Marine and air transportation are more directly impacted by OCS activities, both by the physical presence of offshore structures and by the increased air and boat traffic required to transport personnel, equipment and supplies between onshore facilities and offshore rigs and platforms.

Ground transportation impacts are essentially secondary in nature involving both worktrips and the movement of supplies and equipment from manufacturing and/or warehouse locations to service and supply base locations.

(1) Impact on Marine Transportation

a. Ship Traffic and Navigation

In the Gulf of Mexico safety fairways have been established for the safe passage of vessels en route to or from U.S. ports. Consequently, placement of rigs or platforms are prohibited within the fairways. Ships, however, do not always use these fairways and this increases the possibility of a collision with drilling rigs, permanent platforms, or vessels attending these platforms. Impacts which could result include loss of human life, spillage of oil, release of debris, including part of or the entire drilling rig and/or ship, if it sinks. The contents of the ship's cargo could cause a serious threat to the environment if it includes toxic materials, such as chemicals, crude oil, and refinery products. As discussed in Appendix C, five tracts (tracts 29, 32, 33, 34, and 36) have been identified as having maximal potential impacts on shipping.

A marine casualty is any casualty involving a vessel other than a public vessel, if such casualty occurs upon the navigable waters of the United States, its territories, or possessions; or any casualty involving a United States vessel regardless of the location of the casualty. Casualties involving commercial vessels are required to be reported to the U.S. Coast Guard whenever the casualty results in any of the following: actual physical damage to property in excess of $1,500; material damage affecting the seaworthiness or efficiency of a vessel; stranding or grounding; loss of life; or injury causing any person to remain incapacitated for a period in excess of 72 hours, except injury to harbor workers not resulting in death, and not resulting from vessel casualty or vessel equipment casualty.

Eight cases involving collision of vessels of over 1,000 gross tons with fixed structures were reported in the Gulf of Mexico during the period of July 1, 1972 through June 30, 1973. Twenty-two other collisions of vessels less than 1,000 gross tons with fixed structures were reported during this eleven year period. Fifteen of the accidents involved less than 100 gross tons and the remaining seven vessels were between 100 and 650 gross tons. Of the twenty-two accidents, there was no loss of life involved and damage to the rig was insignificant (USDI, BLM, 1976b).

The most serious environmental hazard involving offshore structures and shipping accidents would occur in the case of an oil tanker colliding with a platform.

Floating trash accidentally lost off platforms also consititutes a hazard to boats. Damaging collisions can result between small fast boats and floating drums, cans, and wood. The screws of all sizes of motor boats and vessels can be fouled on floating plastic sheeting and plastic or nylon ropes. The extent of this problem is unknown.

Crew and workboat operations between onshore service bases and offshore rigs and platforms will result in the increased use of waterways by marine traffic. While it has been assumed that 20 such boats may be operating during the exploratory drilling phase, and that 125 such boats may be operating during the production drilling phase (NERBC-RALI, 1976), any estimation of the impact such traffic would have on existing marine traffic would be meaningless in the

Table III-7. Lease Sale 65: Hypothetical Development Timetable; Range of High and Low Estimates

Year	Exploratory Wells	Platforms	Development Wells	Pipelines (miles)	Terminals
0					
1	210	0	0		
2	4-15	0-2	0		
3	4-20	1-3	2-5		
4	3-20	1-5	3-20	10	
5	2-10	3-15	25-200	20	
6				20	
7				20	
8				20	
9				10	0-2
10					
Totals	15-75	5-15	30-225	400-700	0-2

Table III-8. The Expenditures Estimated 1/ to Result from Lease Sale 65 Range from Approximately $320 to $1,305 (million)

Expenditures	Low Estimate	High Estimate
1. Well drilling		
Exploratory wells	$ 10,000,000	$ 100,000,000
Development wells	30,000,000	300,000,000
Total Well Investment	$ 40,000,000	$ 400,000,000
2. Platforms	$ 35,000,000	$ 240,000,000
3. Pipelines	$240,000,000	$ 650,000,000
4. Terminal/Storage facilities	$ 5,000,000	$ 15,000,000
Totals	$320,000,000	$1,305,000,000

1/ Above table (Table III-8) based on the following estimated costs.

1/ (continued)

Exploratory well	$ 670,000 - $1,330,000
Development well	
Productive	1,000,000 - 1,333,300
Dry	
Platform	7,000,000 - 9,600,000
Terminal/Storage facility	5,000,000 - 7,500,000
Pipeline (per mile)	600,000 - 928,600

Table III-9. Lease Sale 65: Annual Summary of Investment; High Estimate (in millions of dollars)

Year	Exploratory Wells	Platforms	Development Wells	Pipe-lines	Terminals	Total
0						
1	13.4					13.4
2	20.0	19.2		52.0		91.2
3	26.6	28.8	6.7	78.0		140.1
4	26.6	48.0	26.7	130.0	15.0	246.3
5	13.4	144.0	266.6	390.0		814.0
6						
7						
8						
9						
10						
Totals	100.0	240.00	300.0	650.0	15.0	1,305.0

absence of information as to the number of trips/day/boat. Therefore, the magnitude of this impact cannot be estimated at this time. Increases in traffic could, however, result in harbor congestion, increased collisions, spills, and personal injury should such traffic increases be concentrated in one area. Additionally, water craft engaged in seismic and other analyses, and exploratory vessels not travelling in customary directions, slow moving barges, and pipe laying barges may cause commercial fishing vessels and/or other vessels to alter course, thus causing inconvenience.

Stationary offshore structures such as rigs and platforms may function as navigational aids for small boat operators, and thus have a beneficial impact. Also, in Louisiana, lives have been saved by the presence of offshore platforms when pleasure and commercial boat crews and passengers were forced to abandon their craft during storms or following boating accidents. Overall, however, impact on ship traffic and navigation may be expected to increase.

(b) Ports and Harbors

Service facilities are expected to relocate in the Panama City and Manatee areas. These ports will experience a positive impact by the increased and/or continued usage of facilities developed as a result of OCS Sale 32. Should production exceed expectations, these ports would receive additional positive impacts by the increased usage of industrial land and structures which may now be vacant, under-utilized, or marginally used. Economic development in the ports may progress due to the establishment of new industry and additional business may accrue to industries presently located in the ports. It is anticipated that any crude oil produced will be piped to shore for storage and subsequently tankered to refinery locations resulting in increased ship traffic and possible oil spills. Possible oil spills are discussed in Appendix H and in Section III.A.3.c.(2).

Negative impacts which may occur include increased boat and barge traffic in port and resultant harbor congestion; competition for available dock space may occur and could result in increased docking fees. Smaller wharves may sustain damage by docking vessels larger than the wharves were designed to accommodate. Oil spills resulting from tanker operations and loading may also occur in those ports where such activities take place.

(2) Impact on Air Transportation

(a) Aviation

Air traffic can expect minor impacts from the movement of supplies and personnel. Helicopters are the common form of transportation used for the movement of personnel and light equipment. It has been estimated that no more than 10 helicopters would be required during the exploratory drilling phase and that no more than 50 helicopters would be required during the production drilling phase. The helicopter requirement would be reduced to 25 during production and workover (NERBC-RALI, 1976). These helicopters would work out of service base areas at Manatee and Panama City, and, except during exploratory drilling would probably be based at heliports operated by helicopter contractors and oil companies. Therefore, congestion of airways, particularly near commercial airports should not arise.

b. Airport Facilities

Airport facilities will be minimally impacted during exploratory drilling since it is estimated that no more than ten helicopters would be required at this time. Helicopter operations would primarily occur between onshore service bases and offshore rigs while possibly being housed at existing airports. During production drilling and subsequent phases, it is anticipated that helicopter operations would originate from company operated heliports and service bases. Therefore it is expected that airports will be minimally impacted as a result of helicopter operations.

3. Impact on Ground Transportation

(a) Highways

Highways can expect minor impacts due to increased traffic caused by the movement of equipment and supplies. While some trucking will undoubtedly occur, most heavy equipment will probably be transported by barge. Local roads will be impacted somewhat in the vicinity of supply bases as supplies, equipment, and personnel are moved in and out. Impacts, though minimal, will be most evident during the production drilling phase as activity intensifies.

(b) Railroads

While it is expected that some equipment will be transported by rail, impacts will not be significant in that existing service levels should be adequate to accommodate increases in rail traffic.

During the exploratory drilling phase, rail traffic levels should not increase beyond the level attained as a result of OCS Sale 32. Traffic would be expected to increase during production drilling and then decline during the production phase.

d. Impact on Military Use

The Gulf of Mexico is used rather extensively by the Navy and Air Force for conducting military training and research operations. These current activities consist of missile testing, ordnance testing, drone recovery operations, electronic counter measure (ECM) activities by the Air Force, and training of military personnel. Mine research activities are conducted by the Department of the Navy. Most of this activity takes place in areas designated for these purposes (See Figure II-16). Live ordnance testing by the Air Force occasionally involves emergency release of ordnance outside designated bombing areas; however, these are limited to practice bombs containing a 10-pound explosive. Because Air Force procedures provide for dropping ordnance over water in the event of an emergency, which precludes the use of a designated salvo area, a potential hazard exists. Such emergencies have occurred in the past, and ordnances have been jettisoned as far shoreward as Choctawhatchee Bay. No quantification as to the amount of ordnance located in and outside the salvo area is available. The possibility of occurrence of unexploded munitions on the ocean floor in the proposed lease sale area is considered extremely remote by the DOD.

Oil and gas operations in an ordnance disposal area are potentially hazardous. The accidental detonation of munitions during the course of oil and gas drilling or other activities, should it occur, could result in loss of life, destruction of property, or creation of a potential for fire and polluting events and death or injury by concussion to marine life. At this time, we consider the probability of occurrence low because unexploded ordnances and sunken WWII vessels are detectable through magnetometer surveys and sophisticated magnetic detection devices used as part of geophysical survey activities. Also, in many cases, divers can be used as part of geophysical survey activities. Divers can also be used to aid in locating and plotting munitions and sunken vessels on the ocean floor.

The possible use of shallow, nearshore portions of the continental shelf for ordnance disposal would prohibit full exercise of the multiple use concept common to natural resource management programs. However, it is not Department of Defense (DOD) policy to dispose of ordnance in shallow waters. Such disposal is only carried out in an extreme emergency and only when necessary for the preservation of life or saving of an aircraft and never as a routine disposal procedure. Therefore, significant conflict between OCS operations and military operations is not anticipated should this proposed sale be held.

e. Impact on Recreation

(1) Offshore Impacts on Recreation

The only recreational activity which commonly extends out into the areas of the proposed lease tracts is recreational fishing. Experience has shown, especially in the central Gulf off Louisiana, that oil and gas development offshore significantly enhances deep sea recreational fishing. Major semipermanent installations such as easy to locate, multi-well platforms placed in proposed lease tracts would attract and concentrate sport fish and inevitably sport fishermen. The literature is replete with documentation on the reefal effects of artificial structures placed in the marine environment although it is inconclusive on the contribution of artificial structures to productivity or total biomass (Simpson, 1977 and Stone and Colunga, 1974). The degree to which offshore oil and gas development will affect recreational fishing is primarily related to such factors as the number and size of structures erected, the length of time they are in place, and the distance they are from shore. Water depth and bottom conditions around an offshore platform might also have some influence on the recreational fishing associated with oil and gas structures offshore.

(a) Number of Structures

Up to 25 permanent (production life) platforms are predicted to result from this proposal. Many may include satellite structures or well jackets associated with them. Every one of these structures will enhance recreational fishing to those having access to them. Those benefited will include individuals who have a boat capable of venturing out to a structure for a fishing occasion; tourists and residents who hire a chartered boat to fish for reef-associated fish most often found around offshore platforms; and anglers employed on offshore structures.

(b) Length of Time

Exceptional harvest of sport fish are not uncommon within two weeks of placing a platform in offshore waters. Even concurrent with exploratory and production drilling, good catches of sport fish are commonly associated with offshore structures. Production platforms may remain in place from 10-25 years with drilling activity occurring in maybe three of those years. Generally the longer an offshore structure remains on location the more likely it will become a known and utilized sport fishing location.

(c) Distance from Recreation Market Areas

Many avid anglers, especially those seeking big game trophies, commonly venture more than 50 miles offshore in search of productive fishing waters (See Visual No. 4 for general locations of major offshore fishing areas). Most casual recreational fishermen however are more inclined to stay within sight of the shoreline. This being the case, those tracts in the 10-15 mile-from-shore range are most likely to attract the most recreational fishermen should they be leased and developed. Of the 116 selected study tracts only 10 tracts fall in this range. These tracts (1-10) are directly south of Gulf Shores, Alabama and about equidistant from two major recreation market areas, Mobile and Pensacola (Visual No. 1). Two of the study tracts (4 and 6) in this consolidated 20 block area have artificial reefs recently placed in them by the Alabama Department of Conservation and Natural Resources, Division of Marine Resources. Should either of these tracts be leased, oil and gas operations should have a positive impact on the already improved recreational fishing in the area.

Should any of the other 106 tracts considered for leasing in this proposed sale be developed they would only be accessible to long range boats capable of safely travelling from 20 to 120 miles from the shoreline. Large charter boats and some private yachts in the Tampa-St. Petersburg area would be capable of fishing near structures that could be developed 50 to 100 miles west of their home ports. A few of the large recreational fishing boats based at other harbors and marinas around the eastern Gulf may also be within range of possible oil and gas related development resulting from this proposal but the impact on these boats and fishermen should be minimal. Twelve of the 116 study tracts fall within the major offshore fishing areas of the eastern Gulf as depicted on Visual No. 4. Should these tracts be developed, the overall impact on recreational fishermen should be positive.

SCUBA divers, like sport fishermen, are attracted to offshore areas with fish concentrations and should therefore derive incidental benefits from offshore oil and gas developments.

A timely and relevant discussion supporting this generalized assessment on the impact of artificial marine structures is included in a report on the Mississippi and Alabama artificial reefs constructed from government surplus Liberty ships (Crozier, 1977). Two of the constructed ship reefs, Sparkman Reef and Wallace Reef, are in selected study tracts for proposed Sale 65.

The report addressed the biological and socioeconomic implications of the offshore artificial reef programs off the Mississippi and Alabama coasts. Results of research on biological quantification and diversity, fish recruitment, and cost/benefit factors resulting from the Liberty Ship artificial reef program initiated in 1974 show major benefits to sports fishermen with onshore recreational fish support industries ultimately deriving benefit from the sport fishermen. To the degree that the artificial reefs are able to enhance sport fishing success and thereby attract fishermen from outside the immediate area, tourism related industries in the vicinity of primary access points will be benefited also. Even though the artificial reefs constructed by the oil and gas industry (platforms) have the potential of adding pollutants to the marine environment through accidents and tolerable discharges they are superior to the conventional artificial reefs constructed solely for fishing because their spatial orientation extends throughout the water column and above the water surface thereby providing different niches than underwater, bottom type reefs. A study on South Carolina marine artificial reefs demonstrates how the fish attracting qualities of a reef can be enhanced by extending the spatial orientation of the reef in the water column (Hammond, et al, 1977). Sport fishermen and their support industries in bordering states can therefore derive substantial benefits should oil and gas production platforms be placed within their range. These benefits are derived at no direct cost to themselves nor their governing bodies. Construction, operation, and maintenance cost are absorbed totally by leaseholders. These benefits can be expected to increase in time; however, they will come to an abrupt halt when oil and gas production is complete and structures are removed in accordance with Federal regulations. Expected life of any platform erected in the OCS would range from 10-25 years.

(2) Onshore and Associated Nearshore Impacts on Recreation

A large portion of the shoreline and associated land and water of the eastern Gulf of Mexico is composed of designated recreation areas and routinely supports water-oriented and water enhanced recreation activities. A quick glance at Visual No. 4 shows the concentration of developed and natural recreation resources associated with the coastal zone.

Parks, wildlife refuges, and management areas, nearshore marine and estuarine sanctuaries and aquatic preserves, wilderness areas, natural landmarks, scenic rivers, beaches, and barrier islands are many of the places people go to relax, seek diversion, have fun, and spend some of their disposable income. They come to these places to swim, snorkel, boat, relax, play games, observe nature, seek solitude, fish, hunt, camp, picnic, and participate in many other activities associated directly or indirectly with the shorefront. These resources and consequently the people who enjoy them and are economically dependent on them may incur impacts directly from offshore oil and gas developments, product transportation systems, onshore support facility developments, and other activities relating to or resulting from primary offshore petroleum exploration or development.

In reference to the 667 thousand offshore acres being studied for proposed Sale 65, the USGS has estimated that a total of 25 production platforms will be placed somewhere on this acreage and 700 miles of pipeline will be laid on or under the sea floor to accommodate expected production and transportation. Two storage/terminal locations are predicted to be established; one in the Manatee/Tampa area and one in the Mobile/Pensacola area. Pipeline landfalls will likely be in these same areas.

Offshore operations will be serviced by onshore support bases. Support bases are staging areas for the transfer of men, supplies, and equipment offshore. Probable locations for support bases are at Port Manatee and Panama City. Oil finds will probably be piped from production locations or tankered from the anticipated storage terminal established in the Manatee/Tampa vicinity to existing refineries in the central Gulf Coast region. Gas processing plants may be constructed in the Manatee and Mobile areas. Platform and piping requirements to support production from this proposal are expected to come from existing fabrication and coating yards outside the eastern Gulf Coastal area.

Facilities placed in proposed lease blocks would not be visible from shore with the exception of the study tracts offshore Gulf Shores, Alabama. Tracts 1-20 are from 10-18 miles from the shore and large or tall facilities such as platforms or drilling derricks would be within the sight range of the beaches of south Baldwin County, Alabama. Although visible under good climatic conditions, operations in tracts 1-5 would only cause minor intrusion to those offended by an obstructed view of the horizon over the Gulf. Besides the shorefront beaches of Baldwin County, visitors to Gulf State Park may also be affected. Large structures placed in tracts 6-20, even though perceivable under ideal climatic conditions, would probably be indistinguishable from a large boat and, therefore, visual impacts from structures in these tracts would be inconsequential.

Pipeline landfalls would have only minor and very few localized impacts on recreation areas or activities. A maximum right-of-way of 200 feet and construction time of a few weeks would be required for the two possible landfalls. Once a pipeline has been buried it quickly becomes undetectable on the beachfront; however, the right-of-way will probably remain noticable in a marsh or upland environment.

As was the case after the initial lease sale in the eastern Gulf in 1973, operators will probably lease space for support bases during the initial phase of exploratory drilling. Public and private facilities available in the Pensacola, Panama City, and Port Manatee vicinity will likely be utilized. Although some minor competition for dockage space and marine support services with recreational boaters is possible this is not predicted to be a major concern as commercial space is known to be available in these areas.

Although no additonal refineries are envisioned to result from this proposal, oil storage (transshipment terminal) and gas processing plants on shore may be necessary to accommodate commercial discoveries. The U.S. Geological Survey (Appendix D) estimated up to 1200 acres (480ha) of onshore facility requirements for storage and processing. In addition to land, other requirements such as commercial dockage space, energy, fresh water, and impacts such as waste products, air emissions, and noise could adversely influence recreation areas depending on the final site selections and ultimate design and operation of these facilities. Mobile and the Port Manatee areas have been identified as possible locations. Both areas have commercially zoned port related areas suitable for these facilities.

Trash (floating and non-organic) improperly disposed of offshore or floating debris from accidents offshore can eventually impact the aesthetics of shoreline recreation resources and cause increased maintenance problems to resource area administrators. Although a minor problem, such impacts can be expected.

The most feared adverse impact to onshore recreation resources which can result from offshore petroleum exploration and development is oil pollution. Oil spills most likely to affect recreation resources and activities could originate from drill site blowouts, nearshore or onshore pipeline breaks or leaks, and crude oil transport vessel accidents, or a non-dramatic combination of all these causes often called chronic pollution. Crude oil that finds its way into nearshore waters and onto shoreline resources will impact recreation areas and consequently recreation use. Such impact can cause additional impacts on outdoor recreation related tourism and ultimately on local economics.

When the fate of an oil spill in the marine environment is studied, we find that most crude oil slicks can be expected to break up within 4 days, forming a number of discrete particles or "blobs". Within 30 days, a specific spill is unlikely to be visually traceable as an entity. Derivatives of a crude oil spill such as tar balls, some microscopic in size, could remain afloat for several months or until eventually sinking, dissolving, or going ashore. Incidences of tar ball occurrences have already been reported on the beaches of Panama City and in the vicinity of the Florida Keys. Using the results of the risk analysis we can better assess the probable impact to shoreline and nearshore recreation resources which might result from this proposal.

Table 1, Appendix H indicates we can expect approximately 250 small spills (<50 bbl), about 5 medium sized spills (50-1000 bbl) and, at most, only one large spill (<1000 bbl) from the identified study tracts in proposed Sale 65 should all tracts be leased, explored, and developed. Considering the distance all but the first 20 tracts are from shore, it is very unlikely a shoreline recreation area will be significantly impacted from a major offshore oil spill. Significant impact in regard to recreation resources would mean an area would be rendered unusable by recreators or be forced to close because of widespread oil pollution. Based on the probabilities in Table 4, Appendix H, there is less than a 6% chance that a large spill from any of the studied lease tracts would impact a major recreation area anywhere along the shorefront of the eastern Gulf of Mexico within 30 days if the unexpected did occur.

It is very improbable that impacts from any spills resulting from proposed Sale 65 are likely to be significant enough to cause a major or popular concentrated die off of sport fish or hunted birds nearshore, or result in intensive oiling of a recreation beach. The tourist economy dependent on the viability of the shorefront recreation resources is unlikely to be dramatically affected. There is a minimum probability however that as a result of small and infrequent oil spills offshore, pollution in the form of tar balls could adversely affect shoreline recreation resources and be an eyesore and a nuisance to any recreation users having the misfortune to encounter them. Table III-10 shows the ranges of probability that any of the major classes of recreation resources found along the shorefront of the eastern Gulf will be affected by any of the possible offshore spills (Visual No. 4 depicts these resources individually).

The probability of any spill impacting a recreation resource in a 3 day period is very small. The lease tracts off Gulf Shores Alabama, and the transportation route into the Tampa/Manatee area pose the worst threat in the 3 day period. Sandy beaches and Florida aquatic preserves are most vulnerable to the improbable spills from these areas.

The overall probabilities of any spill affecting primary onshore recreation resources within the 10 day period are 0-37%, however, only a few lease areas and transportation routes pose a real threat. Study tracts south of Alabama and the transportation corridor to the Mississippi Delta

Table III-10. Probability (in percent) of an Oil Spill from Proposed Leases or Identified Transportation Routes Affecting Recreation Resources Along the Shoreline of the Eastern Gulf of Mexico.

Recreation	Within 3 days		Within 10 days		Within 30 days		Within 60 days	
Resource Class	Lease Areas	Trans. Routes	Lease Areas	Trans. Routes	Lease Areas	Trans. Routes	Lease Areas	Trans. Routes
Sandy beaches	0-6	0-1	0-21	0-6	0-27	1-14	6-31	4-18
Designated Wildlife, Natural & Conservation Areas	0-1	0	0-37	4-26	0-42	8-33	3-44	10-36
Designated National Wilderness	0-1	0	0-25	3-14	0-27	7-16	1-27	8-16
National Marine & Estuarine Sanctuaries	0	0	0	0	0	0	0-2	0
Florida Aquatic Preserves	0-3	0-11	0-13	0-15	0-19	0-23	1-21	1-25
Designated Shoreline Parks (National & State)	0-4	0	0-13	0-3	0-18	1-7	2-19	2-10

pose the greatest threat within the 10 day period. Spills coming from these areas and remaining in the water for 10 days would most likely affect a Wildlife Conservation Area or the Breton National Wilderness area. Existing leases in this area already pose a threat to nearby shoreline recreation resources; therefore, the proposed action a national wilderness area however is a serious impact.

For spills in the marine environment lasting from 30 to 60 days, the probability of impact from a lease site increases to 44 percent and from a transportation route to 36 percent. Here again the tracts and transportation corridor off Alabama pose the greatest threat to beaches, wildlife-conservation lands, the Breton Wilderness area, and some parks. Even though the potential incidence of impact is high from a few areas in the 30-60 day interval, the impact effect should be low.

Oil spills therefore are not considered a great threat to onshore recreation resources bordering the eastern Gulf; however, the most likely area from which a spill would cause a major recreation area to be impacted would come from the westernmost region of this proposed lease area where existing leases already pose a significant threat. The cumulative threat of this proposal is insignificant. The matrix analysis, Appendix C, also identifies tracts in the westernmost portion of the proposed lease area as having the greatest potential adverse affect to recreation areas.

(3) OTHER IMPACTS ON RECREATION

Revenues derived by the U.S. from offshore mineral development have had a tremendous impact on the annual appropriations into the Land and Water Conservation Fund (L&WCF). The L&WCF is the major federally financed grants program instituted by Congress to assist the States in developing and acquiring outdoor recreation lands and facilities and has assisted them in financing comprehensive outdoor recreation planning. Likewise the L&WCF has been instrumental in assisting Federal land managing agencies in purchasing recreation and endangered species lands in national parks, national forests, national wildlife refuges, national wild and scenic rivers, and national wilderness areas throughout the country. Over $2 billion have been dispersed through the Bureau of Outdoor Recreation since the fund's inception in 1965. Approximately 60 percent of these revenues were derived from leases, bonuses, and royalties stemming from exploration and production of oil and natural gas on the federally administered Outer Continental Shelf. A recent amendment to the L&WCF Act has increased the annual L&WCF authorization ceiling from $300 to $900 million thereby indicating a continued and increasingly important relationship between offshore mineral development and enhancement of America's recreation estate.

In summary this proposal should: (1) enhance recreational fishing offshore in the Gulf of Mexico within leased tracts which are developed; (2) contribute to financing for the development of existing recreation areas and the acquisition of new recreation areas throughout new recreation areas throughout America; and (3) cause residues from oil spills and trash which will mar the aesthetics of some shoreline recreation resources bordering the eastern Gulf from 1980-1995. The incremental impact of the proposal when existing oil and gas leasing is considered will only have a very minor affect on recreation, especially in the western portion of the proposed lease study area.

F. IMPACT ON HISTORICAL/CULTURAL VALUES

(1) OFFSHORE

No shipwrecks of historic value are known to be in any of the 116 tracts selected for study in proposed Sale 65 nor are there any reported archaeological sites in the proposed leasing areas. Tracts 4 and 6, in the Pensacola Area, contain sunken liberty ships; however, these ships were intentionally altered and submerged on location as artificial fishing reefs and are of no present historical consequence. Oil and gas operations within proposed lease blocks would have no affect on known cultural resources offshore because no sites, structures, or objects of historical or archaeological consequence are known to exist within any of the selected study tracts.

Unknown historical and archaeological resources which may be located on the bottom or beneath the sediments are susceptible to alteration from drilling activities and platform and pipeline placement offshore. Some moderation of the contextural relationship of an archaeological assemblage, be it historic maritime wreckage or an exposed early man living site, is possible. Damage to actual artifacts is also predictable should they come into contact with a drill bit, the weight of an offshore platform, the snag of an anchor, or the force of an underwater pipeline jet sled. Conversely lost cultural resources exposed to the ravages of the sea are subject to constant chemical and biological degradation and are susceptible to damage from other man induced activities disturbing the floor of the Gulf of Mexico. Marine mining activities could lead to a discovery, potentially expanding our knowledge of the past which may be foregone without probing the seafloor for oil and gas. With an estimated maximum of 300 wells, 25 platforms, and one underwater completion potentially resulting from this proposed sale a very small portion of one percent of the eastern Gulf's bottom and sub-bottom is to be directly affected. Furthermore, 78 percent of the selected study tracts fall outside the high probability zone for the occurrence of unknown cultural resources.

It has been estimated that up to 700 miles of submerged pipeline could result from this proposal. Most of the pipeline constructed within the high probability cultural resource zone (see Visual No. 1) will require burial to at least three feet below the mudline. Laying and burying hundreds of miles of pipelines have the potential for interacting with and affecting unknown offshore cultural resources.

Leasing oil and gas rights in the eastern Gulf will ultimately lead to the transport of millions of tons of metal and steel offshore. Much of this magnetically sensitive material will remain on the seafloor or imbedded in the sediment of the seafloor. Should some of the proposed sale tracts be leased, explored, and developed, most of these metallics introduced into the eastern Gulf will be in the immediate vicinity of the leased blocks and chosen transportation corridors. These metallics will mask future efforts to locate cultural resources. The primary tool for finding lost maritime wreckage or historic resources such as shipwrecks and airplanes is the magnetometer which can remotely sense magnetic objects on or under the seafloor. Introducing metallics prior to a magnetometer survey will therefore impact subsequent efforts to locate cultural resources in certain areas of the eastern Gulf.

(2) Onshore

It has been estimated that under conditions of ideal visibility some portion of a 30 m (approximately 100 feet) high offshore structure can be perceived (not necessarily recognized) up to a distance of 27 km (approximately 16 miles). The 15 tracts under study in the Pensacola area (tracts 1-15) are the only tracts considered for lease in this proposed sale from which some oil or gas related activity could possibly be visible from the nearest shoreline. The closest study tract is more than 16 km (10 miles) from the shoreline. Visitors to the nearest site on the National Register of Historic Places would be outside the viewing range of these tracts; therefore, the asethetic appreciation of onshore historic resources will be unaffected by lease site offshore activites.

There is, however, a small chance that an oil spill from an offshore lease site or transportation facility could affect onshore historic resources. Most shoreline cultural resources on the National Register of Historic Places (forts, lighthouses, etc.) are protected from tidal action by natural or artificial buffers such as beachfronts and bulkheads. Even if an oil spill reached shore in the vicinity of an onshore historic resource and the primary historic features were unaffected, the overall historic site or the asthetics of the area could be negatively impacted. Such an impact would be a nuisance but should not affect the historic quality of the primary historic resource. Additionally the effect should only be temporary until containment and cleanup operations are complete.

In summarizing the results of the oil spill risk analysis there is between 0-7 percent probability that an oil spill originating from existing or proposed lease sites or probable transportation routes in the eastern Gulf would reach the vicinity of a national register site in up to 60 days from the time of an accident. The risk is greatest from the 20 study tracts (7 percent risk) just offshore from Gulf Shores, Alabama. The analysis also tells us in table 4, Appendix H, that there is at most only a one percent probability that a spill greater than 1000 bbl will occur over the production life of the proposed lease areas which would affect a national register site within 30-60 days of the spill. When weathering and containments are taken into account, the impact of this unlikely occurrence should be minimal.

The Matrix analysis in Appendix C provides similar conclusions as regards potential impacts on known cultural resources (national register sites) from lease site oil spills. Table C-2, which summarizes the matrix results, shows Tracts 1 and 2 as having maximum potential impact on cultural resources. Tracts 1 and 2 are included in the group of study tracts from 10-18 miles south of Gulf Shores Alabama.

The U.S. Geological Survey has estimated two pipeline landfalls and onshore facilities utilizing up to 600 acres of land both of which may be required to handle production, processing, and storage from this proposal. There has been no site specific determination as to the location of these facilities; however, the most likely area for these onshore developments are the Mobile/Pensacola and Port Manatee/Tampa vicinities. Both general areas contain many sites on the national register of historic places and many archaeological sites are known in these areas. Construction of support facilities for this proposal could therefore impact known and unknown cultural resources. Mitigation for onshore impacts to cultural resources from onshore facilities is outside the scope of this proposal.

To summarize, it is possible that some unknown cultural resources, most likely shipwrecks, would be disturbed should leasing and development ensue from this proposal. Should this occur, it is most likely to result from pipeline construction. In trying to put this impact assessment into perspective one should consider effects on unknown cultural resources from natural processes, such as sediment loads deposited on the Gulf floor from major river systems, and bottom disturbances caused by constant shifting of currents and climatic conditions such as hurricanes. Likewise, commercial fishing and other induced activities such as military operations are continuously interacting with the seafloor of the eastern Gulf and are potentially altering the contextural relationship of any exposed and unknown archaeological assemblages on the bottom as well as contributing metallics which could affect future archaeological investigation.

Should this proposal proceed and development occur, the effectiveness of subsequent efforts to locate lost historical resources in the eastern Gulf will be compromised. This is of the greatest concern on nearshore tracts where the probability of encountering maritime wreckage is greatest.

In conclusion there is only a very small possibility that a significant and known cultural resource would be affected offshore or onshore if all tracts in proposed Sale 65 were leased, explored, and developed. Should this low probability occur, any damage caused would probably be temporary and insignificant.

With only a few existing leases outstanding in the eastern Gulf, very little cumulative impact is expected to occur on cultural resources either offshore or onshore unless successful lessees make significant new discoveries which ultimately would stimulate future exploration and additional onshore and offshore development.

2. Impact on Other Social/Economic Factors

a. Impact on Employment

The direct employment resulting from the assumptions incorporated into the high resource estimates range from 441 in the year 1980 to 3,654 in the year 1984 (Scenario B).

The total employment computed in the Gulf of Mexico region by the use of the Harris model ranges from 529 in the year 1980 to 6,249 in the year 2008. The peak year for total employment was 1984, with 7,826 persons employed in the region. Comparison of the peak direct employment with peak total employment indicates a ratio of 2.14, or: that for each worker directly employed, an additional 1.14 worker will be employed elsewhere in the economy. This scenario did not indicate a sharp decline in total employment after the completion of drilling activities. The direct employment related to the sale was hypothesized to decrease from 3,654 in 1984 to 740 in 1985 and the total employment in the region decreased from 7,826 in 1984 to 3,491 in 1992, increased to 4,174 in 1996, and continued to increase to 6,249 in the year 2008, the last year for which data are available.

It is probable that the initial decrease in regional total employment from 7,826 (1984) to 3,491 (1992) is related to the end of the direct employment related to drilling activities, and the growth in total employment in subsequent years is due to the availability of domestic crude oil and natural gas at lower prices than imported crude oil and natural gas. This interpretation is confirmed to some extent by comparison of the total employment effects in the several states (See Table III-11).

Comparison was also made to a scenario that incorporated the low resource estimates provided by the U.S. Geological Survey. This scenario was based on a smaller number of wells and platforms, decreased pipeline mileage, as well as lower levels of hydrocarbon production.

This scenario is described in the Alternative Section.

TABLE III-11. Total Employment (Scenario B)

	1980	1984	1988	1992	1996	2000
Alabama	115	3208	3205	3536	3762	3968
Louisiana	334	3450	239	-235	-271	-232
Mississippi	67	937	770	1069	1371	1684
Texas	13	232	-567	-879	-687	-269
Region	529	7826	3647	3491	4174	5151

Note: Based on Scenario B: Eastern Gulf of Mexico, High Discovery, Mobile and Pascagoula.

An alternate pattern of development that may be applicable specifies the destination points for oil and gas discovered as a result of proposed Sale 65 may be at Jackson County, Mississippi and Mobile County, Alabama. The employment impacts resulting from this selection of landing points are summarized on Table III-11. In the four state region the impacts are as shown.

The assumptions incorporated into the scenarios are not presented as predictions as to the future, particularly since any forecast is limited by the lack of information concerning the most fundamental factors, such as the amount and location of the productive tracts, the type of production and the purchasers of the oil and/or gas that may be found.

However, one of the economic effects of this proposed sale may be the availability of lower priced crude oil and natural gas at some future date at some locations in the Gulf of Mexico, and these locations could experience increased economic activity as a result of the availability of these required inputs.

In comparing the projections obtained by the Florida Coastal Policy Study with the results obtained by the use of the Harris projections, the difference in assumptions should be considered. There are differences in the number of exploratory and development wells, platforms, and destination points for the crude products. See Table III-11 for visual display of this comparison.

Comparison of the conclusions of the Florida Coastal Policy Study with Scenarios A and B suggest that the maximum total employment impact that can be expected to result from operations in the eastern Gulf of Mexico amount to the employment of 7,826 persons. The impact during any given year will be dependent on the rate at which operations are carried forward. The peak total employment developed by the Florida study, based on a more gradual development plan, suggests a peak total employment at about 44 per cent of the level reached by Scenario B.

If the total regional employment impacts occurred in the selected Standard Metropolitan Statistical Areas, shown on the table in the next section (b), the total sale related employment would amount to the percentages of the total projected employment shown.

It is considered more likely that the employment effects will be more dispersed than would be implied by those comparisons.

b. Impact on Population

Comparison of the total population impacts that may result from proposed Sale No. 65 can be based on the OBERS projections.

SMSA	Projected Total Population 1985	Total Sale Related Population	Percent
Mobile, Ala.	433,000	16473	3.80
Biloxi-Gulfport, Miss.	132,400	16473	12.44
Pensacola, Fla.	259,600	16473	6.35
Tampa-St. Petersburg, Fla.	1,540,100	16473	1.07

Source: USD Commerce and USD Agriculture, 1974.

The actual distribution of population that may result from proposed Sale 65 is likely to be more dispersed than indicated by the Table above. The distribution produced by Scenario B indicated major population increases in Mobile County, Alabama, Jackson County, Mississippi, and Jefferson, Orleans, and Plaquemines Parishes, Louisiana in response to specification of landing points, base facilities, and drilling employment locations.

If the level of impacts associated with this proposed sale were to occur in a small community, the impact would be proportionally greater.

It is most probable that the sale-induced population growth will not cause uncontrolled growth in any given location but may induce some migration. The cumulative impact of several OCS sales in the Gulf of Mexico would be expected to produce impacts at varying locations, particularly those areas chosen as points for employment, investment, or landing points. The summation of these various scenarios would be expected to moderate to a great extent the variations computed for a single scenario.

For example, specification of oil and gas operations in the eastern Gulf of Mexico results in the migration of workers to this area. But the employment opportunities that may develop in the western Gulf of Mexico in response to OCS operations in that region may provide a moderating influence on workforce and population changes that may be forecast for this proposed sale.

c. Impact on Housing

Table II-31 of Section II.C.2.b. displays the expected housing situation for Port Manatee (Manatee County, Florida), Panama City (Bay County, Florida), Mobile (Mobile County,

TABLE III-11A

	Florida Coastal Policy Study (see Section III.A.2.b)	Scenario A	Scenario B	Scenario C
Peak direct Employment	2055	3617	3654	1230
Year (Peak)	1984	1984	1984	1983
Peak total Employment	3452	6953	7826	1209
Year (Peak)	1984	1984	1984	1984
Population	8457	14,764	16,473	3360
Year (Peak)	1984	1984	1984	1984
Ratios:				
Total employment / Direct Employment	1.68	1.92	2.14	N/A
Population / Total Employment	2.45	2.12	2.10	2.78

Note: The relationship between direct employment and total employment in Scenario C is ambiguous.

Alabama), and Pensacola (Jackson County, Mississippi). These are the cities that are most likely to be impacted by offshore development such as the proposed sale.

Scenario B of the economic forecasting model of Dr. Curtis Harris of the University of Maryland was used with input furnished by the USGS for proposed Sale 65, forecasting a high discovery. The areas of impact for Scenario B are mainly concentrated in Mobile and Pensacola.

Table III-13 illustrates the effects that projected population impacts could have on the number of houses needed in Mobile and Jackson County in order to house the population increase associated with direct and indirect employment effects of the proposed sale, given a high discovery of oil and gas. The impact on housing needs for Mobile County, Alabama results in a change of between .08% (in 1980) to 2.9% (in 1996) above 1980 expected housing needs. Jackson County, Mississippi housing impacts run between .1% (in 1980) and 4.5% (in 2008). However, if the anticipated impacts on Mobile were felt in Bay County, Florida, the impact could run as high as 25% (in 1996) of 1980 housing levels. If the anticipated impact levels from Scenario B for Jackson County, Mississippi were to fail in Manatee County, Florida the housing requirement would run between .07% and 2% of 1980 housing levels. It should be remembered that these areas are expected to grow in population with or without the proposed sale and that an expanded housing industry may be able to cope with the increased demand.

A further cautionary note should be mentioned at this point. The results of the Harris Model may not be completely relevant when compared against a completely dissimilar county, such as the comparison of Mobile County, Alabama to Bay County, Florida.

d. Impact on Incomes

The effects on regional income of Harris Model Scenario B high discovery are summarized in Table III-14. The greatest effects are seen in Alabama and Mississippi following the establishment of full production of oil and gas in 1984. The greatest early impacts are felt in Louisiana prior to the establishment of full production. These effects are the result of modeling assumptions built into the scenario which imply that workers from Louisiana will be involved in exploration and development drilling but that construction, production, and other permanent workers would migrate to the eastern Gulf area.

Income or earning effects are the result of a combination of employee and population migration to areas of better job opportunity and higher wages. Thus it can be seen in the above referenced table that earnings increase in the new areas of production and decrease in older areas of declining production of oil and gas.

e. Impact on Existing Economic Infrastructure

Infrastructure is defined as the necessary elements of a structure. From the viewpoint of economics and society, the necessary elements of infrastructure are all things which permit the society to function. Examples are schools, police, hospitals, housing, roads, and industry.

The impact of proposed Sale 65 on social and economic infrastructure is composed of direct and induced impacts. Direct impacts will fall on roads, ports, and pipelines, and the associated industries that supply offshore production with items as diverse as chemical testing or napkins.

Induced impacts are largely associated with population increases from workers and their families, and the extra people necessary to support them with services such as groceries and gas stations. These impacts are felt on schools, housing, utility systems, and a multitude of other social supporting services.

If these impacts fall in an area with a large population and an industrial base, the impacts will be slight. If the population is low in the impact area, impacts are likely to have more effect. For a further discussion, see impact sections on population, housing, and income above.

f. Impact on Government Plans, Policies, and Restrictions

It is anticipated that proposed Sale 65 will not impact government plans, policies, and restrictions. Rather, activities resulting from the proposed sale would be required to be carried out in accordance with such plans, policies, and restrictions. This applies both to activities occurring in the federal OCS which must conform to federal requirements including lease stipulations prepared in cooperation with the affected states, and to related onshore activities which must conform to federal, state, and local requirements.

Table III-13. Impact on Population and Housing Scenario B

Area	1980	1984	1988	1992	1996	2000	2004	2008
Mobile Area (Mobile County)								
Population	296	8519	7368	7855	10170	9284	9408	8179
Units of Housing Required 1/	104	2989	2585	2756	3568	3258	3301	2869
Pascagoula Area (Jackson County)								
Population	149	2035	1670	2268	2813	3437	3853	4440
Units of Housing Required 1/	52	714	586	796	987	1206	1352	1558

1/ Using a population to Housing Ratio of 2.85 (Florida State University and University of South Florida, 1975)

Table III-14. Impact on Earnings Scenario B

State (Coastal Area)	Year Thousands of Dollars 1980	1984	1988	1992	1996	2000	2004	2008
Alabama	1350	38438	42625	49977	57417	64768	70487	77062
Mississippi	831	11862	10805	15549	21211	27596	33094	40675
Louisiana	5925	60476	2596	-3170	-4064	-3972	-3856	-3188
Jefferson Parish	2668	28339	2038	-1273	-1381	-1788	-1849	-1645
Orleans Parish	1103	12990	1176	- 920	-1670	-1350	-1188	- 727
Plaquemines Parish	2149	18859	- 102	- 172	- 190	-214	-266	- 309
Texas	260	8434	-6357	-10621	-9136	-3997	-1841	1451
Region	8365	119209	49669	51734	65427	84396	97882	115999

g. Impact on Occupational Hazards

It can be expected that there will be a slight increase in the amount of fatalities and injuries as a result of this proposed sale. The types of accidents most likely to result in fatalities or injuries are fires and explosions, falls, falling objects, and drowning (Table III-6). Approximately 6 fatalities can be expected over the life of the field.

Section IV

Mitigating Measures Included in the Proposed Action

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

BLM
NEW ORLEANS OCS

A. Operations - Protection of the Marine Environment

1. Regulations - OCS Orders

OCS Operating Orders control some of the areawide mitigatory actions planned as part of this proposal. Fourteen established Orders, a proposed Order (number 15) entitled "Submittal of Information Concerning Development Plans to Coastal States," and three proposed National Orders are laid out in detail in Appendix B. All will have, to a greater or lesser degree, the effect of controlling OCS operations and increasing the environmental integrity of the proposed action. The areas of concern and the effective dates of all established OCS Orders that would pertain to leases in this proposed sale are outlined below:

OCS No.	Title	Effective date
1.	Marking of Wells, Platforms and Fixed Structures	August 28, 1975
2.	Drilling Procedures	January 1, 1975
3.	Plugging and Abandonment of Wells	August 28, 1969
4.	Suspensions and Determination of Well Producibility	August 28, 1969
5.	Subsurface Safety Devices	June 6, 1972
6.	Completion of Oil and Gas Wells	August 28, 1969
7.	Pollution and Waste Disposal	October 1, 1976
8.	Platforms, Structures, and Associated Equipment	October 1, 1976
9.	Oil and Gas Pipelines	October 30, 1970
10.	Sulphur Drilling Procedures	August 28, 1969
11.	Oil and Gas Production Rates, Prevention of Waste, and Protection of Correlative Rights	May 1, 1974
12.	Public Inspection of Records	February 1, 1975
13.	Production Measurement and Commingling	October 1, 1975
14.	Approval of Suspensions of Production	January 1, 1977

2. Inspection Programs and Approval Requirements

To enforce the Geological Survey Operating Regulations (30 CFR 250) and OCS Orders, a comprehensive inspection system has been developed. OCS operators must receive approval before commencing any work. Operators are required to submit a notice and detailed description of work they desire to perform to the USGS District Supervisor and to the Governor of the adjacent state (pursuant to 30 CFR 250.34 and the above proposed OCS Order No. 15). This requirement is to insure that no operation is conducted without thorough planning for safety, conservation, and protection of the environment; to determine that all operations meet the standards established by regulations and OCS Orders; and to assure proper coordination with affected states.

a. On-site Inspection

All operations, regardless of the activity, will receive regular on-site inspection for compliance with regulations and OCS Orders. The Geological Survey uses a systematic program including both scheduled and unannounced inspections to assure the achievement of safety objectives. Floating drilling vessels or drilling units will receive a detailed inspection to insure conformance with regulations and OCS Orders before commencement of drilling operations. These predrilling inspections are comprehensive and often require several days to complete. Also, these rigs will be inspected at least once during the drilling of a well, and all well control, safety, and pollution control equipment will be inspected for proper function.

Permission to either abandon or suspend a well must be granted by the USGS; this includes the setting of all required cement plugs. The cutting of the several casing strings below the sea floor, at which time the casing is removed, will be reviewed by the USGS on a case-by-case basis to ensure that sediment migration will not eventually expose the casing stub.

Well workover and well abandonment phases of OCS operations, as with drilling, will receive both scheduled and unscheduled inspections, depending on the progress of a particular operation. Drill stem testing; cement plugs set prior to redrilling a well; cement plugs set to temporarily or permanently abandon a well; and all casing cementing operations must be approved by the USGS Supervisor.

OCS pipelines will be installed in accordance with the Gulf of Mexico OCS Order No. 9, which will provide for submittal of information such as purpose of each line, proposed route, water depths, capacity, operating pressures, size and grade of pipe, burial depth, corrosion protection, protective coating, connecting and metering facilities, and pressure control facilities. The methods of welding and laying the pipeline are monitored, as is the installation of connecting facilities. A hydrostatic test to greater than the designed working pressure of the line is made upon completion of installation.

b. Inspection Schedule and Enforcement

The inspection program for the Gulf of Mexico OCS area is maintained by the U.S. Geological Survey with the intent that required regulations will be followed to avoid potential hazards to personnel, provide protection for the environment, and preserve the multiple-use concept of the OCS lands. Warnings for incidents for noncompliance are issued and the date of correction of defects are recorded.

Visual inspections of the water surface over OCS pipelines in the Gulf of Mexico operating area are currently made by the operator for evidence of failures and leaks. USGS and operator personnel in this area visit production facilities daily and follow a route approximating the pipeline route.

The U.S. Coast Guard also patrols for oil spills or leaks with vessels and aircraft within territorial and continguous waters. Occasionally patrols are made within the prohibited zone, normally within 50 miles of land, to enforce the International Convention for the Prevention of Pollution of the Sea by Oil, as amended.

An approved contingency plan is required from each operator in the Gulf of Mexico that includes spill control, containment and cleanup, and measures to be taken if there is any likelihood that hydrogen sulfide gas might be encountered during the drilling operation.

c. Inspection Procedures for Subsea Systems

A subsea system may possibly be used to produce oil and gas resulting from this proposed sale. Inspections of these systems in the Gulf of Mexico will be in accordance with applicable OCS Orders and USGS policy.

The many Federal agencies involved in the review process of subsea systems include, in addition to the Geological Survey: EPA, Coast Guard, Corps of Engineers, U.S. Fish and Wildlife Service, and the Bureau of Land Management. Except for proprietary parts, plans for exploration and development utilization are available for general public review.

d. Operator Reports

A comprehensive reporting system covering all oil spills and any unusual conditions (for example, reporting and investigation of a persistent oil slick from an unknown source, such as sunken ship or natural oil seep) is required by the OCS Orders, and is a key factor in monitoring operations in the Gulf of Mexico. Operators are also required to maintain records for inspection by the Geological Survey of required periodic tests of safety equipment. A digest of these reports and the various forms that are required can be found in the Gulf of Mexico OCS Order No. 12, Appendix B.

3. Enforcement

USGS policy is intended to eliminate any noncompliance with lease requirements by the operator that may lead to loss of life, loss of property and resources, or damage to the environment. A standardized compilation of items has been prepared by the USGS, entitled "List of Potential Items of Noncompliance and Enforcement Action", the "PINC" list, which is used for inspection. Should an inspection of drilling and production operations detect hazard pressure situations or pollution, either a written warning will be given that allows the operator seven days to correct the incident of noncompliance (INC), or a shut-in order will be issued. The shut-in order may be applied only to the equipment affected by the incident of noncompliance such as a particular piece of production equipment or a producing zone, or to the entire drilling rig, production platform, or onshore facility, as required.

Additional penalties for noncompliance are specified in Section 5(a)(2) of the Outer Continental Shelf Lands Act of 1953, 43 U.S.C. Sec. 1334(a)(2). Any person who knowingly and willfully violates any rule or regulation prescribed by the Secretary for the prevention of waste, the conservation of natural resources, or the protection of correlative rights shall be deemed guilty of a misdemeanor and punished by a fine of not more than $2,000 or by imprisonment, and each day of the violation shall be deemed a separate offense.

Also, Sections 5(b) and 5(b)(2) provide for cancellation by notice of nonproducing leases subject to judicial review or appropriate judicial proceedings.

The cumulative number of warnings issued and suspensions ordered for infractions of OCS Orders which occurred during normal daily inspections are listed in Table IV-1.

During the period of January 1, 1977 through September 31, 1977 there were 12 oil spills of more than 10 barrels reported, three of which are described below:

1. A shrimp trawl was dragged across the tie-in of Placid's 10 inch pipeline and Pennzoil's 14 inch Bonito pipeline, pulling loose a one inch ball valve and nipple allowing 4,000 barrels of oil to spill in the Gulf.

2. A mud slide caused the rupture of a 12 3/4″ line resulting in the release of 250 bbl of oil.

3. A high level sensor on a stock tank failed, allowing the tank to overflow 35 bbl of oil.

In accord with prescribed inspection procedures, Geological Survey personnel verified that remedial action had been taken in all reported spill incidents prior to the reactivation of the production facilities.

A program of intensive inspections is used on OCS leasing. Inspections are conducted on a regular basis with emphasis placed on operations. All production platforms are inspected every six months and each drilling well is inspected at least one time. The Geological Survey inspection force in the Gulf of Mexico has increased from seven technicians and five engineers as of July 1, 1969 to 39 technicians and 29 engineers as of June 30, 1977. During the period November 1, 1972 through June 30, 1977, technicians spent 22,667 inspection days or 199,146 man-hours, and engineers 1,907 inspection days or 16,584 man-hours in the field. Detailed inspections were conducted on 6,684 major producing platforms and 4,508 minor platforms in the Gulf of Mexico from December 1, 1972 through June 30, 1977. Also, during this time period, 3,615 inspections of single-wells or satellites were made by boat. Approximately 95% of these inspections were unannounced. Included in these inspections were 73,808 well completions. Also, during this time period, 8,526 inspections of drilling rigs were conducted. There is no absolute measure of the significance of these data per reporting period. However, it is apparent that inspections have increased considerably per period since 1972.

Minor incidents of non-compliance result in formal warnings while incidents of non-compliance of a potentially more hazardous nature result in well or platform shut-ins until the operation is in full compliance with regulations and orders.

Table IV-2, indicates equipment malfunctions detected during inspection and enforcement actions. These data include the results of some special inspections and all inspections within the last year, and are limited to the most frequent malfunctions detected. Listed in the third column are the number of items which did not operate within acceptable tolerances. These items did not necessarily fail nor cause an undesirable event.

Velocity type subsurface safety valves are periodically pulled from the wells and checked. This requires removing the valve from the well for inspection, repair, adjustment, and reinstallations. One company utilizes test stands to test the valve performance characteristics under simulated flow and pressure conditions. Surface operated subsurface safety valves are tested in place by releasing hydraulic pressure within the closed system thereby closing the valve; subsequently, the valve is reopened by repressuring the system. Automatic equipment is now in use which shuts down production whenever a leak occurs in pipeline or production facilities. These include, but are not limited to, pressure sensors and high and low controls. Drip pans are placed under valves, vessels and the production system in order to prevent leaking oil from escaping into the water of the Gulf.

From January, 1973 to March 1977, the average number of pipeline malfunctions which resulted in oil spillage was approximately 19 per year (USDI, GS, 1977c).

Experienced private and government personnel are aware that public attention was focused on the oil spill at Santa Barbara in January 1969, and probably because of this awareness, there has been a great deal less oil pollution in the Gulf as a result of normal oil and gas producing operations. Table IV-3 summarizes the oil spills in the Gulf of Mexico from June 1976 through June 1977. From January 1, 1971 through June 30, 1977, there were approximately 50,000 barrels of oil produced per each barrel of oil spilled.

4. Oil Spill Contingency Action

Oil spills will occasionally occur as a result of natural disasters, equipment failure, or human error. In the event that such an emergency occurs, the following action will be taken:

Table IV-1. Cumulative Number of Warnings Issued and Suspensions Ordered for Infractions of OCS Orders Which Occurred During Normal Daily Inspections.

WARNINGS			
Period	Drilling	Workover	Production
12/72 - 3/73	17	1	358
9/73	34	2	1529
4/74	46	3	2649
9/74	48	9	3525
6/75	71	13	4931
1/76	74	17	5647
5/76	83	17	5856
12/76	106	17	6170
6/77	126	17	6513

SUSPENSIONS			
Period	Drilling	Workover	Production
12/72 - 3/73	7	0	249
9/73	14	3	764
4/74	26	4	1437
9/74	34	6	2294
6/75	42	6	3298
1/76	50	6	4126
5/76	53	6	4445
12/76	57	6	5321
6/77	67	7	5879

Source: USDI, GS, 1977d.

Table IV-2. Equipment malfunctions detected during complete and partial inspections during the period January 1975 through May 1977

Items	No. Checked	Operable	Inoperable or not with Acceptable tolerances*	Percent Failures or Malfunction
Surface safety valves. .	20,825	20,232	593	2.8%
Flowline	41,052	40,604	448	1.1%
Check valves	19.764	18,527	1,237	6.2%
Pressure vessels:				
High pressure sensors.	16,976	16,550	426	2.5%
Low pressure sensors .	13,941	13,702	239	1.7%
High level shut-in . .	14,640	14,346	294	2.0%
Low level shut-in. . .	8,549	8,271	278	3.2%

Source: USDI, GS, 1977d.

*Items which did not operate within an acceptable tolerance during inspection. It should be understood that these items did not fail and cause an undesirable event.

Table IV-3. Summary of oil slicks and oil spills information which occurred from June 1, 1976 through June 30, 1976 in the Gulf of Mexico.

Month	No. spills	Vol. crude (barrels)	Vol. other (barrels)	No. spills one barrel or less	No. slicks sighted
June 76	6	26	--------	80	45
July 76	5	25	--------	110	61
Aug. 76	5	26	12 diesel	85	50
Sept. 76	7	11	2 condensate 2 diesel	67	53
Oct. 76	9	18	315 diesel	72	20
Nov. 76	4	11	--------	60	22
Dec. 76	12	4,043	2 diesel	59	27
Jan. 77	7	25	12 diesel	51	19
Feb. 77	5	25	--------	51	13
Mar. 77	8	230	2 diesel	66	36
April 77	3	29	--------	63	19
May 77	4	15	--------	92	34
June 77	9	74	--------	89	36
Totals	84	4,558	2 condensate 345 diesel	945	435
Total since November 1972	540	50,763	64 condensate 990 diesel 47 oil base mud 3 distillate 10 corrosion inhibitor 2 methanol	2,932	2,490

Source: USDI, GS, 1977d.

a. Requirements of OCS Order No. 7

In case of any spill, the operator is required to initiate action to control and remove the oil pollution in accordance with his approved emergency plan. A spill or leakage of less than 15 barrels requires a report from the operator to the Supervisor as to the nature of the spill or leakage, the reason for its occurrence, and what steps were taken to correct it. A spill of 15-50 barrels must be reported immediately to USGS by telephone and confirmed in writing. A spill of over 50 barrels or one of any magnitude that cannot be immediately controlled must be reported immediately to the Coast Guard, the Environmental Protection Agency, and the Geological Survey.

b. Regional and National Contingency Plans

If the operator is unable to control and remove the pollution, the Regional or National Oil and Hazardous Substances Pollution Contingency Plan will be activated and the designated Federal On-Scene Coordinator will direct control and cleanup operations at the operator's expense. To date, this has never been necessary in the case of any spill from OCS operations in the Gulf of Mexico.

The Regional or National Oil and Hazardous Substances Pollution Contingency Plan was developed pursuant to the provisions of the Federal Water Pollution Control Act as amended (33 U.S.C. 1101). The Council on Environmental Quality has published the revised National Oil and Hazardous Substance Contingency Plan as required by the Federal Water Pollution Control Act Amendments of 1972. Section 11 (c)(2) of that statute authorized the President, within sixty days after the sections became effective, to prepare and publish such a Plan. The Plan provides for efficient, coordinated, and effective action to minimize damage from oil (and other) discharges, including containment, dispersal, and removal. The Plan includes: assignment of duties and responsibilities; identification, procurement, maintenance, and storage of equipment and supplies; establishment of a strike force and emergency task force; a system of surveillance and notice; establishment of a national center to coordinate response operations; procedures and techniques to be employed in identifying, containing, dispersing, and removing oil; and a schedule identifying dispersants and other chemicals that may be used in carrying out the Plan and the waters and quantities in which they may be safely used. Annex X of the Plan basically sets forth a no-dispersant policy. Exceptions can be made for safety reasons (to prevent fire or explosions) or for certain other circumstances such as the protection of endangered waterfowl. However, the approval of EPA is required, except in cases of safety when the approval of the On-Scene Coordinator is required. The Plan is revised from time to time as necessary. Operation of the National Contingency Plan requires a nationwide network of regional contingency plans. Guidelines for that nationwide network are established in the National Plan. This Plan provides for a pattern of coordinated and integrated responses of departments and agencies of the Federal government to pollution spills. It establishes a nationwide response team and provides guidelines for the establishment of regional contingency plans and the response teams. The Plan also promotes the coordination and direction of Federal, State, and local response systems and encourages the development of local government and private capabilities to handle such pollution spills.

The objectives of the Plan are: to develop appropriate preventive and preparedness measures for discovering and reporting the existence of a pollution spill; to promptly institute measures to restrict further spread of the pollutant; to assure that public health, welfare, and natural resources are provided adequate protection; to provide for the application of techniques for clean-up and disposal of the collected pollutants; to provide strike forces of trained personnel and adequate equipment to polluting spills; to institute actions to recover clean-up cost; and to effect enforcement of existing Federal statutes and regulations issued thereunder. Detailed guidance is contained in the basic Plan, the annexes, and the regional plans.

The Plan is effective for all U.S. navigable waters including inland rivers, the Great Lakes, coastal territorial waters, and the contiguous zone and high seas beyond this zone where a threat exists to U.S. waters, shore-face, or shelf-bottom. Its provisions are applicable to all Federal agencies.

A Memorandum of Understanding between the Department of the Interior and the Department of Transportation outlines the respective responsibilities of the Geological Survey and the Coast Guard under the National Contingency Plan. The Geological Survey is responsible for the coordination and direction of measures to abate the source of pollution when the source is an oil, gas, or sulphur well. This responsibility includes the authority to determine whether pollution control operations within a 500 m radius of the pollution source should be suspended to facilitate measures to abate the source of pollution. The Coast Guard is responsible for the coordination and direction of measures to contain and remove pollutants, and shall furnish the On-Scene Coordinator with authority and responsibilities as provided by the National Contingency Plan. The Gulf of Mexico Strike Force Team in Bay St. Louis, Miss., may also respond to any pollution emergency.

c. Petroleum Industry Contingency Plan

From the upper Texas coast to the Mississippi Delta region, offshore operators maintain a large inventory of various kinds of equipment that could be put to use on short notice for containing and cleaning up an oil spill and stopping the source of the spill. This inventory includes 177 boats ranging from 30 m crewboats to 50 m utility and cargo vessels, 64 helicopters, and 103 fixed-wing aircraft. For a complete inventory of oil spill containment and clean-up equipment see USDI, BLM, 1976, Sale 41, Final Environmental Impact Statement, Appendix C.

Clean Gulf Associates

Clean Gulf Associates is a non-profit organization formed by thirty-nine companies (these companies produce 98% of offshore petroleum) operating in the OCS. Their purpose is to provide for a stockpile of oil spill containment and clean-up materials for use by member companies in offshore and estuarine areas. Clean Gulf Associates has contracted, effective August 1, 1972, with Haliburton Services to supply equipment, materials, and personnel necessary to contain and clean-up spills in the Gulf of Mexico to the limits of the OCS lying offshore and seaward of the states of Texas, Louisiana, Mississippi, Alabama, and Florida.

All of the tracts considered in this proposal fall within this area. Before any drilling commences, should this proposed sale be held, an inventory of pollution combatting equipment would be stockpiled at a strategic location. Spill booms, skimmers, vacuums, sprayers, and absorbents are examples of equipment stockpiled.

At the present time clean-up systems are maintained at five primary bases located at Mississippi River Delta, Grande Isle-LaFourche-Terrebonne, Morgan City-Atchafalaya, Vermilion-Cameron, and the Texas coast.

These systems include: fast response open sea/bay, high volume open sea, and shallow water skimmer systems, and auxiliary shallow water and beach clean-up equipment.

d. Effectiveness of Cleanup Operations

When oil is spilled on water, the first priority is to contain it or, in a river, direct it to a collection point and remove it by absorption, adsorption, or skimming. Presently available equipment is adequate for calm or enclosed waters but fails in rough sea conditions which are in excess of one knot currents and several foot waves.

Booms are used for containment and various types are available. They normally fail when the accumulated oil behind the barrier is carried underneath it by the current. Most often, booms available break apart in high sea states and are not easily deployable in rough weather. The Coast Guard has developed a High Seas Containment Barrier that is capable of withstanding 6m (20 ft) waves and 13 km/hr (7 knot) currents and of operating well in 1.2-1.8 m (4-6 ft) waves, 3.7 km/hr (2 kt) currents, and 37 km/hr (23 kt) winds. It can be transported by plane or truck and deployed fairly rapidly. Exxon has developed a boom that has been shown capable of surviving in 6 m (20 ft) waves, 3.7 km/hr (2 kt) currents, and 37 km/hr (23 kt) winds. However, the boom is cumbersome and not easily deployed. To date, the best boom performance that has been reported (Exxon) is containment in 1.8-2 m (6-8 ft) seas with 32 km/hr (20 kt) winds and 2 km/hr (1.25 kt) currents. Improvements are being made but the effectiveness of booms is reaching its upper limit.

After containment, the oil must be collected. Straw is rapidly being replaced by mechanical skimmers and synthetic sorbents in this task. Skimmers operate on various principles and some types are now available that work well in 1.8-2 m (6-8 ft) waves, 5.5 km/hr (3 kt) currents, and 74 km/hr (40 kt) winds; however, these latter types operate at low recovery rates (1 to 5 bbls/min). The Coast Guard is developing a combination boom and skimmer system, but this will not be available for some time. Recovered oil can then be transferred to a refinery for recycling.

When the oil slick becomes too thin to be collected by these devices, absorbents and adsorbents like straw or the newer synthetic materials can be used. The synthetic sorbents include polyurethane foam, alkylstyrene beads, and other oleophilic products. These absorb or adsorb 5-30 times their weight in oil, and some can be wrung out and reused. The problem with sorbents is that they themselves must be collected either mechanically or manually to prevent them from contaminating the environment.

Various chemicals may also be used to assist in collecting, dispersing, or removing the oil. Surface tension modifers and collecting agents prevent or restrict the spreading of oil on the water's surface and "thicken" the oil slick for easier collection by the skimmers and mops. Their use is authorized when it will result in the least overall damage to the environment or interferences with designated water uses. Dispersants can be used to form oil-in-water emulsions that facilitate the dispersal of oil into the water column. As previously indicated, the use of these chemicals is limited because of their potentially toxic effects on marine organisms. Biological agents that encourage biodegradation of the oil may also be used if previously approved. Burning agents that improve the combustibility of oil may be applied if they have been approved by EPA, and if their use will reduce imminent danger to life, limb, or property and will result in the least environmental harm when compared to other methods. The use of sinking agents is not allowed on the navigable waters of the United States.

All of the above methods are effective in calm harbor and nearshore waters but face severe limitations on the open seas, not the least of which are the 12 or more hours required to respond to a spill several miles offshore as might be the case in this proposed sale area. Oil spill containment on the open seas, then, is severely limited. However, because the efficiency of recovery for any particular spill depends on a combination of wind and wave condition and other physical parameters, no estimate can be made of what amount or what percentage of a spill could be recovered.

Toxicity studies involving the various chemicals available for use for collecting, dispersing, and removing of oil are, by requirement, available through EPA.

B. Structures

If a ship strays from established safety fairways, oil and gas platforms can pose a hazard to commercial shipping. This hazard however, is minimized by the fact that safety fairways are clearly designated on navigation charts. Directional drilling from outside safety lanes is used to develop tracts lying partially under safety lanes. Pertinent portions of the Federal Regulations (33 CFR Sec. 209.135(b), 1971) governing shipping fairways and anchorage areas are as follows: "The Department of the Army will grant no permits for the erection of structures in the areas designated as fairways, since structures located therein would constitute obstructions to navigation. The Department of the Army will grant permits for the erection of structures within an area designated as an anchorage area, but the number of structures will be limited by spacing as follows: The center of a structure to be erected shall be not less than two (2) nautical miles from the center of any existing structure. In a drilling or production complex, associated structures shall be as close together as practicable having the consideration for the safety factors involved. A complex of associated structures, when connected by walkways, shall be considered one structure for the purposes of spacing. A vessel fixed in place by moorings and used in conjunction with the associated structures of a drilling or production complex, shall be considered as attendant vessel and its extent shall include its moorings. When a drilling or production complex includes an attendant vessel and the complex extends more than five hundred (500) yards from the center of the complex, a structure to be erected shall not be closer than two (2) nautical miles from the near outer limit of the complex. An underwater completion installation in an anchorage area shall be considered a structure and shall be marked with lighted buoy as approved by the United States Coast Guard."

Development of those tracts in the proposed sale which lie partially within shipping fairways or anchorage areas will be subject, if leased, to Federal regulations as presented above so far as the placement of structures is concerned. This would help mitigate any potential impact due to the proximity of structures to relatively high frequency sea traffic. Visual No. 1 depicts offered tracts and fairways.

Commercial vessels are required to report to the Coast Guard whenever a casualty results in any of the following: actual physical damage to property in excess of $1,500, material damage effecting the sea-worthiness or efficiency of a vessel, stranding or grounding, loss of life or injury causing any person to remain incapacitated for a period in excess of 72 hours except injury to harbor workers not resulting in death and not resulting from vessel casualty or vessel equipment casualty. Drilling and production platforms (artificial islands) are required to report to the Coast Guard when involved in a casualty or accident and if any of the following occur: if hit by a vessel and damage to property exceeds $1,500, damage to fixed structure exceeds $25,000, material damage affecting usefulness of lifesaving or fire fighting equipment, or loss of life.

Under some conditions, offshore structures are an obstacle to commercial fishing activities. An offshore structure can remove areas of trawling and purse seining waters, and heavy concentrations of platforms can make trawling and purse seining operations difficult.

The erection of more structures on the OCS may affect commercial fishing operations. The impact from platforms may be kept to a minimum by allowing only those structures necessary for proper development and production of the mineral resources, and by placing them with due regard to fishing operations and other competing uses which are evident at the time of platform approval.

The Area Oil and Gas Supervisor considers the views of fishing organizations such as the Gulf States Marine Fisheries Committee with regard to placement of platforms. The Supervisor also from time to time requests information from the Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service to be used in his decision making process of approving or disapproving platform installation. Within the constraints of locations of the reservoirs and the technology necessary to drill directional wells, the Supervisor is mindful that platform location is an important consideration for commercial fisheries and does make decisions regarding platform location which minimize the impact on the commercial fishing industry.

C. Pipelines

1. Existing Responsibilities

Federal responsibility and authority for gas and oil pipeline routing or operation on submerged coastal lands is vested in a number of agencies, including the following: Department of the Interior, (a) Bureau of Land Management -- rights-of-way for common carrier pipelines on the OCS, (b) Geological Survey -- jurisdiction over producer-owned gathering lines and flow-lines on the OCS, and (c) U.S. Fish and Wildlife Service -- protection of fish and wildlife resources and their habitat through consultation with the Corps of Engineers in the process of issuing Federal permits in navigable waters; U.S. Army Corps of Engineers -- issues permits for construction (including pipelines) on OCS and in other navigable waters; Federal Power Commission -- grants certificates of convenience and necessity prior to construction of interstate natural gas pipelines; Interstate Commerce Commission -- grants approval of the tariff rates for transportation of oil by common-carrier pipelines; Department of Transportation, Office of Pipeline Safety -- establishes standards for pipeline construction, operation and maintenance; and Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service -- protection of marine fishery resources and their habitat (in coordination with the U.S. Fish and Wildlife Service), through consultation with the Corps of Engineers in the process of issuing Federal permits in navigable waters.

At present, the cooperative efforts between the Department of the Interior and the Corps of Engineers, and the National Marine Fisheries Service and State conservation agencies is responsible for minimizing the impact of pipeline (and other) construction in navigable waters of the United States. The regulatory functions of the U.S. Corps of Engineers cover structures and work in or affecting navigable waters of the United States, the discharges of dredged or fill material into navigable waters, and the transportation of dredged material for the purpose of dumping into ocean waters. The scope of these regulatory functions is currently defined under Title 33, Code of Federal Regulations, Permits for Activities in Navigable Waters or Ocean Waters, as published in the ''Federal Register'' on July 19, 1977.

The Environmental Protection Agency reviews and comments on dredging projects in navigable waters in accordance with a Memorandum of Understanding with the Corps of Engineers dated July 13, 1967. The National Oceanic and Atmospheric Administration (through its National Marine Fisheries Service) has been vested with responsibility for participation in matters relating to marine and estuarine areas.

The Department of the Interior and its U.S. Fish and Wildlife Service has responsibility and authority under several statutes, including the Fish and Wildlife Act of 1956, the Estuary Protection Act, the Endangered Species Act of 1973, the Migratory Bird Conservation Act, the Fish and Wildlife Coordination Act, the Marine Mammals Protection Act, and various international treaties enacted to preserve, conserve, protect, and enhance fish and wildlife resources and their habits.

The U.S. Fish and Wildlife Service, with assistance from appropriate State and Federal agencies, including the National Marine Fisheries Service now reviews all applications to the Corps of Engineers for permits to construct pipelines in navigable waters and assesses their potential impact on fish and wildlife resources and the environment. When appropriate, the Agency recommends to the Corps specific modification of project plans which are needed to reduce impact on these resources. Occasionally a project plan is so conceived that significant impact cannot be avoided, but at the same time, a satisfactory alternative may not be available; in such cases, a recommendation that the permit not be issued would be appropriate.

2. Mitigating Measures

Federal, state, and local authorities and private landowners may take measures to require that pipelines be buried; that canals in wetlands areas be backfilled where possible; that bulkheads be erected and maintained in marsh areas to prevent saltwater intrusion; that specific types of dredging equipment be used and specific methods for placement or disposal of spoil be required; that beach and dune areas crossed by pipeline be restored; or that pipeline installations in sensitive or valuable areas be seasonally timed so as to occur (for example) during low periods of tourist and recreational activites. In addition, pipeline activities may be prohibited during high periods of tourist and recreational activites, or acute periods of nesting of shore birds, wading birds, or waterfowl and migrations of fish and wildlife. Section III.C.10. contains a discussion of impacts caused by pipeline construction in onshore areas.

The Department will eventually receive applications for the OCS resulting from this sale and may approve pipeline rights-of-way. The procedure for this is outlined in a Memorandum of Understanding between the Bureau of Land Management and the Geological Survey for Outer Continental Shelf pipelines. The purposes of the Memorandum are to clearly define the administrative and operational roles of the Bureau of Land Management and the U.S. Geological Survey relating to pipelines on the OCS, provide consistent and standardized procedures, and minimize or eliminate dual and overlapping functions. The objectives of the Memorandum are to:

(a) Provide an efficient mechanism for approving pipeline routes through the submerged lands of the OCS;

(b) Initiate measures to provide safety and to minimize or eliminate environmental damage which may be associated with the installation and operation of pipelines originating on the OCS;

(c) Be responsive to the interests of the oil and gas industry, other users of the OCS, and the public with respect to pipelines; and

(d) Streamline implementation of the regulations and procedures for more efficient and uniform administration of the Department's authority with respect to pipelines.

The Bureau of Land Management's role in pipeline management on the OCS is defined as follows:

(a) Conduct pipeline routing studies and, with the concurrence of the USGS, designate pipeline corridors on the OCS for all pipelines other than flow or gathering lines within the confines of a single lease or group of contiguous leases under unitized operation or a single operator;

(b) Maintain a central office of record for the location of all existing and future pipelines and associated structures on the OCS;

(c) Prepare environmental assessments, pipeline system planning studies, economic studies, and environmental impact statements when necessary or appropriate, prior to approving applications for rights-of-way pursuant to 43 U.S.C. 1334(c) and 43 CFR 2883;

(d) Receive applications for rights-of-way for pipelines to be installed on the OCS pursuant to 43 U.S.C. 1334(c) and 43 CFR 2883; and

(e) After considering the potential impact of the pipelines on the environment, the relationship of the application to existing pipeline routes on the OCS, and other factors, approve or disapprove the application pursuant to 43 CFR 2883.

Some potential adverse effects brought about by proposed pipeline rights-of-way occur nearshore and onshore and remain outside BLM authority to apply direct mitigatory measures. However, the ability to regulate pipelines on the OCS implies certain influence over the allocation of nearshore and onshore resources. This fact represents a management tool with a potential to indirectly mitigate adverse effects of random or hap-hazard placement of pipelines in coastal areas outside BLM jurisdiction.

The Department plans to structure sale-related pipeline development for tracts leased in this proposed sale as per its responsibility for pipeline system planning on the OCS. Pipeline development activities are partly a function of environmental assessment (both offshore and onshore), operational and economic dictates, and the transportation needs of the impacted area. Recognition of these parameters in a coordinated federal, state, industry, and local governmental effort will result in pipeline sitings which recognize economic feasibility and zones of least environmental impact. Such an effort is aniticpated before the granting of pipeline rights-of-way brought about by this sale.

D. Other Mitigating Measures

1. Department of the Interior Lease Suspensions

The Department of the Interior has issued a regulation in 42 FR 53956 (October 4, 1977) whereby operations pursuant to an OCS lease may be suspended because of the threat (significant irreparable damage) continued operations pose to life, property, or natural resources. The regulation includes provisions for the initiation of studies to determine the mitigating measures necessary to be undertaken to prevent damage or lessen the threat of damage. Should operations on a lease be halted for the initiation of such studies, the lease will be suspended and its terms extended by an amount of time equivalent to the length of the suspension. Under this regulation, depending on the circumstances, the Secretary may teminate a suspension and the lessee may be precluded from resuming lease operations, even though the lease term will continue to run. This might occur either because the lessee refuses to undertake the mitigating measures ordered by the Secretary for the resumption of operations, or because no satisfactory mitigating measures are available; that is, any operations would cause or pose an unacceptable threat of significant irreparable damage. This regulation is designed to allow the Department to take necessary action on those areas of the OCS which, subsequent to being leased, or subsequent to approval of operating plans, a hazard, the risk or probability of which was presumed acceptable, occurs or is found to present a significantly more serious and possibly unacceptable threat of damage.

2. Notices to Lessees and Operators

These notices have the same effect or status as OCS Operating Orders and Regulations and are used when expeditious clarifications or corrections and additions to existing orders and regulations are necessary. By issuing Notices to Lessees and Operators, the extensive amount of time necessary to amend and republish orders and regulations is avoided.

3. Departures

A departure (waiver) from OCS Orders or other rules of the U.S. Geological Survey, may be granted by the Supervisor when such a departure is determined to be necessary for the proper control of a well, conservation of natural resources, protection of aquatic life, protection of human health and safety, protection of property, or protection of the environment (30 CFR 250.12(b)).

Waivers are technically based decisions and are granted only in situations in which expert judgment determines that better and safer operations would result from operations under the waiver.

4. Research on Advanced Technology

The EPA and the Coast Guard are conducting research on more efficient containment and recovery devices (booms and skimmers). The efficiency of booms and skimmers depends upon sea state and spill conditions but in any case they are never 100% efficient.

When the results of these studies and any other similar studies so indicate, the requirement for use of better techniques and equipment will be incorporated into the OCS regulations and orders as appropriate. If incorporated, the requirements will be applied to all leases.

5. Geophysical Information

The Conservation Division of the Geological Survey is aware of near-surface structural configurations and its effect on drilling, fixed-structure emplacement, pipelines, etc., in relation to the proposed lease tracts. Knowledge of near-surface structural conditions is fundamental to a sound lease management program for the OCS.

Geophysical data which show the shallow structural and sedimentary environment are used to predict, thereby minimizing any geologic hazards to drilling operations and, consequently, possible dangers to the environment from pollution. When surface and shallow subsurface geologic hazards are properly identified and correlated with surrounding strata, they seldom create insurmountable obstacles for a minimal risk program of exploration and exploitation involving economically attractive structures.

High-resolution geophysical data covering all tracts to be offered for this proposed sale will be purchased by GS and analyzed by GS geophysical personnel. These data provide definitive information on the thickness of unconsolidated sediments; structural configurations of shallow seismic horizons; sea floor anomalies, mud mounds, mud waves, and potential slide areas; pipelines and other objects on the sea floor; and, suitable locations for bore holes as interpreted from a combined analysis of several geophysical measurements and bathymetry.

Information from these high resolution data are extremely useful in detecting shallow geologic hazards such as potentially unstable bottom conditions (mud waves, etc.), shallow faults, and in some cases, near surface solution cavities. When these features are identified prior to drilling operations or platform construction, the operator is notified so that he can take the necessary action which will further insure that operations will be conducted with maximum safety.

Interpretations of high resolution sub-bottom profile data which disclose bottom and subsurface conditions posing a special environmental hazard for drilling or production operations in the offshore area will be made available to the Bureau of Land Management prior to the decision to issue a lease, and to the Geological Survey prior to the approval of drilling operations. If it becomes necessary, the District Supervisor, Geological Survey, will prohibit the placement of platforms on areas of instability through his authority to issue or not issue permits for platform placement.

6. Conservation Practices

In the interest of conservation, the GS Oil and Gas Supervisor is authorized, pursuant to 30 CFR Part 250 and OCS Operating Orders, to approve well locations and well spacing programs necessary for proper development, to give consideration to such factors as the location of drilling platforms, the geological and reservoir characteristics of the field and the number of wells that can be drilled economically, the protection of correlative rights, and the minimizing of unreasonable interference with other uses of the Outer Continental Shelf. The Supervisor draws his authority from the following regulations and OCS operation orders: 30 CFR 250.11 outlines in broad terms the GS Supervisor's authority to control development of the OCS to protect the natural resources of the OCS, and to obtain maximum economic recovery of mineral resources under sound conservation practices. 30 CFR 250.16 authorizes the GS Supervisor to specify the permissible production of a well. Thereafter, OCS Order No. 11 establishes the production rate control as the Maximum Efficient Rate (MER) of the well or reservoir. 30 CFR 250.17 deals with well spacing, authorizes approval of well and platform locations, and lists factors for consideration in this regard. 30 CFR 250.30 requires lessee's compliance with OCS Orders and general regulations, and demands all necessary precautions to prevent damage to the environment, waste, and injuries. 30 CFR 250.34 requires that the lessee submit to GS Oil and Gas Supervisor exploratory drilling plans, lease development plans, and applications for permits to drill prior to these programs.

The GS Oil and Gas Supervisor utilizes well information such as electric well logs, core information from other wells previously drilled in the vicinity of the proposed drilling program, geological and geophysical data, and other pertinent reservoir information in order to determine the proper number of wells which are necessary for development.

At least 30 days prior to the submission of a development plan to the Supervisor, the lessee shall deliver to the Governor of each directly affected state information about the development to be proposed. Information, which is not a part of the development plan itself, shall include a description of all offshore and onshore facilities and operations proposed by the lessee or directly related to the proposed development including location, size, requirements for land, labor, materials, and energy, and timing of development and operation, and other related information as may be required by the Supervisor. Any state not wishing to have such information may so indicate to the Supervisor.

Prior to the approval of a lessee's development plan, that plan, with the exception of any proprietory information, shall be provided by the Supervisor to the Governor of any directly affected state. A period of 60 days shall be provided for the Governor's review and comment upon the plan. Any state not wishing to review a development plan may so indicate to the Supervisor. (The full text of this regulation as revised November 4, 1975 can be found in Appendix 12, Final EIS for OCS Sale No. 40, Offshore the Mid-Atlantic States.) 30 CFR 250.50 grants the Director of the USGS authority to demand pooling or unitization which the Secretary is authorized to require under the OCS Lands Act in the interest of conservation. 30 CRF 250.51 refers to the unit plan regulations contained in 30 CFR 226 with regard to obtaining approval of units or cooperative agreements. 30 CRF 250.52 lists purposes for which the GS Supervisor may approve pooling or drilling agreements.

7. Requirements of Other Federal Agencies

The operator must comply with applicable navigation and inspection laws and regulations administered by the U.S. Coast Guard. These relate to the safety of personnel and display of prescribed navigational lights and signals for the safety of navigation.

Permits to install islands and fixed structures and permits for the drilling of wells from mobile drilling vessels must also be obtained from the U.S. Army Corps of Engineers, which is authorized by the OCS Lands Act to prevent obstruction to navigation.The decision as to whether a permit will be issued by the Corps of Engineers is based on an evaluation of the impact of the proposed work on navigation and consideration of national security.

All drilling structures must be located outside of any navigation fairway established by the Secretary of the Army. Pipeline construction must also be in compliance with standards established by the Office of Pipeline Safety Operations in the Materials Transportation Bureau, Department of Transportation.

The Department of Labor establishes Occupational Safety and Health Standards which are applicable to OCS operations.

Operators must comply with the requirements of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500; 86 Stat. 816) which establishes a National Pollutant Discharge Elimination System 40 CFR Part 125, F.R. 13528 (1973). This system applies to discharge on the OCS from any point source and requires any person to obtain a permit from the EPA for the discharge of any pollutant as defined by the Act. Discharges of any pollutant without the necessary permit from EPA is made unlawful by the Act. Pursuant to section 501(b) of the Act, the Department of the Interior has suggested to EPA that the feasibility of a memorandum of understanding between the two agencies be considered in order to facilitate the administration of the NPDES as it applies to discharges arising from OCS lease operations and to minimize any redundancy of efforts by the Geological Survey and EPA. This feasibility study is currently under consideration.

The U.S. Geological Survey also establishes GS Safety Requirements pertaining to OCS operations:

Geological Survey Standard, Outer Continental Shelf No. 1 (GSS-OCS-1), defining the safety requirements for drilling operations in a hydrogen sulfide environment, was published in the Federal Register, Vol. 41, No. 42, March 2, 1976. This standard will be referenced in the Hydrogen Sulfide Section of OCS Order No. 2.

8. Recommended Special Stipulations

Leases for oil and gas exploration and development are subject to all OCS operating orders and regulations. Additionally, in some cases, special stipulations are attached to particular leases which require that measures be taken to protect specific resources or activities. In previous OCS oil and gas lease sales, lease stipulations have been implemented which provide for protection of biological and cultural resources, and for avoidance of conflict with military and other uses of the OCS.

Stipulations which are being proposed for inclusion in leases of this proposed sale are presented below.

It is the Department's intent to include stipulations in certain leases, should the sale be held, as the most effective way of mitigating certain adverse impacts.

Once a stipulation has been attached to a lease, it can only be effective if implemented with expertise and with consideration of all appropriate information. Secretarial Order 2974 provides for intra-Departmental coordination on matters of this sort. BLM, other Interior agencies, and affected states have coordinated with each other in the development of these stipulations.

Stipulation No. 1 (Cultural Resource Stipulation)

a. (To apply to all leases resulting from this proposed sale)

The lessee agrees that if any site, structure, or object of historical or archaeological significance should be discovered during the conduct of operations on any leased area, he shall report immediately such findings to the Supervisor, and make every reasonable effort to preserve and protect the cultural resource from damage until the Supervisor has given directions as to its disposition.

b. (To apply only to the leases resulting from this proposed sale for tracts 65-1 through 65-21 and 65-89 through 65-103)

For these lease tracts, falling within Cultural Resource Zones 1 and 2 as defined and plotted in the final report *Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf* (Coastal Environments, Inc., 1977), and tracts falling outside the Zones 1 and 2 in which there is reason to believe a cultural resource exist, the Supervisor shall require the lessee to comply with the following:

Prior to any drilling activity or the construction or placement of any structure for exploration or development on the lease, including but not limited to, well drilling and pipeline and platform placement, hereinafter in this stipulation referred to as "operation", the lessee shall conduct remote sensing surveys to determine the potential existence of any cultural resource that may be affected by such operations. All data produced by such remote sensing surveys as well as other pertinent natural and cultural environmental data shall be examined by a qualified marine survey archaeologist to determine if indications are present suggesting the existence of a cultural resource that may be adversely affected by any lease operation. A report of this survey and assessment prepared by the marine survey archaeologist shall be submitted by the lessee to the Supervisor and to the Manager, Bureau of Land Management (BLM) Outer Continental Shelf (OCS) Office for review.

If such cultural resource indicators are present the lessee shall: (1) locate the site of such operation so as not to adversely affect the identified location; or (2) establish, to the satisfaction of the Supervisor, on the basis of further archaeological investigation conducted by a qualified marine survey archaeologist or underwater archaeologist using such survey equipment and techniques as deemed necessary by the Supervisor, either that such operation will not adversely affect the location identified or that the potential cultural resource suggested by the occurrence of the indicators does not exist.

A report of this identification investigation prepared by the marine survey archaeologist or underwater archaeologist shall be submitted to the Supervisor and the Manager, BLM OCS Office, for their review. Should the Supervisor determine that the existence of a cultural resource which may be adversely affected by such operation is sufficiently established to warrant protection, the lessee shall take no action that may result in an adverse effect on such cultural resource until the Supervisor has given directions as to its disposition. Evaluation of the Cultural Resource Stipulation:

Should the archaeology survey be implemented prior to initiating bottom disturbing oil and gas operations within the high probability cultural resource zone (See Visual No. 1, Cultural Resource Demarcation Line), the likelihood that petroleum related activities would endanger an unknown or reported historic shipwreck or early man living site would be further reduced. The effectiveness of remote sensing surveys can vary depending on factors such as instrumentation, professional interpretation, technique, and physical conditions such as water depth and weather conditions. The provisions of the stipulation assure professional involvement in determining where site specific surveys will be required and interpretation of data collected. Should the stipulation be adopted, instructions as to instrumentation, navigation, line spacing, and report format requirements are specified in a Notice to Lessees and Operators. Following this discussion is the Notice currently utilized in the Gulf of Mexico. The Department of Interior is presently drafting a proposed revision to this notice. The proposed revision will be published in the Federal Register and comments solicited. Should a new notice be adopted, all surveys performed after the date of adoption would be subject to the revisions.

Instrumentation utilized, record quality, and line spacing can all affect the ability of the professional interpreter to identify and define signatures indicative of potential cultural resources. All areas so identified as potentially containing valuable historic or archaeological resources would be either avoided, protected, and/or identified and mitigated in accordance with prescribed regulations. The flexibility of offshore operations has allowed most operators to avoid culturally sensitive areas. A permanent record of all survey reports is maintained by the USGS and BLM; therefore, should further archaeological investigation be desired at some future date, the results of remote sensing cultural resource surveys prior to oil and gas operations can be recalled.

In summary, adoption of the cultural resource stipulation would minimize the probability that a valuable cultural resource would be adversely impacted by this lease proposal. Furthermore, adoption of this stipulation will increase the data base, adding to our knowledge of the potential cultural resource sensitivity of the Gulf of Mexico's Outer Continental Shelf.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
GULF OF MEXICO AREA

75-3 (SUPERSEDES No. 74-10) January 20, 1975

NOTICE TO LESSEES AND OPERATORS OF FEDERAL OIL AND GAS LEASES IN THE OUTER CONTINENTAL SHELF, GULF OF MEXICO AREA MINIMUM GEOPHYSICAL SURVEY REQUIREMENTS TO PROTECT CULTURAL RESOURCES

Recent OCS leases include stipulations concerning archaeological surveys. Should such an archaeological survey be required in the leased area, or area sought for permit, the following minimum requirements must be fulfilled. These requirements will be effective as of the date of this notice and shall apply also to all existing leases that contain archaeological stipulations, including MAFLA leases, where the archaeological surveys have not yet been conducted.

Prior to drilling operations or the installation of any structure or pipeline, the lessee shall conduct a high resolution geophysical survey in the immediate area to determine the possible existence of a cultural resource. The following equipment is required in performing the survey. All equipment shall be representative of the state of technological development.

A. *Magnetometer*—Total field intensity instruments are needed. The sensor of the magnetometer should be trailed as near as possible to the sea floor; six meters or less is recommended. Knowledge of the sensor depth of tow above the bottom is highly desirable for future analyses.

B. *Dual Side Scan Sonar*—Coverage of the sea floor at a range width of at least 150 meters per side in the proposed area is needed.

C. *Depth Sounder and Sub-bottom Profiler*—An analog recorder shall be used for bathymetry and the profiler shall be capable of resolving the upper 50 feet of sediment.

Navigation for the survey shall utilize state-of-the-art positioning systems correlated to annotated geophysical records. Navigation accuracy shall be on the order of ± 50 feet at 200 miles.

Optional tools could include cameras, underwater TV, divers, and cores. Any engineering soil borings which are obtained shall be made available for the archaeologist's inspection. These data shall be evaluated for indications of aboriginal habitation sites as well as for historic sites.

The tract or survey line spacing shall follow the attached illustrated plans.

For a single-drill site or platform location, all geophysical equipment shall run an area approximately one mile square with eleven principal survey lines spaced 150 meters apart with three cross-lines. In addition, two diagonal lines centered on the proposed drill site shall be run. (See attached plan A).

For an entire lease block, or significant portions, a 150 meter x 1000 meter spacing shall be used. (See attached plan B).

For a pipeline installation, three principal survey lines shall be run, one following the exact course of the proposed pipeline with an offset line on either side spaced to coincide with the area which would be disturbed by the barge anchors. The distance of these offset lines from the proposed pipeline route cannot be stated specifically since this is a function of water depth and equipment. (See attached plan C).

A professional underwater archaeologist is not required to be present on all survey activities. A geophysicist must accompany the survey to insure that the equipment is properly tuned and records are accurate and readable. The records shall be inspected by the archaeologist along with the survey geophysicist who shall advise the archaeologist as to record quality and anomaly occurrences. The data will be maintained by the lessee and shall be available to BLM and USGS upon request.

Survey Report Format

The archaeological survey report shall include, as a minimum, the following:

1. Description of tract surveyed to include tract number, OCS number, block number, geographic area, e.g., Mobile South No. 1 Area, and water depth.

2. (a) Map (1″=2,000′) of the lease block showing the area surveyed.

(b) Navigation postplot Map (1″=1,000′) of area surveyed showing tract lines and shotpoints with U.T.M. X and Y coordinates and latitude-longitude reference points.

3. Survey personnel and duties.

4. Survey instrumentation, procedures and logs.

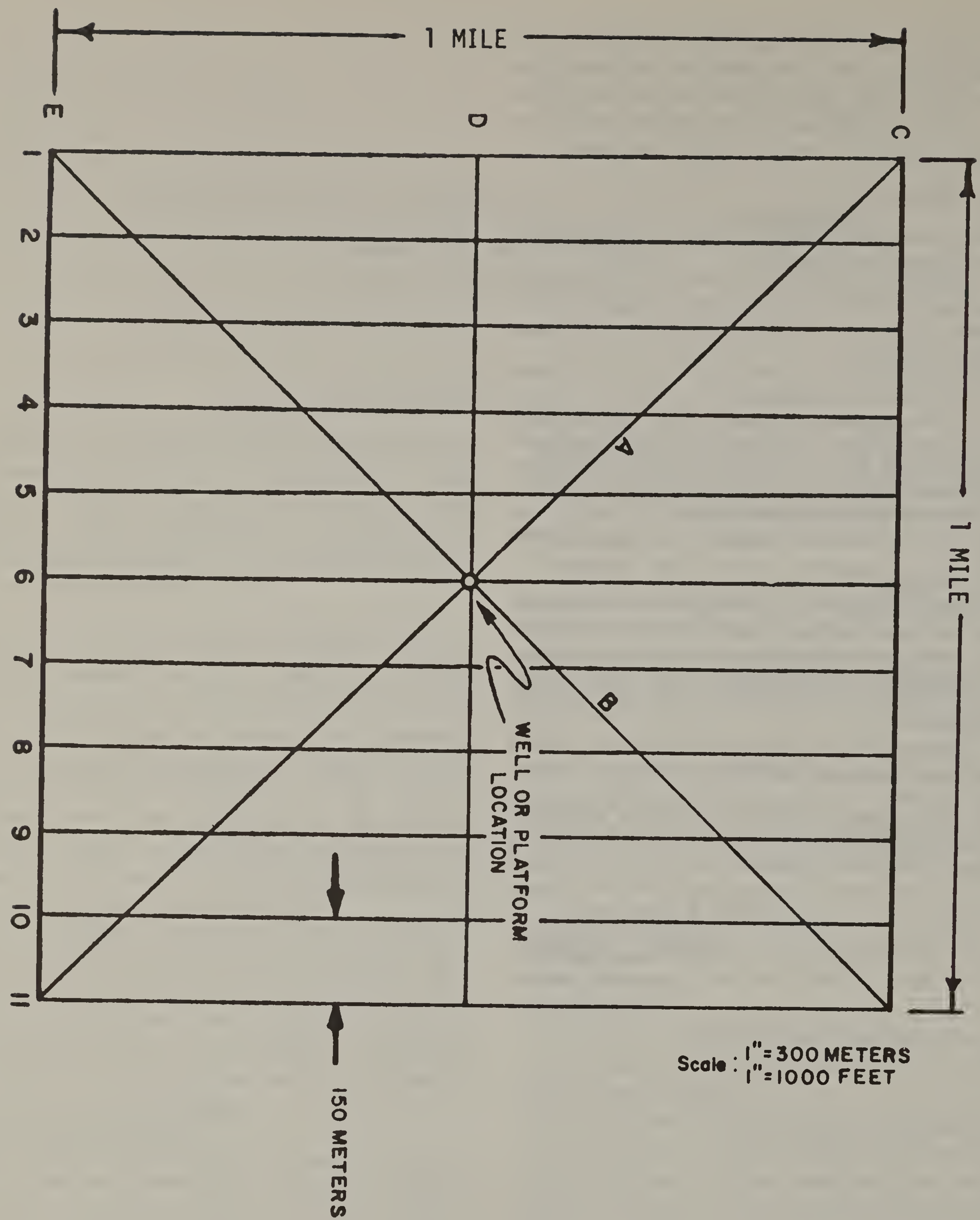
5. Sea state.

6. The original of a selected line of survey data for each instrument used shall be submitted with each report. In all cases where an anomaly is encountered, the original of all survey data for the line(s) indicating the anomaly shall be submitted.

7. Archaeological assessment, with a signed statement as to the possible existence of a cultural resource.

8. Two copies of the report shall be submitted to this office and also two copies to the New Orleans OCS Office, BLM.

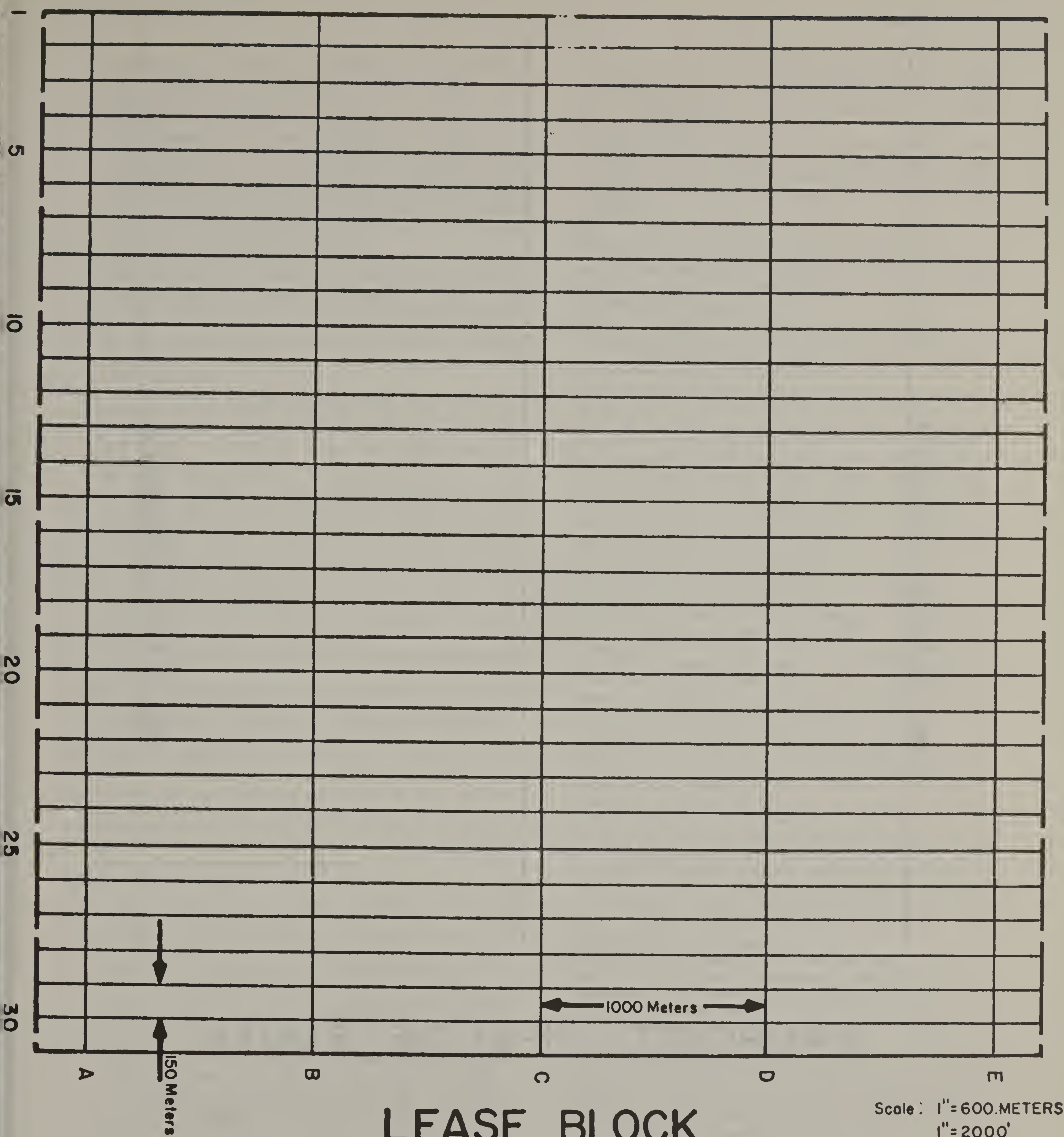
/s/ D.W. Solanas
Oil and Gas Supervisor
Field Operations
Gulf of Mexico Area



WELL OR PLATFORM LOCATION

GEOPHYSICAL SURVEY GRID TO DETERMINE THE EXISTENCE OF CULTURAL RESOURCES

PLAN "A"

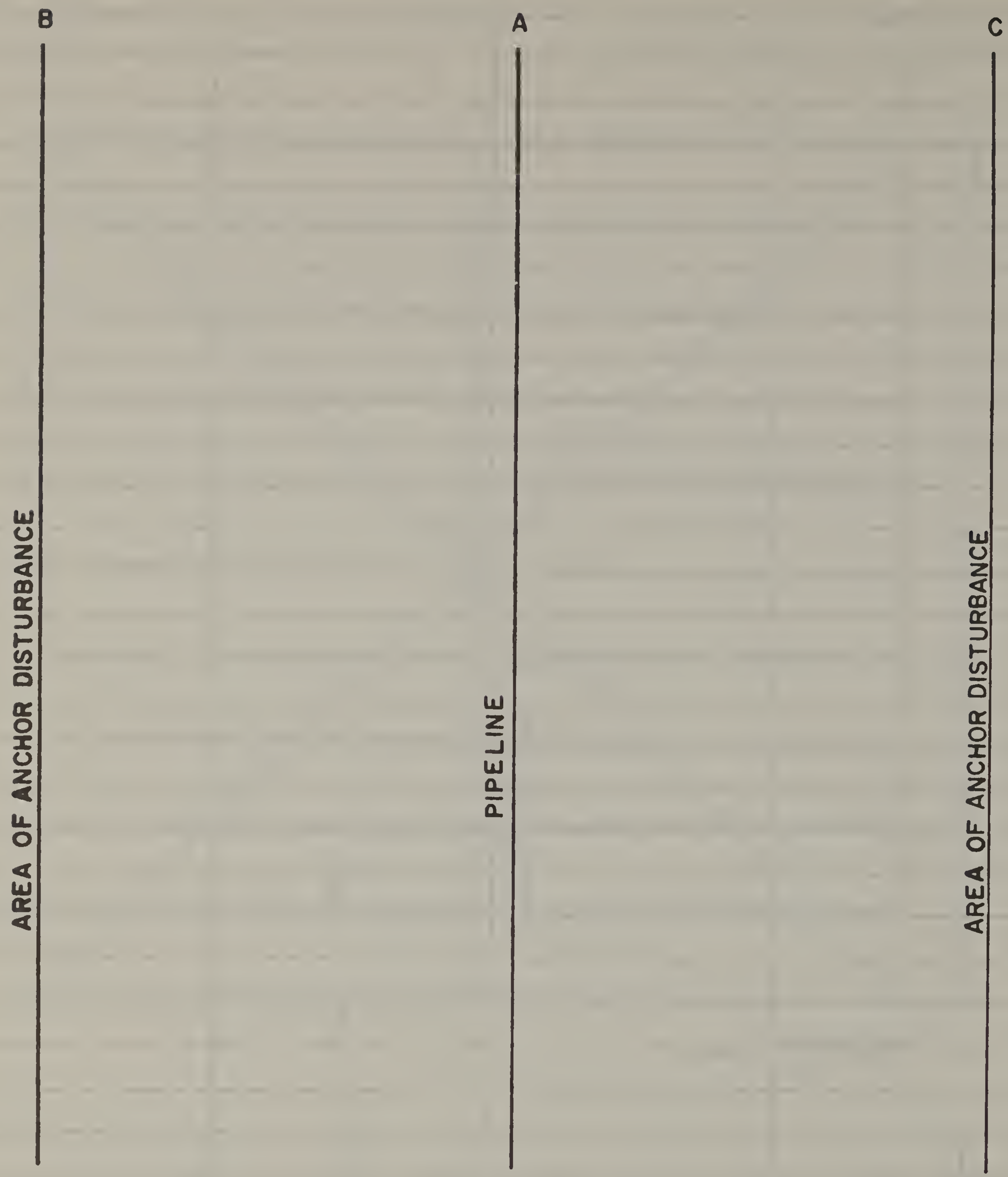


LEASE BLOCK

Scale: 1" = 600. METERS
1" = 2000'

GEOPHYSICAL SURVEY GRID TO DETERMINE THE EXISTENCE OF CULTURAL RESOURCES

PLAN "B"



PROPOSED PIPELINE ROUTE

No Scale

GEOPHYSICAL SURVEY GRID TO DETERMINE THE EXISTENCE OF CULTURAL RESOURCES

PLAN "C"

Stipulation No. 2 - Biological Stipulation) (to apply only to leases resulting from this proposed sale for tracts 65-1 through 65-20 and 65-89 through 65-93)

Prior to any drilling activity or placement of any fixed structures or pipeline or any other exploration or production activity, the lessee will submit to the Supervisor as part of his exploration and/or development plan a bathymetry map, prepared utilizing remote sensing survey techniques. This map will include interpretations for the presence of live bottom areas within a minimum one-mile radius of the proposed exploration or production activity site.

For the purpose of this stipulation, "Live Bottom Areas" are defined as those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or whose lithotope favors the accumulation of turtles and fishes.

If it is determined that the remote sensing data indicate the possibility of live bottom areas, the lessee will also submit to the Supervisor photo or other documentation of the sea bottom of the proposed exploratory drilling sites or proposed platform locations or points as determined by the Oil and Gas Supervisor, U.S. Geological Survey.

If it is determined that live bottom areas might be adversely impacted by the proposed activities, then the Supervisor will require the lessee to undertake any measures deemed economically, environmentally, and technically feasible to protect live bottom areas. These measures may include, but are not limited to, the following:

a. The relocation of operations to avoid live bottom areas.
b. The shunting of all drilling fluids and cuttings in such a manner as to avoid live bottom areas.
c. The transportation of drilling fluids and cuttings to approved disposal sites.
d. The monitoring of live bottom areas to assess the adequacy of any mitigation measures taken and the impact of lessee initiated activities. Evaluation of the Biological Stipulation:

The biological stipulation being recommended for twenty-five tracts is designed to ensure that live bottom areas, as defined in the stipulation, are adequately protected. It is envisioned that such protection will consist of, first, delineating with precision the location and extent of live bottom areas, and second, ensuring that if oil and gas exploration and development activities take place in such areas, the effects of these operations are mitigated.

This proposed stipulation requires the operator of each of these 25 blocks, if leased, to prepare a bathymetry map, and to make judgements from it and other remote sensing techniques as to the presence of live bottom areas. If the map and interpretation indicates that live bottom areas may be present, the operator must submit documentation, perhaps including photographs, that the area in which he desires to work is clear of live bottoms. It is possible that in order to fully develop a particular discovery, such activities may have to take place on a live bottom area, especially if that area is fairly extensive. In such cases protection would be provided by imposing the measures enumerated in the stipulation as "b-d": such measures would, we believe, ensure (and document) that no harm to the biota results from such activities. However, present information indicates that these live bottoms are not extensive in individual area and are scattered throughout the region. Thus in most cases protection should be available by simply permitting planned drilling sites a few hundred meters or so away from a live bottom (i.e., measure "a" of the stipulation).

All of the 25 tracts involved are in less than 50 m of water, and are thus considered to be especially productive. Tracts in deeper waters, while perhaps containing similar "hard" bottom areas, are not considered productive to the extent that special measures requiring operational restrictions should be imposed.

It is believed that this stipulation will, when imposed on any of these 25 tracts which may be leased, provide adequate protection for areas of unique and/or productive biota from damage from oil and gas exploration and development operations.

Stipulation No. 3—(Department of Defense Restrictions)

a. (To apply only to the leases resulting from this proposed sale for tracts 65-6, 65-11, 65-16, 65-17, 65-18, 65-21 through 65-28, 65-30, 65-31, 65-37 through 65-70, 65-73 through 65-78, and 65-94 through 65-116)

Whether or not compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occurs in, on, or above the Outer Continental Shelf, to any persons or to any property of any person or persons who are agents, employees or invitees of the lessee, its agents, independent contractors or subcontractors doing business with the lessee in connection with any activities being performed by the lessee in, on, or above the Outer Continental Shelf, if such injury or damage to such person or property occurs by reason of the activities of any agency of the U.S. Government, its contractors or subcontractors, or any of their officers, agents or employees, being conducted as a part of, or in connection with, the programs and activities of the Gulf Test Range, the Pensacola Naval Air Station, Eglin Air Force Base, MacDill Air Force Base, Tyndall Air Force Base or Naval Air Advance Training Command, Naval Air Station, Corpus Christi, Texas. The lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the United States, its contractors or subcontractors, or any of their officers, agents, or employees. The lessee further agrees to idemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the lessee, and to indemnify and save harmless the United States against, and to defend at its own expense the United States against, all claims for loss, damage, or injury sustained by the agents, employees, or invitees of the lessee, its agents or any independent contractors or subcontractors doing business with the lessee in connection with the programs and activities of the aforementioned military installations, whether the same be caused in whole or in part by the negligence or fault of the United States, its contractors, or subcontractors, or any of their officers, agents, or employees and whether such claims might be sustained under theories of strict or absolute liability or otherwise.

The lessee agrees to control his own electromagnetic emissions and those of his agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning areas in accordance with requirements specified by the commander of the appropriate onshore military installation, i.e., Pensacola Naval Air Station, Eglin Air Force Base, MacDill Air Force Base, or Tyndall Air Force Base, to the degree necessary to prevent damage to, or unacceptable interference with, Department of Defense flight, testing or operational activities, conducted within individual designated warning areas. Necessary monitoring control, and coordination with the lessee, his agents, employees, invitees, independent contractors or subcontractors, will be effected by the commander of the appropriate onshore military installation conducting operations in the particular warning area; *provided, however*, that control of such electromagnetic emissions shall in no instance prohibit all manner of electromagnetic communication during any period of time between a lessee, its agents, employees, invitees, independent contractors or subcontractors and onshore facilities.

The lessee, when operating or causing to be operated on its behalf boat or aircraft traffic into the individual designated warning areas shall enter into an agreement with the commander of the appropriate onshore military installation, i.e., Pensacola Naval Air Station, Eglin Air Force Base, MacDill Air Force Base, Tyndall Air Force Base, utilizing an individual designated warning area prior to commencing such traffic. Such agreement will provide for positive control of boats and aircraft operating into the warning areas at all times.

b. (To apply only to the leases resulting from this proposed sale for tracts 65-25 through 65-28, 65-30, and 65-31)

When the activities of the Armament Development and Test Center at Eglin Air Force Base may endanger personnel or property, the lessee agrees, upon receipt of a directive from the Secretary, to evacuate all personnel from all structures on the lease and to shut-in and secure all wells and other equipment, including pipelines on the lease, within forty-eight (48) hours or within such longer period as may be specified by the directive. Such directive shall not require evacuation of Personnel and shutting-in and securing of equipment for a period of time greater than seventy-two (72) hours; however, such period of time may be extended by subsequent directive from the Secretary. Equipment and structures may remain in place on the lease during such time as the directive remains in effect.

Stipulation No. 4—(Transport of Oil and Gas)—to apply to all leases resulting from this sale)

Pipelines will be required, (1) if pipeline right-of-way can be determined and obtained, (2) if laying such pipelines is technically feasible and environmentally preferable, and (3) if, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple use conflicts. The lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to any recommendation of the intergovernmental planning program for leasing and management of transportation of Outer Continental Shelf oil and gas with the participation of federal, state, and local government and the industry. Where feasible, all pipelines, including both flow lines and gathering lines for oil and gas, shall be buried to a depth suitable for adequate protection from water currents, sand waves, storm scouring, fisheries trawling gear, and other uses as determined on a case-by-case basis.

Following the completion of pipeline installation, no crude oil production will be transported by surface vessel from offshore production sites, except in the case of emergency. Determinations as to emergency conditions and appropriate responses to these conditions will be made by the Supervisor. Where the three criteria set forth in the first sentence of this stipulation are not met and surface transportation must be employed:

All vessels used for carrying hydrocarbons to shore from the leased area will conform with all standards established for such vessels, pursuant to the Ports and Waterways Safety Act of 1972 (46 U.S.C., 391a).

Evaluation of the Transportation Stipulation:

The Intergovernmental Planning Program for the Leasing and Transportation of OCS Oil and Gas referred to above is, at the time of this writing, a proposed program which is anticipated to become operational in early 1978. The program, if implemented, would establish regional and state working groups consisting of federal, state, and local government and industry representation. The regional working groups would be used to expedite existing pre-leasing activities between the states and Federal agencies and to develop recommendations for regional transportation management plan studies. State working groups, consisting of affected states, would be activated following a marketable discovery and would be used to design site-specific transportation management studies plans and to formulate regional transportation management plan recommendations.

Section V

Unavoidable Adverse Environmental Impacts

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

BLM
NEW ORLEANS OCS

A. Effects on Marine Organisms

Some individual organisms will be killed as a result of oil and gas operations. Some individiual organisms will be temporarily functionally impaired as a result of oil and gas operations.

Primary productivity (photosynthesis) activity will be impaired and some organisms killed in the area of high turbidities generated by oil and gas activities.

Individual organisms will be killed by the physical processes of oil and gas operations, by being squashed by platform legs, anchors, and pipelines. This will primarily affect non-mobile or slow-moving benthic organisms.

Individual organisms will be killed or functionally impaired by oil spills. Although it is not possible to quantify the magnitude of this effect is expected to be small.

B. Effects on Wetlands and Beaches

Organisms in these habitats will be killed or functionally impaired by pipeline construction and/or oil spills. Some very localized community disruption may also occur. The magnitude of this effect is expected to be small.

C. Deterioration of Air Quality

The air quality near offshore production sites will be adversely affected should this proposed sale proceed. Offshore operations generate a small but significant amount of air pollutants resulting from stationary combustion or from venting produced gas. In most cases, these emissions will be local in nature and will be quickly dissipated by climatic conditions. There would not be increased air quality degradation onshore. The oil and gas that would be processed onshore would not be an increase but rather a replacement of oil and gas already being processed.

If a natural gas leak or blowout were to occur, degradation would occur locally. It is expected that the methane pollutants would quickly volatilize and drift away. In the case of a fire, pollutants would be largely carbon dioxide and water vapor. Oil leaks and oil spills which would not be accompanied by a fire would introduce highly volatile, low molecular weight hydrocarbons such as benzene and toluene into the atmosphere. These lighter fractions of crude oil would undergo some unknown degree of degradation, possibly resulting in photochemical smog. If a spill were to result in a fire, large amounts of particulate carbon and oxides of carbon, along with smaller but unknown amounts of sulfur oxides, evaporated crude oil liquids, and partially oxidized compounds would enter the air. Local air quality would be severely degraded during the duration of the fire. The extent of degradation cannot be determined but it is unlikely that it would be high enough to effect land resources or human health. Should a fire occur, the resultant impact would be considered adverse and unavoidable.

D. Deterioration of Water Quality

Water quality in the Gulf will be temporarily degraded by resuspension of sediment during pipeline construction and burial. The jetting away of the substrate from beneath the pipeline will result in suspension of sediments which may contain pollutants such as heavy metals and pesticides. The area affected will be in the direction of the current movement. Various other phases of offshore operations (emplacement of re-entry collars, blowout preventers, drilling platforms, etc.) will also cause suspension of bottom sediments in a localized area. The magnitude of deterioration depends on numerous variables, among them bottom type, currents, and duration of the activity.

During drilling operations, discharged drill cuttings will adversely affect water quality. The severity of this impact depends upon such factors as the volume and type of mud discharged and the volume and type of cuttings discharged. The turbidity plume that would result from the discharge of drilling fluids and cuttings would be localized. A turbidity plume from a rig can extend well over a mile in length.

The production and discharge of formation waters (oil field brines) may contribute to water quality degradation when released into the Gulf. Produced formation waters may contain toxic substances, heavy metals, dissolved hydrocarbons, and inorganic salts. The heavy metals may include cadmium, chromium, copper, lead, mercury, nickel, and zinc, although these are generally present in trace quantities (US EPA, 1975). The constituents of these brines may vary from formation to formation and within a single formation.

Water quality will also be somewhat affected by chronic pollutants and possibly by a significant oil spill.

E. Effect on Commercial Fishing Operations

Trawling operations will suffer interference and inconvenience from oil and gas operations in several ways. It is projected that a maximum of 25 platforms could be installed if this proposed lease sale is held. This would amount to an average of one platform for every 4.6 tracts offered. It is estimated that each platform and a navigational safety zone around it would occupy 2 ha, therefore a total of 50 ha of seafloor could be removed from trawling operations. This is less than .02% of the total area offered for lease. Trawl nets reportedly become snagged on underwater stubs, causing damage or loss of the nets. Also, large objects which were lost overboard from petroleum industry boats, pipeline lay barges, and platforms are sometimes caught in trawling nets, resulting in damage to the net and/or its catch of fish. Frequency of occurrence of this type of incident has not been measured, but is generally considered low in the Gulf of Mexico.

Commercial fishermen would probably not trawl in the area of an oil spill. As spilled oil could coat or contaminate commercial fish species in spill areas, the result could be to render them unmarketable. This would be another adverse effect to commercial fishing.

F. Interference with Ship Navigation

Very little interference can be expected between drilling rigs and platforms and ships that are utilizing established fairways. However, at night and, especially during rough weather, fog, and heavy seas, ships not navigating the fairways could collide with fixed structures. Tracts 29, 32, 33, 34, and 36 have been identified as having maximal potential impacts on shipping. Also, fishing boats engaged in trawling will be inconvenienced by having to navigate around fixed structures located on fishing grounds. Estimates are that 5-25 new platforms could result from this proposed sale. Although the increment is small, especially when added to the approximately 2,040 platforms now in the Gulf of Mexico, it still represents a potential increase in possible interference with shipping.

G. Damage to Historical and Archaeological Sites, Structures, and Objects

Should cultural resource surveys not be required along pipeline rights-of-way entering state waters there is some probability of adverse impact to unknown cultural resources in the pipeline burial process. The nearshore waterbottom in the vicinity of Mobile and Tampa Bay are the likely impact areas. Remote sensing geophysical surveys with professional archaeological interpretation are not 100% effective. There remains therefore some small chance that oil and gas operations within the 26 tracts included north and east of the cultural resource demarcation line will adversely affect unknown cultural resources. Likewise there is a small probability that an unknown cultural resource exists within the 90 tracts outside the cultural resource demarcation line; therefore, there is a very small probability that oil and gas activities within these 90 tracts would adversely affect unknown cultural resources.

Should oil and gas activities interact with cultural resources anywhere offshore, the adverse impact would probably be minor. The most likely adverse impact would be disrupting the contextural relationship on an archaeological assemblage lying on or very near the seafloor.

H. Interference with Recreation Activities

Oil spills (including those from transportation routes) may occur as a result of OCS oil and gas operations. Even though containment efforts are likely on large spills, some of the crude oil derivatives such as small tar balls from point source spills or chronic pollution will probably adversely affect recreation areas, especially beaches, during intervals in the 25 year life of this proposal. The resulting pollution incidences should have a minor adverse affect on the aesthetics or shoreline recreation areas and will be a nuisance to beach users.

Accidents and human nature will result in some non-petroleum floating debris being introduced into the Gulf, some of which will come to rest on shoreline recreation resource areas causing a minor adverse impact.

I. Degradation of Aesthetic Values

Platforms and drilling derricks placed in tracts 1-5 will cause a minor obstruction in the view of the horizon over the Gulf from Baldwin County beachfronts on a clear day. Likewise tar balls from oil spill accidents and some waste matter improperly disposed of by individuals involved in oil and gas operations offshore and non-petroleum debris from offshore accidents will be an aesthetic detriment to any shoreline resources impacted by these materials.

J. Effects from Increased Employment and Population Migration

Increased employment is seldom seen as an adverse effect but the associated population increases usually have a negative impact on resources, infrastructure, and the environment by increasing population pressure. In those areas where the local population has significantly different lifestyles and attitudes than the inmigrating people, the possibility of social friction and discontent are also possible.

In areas where population is already high, the population increase associated with OCS activity will go largely unnoticed, but in the areas of lighter population, the possibility of impact can be significant. For a further discussion, see the impact sections on population, housing, and existing infrastructure.

Section VI

Relationship Between Local Short-Term Use and Maintenance and Enhancement of Long-Term Productivity

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BLM
NEW ORLEANS OCS

As indicated in Section III, the operations resulting from this proposed lease sale, if it is held, will have a small, localized, and short term effect on some of the living resources of the Gulf of Mexico Outer Continental Shelf. Some plants and animals will be killed, and some areas will be eliminated as habitat. On the other hand, platforms constructed in the Gulf will provide some new habitat. However, the new habitat would not be a precise equivalent for the altered habitat. In any event, the long term effects of OCS oil and gas operations on the biota are considered to be very small; if all such operations were to cease tomorrow, and all platforms and unburied pipelines removed, within a few years the biological communities would probably return to pre-drilling levels and compositions, barring other natural and man-made disturbances. Even an oil spill would probably have only short-term effect on the biota (i.e., several years if contained and cleaned up properly) despite its visibility and seemingly disastrous nature at the time of the spill.

Previous experience with the extent of onshore impacts resulting from OCS operations in the eastern Gulf of Mexico has been limited to the minor changes associated with unsuccessful exploratory drilling.

If successful exploratory drilling should result from this proposed action, the employment and population impacts resulting from production and transportation activities will be greater than has been previously experienced in the area.

The induced development may result in short-term adverse impacts to communities. A strain on existing infrastructure would be expected if new OCS-related facilities are located in areas of low population with little current industrial base. However, in the long-term, an adjustment can be expected as population gains and induced industrial development are absorbed in the expanded communities. Land utilized for facilities directly associated with OCS operations will be excluded from other uses over the 25-year life of the field; however, only a portion of this land area may continue to be so utilized after production ceases.

The major tradeoff, then, between short-term use and long-term productivity involves the mineral resources, specifically oil and gas, and the effects of such minerals on economic conditions such as employment, production of other products, use for heat and light, and use in transportation. Over the short-term, oil and gas is needed for these uses, and if not produced from domestic sources, probably will be imported. Such importation will have its own effect on employment in the U.S. gas and oil industry and perhaps on the price of oil and gas. Producing U.S. oil and gas now will preclude the use of that oil and gas in the future when imports may be unavailable.

Since initial OCS development off Louisiana in the 1950's, recreational fishermen, SCUBA divers, and some commercial fishermen (snapper-grouper) have focused greater and greater attention on pursuing their vocations and avocations around offshore platforms. This stimulated a surge in the manufacture and sale of larger private fishing vessels and specialized fishing and recreational equipment. Additionally, commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. This proposed sale will increase these incidental benefits of offshore development. The 5-25 platforms expected to result from the proposed action will help replace those currently being removed where production has terminated. As the incidence of offshore fishing and diving has gradually increased in the past three decades, the focus of that activity bas centered on platforms constructed for mineral development. In order to maintain the long-term productivity of site specific locations attractive to fishermen and divers, some means, such as artificial reef development programs, will need to eventually replace removed platforms.

If this sale were not to be held (or more accurately, not to be held at this time) offshore industry employment would be reduced, but other employment should remain about the same, since increased imports would probably be used to make up for decreased OCS production.

If this sale is not held, or exploration and production activities in the Gulf of Mexico do not continue, the most probable result will be a continuation in the decline of oil and condensate production in the Gulf of Mexico. If this decline occurs, it is probable that the refining centers in the Gulf of Mexico will utilize additional crude oil from other areas. To the extent that this oil is transported by tanker to the refineries, a potential impact to the long-term productivity of other resources would be present due to the potential for oil spills attributable to marine transportation activities.

Several proposals for the importation of natural gas from foreign areas are being considered at the present time. Imported natural gas implies additional onshore pipeline construction, or the construction of terminals for receiving imported LNG, or a combination of these facilities. Some impact on long-term uses would be expected to result from these alternative methods for obtaining natural gas.

Section VII

Irreversible and Irretrievable Commitment of Resources

U.S. DEPARTMENT OF THE INTERIOR
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A. Energy Resources

Leasing of the proposed tracts in this sale would permit development and extraction of the minerals contained herein. This proposed lease sale could result in production of 15-150 million barrels of oil and 20-175 billion cubic feet of gas which would represent an irreversible and irretrievable commitment of these mineral resources.

More than one mineral lease may be issued for the same area for the retrieval of other types of minerals, but 43 CFR Part 3307.4-5 provides that other leases may not unreasonably interfere with or endanger operations of any existing lease.

Other mineral resources in the form of fuels required for exploration, production, and transportation of resources discovered and produced as a result of this sale would be irretrievably committed.

Exploration, production, and transportation of the sale-related hydrocarbons would require the use of fabricated metal products. Although recovery of some portion of these products could be carried out at the end of oil and gas related activity, some of these mineral products would be irretrievably committed.

B. Land Resources

It has been estimated that 0-2 terminal storage facilities may result from this proposed sale. This would represent a long-term use of land resources, but not an irreversible and irretrievable commitment.

Since no major trunklines are anticipated to result from this sale, no permanent dedication of land resources for pipeline right-of-way purposes is anticipated. Incremental additions of pipeline right-of-way will be required on the Outer Continental Shelf in order to connect new producing facilities to existing pipelines. Areas required for this purpose, as well as the area required for platform installation would be withdrawn during the life of production, but these uses would not be irreversible and irretrievable in nature.

The continued use of existing facilities within the oil and gas related economies of the states bordering the Gulf of Mexico implies that to some extent land resources may be committed to longer periods than would otherwise be anticipated, but probably not in an irreversible and irretrievable manner.

Some facilities, such as refineries, are not completely dependent on OCS production for their continued operation, although continued OCS production could be conceived as one factor that may have some effect in inducing the continued utilization of an existing facility.

The states bordering the Gulf of Mexico contain the home areas of persons engaged in the exploration, production, and transportation of oil and gas produced from the OCS, as well as production from areas located onshore and in state marine waters. To the extent that these persons are employed in activities related to the Outer Continental Shelf, their continued employment would imply the continued use of existing dwellings and land areas required for residential uses, as well as land areas required for commercial and other uses which meet the needs of these residents for goods and services.

C. Biological Resources

Assuming at least one oil spill greater that 1,000 bbl will occur sometime during the 25 year production life of the proposed leases and a 2% (3 day) to 16% (60 day) probability of an oil spill reaching land; there will be a minimal incremental irreversible and irretrievable commitment of biological resources as a result of this proposal.

A moderate irreversible and irretrievable commitment of bird species within the eastern Gulf of Mexico would result if an oil spill occurred during the winter season and drifted into the coastal bend area of Florida. An estimated 6,000 to 10,000 waterfowl could be affected.

There probably would be an incremental irreversible and irretrievable commitment of marine mammals and turtles either directly or indirectly through oil contamination of individuals, food, and/or habitat. This commitment is difficult to evaluate because population and migration information for the majority of these species is lacking.

There will be a minimal irreversible and irretrievable commitment of other wildlife as a result of onshore habitat loss (240 to 480 ha) and disturbance from the construction of two storage facilities.

A minimal irreversible and irretrievable commitment of an endangered species may result if populations of a species are initially affected by spills, through food contamination, or any other disruption or disturbance that may result from this proposal.

D. Cultural Resources

Any damage to archaeological sites or historic shipwrecks will comprise an irretrievable commitment of non-renewable resources. Considering that the existence of an early man living site on the OCS has yet to be substantiated and a few thousand historic ships known to have been lost are scattered over and under millions of acres of seafloor, the likelihood of operations from OCS activities from 3 to 120 miles offshore encountering such resources is considered remote.

E. Human Resources

Since 1954, when Outer Continental Shelf leasing began, through February 1976, there have been 75 deaths directly associated with drilling operations in the Gulf of Mexico. In addition, there have been numerous deaths associated with oil and gas production on the OCS including helicopter crashes and boat accidents.

In the years 1970 through 1976, there have been a total of 102 fatalities and 162 injuries on the Gulf of Mexico from petroleum associated occupational hazards. For a further discussion see Section III.A.3.c.(3). It will be impossible to avoid all human casualities, but they have been minimized through measures already implemented which are continually updated to improve the safety of OCS operations. Fatalities and/or permanent impairments as a consequence of accidents and personnel error will result in an irreversible and irretrievable commitment of human resources.

F. Economic Resources

A decision to proceed with this proposed sale would result in production of certain OCS-related goods and services, including investments in required facilities, stimulation of certain industries within the region, and if recoverable resources are proved, oil and gas. To the extent that resources would be drawn away from other uses, production of goods and services in other areas or of other types would possibly have to be foregone. Steel products, specialized manpower, and capital constitute required resources which may be the scarcest. Use of these resources to develop this proposal would mean that other opportunities for their use might have to be foregone. While these resources may be reclaimed over time, their use as a result of this proposed sale would constitute an irreversible and irretrievable commitment of resources during a period of time.

To the extent that unemployed resources are used, the employment of resources as a result of this proposed sale would not constitute a cost to society in the form of foregone opportunities.

Section VIII

Alternatives to the Proposed Action

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The major alternatives to holding the sale are considered to be 1) hold the sale in modified form, 2) withdraw the sale, or 3) delay the proposed sale. These basic options in various modifications are evaluated below for their environmental impacts.

A. Hold the Sale in Modified Form

1. Substitution of Tracts Within the St. Petersburg Area

One alternative considered during the tract selection process relating to proposed OCS Sale No. 65 was the inclusion of an additional 35 tracts within the St. Petersburg (NG 17-1) Area. See Figure VIII-1.

An additional 35 blocks located west of St. Petersburg in Protraction Diagram (NG 17-1) numbered 275-279, 319-323, 363-367, 407-411, 451-455, 495- 499, and 539-543 could have been substituted for 35 of the tracts included within the sale, since some degree of industry interest was expressed in these blocks.

If this option had been selected, and the sale held in this modified form, the level of development would be approximately the same as those described in Section III of this impact statement. However, these blocks would have been located closer to shore than the tracts selected for inclusion in the sale as proposed. Impacts of this Alternative:

Since the thirty-five tracts would be located closer to shore, they pose a potentially higher probability of oil spill impact on virtually all of the assessed resources present in the eastern Gulf of Mexico.

For example, based on 30 day trajectory simulations, the probability of impact on land would be approximately 31 percent compared to 6 to 9 percent probabilities for spills originating on the tracts included within the St. Petersburg area in the sale as proposed.

The addition of the 35 tracts would also have sharply increased the probability of impact on the adult female blue crab migration route, stone crab habitat, and calico scallops. The employment and population impacts would be approximately the same as those described in Section III.

2. Inclusion of an Additional 129 Tracts Within the Charlotte Harbor Area (NG 17-4)

A large group of 135 blocks located in the south central portion of the Charlotte Harbor Protraction Diagram was a portion of the area in which industry expressed interest. only 6 tracts from the 135 were included within the proposed sale blocks are 627, 628, 671, 672, 715, and 716. Another alternative would be the inclusion of other tracts in this area: blocks that could have been offered were 629-641, 673-685, 717-729, 759-773, 803-817, 847-861, 891-905, 935-949, and 979-993. See Figure VIII-2.

The inclusion of these additional blocks would have approximately doubled the size of the sale offering. The extent of additional oil and gas resources and the level of general development could have been the same, or possibly as much as twice as high as the impacts described in Section III of this impact statement.

In the event that these additional tracts had been included, the closest tracts in this area would have been located 38 miles from the coast, instead of 63 miles as the sale is presently proposed.

IMPACTS OF THIS ALTERNATIVE:

In the event of an oil spill originating from these tracts, greater probability of adverse impact on the assessed resources could be anticipated, but specific quantification in the form of trajectory analysis is not available for this group of tracts. The relationship of the area included within these additional 129 blocks and the area occupied by alternate resources indicates that increased risk of oil spill impacts on other resources could result.

The hypothetical spill location that is nearest to the tracts included in this alternative is point P14. A spill at this location had a probability of reaching land of 11 percent, the West Florida blue crab larval transport route of 31 percent; stone crab habitat of 13 percent, and calico scallops of 11 percent. In the event that oil production occurred on these tracts, increased risk of environmental damage to the above resources could result. The employment and population effects could have been the same or as much as twice as great as those described in Section III.

3. Withdraw Tracts With Maximal Potential Impact Rating: Delete Tracts 1 and 2

An analysis of each tract proposed to be offered in this sale has been made in an attempt to quantify the environmental risks encountered by oil and gas development of these areas. The resource factors considered include littoral

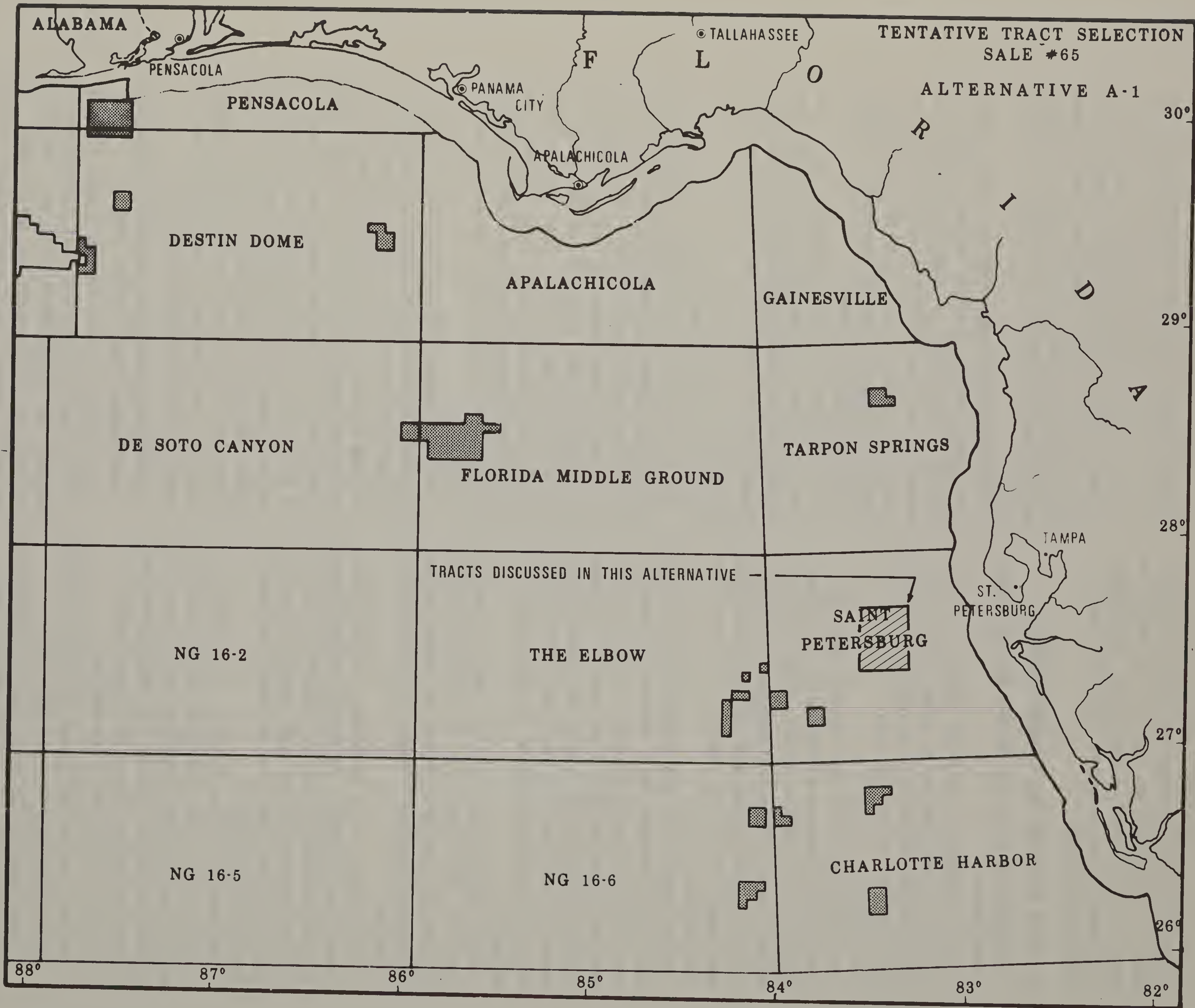

FIGURE VIII-1

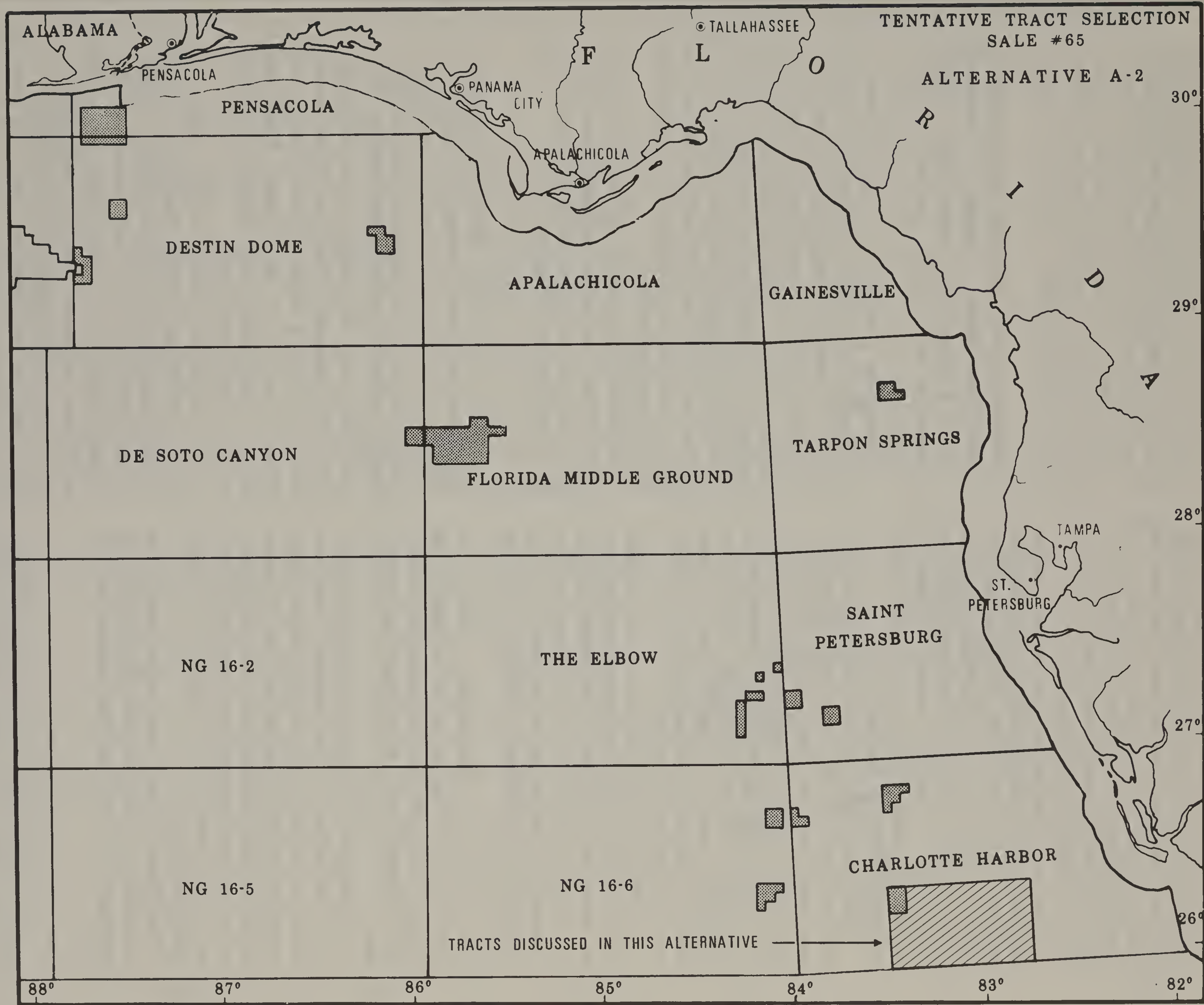

FIGURE VIII-2

systems, reefal systems, other benthic systems, endangered species, commercial and sport fishing, shipping, aesthetics, outdoor recreation, and cultural resources. The impact producing factors are considered to be the potential occurrence of oil spills and the presence of structures required for production activities on the lease tracts.

Based on consideration of the resource factors and the impact producing factors, each tract was assigned a sensitivity value indicating the sensitivity of each tract to each impact producing factor. The three levels of potential magnitude of impact are: 3, maximal potential impact; 2, moderate potential impact; and 1, minimal potential impact. (Refer to Appendix C.)

Tracts 1 and 2 in the proposed sale are estimated to present a risk of maximal potential impact on other resources and activities on the OCS. See Figure VIII-3. The additive impact of these tracts range from 1.44 to 2.00 and is interpreted to mean that the risk of damage to all other identified resources and activities from the placement of structures or the occurrence of oil spills is the greatest for these tracts.

It is believed that these tracts can be offered. If Tracts 1 and 2 were withdrawn from the sale, an incremental reduction in sale related activity would occur, possibly be 2 to 3 percent, implying a reduction in the number of test wells by 1 or 2, a reduction in development wells by 5 or 6, and 1 platform less.

It would also incrementally reduce the discharges and disposal of waste water, drill cuttings, and muds that are estimated to occur along with exploration, development, and production.

The deletion of these tracts would probably have little effect on the estimated miles and number of additional offshore pipelines that might be required for this proposed sale, but it is possible that deletion of these tracts would eliminate a few of the small flow lines that connect platforms with other platforms and eventually with major pipelines to shore.

The deletion of these tracts would result in the elimination of 4,662 hectares (10,520 acres), a small portion of the total area proposed for this sale.

Impacts of this Alternative:

The very small reduction in acreage, wells, and platforms would have a small amelioration effect on possible impact on biological resources. Since these tracts are classified as probable oil/gas prone, the deletion of these tracts would result in a small decreased risk of oil spill damage on commercial fishing and recreation resources. Essentially the impacts of this alternative would be the same as for the proposal, with the above exceptions.

4. Withdraw Tracts With High Oil Spill Impact Risk: Delete Tracts 1 through 24 (Pensacola NG 16-5 Blocks 1-15, Destin Dome NH16-8 Blocks 2-6, 313, 314, 357, and 358) See Figure VIII-4.

Although the probability of an oil spill reaching an object or land segment within 30 days from any of the proposed tracts is generally less than 60 percent, the oil spill risk analysis prepared for proposed Sale 65 indicated that an oil spill originating on production area P1 would have a probability of reaching land after 30 days of 89 percent, and an oil spill originating on production area P2 would have a probability of reaching land of 65 percent after 30 days.

Incremental reductions in the number of wells and platforms, and incremental reduction in possible oil and gas production would also result from the adoption of this alternative.

Impacts of this Alternative:

Deletion of the 24 tracts included within these production areas could decrease the risk of oil spill damage below those discussed in Section III. Lower risk of oil spill damage to land resources such as beaches in the Pensacola, Florida area, marshlands near the mouth of the Mississippi River, the Chandeleur Islands east of the Mississippi River delta, a National Wildlife Refuge and included as part of the National Wilderness System, and marine turtle nesting sites could result from this alternative.

The location of onshore facilities that may result from the sale may be changed as a result of this option in that there would be less incentive to locate facilities in the coastal Alabama or Pensacola, Florida areas, and this change may result in different employment and population changes than were hypothesized in Chapter III. Those effects would be expected, therefore, to be lower than described in Chapter III.

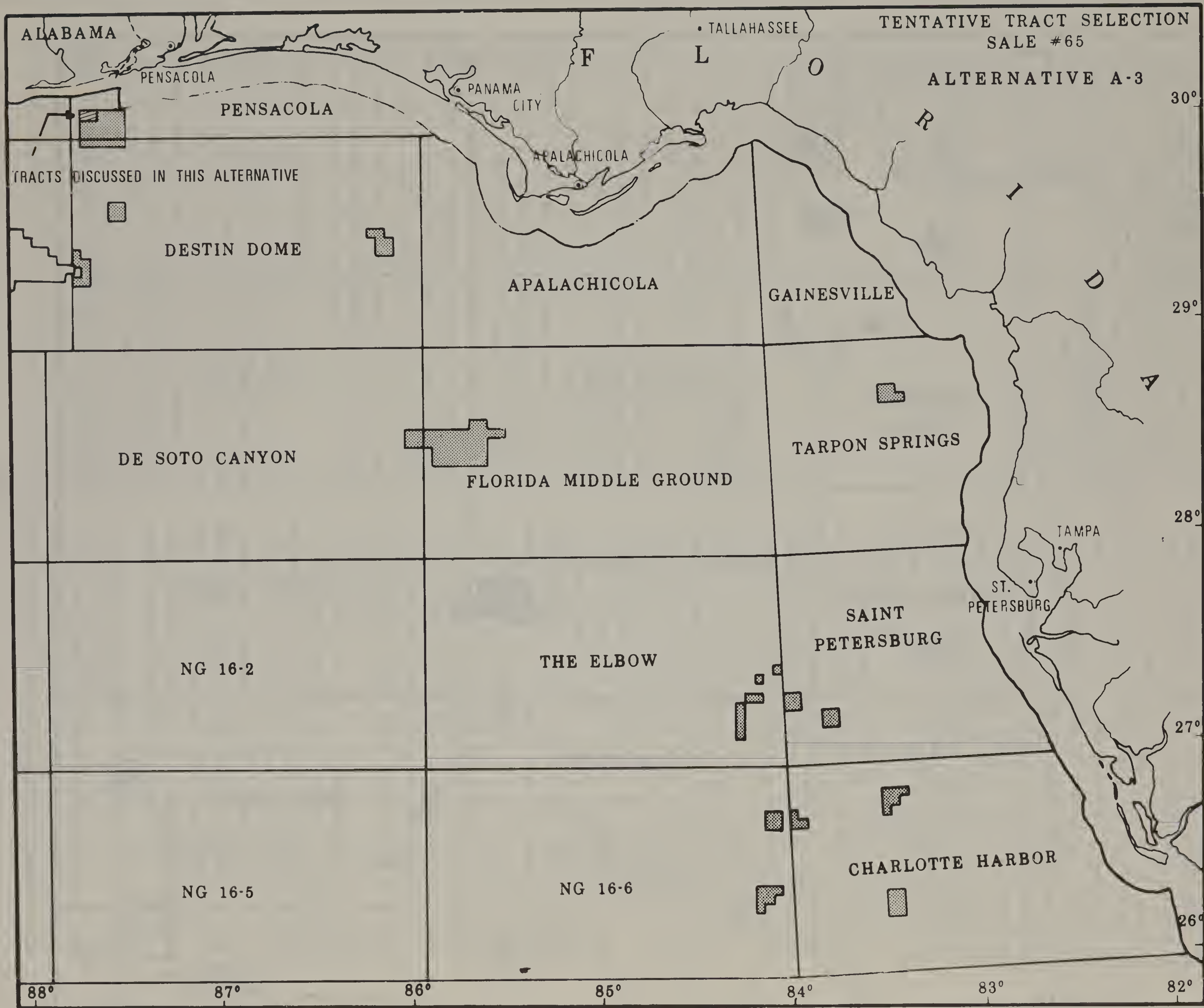

FIGURE VIII-3

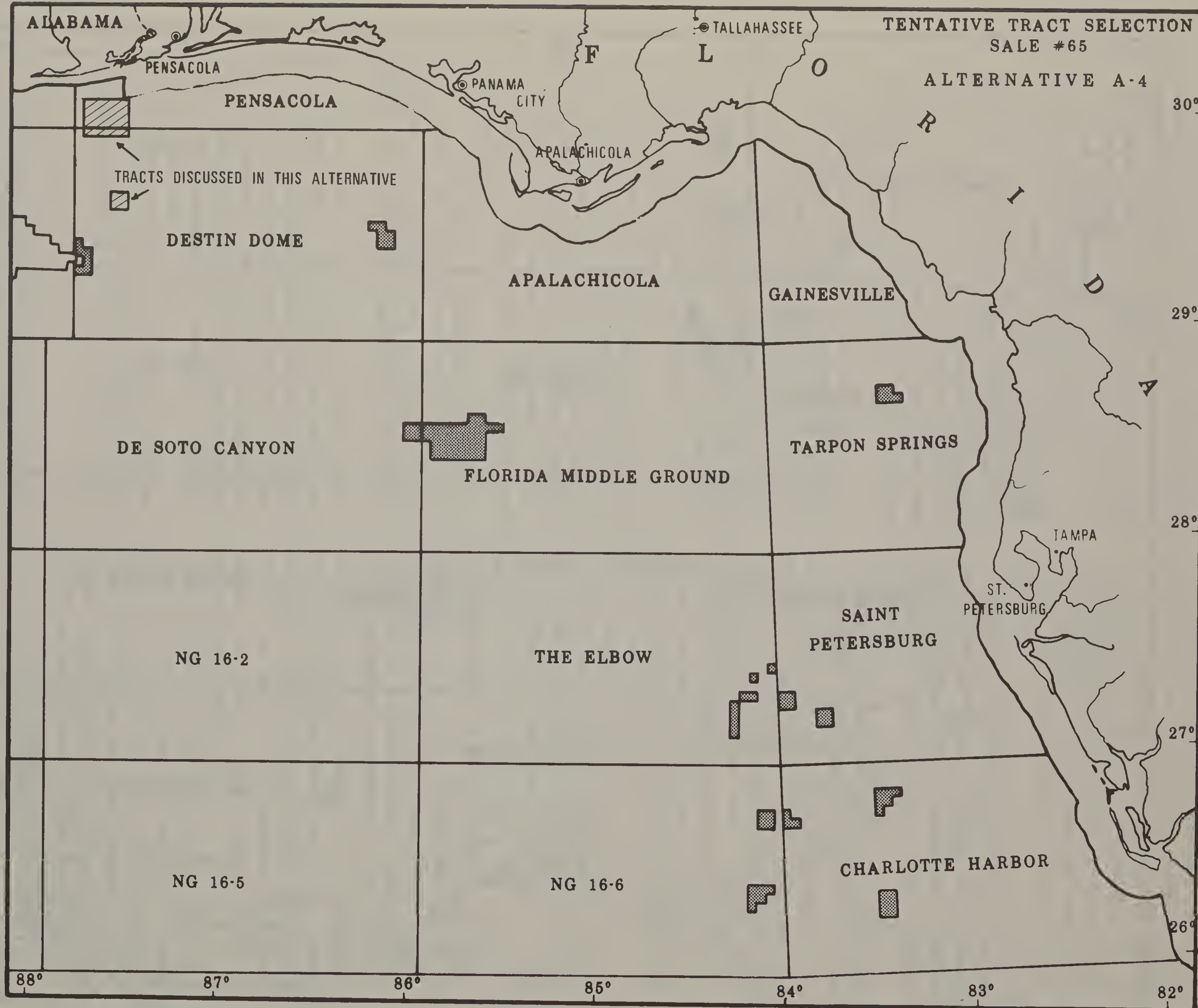

FIGURE VIII-4

B. Withdraw the Sale

Another option is to cancel the proposed sale. This alternative would reduce the future OCS oil and gas production and would thus necessitate other measures such as increased imports, reduced energy consumption by reducing demand or supply shortfalls, or the development of alternative energy sources, or a combination of the above measures.

Alternative energy measures to offshore oil and gas include:

Energy Conservation
Conventional oil and gas supplies
Coal
Nuclear
Oil shale
Hydroelectric power
Solar energy
Oil imports
Natural gas imports
Liquefied natural gas imports
Geothermal energy
Other energy sources (wind, tidal)

Table VIII-1 estimates the energy required from other sources to replace the expected petroleum production from proposed Sale 65.

A discussion of energy alternatives and their impacts, that could result if energy substitution occurs, can be found in the Final Environmental Impact Statement, Volumes 1-3, Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf by the U.S. Department of the Interior, 1975, and further elaboration is explained in Energy Alternatives: A Comparative Analysis by the Science and Public Policy Program of the University of Oklahoma. Copies of this later study are available for review in the New Orleans OCS Office, and can be purchased for $7.45 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock Number 041-011-00015-4).

Impacts of this Alternative:

None of the environmental effects expected from the proposed sale would occur should the proposed sale be withdrawn. However, a major economic impact would be a further delay in the national goal of achieving energy independence. The estimated 15 to 150 million barrels of oil and the 20 to 175 billion cubic feet of gas which would result from this sale would have to be supplied from other sources; the majority of it imported. Such increased imports could have adverse economic impacts.

The extensive petroleum refining industry in the Gulf of Mexico is an important component of the total national industry. In the event that oil production does not result from this proposed sale, due to withdrawal of the sale, it appears likely that crude oil imports will be utilized in place of this volume of domestic oil production. Since this foreign crude oil would be transported in tankers, increased oil spills originating from tanker operations could then result. Furthermore, this increased tanker traffic could increase the possibility of collision of tankers with other shipping and existing fixed structures, resulting in spilled oil, injuries, and deaths beyond existing levels associated with the present volume of crude imports.

The energy expected to be realized from this proposed sale could be provided from coal. The acceleration of coal development to the point of replacing expected energy resources from the proposed OCS sale within a similar timeframe, however, would probably have a greater adverse impact on the general environment than the proposed action. Such impact would affect other sections of the U.S. and have environmental consequences of a different nature, principally land disruption and air pollution.

The substitution of energy resulting from the proposed sale by other sources such as oil shale, hydroelectric power, geothermal energy, solar energy, and other energy sources is beyond our technological capabilities at the present time. Much research is being done in these fields and in the future, greater dependence on them may be feasible. Except for oil shale development, their environmental consequence would appear to be generally less severe than would occur with coal development.

In summary, the major environmental effects of the proposal would be entirely avoided by withdrawal of this sale. However energy substition which would probably take the form of greater oil imports would further increase the chance of collision and tanker accident in the Gulf of Mexico region. Greater potential environmental effects could thus be expected as well as further adverse economic impacts.

C. Delay the Sale

The sale could be delayed for a period of time sufficient to develop new environmental protection equipment, the completion of studies in the

Gulf of Mexico concerning potential environmental impacts of offshore mineral development, the development of coastal zone plans, or the development of other legislation altering the program.

In the event of this occurrence, all of the environmental effects that are discussed in this impact statement Chapter III would be postponed during the delay time.

Oil requirements of present refineries in the Gulf of Mexico for crude would probably be met by a minor increase in imports. Delay in natural gas production would probably cause increased volumes of natural gas to be imported. The effects of these trends would be expected about as described below.

Impacts of this Alternative:

Losses of employment in the offshore activity from exploration, production, and transportation of crude oil and natural gas could occur. The availability of imports that might be substituted should permit the processing, manufacture, and transportation of petroleum products derived from imported crude to continue. Unemployment effects due to interrupting of natural gas production are more difficult to determine, but would more likely have their major effect at points further from the Gulf of Mexico.

D. Alternative Scenarios of Development

There is a certain degree of uncertainty attached to exploratory operations on the Outer Continental Shelf. Some of the uncertainty is due to lack of precise knowledge as to the composition and location of any oil and gas reserves that may be discovered. Other uncertainty relates to how states and local governments respond in their planning.

Discoveries adjacent to the coastal portions of Alabama could lead to development in that area. If discoveries were made in the region west of Tampa, Florida, different devlopment patterns would result, possibly concentrating shore activity there.

Two additional scenarios incorporating different assumptions were specified in order to obtain some concept of the variations that could result. These scenarios incorporate several assumptions that differ from the ''most likely'' scenario discussed in Chapter III of this statement.

It should be pointed out that these are not alternative decisions that lie within the field of choice for the Secretary of the Interior. Rather, there are different possibilities of development that could result as a consequence of action by other levels of government or from different levels of discovered resource. They are presented here so those possible consequences can be understood.

1. Scenario A (Refer to Table VIII-2)

Scenario A incorporates the assumption of an offshore terminal located south of Mobile County Alabama. Oil could be transported directly from this terminal to refinery locations by tanker or barge. Pipelines would be required to link producing facilities to the terminal, and pipelines would be required for natural gas transport.

There are several offshore gathering and surface transportation systems in operation at the present time in the Gulf of Mexico and in the North Sea and a system proposed for use in the Santa Barbara Channel area of California is under consideration.

The Gulf of Mexico systems incorporate offshore storage facilities with provision for transferring petroleum liquids to barges. These systems are in use for production levels ranging from 300 to 6600 barrels of oil per day. One of these systems serving an area with a production level of 2800 barrels of oil per day provides offshore storage capacity of 16,000 barrels, and requires an annual total of 104 barge loadings to transfer the production to shore terminals.

A floating treating and storage facility to be operated in conjunction with a production platform has been proposed for use in the Santa Barbara Channel area of California. This system was designed for a capacity of 40,000 barrels per day and incorporates a system for the separation of oil from gas on the platform, the transfer of the oil to a floating storage facility (a converted tanker) and transfer to a refining center by means of a shuttle tanker or barge.

The facilities in the North Sea area include systems in use in the Argyll, Auk, Beryl, and Brent Fields which incorporate some type of facility for loading tankers at rates ranging from 2,000 to 40,000 barrels per hour, provide storage for volumes of oil ranging up to 1.3 million barrels of oil, and require two shuttle tankers to transport the oil for refining.

A precise description of an offshore storage and transport system that might be used in the eastern Gulf of Mexico cannot be provided until more definitive information concerning the location and quantity of resources become available. However, the daily oil production rates estimated for proposed Sale 65 range from 2500 to 24,000 barrels.These levels of production can be accommodated within a system similar to the existing offshore storage-barging systems in the Gulf of Mexico or in a system similar to that proposed for the Santa Barbara Channel. Daily production rates of 24,000 barrels would imply a storage capacity of 168,000 barrels and frequency of visit by a tanker at 25,000 DWT size of about once a week. In the event that an offshore terminal would be constructed as a result of such activity, it is probable that the total transportation requirements would be reduced by the elimination of crude oil pipelines to shore, and possibly result in a reduction in the costs of transportation.

Since the oil storage facility would probably be located in a production area, it is most probable that the trajectories computed for the proposal and discussed in Section III would be applicable to this alternative.

Impacts of this Alternative:

The alternative of Scenario A would eliminate the necessity for crude oil pipelines from offshore producing areas to onshore terminals and therefore reduce the amount of disturbance to the sea floor, as well as the land areas that would be required for onshore terminals.

The most significant impact would be a larger concentration of total employment in Alabama, and lower total employment in the other Gulf states than was computed for Scenario B (assessed in Section III).

Higher employment would imply larger population shifts into Alabama. To the extent that the development was desired by responsible governing agencies, this type of development implies a total employment of 6,135 in the year 2000, compared to 3,968 in the year 2000 computed for the base scenario.

The surface transportation required by this proposal may increase the risk of an oil spill in inshore waters or in harbors, when compared to pipeline transportation. The offshore storage facility may pose an incremental addition to the risk of collision with passing vessels, but if the facility were combined with a production platform, no increased risk of collision beyond that discussed in Chapter III would be expected.

2. Scenario C (Refer to Table VIII-3)

This scenario incorporates the low resource estimates of the sale area. The lower resource estimates and the decreased number of platforms and wells result in lower forecasts of total employment. In the region as a whole the maximum total employment in the year 1984 was 1209 persons in this scenario compared to 7,806 persons estimated for the proposed action. Reduced number of wells, platforms, and transportation facilities, reduced requirements for labor, and material to construct the required facilities all would seem likely.

Impacts of this Alternative:

The lower estimates of volume of oil and gas to be produced imply that the risk of environmental harm on individual resources will be considerably reduced from those estimated in the discussions incorporated into Section III of this impact statement.

Section IX

Consultation and Coordination with Others

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BLM
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A. Preparation of the Draft Environmental Statement

1. Federal Agencies

Numerous Federal agencies were contacted for information and suggestions throughout the environmental assessment and statement preparation process.

Federal agencies contacted include:

Department of Agriculture

Forest Service

Soil Conservation and Stabilization Service

Extension Service

Department of Commerce

National Weather Bureau

Bureau of the Census

Social and Economic Statistics Administration

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

Office of Coastal Zone Management

Office of Ecology and Environmental Conservation

Department of Defense

Deputy Assistant Secretary

Eastern Sea Frontier Commander

United States Air Force

United States Navy

Naval Oceanographic Office

United States Army

Corps of Engineers

Department of the Interior

Bureau of Mines

Bureau of Outdoor Recreation

U.S. Fish and Wildlife Service

U.S. Geological Survey

National Park Service

Department of Transportation

Federal Aviation Administration

Federal Highway Administration

U.S. Coast Guard

Department of the Treasury

Energy Research and Development Administration

Environmental Protection Agency

Federal Energy Administration

Federal Power Commission

2. State and Local Agencies

BLM also works closely with the Gulf states; their expertise is invaluable in developing statements and policies, and BLM endeavors to keep the states informed of its plans and policies.

Mississippi, Alabama, and Florida agencies with which BLM has consulted include:

Mississippi

Governor's Office

Mississippi Department of Archives and History

Mississippi Natural Heritage Trust

Mississippi Bureau of Outdoor Recreation

Mississippi Research and Development Center

Mississippi Marine Resources Council

Southern Mississippi Regional Planning Commission

Gulf Regional Planning Commission

Jackson County Planning Commission

Mississippi Cooperative Extension Service

Mississippi Marine Resources Council Advisory Committee

Alabama

Governor's Office

Alabama Geological Survey

Alabama Development Office

Alabama Historical Commission

Alabama Department of Conservation

Alabama Water Improvement Commission

Alabama State Planning Office

Alabama Coastal Area Board

Tombigbee Regional Commission

Mobile Office of Intergovernmental Relations

Florida

Governor's Office

Florida Department of Natural Resources

Florida Department of Transportation

Florida Department of State, Division of Archives, History, and Records Management

Florida Division of Economic Development

Florida Bureau of Coastal Zone Planning

West Florida Regional Planning Council

Tampa Port Authority

3. Professional and Industrial Firms and Associations, Academic Institutions, and Others

Institutions, associations, and groups which were contacted for information or input include, but are not limited to, the following:

Academic Institutions

Auburn University (Alabama)
Florida State University
Louisiana State University
State University System Institute of Oceanography (Florida)
Tulane University (Louisiana)
University of South Alabama

Industrial Firms

Brown and Root
Chevron
Clean Gulf Associates
Exxon
Gulf
J. Ray McDermott
Offshore Operators Committee
Shell
Texaco
Zapata Offshore

4. Review of Pre-Draft Environmental Statement

The three eastern Gulf of Mexico states - Alabama, Mississippi, and Florida - were invited to review the working draft of this draft environmental statement for the purpose of identifying any errors or omissions, or for making any suggestions for completeness prior to the draft statement's submission to the Washington BLM headquarters office for formal review and subsequent submission to the Environmental Protection Agency.

Section X

Bibliography

U S DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
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X. BIBLIOGRAPHY

Alabama Department of Conservation & Natural Resources. 1971. Alabama outdoor recreation plan. Volumes 13 & 21 and Executive Summary. Auburn University. Auburn Alabama.

Alabama Development Office. 1976. Agency identification and coordination. Alabama Coastal Area Management Program. Montgomery Alabama. 192 p.

Alabama Water Improvement Commission. 1976. Water quality management plans, Perdido-Escambia River and Mobile River Basins.

Alaska, State of. 1971. Comments on the proposed trans-Alaska pipeline. US Department of the Interior, July 30, 1971. 192 p.

Algermissen, S.T. 1969. Seismic risk studies in the United States *In:* Fourth World Conference on Earthquake Engineering. Santiago Chile. January 13-18, 1969.

Algermissen, S.T. and Perkins, D.M. 1976. A probabilistic estimate of maximum acceleration in rock in the contiguous US. Washington DC.

American Institute of Planners. 1976. State land use activity. Prepared for US Department of Housing and Urban Development. Washington DC. 524 p.

American Petroleum Institute. 1974. Recommended practice orientation program for personnel going offshore for the first time. API RPT-1. January 1974.

Askari, H. and Creasy, J. 1977. Texas and OPEC: a case for economic interdependence. *In:* Texas Business Review. September 1977. University of Texas. Austin Texas.

Balech, E. 1967. Dinoflagellates and fintinnids in the northeast Gulf of Mexico. Bull. Mar. Sci. 17:280-298.

Beardsley, Grant L., Director. 1977. Oceanic game fish investigations, 1976 newsletter. May 1977. US Department of Commerce, NOAA, NMFS, Southeast Fisheries Center. Miami Florida.

Bellrose, F.C. 1976. Ducks, geese, and swans of North America. Stockpole Books. 544 p.

Biggs, Huntley. 1977. Personal communication. Mississippi Research and Development Center. Jackson Mississippi.

Boesch, D.F., C.H. Hershner, and J.H. Milgram. 1974. Oil spills and the marine environment. Ballinger Publishing Company, Cambridge. 114 p.

Bourne, W.R. 1968. Observation of an encounter between birds and floating oil. Nature 219(5154):632.

Bright, T.J. 1975. Personal communication. Texas A & M University. College Station Texas.

Bright, T.J. and Jaap, W.C. 1976. Ecology and Management of coral reefs and organic banks. Paper presented at annual meeting of the American Institute of Biological Sciences in New Orleans, June 1, 1976.

Brooks, J.M. and Bernard B.B. 1977. Report to Pennzoil Oil Company through Decca Survey Systems, Inc. on geochemical study around a platform blowout in High Island South Addition Block 563. Pennzoil Company. Houston Texas.

Caldwell, D.K. 1969. Baby loggerhead turtles associates with Sargassum weed. Quart. J. Fla. Acad. Sci. 31(4).

Cannon, Susanne E. 1977. Texas construction. *In:* Texas Business Review. September 1977. University of Texas. Austin Texas.

Cantrell, Aileen. 1974. Annual refining survey. In: Oil and Gas Journal, Vol. 72 No. 13. April 1, 1974. Tulsa Oklahoma.

Card, J.C., P.V. Ponce, and W.D. Snider. 1975. Tankship accidents and resulting oil outflows, 1969-1973. March 1975. API 1975 Conference on Prevention and Control of Oil Pollution. *In:* Office of Technology Assessment, Oil Transportation by Tankers. July 1975. Washington DC.

Chan, E.I. 1976. Oil pollution and tropical littoral communities: Biological effects of the 1975 Florida Keys oil spill. Masters thesis, University of Miami, Rosentiel School of Marine and Atmospheric Science. Miami Florida.

Chan, G. 1972. A study of the effects of the San Francisco oil spill on marine organisms. Part I. College of Marin. Kentfield California. 78 p.

Charter, D.B., R.A. Sutherland, and J.D. Porricelli. 1973. Quantitative estimates of petroleum in the oceans. Nat. Aca. of Sci. Nat. Res. Coun. Washington DC.

Chew, F. 1974. The turning process in meandering currents: A case study. Jour. Phys. Ocn. 4(1):21-57.

Chubb, J.C. 1954. Observations on oiled birds, 1951-1953. Northwest Natur. 2:460-461.

Clark, R.B. 1969. Oil pollution and the conservation of sea birds. Proc. Intl. Conf. Oil Pollution of the Sea, Rome. p. 76-112.

Clark, R.B. 1971. Oil pollution and its biological consequences. A review of current scientific literature. Prepared for Great Barrier Reef Petroleum Drilling Royal Commissions. 11 p.

Coastal Environments, Inc. 1977. Cultural resources. Drilling Royal; Commissions. 11 p.

Coastal Environments, Inc. 1977. Cultural resources evaluation of the northern Gulf of Mexico. 4 volumes. (in press) Being published by National Park Service. Washington DC.

Coastal Zone Management Newsletter. 1977. Botzum, John R. ed. Nautilus Press. Washington DC.

Collard, S.B. and D'Asaro, C.N. 1973. Benthic invertebrates of the eastern Gulf of Mexico. *In:* A summary of knowledge of the eastern Gulf of Mexico. J.I. Jones, R.E. Ring, M.O. Rinkel, and R.E. Smith (eds). State University System Institute of Oceanography. St. Petersburg Florida.

Collins, A.G. 1974. Geochemistry of liquids, gases, and rocks from the Smackover Formation. Report of Investigations 7897, USDI, Bartlesville Energy Res. Ctr. Bartlesville Oklahoma.

Collins, A.G. 1975. Geochemistry of oil field waters. American Elsevier Publishing Co., Inc. New York.

Congressional Research Service and US Geological Survey. 1977. National energy transportation, Vol. 1-Current systems and movements. Washington DC. 587 p.

Corcoran, E.F. 1972. Data interpretation report of the study of the distribution and concentration of trace metals and pesticides of the Florida territorial sea of ESCAROSA: 1-71. Contract No. CCC-04-71 between SUSIO and FCCC.

Crocker, A.D., J. Cronshaw, and W.N. Homes. 1974. The effect of crude oil on interstitial intestinal absorption in ducklings (*Anas platyrhychos*). Env. Pollution, 7:165-177.

Crozier, George F., Principal Investigator. 1977. Development of Gulf Coast artificial reefs. Final Report: NOAA/Sea Grant 04-5-158-54-07(1).

Curl, H. 1959. The phytoplankton of Apalachee Bay and the northeastern Gulf of Mexico. Pub. Inst. Sci. University of Texas 6:275-320.

Daniel, D.L. and Seward, J.E., Jr. 1975. Natural and artificial reefs in Mississippi coastal waters: Sport fishing pressure and economic considerations. MASGP-75-007. Bureau of Business Research, University of Southern Mississippi. Hattiesburg Mississippi. 27 p.

Davis, C.C. 1950. Observations of plankton taken in marine waters of Florida in 1947 and 1948. Quarterly Journal, Fla. Acad. Sci. 12:67-103.

Davis, J.H., Jr. 1940. The ecology and geologic role of mangroves in Florida. Carnegie Institute, Washington DC. Pub. 517. Tortugas Lab. Paper 32:303-412.

Davis, J.H. 1967. General map of natural vegetation of Florida. Agricultural Experiment Station, University of Florida. Gainesville Florida.

Defaunt, A. 1961. Physical Oceanography, Vol. II. Pergamon Press. New York. 598 p.

Defenbaugh, Richard E. 1976. A study of the benthic macroinvertebrates of the continental shelf of the northern Gulf of

Mexico. Unpublished PhD dissertation, Texas A & M University. College Station Texas. 476 p.

DeLong, R.L., W.G. Gilmartin, and J.G. Simpson. 1973. Premature births in California sea lions: Association with high organochloride pollutant residue levels. Science. 181; 1168-1170.

Deuel, D.G. 1973. 1970 salt-water angling survey. US Department of Commerce, NOAA, NMFS. Current Fishery Statistics, No. 6200. Washington DC. 54 p.

Dragovich, A. 1963. Hydrology and plankton of coastal waters at Naples Florida. Quarterly Journal, Fla. Acad. Sci. 26:22-47.

Durham, D.L. and Reid, R.O. 1967. Analysis of tidal current observations over the north-eastern shelf of the Gulf of Mexico. Department of Oceanography, Texas A & M University. College Station Texas. 110 p.

Ehrhardt, M. 1972. Petroleum hydrocarbons in oysters from Galveston Bay. Env. Poll. 3:257-271.

Eleuterius, C.K. 1974. Mississippi superport study environmental assessment. Prepared for the office of Science and Technology, Office of the Governor, State of Mississippi.

El Sayed, S.Z. 1972. Primary productivity and standing crop of phytoplankton in the Gulf of Mexico. *In:* Chemistry: Primary productivity, and benthic algae of the Gulf of Mexico. Serial Atlas of the Environment, Folio 22, American Geographical Society. New York.

Erickson, R.C. 1963. Oil pollution and migratory birds. Atl. Natl. 9(1):5-15.

Fable, W.A., Jr. and Saloman, C.H. 1974. The recreational fishery on three piers near St. Petersburg Florida during 1971. *In:* Marine Fisheries Review Paper 1093, 36(10):14-18. Washington DC.

Fanning, J.K. 1974. Nutrient analysis. Vol. 2, Draft report of the baseline environmental survey of the MAFLA lease areas. State University System Institute of Oceanography. St. Petersburg Florida.

Faulk, M.R. and Lawrence, M.J. 1973. Acute toxicity of petrochemical drilling fluids, components, and wastes to fish. Tech. Rept. Series No. CEN-T-73-1. Resource Mgmt. Branch, Dept. of Environment, Freshwater Inst., Winnipeg Manitoba.

Faulkinberry, Patricia. 1977. New faces in the South. *In:* Monthly Review and Economic Survey, February 1977. Federal Reserve Bank of Atlanta. Atlanta Georgia.

Federal Register. 1975a. Endangered and threatened wildlife and plants. USDI, Fish and Wildlife Service. September 26, 1975.

Federal Register. 1975b. Critical habitat designation. USDI, Fish and Wildlife Service. April 22, 1975.

Federal Register. 1976. Determination of critical habitat for American crocodile, California condor, Indiana bat, and Florida manatee. USDI, Fish and Wildlife Service. September 24, 1976.

Federal Register. 1977a. Reclassification of American alligator to threatened status in certain parts of its range. USDI, Fish and Wildlife Service. January 10, 1977.

Federal Register. 1977b. Determination of critical habitat for Mississippi sandhill crane. USDI, Fish and Wildlife Service. August 8, 1977.

Federal Register. 1977c. Endangered and threatened wildlife and plants, Republication of list of species. USDI, Fish and Wildlife Service. July 14, 1977.

Federal Register. 1977d. National Register of Historic Places. USDI, National Park Service. February 1, 1977, and Updates.

Federal Register. 1977e. Proposed endangered status and critical habitat for the pine barrens treefrog in Florida. USDI, Fish and Wildlife Service. April 5, 1977.

Federal Reserve Bank of Atlanta Research Department 1976. Southeastern statistics. December 1976. Atlanta Georgia.

Fergus, James T. 1977. Energy dependence and southeastern economic growth: and input-output analysis. *In:* Economic Review. October 1977. Federal Reserve Bank of Atlanta. Atlanta Georgia.

Florida Board of Regents. 1976. Final Report on the baseline environmental survey of the MAFLA lease areas. Report to BLM, Washington DC. 148 p.

Florida Department of Commerce, Division of Tourism. 1976. 1975 Florida tourist study-Executive summary. Tallahassee Florida. 12 p.

Florida Department of Natural Resources, Division of Recreation and Parks. 1976. Outdoor recreation in Florida: 1976. Tallahassee Florida. 143 p. + apps.

Florida Department of Natural Resources, Division of Resource Management, Bureau of Coastal Zone Planning. 1977a. Florida coastal zone management program (Section 305), status report to the Governor and Cabinet. Tallahassee Florida. 125 p.

Florida Department of Natural Resources, Division of Resource Management, Bureau of Coastal Zone Planning. 1977b. Suggested state objectives, policy, and criteria for coastal management in Florida. Tallahassee Florida. 93 p.

Florida Department of Natural Resources, Division of State Planning. 1973. Florida 10 million. Tallahassee Florida. 64 p.

Florida Department of State, Division of Archives, History, and Records Management. 1977. Letter from L. Ross Morrell, Deputy State Historic Preservation Officer commenting on the cultural sensitivity of the Florida coastal area and nearshore waters to BLM, New Orleans Louisiana.

Florida State University, Department of Urban and Regional Planning and University of South Florida, Department of Geography. 1975. Florida coastal policy study: the impact of offshore oil development. December 1975. Prepared for the Florida Energy Office and State University System of Florida. Tallahassee Florida.

Gagliano, S.M., P. Light, and R. Becker. 1972. Proposed multi-use management plan for the Louisiana coastal zone. Coastal Research Unit, Center for Wetland Research, Louisiana State University. Baton Rouge Louisiana.

Galtsoff, P.S. 1959. Environmental requirements of oysters. *In:* Transactions of the Second Seminar on Biological Problems in Water Pollution. US Department of Health, Education, and Welfare. Washington DC.

Gillespie, M.C. 1971. Analysis and treatment of estuarine waters of Louisiana. *In:* Cooperative Gulf of Mexico Estuarine Inventory and Study: Louisiana. La. Wild. and Fish. Comm.

Golay, C.E. 1976. Personal communication. Offshore Operators Committee. New Orleans Louisiana.

Gordon, D.C., Jr., and Prouse, N.J. 1973. The effect of three oils on marine phytoplankton photosynthesis. Mar. Biol. 22:329-333.

Grace, S.F. 1932. The principal diurnal constituent of tidal motion in the Gulf of Mexico. Monthly Notices, Royal Astron. Soc. Geophys. Suppl. 2(2):70-83.

Gulf Regional Planning Commission. 1976. Geographic areas of particular concern and priority of uses. Prepared for Mississippi Marine Resources Council. Long Beach Mississippi. 71 p.

Gulf Universities Research Consortium. 1974. The offshore ecology investigation. Final report planning council consensus. GURC Report No. 138. Galveston Texas. 39 p.

Gunter, G. 1967. p. 621-638. *In:* Estuaries. G.H. Lauff (ed.), Pub. No. 83 AAAS, Washington DC.

Gunther, William D. 1975. The economy: past, present, and future. *In:* Alabama Business, Vol. 45 No. 6. February 1975. University of Alabama. University Alabama.

Hammond, Donald, D. Myatt, & D. Cupka. 1977. Evaluation of midwater structures as a potential tool in the management of the fisheries resources of South Carolina's artificial fishing reefs. South Carolina Marine Resources Center-Tech. Report series Number 15. Charleston South Carolina.

Hartman, D.S. 1969. Florida's manatee, mermaid in peril. National Geog. Mag. 136:342-353.

Hartung, R. 1965. Some effects of oiling on reproduction of ducks. J. Wildl. Mgmt. 29(4):872-874.

Hartung, R. 1967. Energy metabolism in oil-covered ducks. J. Wildl. Mgmt. 31(4):798-804.

Hartung, R. and Hunt, G.S. 1966. Toxicity of some oils to waterfowl. J. Wildl. Mgmt. 30(3):564-570.

Hastings, Robert W, L.H. Ogren, and M.T. Mabry. 1976. Observations on the fish fauna associated with offshore platforms in the northeastern Gulf of Mexico. Fish. Bull. 74(2):387-402.

Hood, D.W. 1963. Chemical oceanography. Oceanography Marine Biology Annual Review 1:129-155.

Hopkins, S.H. 1973. Aquatic life: nekton. *In:* Environmental impact assessment of shell dredging in San Antonio Bay Texas, Vol. 3. US Army Corps of Engineers, Galveston Texas.

Hopkins, T.S., D.R. Blizzard, and D.K. Gilbert. 1977. The molluscan fauna of the Florida Middle Grounds with comments on it's zoogeographical affinities. Northeast Gulf Sci. 1:39-47.

Horne, R.A. 1969. Marine chemistry. Wiley Interscience. New York. 568 p.

Hughes, E.A. 1972. Jubilee brings excitement to eastern shore. Alabama Conservationist 42(4):6-7.

Humm, H.J. 1973. The biological environment: seagrasses. p. III C-1 to III C-10. *In:* A Summary of Knowledge of the Eastern Gulf of Mexico. J.I. Jones, R.E. Ring, M.O. Rinkel, and R.E. Smith (eds.). State University System Institute of Oceanography. St. Petersburg Florida.

Ichiye, T., H. Kuo, and M. Carnes. 1973. Assessment of currents and hydrography of the eastern Gulf of Mexico. Department of Oceanography, College of Geosciences, Texas A & M University. College Station Texas.

Jackson, Elmo L. 1975. Florida economy: fourth quarter 1974. January 1975. University of Florida. Gainesville Florida.

Jackson, Gerry A. 1972. A sport fishing survey of Biloxi Bay and the adjacent Mississippi Sound. Masters thesis, Department of Wildlife and Fisheries, Mississippi State, Mississippi. 101 p.

Jones, J.I., R.E. Ring, M.O. Rinkel, and R.E. Smith (eds.) 1973. A summary of knowledge of the eastern Gulf of Mexico. State University System Institute of Oceanography. St. Petersburg Florida.

Jones, J.I. and Williams, S. 1973. Trace elements in the bottom sediments of the OEI study area. *In:* Gulf Universities Research Consortium Offshore Ecology Investigation. GURC Rept. No. 126.

Jones, Lamar B. and Rice, G.R. 1972. An economic base study of coastal Louisiana. Louisiana State University. Baton Rouge Louisiana.

Ketchum, B.H. 1973. Oil in the marine environment. *In:* Background Papers for a Workshop on Inputs, Fates, and Effects of Oil in the Marine Environment, Vol. 2. Ocean Affairs Board, National Academy of Sciences. Washington DC.

Kiernan, L.A. 1976. Extent of oil spill surprised investigators. Washington Post. February 21, 1976.

King, John M. and Associates. 1971. The regional plan for open spaces, recreation, and environmental appearance: Hancock, Harrison, Jackson, and Pearl River Counties Mississippi. Prepared for the Gulf Regional Planning Commission. Gulfport Mississippi. 157 p.

Koons, C.B., C.D. McAuliffe, and F.T. Weiss. 1975. Environmental aspects of produced waters from oil and gas extraction operations in offshore and coastal waters. Sheen Technical Subcommittee of the Offshore Operators Committee.

Koons, C.B., C.D. McAuliffe, and F.T. Weiss. 1977. Environmental aspects of produced waters from oil and gas extraction operations in offshore and coastal waters. J. of Petroleum Technology. June 1977.

Kreider, R.E. 1971. Identification of oil leaks and spills. Proc. Conference on Prevention and Control of Oil Spills, API, Washington (1971):119-124.

Lee, R.F. 1975. Fate of petroleum hydrocarbons in marine zooplankton. *In:* Proceedings, 1975 Conference on Preventional Control of Oil Pollution, March 25-27, 1975. San Francisco.

Leipper, D.F. 1954a. Marine meteorology of the Gulf of Mexico, a brief review. *In:* Gulf of Mexico, its Origin, Waters, and Marine Life. P.S. Galtsoff (ed.) Fisheries Bulletin. No. 89, Fish and Wildlife Service, US Department of the Interior. Washington DC. 58:89-98.

Leipper, D.F. 1954b. Physical oceanography of the Gulf of Mexico. *In:* Gulf of Mexico, its Origins, Waters, and Marine Life. P.S. Galtsoff (ed.) Fisheries Bulletin 89. Fish and Wildlife Service, US Department of the Interior. Washington DC.

Leipper, D.F. 1970. A sequence of current patterns in the Gulf of Mexico. Jour. Geo. Res. 75(3):637-657.

Levorsen, A.I. 1958. Geology of petroleum (2nd ed). W.H. Freeman, San Francisco. 702 p.

Levorsen, A.I. 1967. Geology of petroleum (2nd Ed). W.H. Freeman. San Francisco. 724 p.

LOOP. 1975. Environmental assessment of a Louisiana offshore oil port., Vol. 1. New Orleans Louisiana.

Louisiana Advisory Commission on Coastal and Marine Resources. 1973. Louisiana wetlands prospectus. September 1973. Louisiana State University. Baton Rouge Louisiana.

Lowery, G.H., Jr. 1974. The mammals of Louisiana and its adacent waters. Louisiana State University. Baton Rouge Louisiana. 565 p.

Lyons, W.G. and Collard, S.B. 1974. Benthic invertebrate communities of the eastern Gulf of Mexico. *In:* Proceedings of Marine Environmental Implications of Offshore Drilling: Eastern Gulf of Mexico, R.E. Smith (ed.) State University System Institute of Oceanography. St. Petersburg Florida.

McFarlane, R.H. 1963. Disorientation of loggerhead hatchlings by artificial road light. Copeia 1:153.

McGovern, J.C., C.G. Groat, L.F. Brown, W.L. Fisher, and A.J. Scott. 1970. Effects of hurricane "Celia": A focus on environmental geology problems of the Texas coastal zone. Geol. Circ. 70-3. Bureau of Economic Geology, University of Texas. Austin Texas. 35 p.

Mackin, J. 1973. A review of significant papers on effect of oil spills and oil field brine discharges on marine brotic communities. Research Foundation Project 737 Report. Texas A & M University. College Station Texas.

Manheim, F.T. 1974. Geology - introduction. *In:* Proceedings of Marine Environmental Implications of Offshore Drilling in the Eastern Gulf of Mexico. March 1974. SUSIO. St. Petersburg Florida.

Martin, R.G. 1976. Geologic framework of northern and eastern continental margins: Gulf of Mexico. *In:* Beyond the Shelf Break, Short Course, Vol. 2. May 1976. New Orleans Louisiana.

Massachusetts Institute of Technology. 1973. Georges Bank petroleum study. Offshore Oil Task Group. Sea Grant Prof. Off. Rept. No. MITSG 73-5. Cambridge Massachusetts.

Maul, G.A. 1974. An evaluation of the use of the earth resources technology satellite for observing ocean current boundaries in the Gulf Stream system. NOAA Technical Report. Washington DC.

May, E.B. 1973a. Environmental effects of hydraulic dredging in estuaries. Alabama Marine Resources. Bull. 9:1-85.

May, E.B. 1973b. Extensive oxygen depletion in Mobile Bay Alabama. Limnology and Oceanography 18(3):353-356.

Menzel, R.W. ed. 1971. Checklist of the flora and fauna of the Apalachee Bay and the St. George's Sound area (3rd edition). Department of Oceanography, Florida State University. Tallahassee Florida.

Mills, E.R., Jr. 1974. Effects of water dispersions and water-soluble fractions of two crude and two processed oils on three marine algae species. PhD dissertation, Texas A & M University. College Station Texas.

Mironov, O.G. 1970. The effect of oil pollution on flora and fauna of Black Sea. *In:* Atlas of the Living Resources of the Sea. FAO Department of Fisheries. Rome Italy.

Mississippi Marine Resources Council. 1977. Interim report on permissible land and water uses in the Mississippi coastal zone (draft). 91 p.

Mississippi Marine Resources Council. (n.d.) Mississippi coastal zone management. Long Beach Mississippi. 25 p.

Mississippi State University, Division of Research, College of Business and Industry. 1974. Mississippi statistical abstract. Mississippi State University. 529 p.

Molinari, R.L., S. Baig, D.W. Behringer, G.A. Maul, and R. Legeckis. 1977. Winter intrusions of the Loop Current. Science 198(4316):505-507.

Moritas, Y. 1961. Unpublished data. p. II C-4. *Ref In:* A Summary of Knowledge of the Eastern Gulf of Mexico, Jones, et al (eds).

Murphy, R.C. 1967. Serial atlas of the marine environment. Folio 14: Distribution of North Atlantic pelagic birds. Amer. Geog. Soc. New York.

Murphy, T.A. 1971. Environmental effects of oil pollution. J. Sanitary Engineering Div. Proc. Am. Soc. Civil Engineers 97(SA3):361-371.

National Academy of Science (NAS). 1975. Petroleum in the marine environment. Washington DC. 107 p.

Naval Oceanographic Office. 1955. Atlas of pilot charts, Central American waters and South Atlantic Ocean (2nd edition).

Nelson-Smith, A. 1973. Oil pollution and marine ecology. Plenum Press. New York.

New England River Basins Commission and the Resource and Land Investigations Program, USGS. 1976. Factbook: Onshore facilities related to offshore oil and gas development. New England River Basins Commission. Boston Massachusetts.

Nowlin, W.D. 1971. Water masses and general circulation of the Gulf of Mexico. Oceanology 6(2):28-33.

Nowlin, W.D. 1972. Winter circulation patterns and property distributions. *In:* L.R.A. Capurro and J.L. Reed (eds.) Contributions on the Physical Oceanography of the Gulf of Mexico, p. 3-51. Texas A & M University. Gulf Publishing Co. Houston Texas.

Ocean Oil Weekly. 1977. Ball, Eldon R. ed. Vol. 11 No. 50. September 5, 1977. Houston Texas.

O'Connor, Dennis M. 1972. Legal aspects of coastal zone management in Escambia and Santa Rosa Counties Florida. Report submitted to the Coastal Coordinating Council of the Department of Natural Resources. March 1972.

Odum, E.P. 1961. The role of tidal marshes in estuarine production. N.Y. State Conservation Dept. The Conservationist, June-July, 1961: 12-15,35.

Oil and Gas Journal. 1977a. The Petroleum Publishing Company. Vol. 75 No. 38. September 12, 1977. Tulsa Oklahoma.

Oil and Gas Journal. 1977b. The Petroleum Publishing Company. Vol. 75 No. 44. October 17, 1977. Page 39. Tulsa Oklahoma.

Ogren, L. 1976. Personal communication. Fisheries Biologist. US Department of Commerce, NOAA, NMFS, Panama City Florida.

Onuf, C.P. 1973. An analysis of the main scientific papers dealing with long term, low level effects of oil pollution. *In:* Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment, Vol. 2. Ocean Affairs Board, National Academy of Sciences. Washington DC.

Oppenheimer, C.H., W. Gunkel, and G. Gassmann. 1977. Microorganisms and hydrocarbons in the North Sea during July-August 1975. *In:* Proceedings 1977 Oil Spill Conference, New Orleans La. American Petroleum Institute Publication No. 4284, p. 593-609.

Orr, J.M. (n.d.) A survey of *Tursiops* populations in the coastal United States, Hawaii, and territorial waters. Marine Mammal Commission, Registration No. PL 92-522. Washington DC.

Orton, R.B. 1964. The climates of Texas and adjacent Gulf waters. US Department of Commerce, Weather Bureau. Washington DC.

Otteman, L.G. 1976. Letter from Shell Oil Company's New Orleans Division Production Manager commenting on the DES for OCS Sale 44. Published in DES, Sale 44, BLM. 1976. Washington DC.

Peak, J.S. and Muller, A. 1971. Fog in Louisiana hydroclimatology.

Pequegnat, W.E., R.M. Darnell, B.M. James, E.A. Kennedy, L.A. Pequegnat, and J.T. Turner. 1976. Ecological aspects of the upper continental slope of the Gulf of Mexico. Tereco Corp. College Station Texas. Prepared for BLM:Contract No. 08550-CT4-12.

Petroleum Publishing Company. 1976. Worldwide petrochemical directory: 1977 (15th edition). November 1976. Tulsa Oklahoma.

Plaisted, R.O., K.M. Waters, and P.P. Niiler 1975. Current meter data report from NSF Continental Shelf Dynamics Program: 1973-1974. NOVA University Scientific Data Report.

Porricelli, J.D. and Keith, V.F. 1973. Tankers and the US energy situation: An economic and environmental analysis. Presentation at the Int. Tran. Conf. Denver Colorado September 24-27, 1973, of the Intersoc. Comm. on Trans.

Price, J.F. and Mooers, C.N.K. 1974a. Hydrographic data report from the winter 1973 experiment NSF Continental Shelf Dynamics Program. RSMAS University of Miami Scientific Report UM-RSMAS-74006. 61 p.

Price, J.F. and Mooers, C.N.K. 1974b. Current meter data report from the winter 1973 experiment NSF Continental Shelf Dynamics Program. RSMAS University of Miami Scientific Report UM-RSMAS-74020. 78 p.

Price, J.F. and Mooers, C.N.K. 1974c. Current meter data report from the fall experiment, NSF Continental Shelf Dynamics Program. RSMAS University of Miami Scientific Report UM-RSMAS-74035. 59 p.

Price, J.F. and Mooers, C.N.K. 1975. Hydrographic data report from the fall 1973 experiment. RSMAS University of Miami Scientific Report UM-RSMAS-75018. 52 p.

Ray, S.M. and Mills, E.R., Jr. 1974. Effects of oil on phytoplankton. *In:* Fate and Biological Effects of Oil in the Marine Environment. May 1974. American Petroleum Institute. Washington DC.

Raymont, J.E.G. 1963. Plankton and primary productivity in the oceans. Pergamon Press Ltd. Oxford England.

Ridgely, John. 1975. Selected information on recreational boats in the United States. Marine Fisheries Review Paper 1122, 37(2):16-18.

Roberts, M.H., Jr. 1974. A socio-economic environmental baseline summary for the South Atlantic region between Cape Hatteras, N.C. and Cape Canaveral, Fla. Volume III. Chemical and Biological Oceanography. Virginia Institute of Marine Science. Gloucester Point Virginia.

Rodgers, Robert M., Jr. 1977. Tropic interrelationships of selected fishes on the continental shelf of the northern Gulf of Mexico. Unpublished PhD dissertation, Texas A & M University. College Station Texas. 229 p.

Rona, E., D. Hood, L. Muse, and B. Buglio. 1962. Activation analysis of manganese and zinc in seawater. Limnology and Oceanography. 7:201-206.

Ryan, Robert H. 1973. Texas manufacturing. *In:* Texas Almanac and State Industrial Guide: 1974-1975. Dallas Texas.

Sackett, W.M. 1972. Chemistry. *In:* Chemistry, Primary Productivity and Benthic Algae of the Gulf of Mexico. V.C. Bushnell (ed.) Serial Atlas of the Marine Environment, Folio 22. Amer. Geog. Soc. New York.

St. Amant, L.S. 1973. Some consideration of the chronic effects of petroleum in the marine environment. *In:* Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment, Vol. 2. Ocean Affairs Board, National Academy of Sciences. Washington DC.

Saunders, R.P. and Glenn, D.A. 1969. Diatoms. *In:* Memoirs of the Hourglass Cruises 1(3). Florida Department of Natural Resources, Mar. Res. Lab.

Schmidly, D.J. and Melchor, B.A. 1974. Series of three articles on marine mammals in the Gulf of Mexico. Texas Parks and Wildlife. Vol. 1, 2, and 3.

Scruton, P.C. 1956. Oceanography of the Mississippi Delta sedimentary environments. Am. Assoc. of Petrol. Geol. Bull 40(12):2864-2952.

Shields, W., J. Goering, and D. Wood. 1973. Crude oil phytotoxicity studies. *In:* Environmental Studies of Port Valdez. D.W. Hood, et al (eds). Inst. Mar. Sci. University of Alaska.

Shipp, Robert H. 1977. Personal Communication. University of South Alabama. Mobile Alabama.

Simmons, E.G. and Thomas, W.H. 1962. Annotated checklist of the phytoplankton of the eastern Mississippi delta. Pub. Inst. Mar. Sci. University of Texas 3:269-298.

Simpson, Robin A. 1977. The biology of two offshore oil platforms. Institute of Marine Resources, University of California. IMR Reference 76-13.

Simpson, R.H., and Lawrence, Miles B. 1971. Atlantic hurricane frequencies along the US coastline, NOAA Technical Memorandum NWS SR-58. June 1971. Ft. Worth Texas. 14 p.

Slowey, J.F. and Hood, D.W. 1969. Copper, manganese, and zinc concentrations in the Gulf of Mexico waters. Geochim. et Cosmochim. Acta, 35:121-138.

Smith, J.E., ed. 1968. Torey Canyon pollution and marine life. Cambridge University Press. Cambridge England. 196 p.

Smith, Gregory B. 1976. Ecology and distribution of eastern Gulf of Mexico reef fishes. Fla. Mar. Res. Publ. No. 19. 78 p.

Smith, G.B. and Ogren, L.H. 1974. Comments on the nature of the Florida Middle Ground reef ichthyofauna. *In:* R.E. Smith (ed.), Proceedings Marine Environmental Implications of Offshore Drilling in the Eastern Gulf of Mexico: 1974. State University System Institute of Oceanography. St. Petersburg Florida.

Snyder, N.W. 1974. Energy recovery and resource recycling. Chemical Engineering/Deskbook issue. p. 65-72.

Sonnier, F., J. Teerling, and H.D. Hoese. 1976. Observations on the offshore reef and platform fish fauna of Louisiana. Copeia, 1976 (1):105-111.

Sonu, C.J., S.P. Murray, S.A. Hsu, J.N. Shuayda, and E. Waddel. 1973. EOS Trans. of AGU 54:9.

South Alabama Regional Planning Commission. 1972. Regional transportation system. Mobile Alabama. 124 p.

State University System of Florida Institute of Oceanography (SUSIO). 1975. Compilation and summation of historical and existing physical oceanographic data from the eastern Gulf of Mexico, Final Report to BLM.

State University System of Florida Institute of Oceanography (SUSIO). 1976. Baseline monitoring studies: Mississippi, Alabama, Florida Outer Continental Shelf. A Report to the Bureau of Land Management in fulfillment of Contract No. 08550-CT5-30.

Steidinger, K.A. 1973. The biological environment: phytoplankton. *In:* A Summary of the Knowledge of the Eastern Gulf of Mexico. J.I. Jones, R.E. Ring, M.O. Rinkel, and R.E. Smith (eds). SUSIO. St. Petersburg Florida.

Stepien, W.P. and Fernandez, S.J. 1977. Wetlands-related legislation in the United States. University of Miami School of Law. Miami Florida. 76 p.

Stewart, R.J., J.W. Devanney, and W. Briggs. 1974. Oil spill trajectory studies for Atlantic coast and Gulf of Alaska. *In:* Primary Physical Impacts of Offshore Petroleum Developments. Report No. MITSG 74-20, MIT. Cambridge Massachusetts. 186 p.

Stockton, J.R. 1975. The business situation in Texas. *In:* Texas Business Review. November 1975. University of Texas. Austin Texas.

Stone, J.H. 1972. Preliminary assessment of the environmental impact of a super port on the southeastern coastal area of Louisiana. LSU Sea Grant Pub. 72-05. Baton Rouge Louisiana.

Stone, Richard and Colunga, L. 1974. Proceedings of an international conference on artificial reefs. TAMU-SG-74-103. Center for Marine Resources, Texas A&M University. College Station Texas. 152 p.

Straughan, D. 1972. The influence of the Santa Barbara oil spill (January-February, 1969) on the intertidal distribution of marine organisms. Rept. to Western Oil Gas Assoc. 59 p.

Stursa, M.L. 1973. A summary of knowledge of the eastern Gulf of Mexico: 1973. State University System Institute of Oceanography. St. Petersburg Florida. 24 p.

SUSIO - see State University System of Florida Institute of Oceanography.

Sutherland, D.F. 1977. Catch and catch rates of fishes caught by anglers in the St. Andrew Bay system Florida and adjacent coastal waters: 1973. US Department of Commerce, NOAA, NMFS, Technical Report SSRF-708. Seattle Washington.

Sweet, W.E. 1974. Surface current study. NW Gulf of Mexico, a study of naturally occurring hydrocarbon in the Gulf of Mexico. Texas A&M University Report. College Station Texas.

Taylor, J.L. 1971. Polychaetous annelids and benthic environments in Tampa Bay Florida. PhD dissertation, University of Florida. Gainesville Florida.

Teal, J.M. 1962. Energy flow in the salt marsh ecosystem of Georgia. Ecology 43:614-624. Teal, J.M. and Stegeman, J.J. 1973. Accumulation and release of petroleum hydrocarbons by the oyster *Crassostrea virginica*. *In:* Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment, Vol. 2. Ocean Affairs Board, National Academy of Sciences. Washington DC.

Thompson, Ralph B. 1975. Manufacturing in Florida: 1972. January 1975. University of Florida. Gainesville Florida.

Tuck, L.M. 1960. Department of Northern Affairs and Natl. Res., Natl. Parks Br., Can. Wildl. Serv. Ser. 1. 260 p.

University of Alabama, Graduate School of Business, Center for Business and Economic Research. 1975. Economic abstract of Alabama: 1975. December 1975. University Alabama.

University of Alabama, Graduate School of Business. 1977. Midyear review of the economy. *In:* Alabama Business Vol. 47 No. 12. August 1977. University Alabama.

University of Florida, College of Business Administration, Bureau of Economic and Business Research. 1975. Florida statistical abstract: 1975. Gainesville Florida. 629 p.

University of Florida, College of Business Administration, Bureau of Economic and Business Research. 1976a. Projections of Florida population for 1978-2000. August 1976. Gainesville Florida.

University of Florida, College of Business Administration, Bureau of Economic and Business Research. 1976b. Florida statistical abstract: 1976. Gainesville Florida.

University of Florida, Holland Law Center, Center for Governmental Responsibility. 1976. Analysis of laws relating to Florida coastal zone management. October 1976. Prepared for Florida Department of Natural Resources, Bureau of Coastal Zone Planning. 814 p.

University of Southern Mississippi, Department of Geography and Area Development. 1976. An analysis of Mississippi's potential as a site for staging operations associated with the development of oil and gas resources in the Outer Continental Shelf of the Gulf of Mexico. Prepared for: Mississippi Marine Resources Council. Long Beach Mississippi. 44 p.

US Council on Environmental Quality. 1974. OCS oil and gas - an environmental assessment, Volume 5. Washington DC.

US Department of the Army, Corps of Engineers. 1973a. Report on Gulf coast deep water port facilities - Texas, Lousiana, Mississippi, Alabama, and Florida. COE, Lower Mississippi Valley Division. Vicksburg Mississippi. 136 p.

US Department of the Army, Corps of Engineers. 1973b. National shoreline study, Vol. 3. US Government Printing Office. Washington DC.

US Department of Commerce, Bureau of the Census. 1972. 1970 census of population and housing. US Government Printing Office. Washington DC.

US Department of Commerce, Bureau of the Census. 1974a. 1972 census of mineral industries: natural gas liquids (SIC 132, MIC 72 (1)-13B). December 1974. Washington DC.

US Department of Commerce, Bureau of the Census. 1974b. Statistical abstract of the US: 1974. US Government Printing Office. Washington DC.

US Department of Commerce, Coast and Geodetic Survey, Environmental Science Services Administration. 1967. United States coast pilot 5: Atlantic Coast, Gulf of Mexico, Puerto Rico, and Virgin Islands (6th edition). Washington DC. 301 p.

US Department of Commerce, NOAA, Environmental Data Service, National Climatic Center. 1972. Environmental guide for the US Gulf Coast. Asheville North Carolina. 177 p.

US Department of Commerce, NOAA. 1976. Final report: Environmental studies of the South Texas Outer Continental Shelf: 1975, 1:105-142.

US Department of Commerce, NOAA. 1977. Fisheries of the United States, 1976. Current Fisheries Statistics No. 7200, National Marine Fisheries Service. Washington DC. 94 p.

US Department of Commerce, NOAA, OCZM and US Department of Interior, BLM. 1977. State information needs related to onshore and nearshore effects of OCS petroleum development. US Government Printing Office. Washington DC. 65 p. + apps.

US Department of Commerce, Social and Economic Statistics Administration, Bureau of Economic Analysis, Regional Economic Analysis Division and US Department of Agriculture, Economic Research Service, Natural Resources Economics Division. 1974. 1972 OBERS projections, series E: population. April 1974. US Water Resources Council. Washington DC.

US Department of Housing and Urban Development, Federal Insurance Administration. 1976. Statutory land use control enabling authority in the fifty states. Washington DC. 304 p.

US Department of the Interior, Bureau of Land Management. 1973. Final environmental impact statement, OCS Sale 32. Washington DC.

US Department of the Interior, Bureau of Land Management. 1975. Final environmental impact statement, proposed increase in oil and gas leasing on the OCS. Washington DC.

US Department of the Interior, Bureau of Land Management. 1976a. Final environmental impact statement, OCS Sale 40, Vol. 1-4. Washington DC.

US Department of the Interior, Bureau of Land Management. 1976b. Final environmental impact statement, OCS Sale 41. Washington DC.

US Department of the Interior, Bureau of Land Management. 1976c. Final environmental impact statement, OCS Sale 44. Washington, DC.

US Department of the Interior, Bureau of Mines. 1975. Minerals yearbook (1973) Volume 1: metals, minerals, and fuels. Washington DC.

US Department of the Interior, Bureau of Mines. 1976. Natural gas production and consumption: 1975. October 1976. Washington DC.

US Department of the Interior, Bureau of Mines. 1977a. Petroleum refineries in the United States and Puerto Rico. July 1977. Washington DC.

US Department of the Interior, Bureau of Mines. 1977b. Crude petroleum, petroleum products, and natural gas liquids: 1975. February 1977. Washington DC.

US Department of the Interior, Fish and Wildlife Service. 1976. US list of endangered fauna. Washington DC.

US Department of the Interior, Geological Survey. 1975a. Personal communication. From Oil and Gas Supervisor. Metairie Louisiana.

US Department of the Interior, Geological Survey. 1975b. Oil spills: 1971-1975, Gulf of Mexico Outer Continental Shelf. Circular 741. Washington DC.

US Department of the Interior, Geological Survey. 1976. Initial accidents connected with federal oil and gas operations on the Outer Continental Shelf, Gulf of Mexico. Conservation Division. Metairie Louisiana.

US Department of the Interior, Geological Survey. 1977a. Outer Continental Shelf statistics. June 1977. Conservation Division. Washington DC.

US Department of the Interior, Geological Survey. 1977b. An investigation of Pennzoil's blowout and loss of platform, High Island Block A-563, Gulf of Mexico. May 1977. Washington DC.

US Department of the Interior, Geological Survey. 1977c. Accidents connected with federal oil and gas operations on the Outer Continental Shelf. January 1977. Conservation Division. Metairie Louisiana.

US Department of the Interior, Geological Survey. 1977d. Outer Continental Shelf Statistics. August 1977. Conservation Division. Metairie Louisiana.

US Department of Transportation, Coast Guard. 1977. Boating statisitcs: 1976. LG-357. US Government Printing Office. Washington DC. 35 p.

US Environmental Protection Agency. 1975. Development document for interim final effluent limitations guidelines and new source performance standards for the offshore segment of the oil and gas extraction point source category. EPA 440/l-75/055. Group II. September 1975. Washington DC.

US Environmental Protection Agency. 1976. EPA regulations on national primary and secondary ambiant air quality standards by Bureau of National Affairs, 1976. 40 CFR 50: 36 FR 22384, November 25, 1971 amended by 40 CFR revised July 1, 1976; 41 FR 52686, December 19, 1976.

US Environmental Protection Agency. 1977a. Air quality information from Region IV data bank. October 1977.

US Environmental Protection Agency. 1977b. Air quality information from Region VI data bank. October 1977.

US Environmental Protection Agency. 1977c. Atmospheric emissions from offshore oil and gas development and production. June 1977. EPA-Y50/3-77-026.

US Federal Energy Administration, Office of Energy Information and Analysis. 1977. Monthly energy review. September 1977. Washington DC.

US Federal Power Commission. 1975. Comments on possible sale of oil and gas leases offshore Florida. January 3, 1975 letter to US Bureau of Land Management from Chairman, Federal Power Commission (now part of the Department of Energy).

US Federal Power Commission. 1977. Gas supply indicators, FPC news, Vol. 10 No. 25-A. June 24, 1977. Washington DC.

Wade, Bill. 1976. Marine sport fishing survey. Report No. Ala-ADO-x996-CZMP-10. Alabama Department of Natural Resources. Montgomery Alabama.

Weaver, R.W. and Weinhold, R.J. 1972. An experiment to determine if pressure pulses radiated by seismic air guns adversely effect immature coho salmon. Alaska Department of Fish and Game. 10 p.

Whitehorn, Norman C. 1973. Economic analysis of the petrochemical industry in Texas. May 1973. Texas A&M University. College Station Texas.

Williams, L.G. 1977. Letter. *In:* Science 195 (4279): 636.

Willingham, C.A. H.W. Cornaby, and D.B. Engstrom. 1975. A study of selected coastal zone ecosystems in the Gulf of Mexico in relation to gas pipelining activities. Final report from Battelle Columbus Laboratories to Offshore Pipeline Committee.

Yerger, R.W. 1965. The leatherback turtle on the Gulf Coast of Florida. Copeia 3:365-366.

Zingula, R.P. 1975. Effects of drilling operations on the marine environment. *In:* Environmental Aspects of Chemical Use in Well Drilling Operations. EPA-56011-75-004. US Environmental Protection Agency.

Section XI

Appendices

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BLM
NEW ORLEANS OCS

Appendix A

Tract List

APPENDIX A

List of Tracts Proposed for Leasing in Tentative Sale No. 65

Tract Number	Block	Description	Res.	Hectares	Distance From Shore (Kilometers)	Water Depth (Meters)
Pensacola NH 16-5						
1	882	All	O&G	2331	16	20
2	883	All	O&G	2331	16	20
3	884	All	O&G	2331	18	21
4	885	All	O&G	2331	19	23
5	886	All	O&G	2331	19	24
6	926	All	O&G	2331	24	23
7	927	All	O&G	2331	23	24
8	928	All	O&G	2331	23	25
9	929	All	O&G	2331	24	26
10	930	All	O&G	2331	26	27
11	970	All	O&G	2331	26	25
12	971	All	O&G	2331	27	26
13	972	All	O&G	2331	29	26
14	973	All	O&G	2331	29	29
15	974	All	O&G	2331	29	30
Destin Dome NH 16-8						
16	2	All	O&G	2331	32	26
17	3	All	O&G	2331	32	27
18	4	All	O&G	2331	34	28
19	5	All	O&G	2331	34	31
20	6	All	O&G	2331	35	32
21	313	All	O&G	2331	66	40
22	314	All	O&G	2331	68	50
23	357	All	O&G	2331	71	50
24	358	All	O&G	2331	72	60
25	473	All	O&G	2331	77	110
26	474	All	O&G	2331	74	90
27	518	All	O&G	2331	74	100
28	519	All	O&G	2331	69	90
29	529	All	O&G	2331	89	70
30	562	All	O&G	2331	76	120
31	563	All	O&G	2331	71	100
32	573	All	O&G	2207.49	93	80
33	574	All	O&G	2331	93	90
34	618	All	O&G	2331	98	120
35	661	All	O&G	2331	101	160
36	662	All	O&G	2331	103	200

Tract Number	Block	Description	Res.	Hectares	Distance From Shore (Kilometers)	Water Depth (Meters)
De Soto Canyon NH 16-11						
37	436	All	O&G	2331	134	348
38	437	All	O&G	2331	132	345
39	480	All	O&G	2331	138	350
40	481	All	O&G	2331	137	349
Florida Middle Ground NH 16-12						
41	358	All	O&G	2331	119	225
42	359	All	O&G	2331	118	200
43	397	All	O&G	2331	130	301
44	398	All	O&G	2331	129	300
45	399	All	O&G	2331	127	290
46	400	All	O&G	2331	126	265
47	401	All	O&G	2331	126	250
48	402	All	O&G	2331	124	235
49	403	All	O&G	2331	122	200
50	404	All	O&G	2331	122	198
51	405	All	O&G	2331	121	190
52	441	All	O&G	2331	135	325
53	442	All	O&G	2331	132	310
54	443	All	O&G	2331	132	300
55	444	All	O&G	2331	130	275
56	445	All	O&G	2331	128	260
57	446	All	O&G	2331	128	240
58	447	All	O&G	2331	127	225
59	486	All	O&G	2331	137	325
60	487	All	O&G	2331	135	315
61	488	All	O&G	2331	135	300
62	489	All	O&G	2331	134	280
63	490	All	O&G	2331	132	260
64	491	All	O&G	2331	132	245
65	530	All	O&G	2331	142	350
66	531	All	O&G	2331	140	335
67	532	All	O&G	2331	138	315
68	533	All	O&G	2331	138	300
69	534	All	O&G	2331	137	280
70	535	All	O&G	2331	135	260
The Elbow NG 16-3						
71	567	All	O	2077.93	127	70
72	609	All	O	2331	137	80
73	696	All	O	2331	143	90
74	697	All	O	2331	140	85
75	739	All	O	2331	150	100

Tract Number	Block	Description	Res.	Hectares	Distance From Shore (Kilometers)	Water Depth (Meters)
The Elbow NG 16-3 (continued)						
76	783	All	0	2331	151	100
77	827	All	0	2331	153	110
78	871	All	0	2331	155	110
Protraction Diagram NG 16-6						
79	258	All	0	2331	161	120
80	259	All	0	2331	158	110
81	302	All	0	2331	163	130
82	303	All	0	2331	159	120
83	609	All	0	2331	187	150
84	610	All	0	2331	182	140
85	611	All	0	2331	177	135
86	653	All	0	2331	188	155
87	654	All	0	2331	184	154
88	697	All	0	2331	192	155
Tarpon Springs NH 17-10						
89	233	All	O&G	2331	58	20
90	234	All	O&G	2331	56	20
91	277	All	O&G	2331	63	20
92	278	All	O&G	2331	60	20
93	279	All	O&G	2331	58	18
St. Petersburg NG 17-1						
94	661	All	0	2331	126	75
95	662	All	0	2331	121	70
96	705	All	0	2331	126	75
97	706	All	0	2331	122	70
98	753	All	0	2331	111	60
99	754	All	0	2331	105	59
100	797	All	0	2331	111	60
101	798	All	0	2331	106	59
Charlotte Harbor NG 17-4						
102	143	All	0	2331	103	55
103	144	All	0	2331	101	53
104	145	All	0	2331	97	50
105	187	All	0	2331	106	56
106	188	All	0	2331	103	53
107	221	All	0	2331	151	100

Tract Number	Block	Description	Res.	Hectares	Distance From Shore (Kilometers)	Water Depth (Meters)
Charlotte Harbor NG 17-4 (continued)						
108	231	All	0	2331	109	58
109	265	All	0	2331	153	99
110	266	All	0	2331	148	109
111	627	All	0	2331	127	60
112	628	All	0	2331	122	59
113	671	All	0	2331	128	60
114	672	All	0	2331	124	59
115	715	All	0	2331	130	60
116	716	All	0	2331	126	59

Appendix B

O.C.S. Orders

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION

GULF OF MEXICO AREA

OCS ORDER NO. 1

Effective August 28, 1969

MARKING OF WELLS, PLATFORMS, AND FIXED STRUCTURES

This order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.37. Section 250.37 provides as follows:

Well designations. The lessee shall mark promptly each drilling platform or structure in a conspicuous place, showing his name or the name of the operator, the serial number of the lease, the identification of the wells, and shall take all necessary means and precautions to preserve these markings.

The operator shall comply with the following requirements. Any departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

1. *Identification of Platforms, Fixed Structures.* Platforms and structures, other than individual wellhead structures and small structures, shall be identified at two diagonal corners of the platform or structure by a sign with letters and figures not less than 12 inches in height with the following information: The name of lease operator, the name of the area, the block number of the area in which the platform or structure is located, and the platform or structure designation. The information shall be abbreviated as in the following example:

"The Blank Oil Company operates 'C' platform in Block 37 of South Timbalier Area."

The identifying sign on the platform would show:

"BOC - S.T. - 37 - C."

2. *Identification of Single Well Structures and Small Structures.* Single well and small structures may be identified with one sign only, with letters and figures not less than 3 inches in height. The information shall be abbreviated as in the following example:

"The Blank Oil Company operates well No. 1 which is equipped with a protective structure, in Block 68 in the East Cameron Area."

The identifying sign on the protective structure would show:

"BOC - E.C. - 68 - No. 1"

3. *Identification of Wells.* The OCS lease and well number shall be painted on, or a sign affixed to, each singly completed well. In multiple completed wells each completion shall be individually identified at the well head. All identifying signs shall be maintained in a legible condition.

/s/ Robert F. Evans
Supervisor

Approved: August 28, 1969

/s/ Russell G. Wayland
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION
GULF OF MEXICO AREA

OCS ORDER NO. 2
Effective January 1, 1975

DRILLING PROCEDURES

This Order is established pursuant to the authority prescribed in 30 CFR 250.11. All exploratory and development wells drilled for oil and gas shall be drilled in accordance with 30 CFR 250.34, 250.41, 250.91, and the provisions of this Order which shall continue in effect until field drilling rules are issued. When sufficient geologic and engineering information is obtained through exploratory drilling, operators may make application or the Area Supervisor may require an application for the establishment of field drilling rules. After field drilling rules have been established by the Area Supervisor, development wells shall be drilled in accordance with such rules.

All wells drilled under the provisions of this Order shall have been included in an exploratory or development plan for the lease as required under 30 CFR 250.34. Each application for Permit to Drill (Form 9-331C) shall include all information required under 30 CFR 250.91, and shall include a notation of any proposed departures from the requirements of this Order. All departures from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 250.12(b).

The operator shall comply with the following requirements. All applications for approval under the provisions of this Order shall be submitted to the appropriate District Supervisor.

1. *Well Casing and Cementing*. All wells shall be cased and cemented in accordance with the requirements of 30 CFR 250.4(a)(1), and the Application for Permit to Drill shall include the casing design safety factors for collapse, tension, and burst. In cases where cement has filled the annular space back to the Gulf floor, the cement may be washed out or displaced to a depth not exceeding 12 meters (40 feet) below the Gulf floor to facilitate casing removal upon well abandonment. For the purpose of this Order, the several casing strings in order of normal installation are drive or structural, conductor, surface, intermediate, and production casing.

The design criteria for all wells shall consider all pertinent factors for well control, including formation fracture gradients and pressures and casing setting depths.

The operator shall utilize technology and state-of-the-art methods, such as drilling rate evaluation, shale density analysis, or other appropriate methods, in order to enhance the evaluation of conditions of abnormal pressure, and to minimize the potential for the well to develop a flow or kick.

All casing, except drive pipe shall be new pipe or reconditioned used pipe that has been tested to insure that it will meet API standards for new pipe.

A. *Drive or Structural Casing*. This casing shall be set by drilling, driving, or jetting to a minimum depth of 100 feet below the Gulf floor or to such greater depth required to support unconsolidated deposits and to provide hold stability for initial drilling operations. If this portion of the hole is drilled, the drilling fluid shall be of a type that is in compliance with the liquid disposal requirements of OCS Order No. 7, and a quantity of cement sufficient to fill the annular space back to the Gulf floor shall be used.

B. *Conductor and Surface Casing*. Casing design and setting depths shall be based upon all engineering and geologic factors, including the presence or absence of hydrocarbons or other potential hazards and water depths.

(1) *Conductor Casing*. This casing shall be set at a depth in accordance with paragraph 1B(3) below. A quantity of cement sufficient to fill the annular space back to the Gulf floor shall be used.

(2) *Surface Casing*. This casing shall be set at a depth in accordance with paragraph 1B(3) below and cemented in a manner necessary to protect all freshwater sands and provide well control until the next string of casing is set.

This casing shall be cemented with a quantity sufficient to fill the calculated annular space to at least 1,500 feet above the surface casing shoe and at least 100 feet inside the conductor casing or as approved by the District Supervisor. When there are indications of improper cementing, such as lost return, cement channeling, or mechanical failure of equipment, the operator shall recement or make the necessary repairs. After drilling a maximum of 100 feet below the surface casing shoe, a pressure test shall be obtained to aid in determining a formation fracture gradient either by testing to formation leak-off or by testing to a predetermined equivalent mud weight. The results of this test and any subsequent tests of the formation shall be recorded on the driller's log and used to determine the depth and maximum mud weight of the intermediate hole.

(3) *Conductor and Surface Casing Setting Depths*. These strings of casing shall be set at the depth specified below, subject to approved variation to permit the casing to be set in a competent bed, or through formations determined desirable to be isolated from the well by pipe for safer drilling operations, provided, however, that the conductor casing shall be set immediately prior to drilling into formations known to contain oil or gas, or, if unknown, upon encountering such formations. These casing strings shall be run and cemented prior to drilling below the specified setting depths. For those wells which may encounter abnormal pressure conditions, the District Supervisor may prescribe the exact setting depth. Conductor casing setting depths shall be between 500 feet and 1,000 feet (TVD below Gulf floor).

Engineering and geologic data used to substantiate the proposed setting depths of the conductor and surface casing (such as estimated fracture gradients, pore pressures, shallow hazards, etc.) shall be furnished with the Application for Permit to Drill.

C. *Intermediate Casing*. This string of casing shall be set when required by anticipated abnormal pressure, mud weight, sediment, and other well conditions. The proposed setting depth for intermediate casing will be based on the pressure tests of the exposed formation below the surface casing shoe or on subsequent pressure tests.

A quantity of cement sufficient to cover and isolate all hydrocarbon zones and to isolate abnormal pressure intervals from normal pressure intervals shall be used. If a liner is used as an intermediate string, the cement shall be tested by a fluid entry or pressure test to determine whether a seal between the liner top and next larger string has been achieved. The test shall be recorded on the driller's log. When such liner is used as production casing, it shall be extended to the surface and cemented to avoid surface casing being used as production casing.

D. *Production Casing*. This string of casing shall be set before completing the well for production. It shall be cemented in a manner necessary to cover or isolate all zones which contain hydrocarbons, but in any case, a calculated volume sufficient to fill the annular space at least 500 feet above the uppermost producible hydrocarbon zone must be used. When a liner is used as production casing, the testing of the seal between the liner top and the next larger string shall be conducted as in the case of intermediate liners. The test shall be recorded on the driller's log.

E. *Pressure Testing*. Prior to drilling the plug after cementing, all casing strings, except the drive or structural casing, shall be pressure-tested as shown in the table below. The test pressure shall not exceed the internal yield pressure of the casing. The surface casing shall be tested with water in the top 100 feet of the casing. If the pressure declines more than 10 percent in 30 minutes, or if there is other indication of a leak, the casing shall be recemented, repaired, or an additional casing string run, and the casing shall be tested again in the same manner.

Casing	*Minimum Surface Pressure*
Conductor	200
Surface	1,000
Intermediate	1,500 or 0.2 psi/ft., whichever is greater.
Liner	1,500 or 0.2 psi/ft., whichever is greater.
Production	1,500 or 0.2 psi/ft., whichever is greater.

After cementing any of the above strings, drilling shall not be commenced until a time lapse of eight hours under pressure for conductor casing string or 12 hours under pressure for all other strings. Cement is considered under pressure if one or more float valves are employed and are shown to be holding the cement in place or when other means of holding pressure is used. All casing pressure tests shall be recorded on the driller's log.

F. *Directional Surveys*. Wells are considered vertical if inclination does not exceed an average of three degrees from the vertical. Inclination surveys shall be obtained on all vertical wells at intervals not exceeding 1,000 feet during the normal course of drilling.

Wells are considered directional if inclination exceeds an average of three degrees from the vertical. Directional surveys giving both inclination and azimuth shall be obtained on all directional wells at intervals not exceeding 500 feet during the normal course of drilling and at intervals not exceeding 100 feet in all angle change portions of the hole.

On both vertical and directional wells, directional surveys giving both inclination and azimuth shall be obtained at intervals not exceeding 500 feet prior to, or upon, setting surface or intermediate casing, liners, and at total depth.

Composite directional surveys shall be filed with the District Supervisor. The interval shown will be from the bottom of conductor casing, or, in the absence of conductor casing, from the bottom of drive or structural casing to total depth. In calculating all surveys, a correction from true north to Lambert-Grid north shall be made after making the magnetic to true north correction.

2. *Blowout Prevention Equipment*. Blowout preventers and related well-control equipment shall be installed, used, and tested in a manner necessary to prevent blowouts. Prior to drilling below the drive pipe or structural casing and until drilling operations are completed, blowout prevention equipment shall be installed and maintained ready for use as follows:

A. *Drive Pipe or Structural Casing*. Before drilling below this string, at least one remotely controlled, annular-type blowout preventer or pressure-rotating, pack-off-type head and equipment for circulating the drilling fluid to the drilling structure or vessel shall be installed. When the blowout preventer system is on the Gulf floor, the choke and kill lines or equivalent vent lines, equipped with necessary connections and fittings, shall be used for diversion. An annular preventer or pressure-rotating, pack-off-type head, equipped with suitable diversion lines as described above and installed on top of the marine riser, to permit the diversion of hydrocarbons and other fluids, may be utilized for diversion. A diverter system which provides at least the equivalent of two 4-inch lines (22 square inches internal cross-sectional area) and full-open or butterfly valves shall be installed in order to permit the full diversion of hydrocarbons and other fluids. The diverter system shall be equipped with automatic, remote-controlled valves which open, prior to shutting in the well, at least two lines venting in different directions to accomplish downwind diversion. A schematic diagram and operational procedure for the diverter system shall be submitted with the Application for Permit to Drill (Form 9-331C) to the District Supervisor for approval.

In drilling operations where a floating drill ship or semisubmersible type of drilling vessel is used, and/or where the placement of the initial structural casing is not operationally feasible to provide adequate formation competence to subsequently safely contain shallow hydrocarbons or other fluids while drilling conductor hole, a program which provides for rig and personnel protection and safety in these operations shall be described and submitted to the District Supervisor for his consideration and approval. This program shall include all known pertinent and relevant information, including seismic and geologic data, water depth, drilling-fluid hydrostatic pressure, schematic diagram from rotary table to proposed conductor casing seat, and contingency plan for moving off location. In all areas where shallow hazards or hydrocarbons are unknown, seismic data shall be obtained, and a small-diameter initial pilot hole from the bottom of drive or structural casing to proposed conductor casing seat shall be drilled to determine the presence or absence of these hazards.

B. *Conductor Casing*. Before drilling below this string, at least one remotely controlled, annular-type blowout preventer and equipment for circulating the drilling fluid to the drilling structure or vessel shall be installed. A diverter system as described in paragraph 2A above shall be installed.

C. *Surface Casing*. Before drilling below this string, the blowout prevention equipment shall include a minimum of: (1) three remote-controlled, hydraulically operated blowout preventers with a working pressure which exceeds the maximum anticipated surface pressure, including one equipped with pipe rams, one with blind rams, and one annular type; (2) a drilling spool with side outlets, if side outlets are not provided in the blowout preventer body; (3) a choke line and manifold; (4) a kill line separate from choke line; and (5) a fill-up line.

D. *Intermediate Casing*. Before drilling below this string, the blowout prevention equipment shall include a minimum of: (1) four remote-controlled, hydraulically operated blowout preventers with a working pressure which exceeds the maximum anticipated surface pressure, including at least two equipped with pipe rams, one with blind rams, and one annular type; (2) a drilling spool with side outlets, if side outlets are not provided in the blowout preventer body; (3) a choke line and manifold; (4) a kill line separate from choke line; and (5) a fill-up line.

E. *Testing*.

(1) B.O.P. Controls—A minimum of one operable remote blowout preventer control station shall be provided in addition to the primary blowout preventer control station on the drilling floor. Accumulators or accumulators and pumps shall maintain a pressure capacity reserve at all times to provide for repeated operation of hydraulic blowout preventers.

(2) Pressure Tests—Ram-type blowout preventers and related control equipment shall be tested at the rated working pressure of the B.O.P. stack assembly, or at 70 percent of the minimum internal yield pressure of the casing, whichever, is the lesser. Annular-type preventers shall be tested at 70 percent of the applicable above pressure test requirements. All preventers shall be tested (a) when installed, (b) before drilling out after each string of casing has been set, (c) not less than once each week, alternating between control stations, and (d) following repairs that require disconnecting a pressure seal in the assembly.

(3) Actuation—While drill pipe is in use, the following actuation procedures shall be performed, as a minimum, to determine proper functioning of the blowout preventers and control stations:

Pipe Rams—Actuated daily.

Blind/Shear Rams—Actuated while drill pipe is out of the hole. Once each trip, but not more than once each day.

Tapered Drill String Pipe Rams—The smaller size pipe rams shall be actuated on the appropriate drill pipe size, once each trip.

Annular-Type Preventer—Actuated on the drill pipe, in conjunction with the pressure test, once each week.

Control Stations—Actuated while drill pipe is out of the hole, once each trip, but not more than once each day.

F. *Other Equipment*. An inside blowout-preventer assembly (back-pressure valve) and an essentially full-opening drill-string safety valve in the open position shall be maintained on the rig floor to fit all pipe in the drill string. A kelly cock shall be installed below the swivel, and an essentially full-opening kelly cock of such design that it can be run through the blowout preventers shall be installed at the bottom of the kelly.

3. *Mud Program*. The characteristics, use, and testing of drilling mud and the conduct of related drilling procedures shall be such as are necessary to prevent the blowout of any well. Quantities of mud materials sufficient to insure well control shall be maintained readily accessible for use at all times.

A. *Mud Control*. Before starting out of the hole with drill pipe, the mud shall be properly conditioned. Proper conditioning requires either circulation with the drill pipe just off bottom to the extent that the annular volume is displaced, or proper documentation in the driller's log prior to pulling the drill pipe that: (1) there was no indication of influx of formation fluids prior to starting to pull the drill pipe from the hole, (2) the weight of the returning mud is not less than the weight of the mud entering the hole, and (3) other mud properties recorded on the daily drilling log are within the specified ranges at the stage of drilling the hole to perform their required functions. In those cases when the hole is circulated, the driller's log shall be so noted.

When coming out of the hole with drill pipe, the annulus shall be filled with mud before the mud level drops 100 feet. A mechanical device for measuring the amount of mud required to fill the hole shall be utilized, and any time there is an indication of swabbing, or influx of formation fluids, the necessary safety devices and action shall be employed to control the well. The mud shall not be circulated and conditioned, except on or near bottom, unless well conditions prevent running the drill pipe back to bottom. The mud in the hole shall be circulated or reverse-circulated prior to pulling drill-stem test tools from the hole.

The hole shall be filled by accurately measured volumes of mud. The number of stands of drill pipe and drill collars that may be pulled between the times of filling the hole shall be calculated and posted. The number of barrels and pump strokes required to fill the hole for this designated number of stands of drill pipe and drill collars shall be posted. For each casing string, the maximum pressure which may be applied to the blowout preventer before controlling excess pressure by bleeding through the choke shall be posted near the driller. Drill pipe pressure shall be monitored during the bleeding procedure for well control.

An operable degasser shall be installed in the mud system prior to the commencement of drilling operations and shall be maintained for use throughout the drilling and completion of the well.

B. *Mud Test Equipment*. Mud test equipment shall be maintained on the drilling rig at all times, and mud tests shall be performed daily, or more frequently as conditions warrant. The following mud-system monitoring equipment shall be installed (with derrick floor indicators) and used at the point in the drilling operation when mud returns are established and throughout subsequent drilling operations:

(1) Recording mud pit level indicator to determine mud pit volume gains and losses. This indicator shall include a visual and audio warning device.

(2) Mud volume measuring device for accurately determining mud volumes required to fill the hole on trips.

(3) Mud return indicator to determine that returns essentially equal the pump discharge rate.

(4) Gas-detecting equipment to monitor the drilling mud returns.

C. *Mud Quantities*. Daily inventories of mud materials, including barite, shall be recorded to provide a basis for determining minimum quantities needed for emergency use. Drilling operations shall be suspended in the absence of minimum quantities of mud materials for emergency use.

4. *Well Control Surveillance and Training*

A. *Surveillance*. From the time drilling operations are initiated and until the well is completed or abandoned, a member of the drilling crew or the toolpusher shall maintain rig floor surveillance at all times, unless the well is secured with blowout preventers or cement plugs.

B. *Training*. Company and drilling-contractor supervisory personnel shall be trained in and knowledgeable of present-day well control. The operator shall maintain a record of such training on the facility. Training shall include:

(1) Abnormal pressure detection methods.

(2) Well control operations, including kicks, lost circulation, and trips.

5. *Hydrogen Sulfide*. When drilling operations are undertaken to penetrate reservoirs known or expected to contain hydrogen sulfide (H_2S), or, if unknown, upon encountering H_2S, the following preventive measures shall be taken to control the effects of the toxicity, flammability, and corrosive characteristics of H_2S. Alternative equipment or procedures that achieve the same or greater levels of safety may be approved by the District Supervisor. When sulphur dioxide (SO_2), a product of combustion of H_2S, is present, the procedures outlined in the approved contingency plan required in paragraph 5a(3) of this Order shall be followed.

A. *Personnel Safety and Protection.*

(1) *Training Program.*

(a) All personnel, whether regularly assigned, contracted, or employed on an unscheduled basis, shall be informed as to the hazards of H_2S and SO_2. They shall also be instructed in the proper use of personnel safety equipment and informed of H_2S detectors and alarms, ventilation equipment, prevailing winds, briefing areas, warning systems, and evacuation procedures.

(b) Information relating to these safety measures shall be prominently posted on the drilling facility and on vessels in the immediate vicinity which are serving the drilling facility.

(c) To promote efficient safety procedures, an on-site H_2S safety program, which includes a weekly drill and training session, shall be established. Records of attendance shall be maintained on the drilling facility.

(d) All personnel in the working crew shall have been indoctrinated in basic first-aid procedures applicable to victims of H_2S exposure. During subsequent on-site training sessions and drills, emphasis shall be placed upon rescue and first aid for H_2S victims. Each drilling facility shall have the following equipment, and each crew member shall be thoroughly familiar with the location and use of these items:

(i) A first-aid kit.

(ii) Resuscitators, complete with face masks, oxygen bottles, and spare oxygen bottles.

(iii) A Stokes litter or equivalent.

(e) One person, who regularly performs duties on the drilling facility, shall be responsible for the overall operation of the on-site safety and training program.

(2) *Visible Warning System*. Wind direction equipment shall be installed at prominent locations to indicate to all personnel, on or in the immediate vicinity of the facility, the wind direction at all times for determining safe upwind areas in the event that H_2S is present in the atmosphere.

Operational danger signs shall be displayed from each side of the drilling ship or platform, and a number of rectangular red flags shall be hoisted in a manner visible to watercraft and aircraft. Each flag shall be of a minimum width of three feet and a minimum height of two feet. Each sign shall have a minimum width of eight feet and a minimum height of four feet, and shall be painted a high-visibility yellow color with black lettering of a minimum of

12 inches in height, indicating: "DANGER—HYDROGEN SULFIDE—H_2S". All signs and flags shall be illuminated under conditions of poor visibility and at night when in use. These signs and flags shall be displayed to indicate the following operational conditions and requirements:

(a) Moderate Danger. When the threshold limit value of H_2S (10 parts per million) is reached, the signs will be displayed. If the concentration of H_2S reaches 20 parts per million, protective breathing apparatus shall be worn by all personnel, and all nonworking personnel shall proceed to the safe briefing areas.

(b) Extreme Danger. When H_2S is determined to have reached the injurious level (50 parts per million), the flags shall be hoisted in addition to the displayed signs. All nonessential personnel or all personnel, as appropriate, shall be evacuated at this time. Radio communications shall be used to alert all known air- and watercraft in the immediate vicinity of the drilling facility.

(3) *Contingency Plan*. A contingency plan shall be developed prior to the commencement of drilling operations. The plan shall include the following:

(a) General information and physiological response to H_2S and SO_2 exposure.

(b) Safety procedures, equipment, training, and smoking rules.

(c) Procedures for operation conditions:

(i) Moderate danger to life.

(ii) Extreme danger to life.

(d) Responsibilities and duties of personnel for each operation condition.

(e) Designation of briefing areas as locations for assembly of personnel during Extreme Danger condition. At least two briefing areas shall be established on each drilling facility. Of these two areas, the one upwind at any given time is the safe briefing area.

(f) Evacuation plan.

(g) Agencies to be notified in case of an emergency.

(h) A list of medical personnel and facilities, including addresses and telephone numbers.

(4) *H_2S Detection and Monitoring Equipment*. Each drilling facility shall have an H_2S detection and monitoring system which activates audible and visible alarms before the concentration of H_2S exceeds its threshold limit value of 10 parts per million in air. This equipment shall be capable of sensing a minimum of five parts per million H_2S in air, with sensing points located at the bell nipple, shale shaker, mud pits, driller's stand, living quarters, and other areas where H_2S might accumulate in hazardous quantities.

H_2S detector ampules shall be available for use by all working personnel. After H_2S has been initially detected by any device, frequent inspections of all areas of poor ventilation shall be made with a portable H_2S-detector instrument.

(5) *Personnal Protective Equipment*.

(a) All personnel on a drilling facility or aboard marine vessels serving the facility shall be equipped with proper personnel protective-breathing apparatus. The protective breathing apparatus used in an H_2S environment shall conform to all applicable Occupational Safety and Health Administration regulations and American National Standards Institute standards. Optional equipment, such as nose cups and spectacle kits, shall be available for use as needed.

(b) The storage location of protective breathing apparatus shall be such that they are quickly and easily available to all personnel. Storage locations shall include the following:

(i) Rig floor.

(ii) A working area above the rig floor.

(iii) Mud-logging facility.

(iv) Shale-shaker area.

(v) Mud pit area.

(vi) Mud storage area.

(vii) Pump rooms (mud and cement).

(viii) Crew quarters.

(ix) Each briefing area.

(x) Heliport.

(c) A system of breathing-air manifolds, hoses, and masks shall be provided on the rig floor and in the briefing areas. A cascade air-bottle system shall be provided to refill individual protective-breathing-apparatus bottles. The cascade air-bottle system may be recharged by a high-pressure compressor suitable for providing breathing-quality air, provided the compressor suction is located in an uncontaminated atmosphere. All breathing-air bottles shall be labeled as containing breathing-quality air fit for human usage.

(d) Workboats attendant to rig operations shall be equipped with protective breathing apparatus for all workboat crew members. Pressure-demand or demand-type masks, connected to a breathing-air manifold, and additional protective breathing apparatus shall be available for evacuees. Whenever possible, boats shall be stationed upwind.

(e) Helicopters attendant to rig operations shall be equipped with a protective breathing apparatus for the pilot.

(f) The following additional personnel safety equipment shall be available for use as needed:

(i) Portable H_2S detectors.

(ii) Retrieval ropes with safety harnesses to retrieve incapacitated personnel from contaminated areas.

(iii) Chalk boards and note pads located on the rig floor, in the shale-shaker area, and in the cement pump rooms for communication purposes.

(iv) Bull horns and flashing lights.

(v) Resuscitators.

(6) *Ventilation Equipment*. All ventilation devices shall be explosion-proof and situated in areas where H_2S or SO_2 may accumulate. Movable ventilation devices shall be provided in work areas and be multidirectional and capable of dispersing H_2S or SO_2 vapors away from working personnel.

(7) *Notification of Regulatory Agencies*. The following agencies shall be immediately notified under the alert conditions indicated:

(a) *Moderate Danger*.

(i) U.S. Geological Survey.

(ii) U.S. Coast Guard.

(b) *Extreme Danger*.

(i) U.S. Geological Survey.

(ii) U.S. Coast Guard.

(iii) Department of Defense (when operating in Department of Defense warning areas in the northeast Gulf of Mexico).

(iv) Appropriate State Agencies.

B. *Metallurgical Equipment Considerations*. Equipment used when drilling zones bearing H_2S shall be constructed of materials which, according to design principles, will be able to resist damage from the phenomena known variously as sulfide stress cracking, hydrogen embrittlement, or stress corrosion cracking. Such equipment includes drill pipe, casing, casing heads, blowout-preventer stack assemblies, kill lines, choke manifolds, and other related equipment. A knowledge of the various interactions between stress, environment and the metallurgy employed is required for successful operation in H_2S environments. The following general practices are required for acceptable performance:

(1) *Drill String*. Drill strings shall be designed consistent with the anticipated depth, conditions of the hole, and reservoir environment to be encountered. Care shall be taken to minimize exposure of the drill string to high stresses as much as is practical and consistent with the anticipated hole conditions to be encountered.

(2) *Casing*. Casing, couplings, flanges, and related equipment shall be designed for H_2S service. Field welding on casing (except conductor and surface strings) is prohibited unless approved by the District Supervisor.

(3) *Wellhead, Blowout Preventers, and Pressure Control Equipment*. The blowout preventer stack assembly shall be designed in accordance with criteria evolved through technology of the latest state-of-the-art for H_2S service. Surface equipment such as choke lines, choke manifold, kill lines, bolting, weldments, and other related well-killing equipment shall be designed and fabricated utilizing the most advanced technology concerning sulfide stress cracking. Elastomers, packing, and similar inner parts exposed to H_2S shall be resistant at the maximum anticipated termperature of exposure.

C. *Mud Program*.

(1) Either water- or oil-base muds are suitable for use in drilling formations containing H_2S. If oil-base muds are used, cuttings shall be cleaned of oil prior to disposal into Gulf waters.

(2) A pH of 10.0 or above shall be maintained in a water-base mud system to control corrosion and prevent sulfide stress cracking.

(3) Consideration shall also be given to the use of H_2S scavengers in both water- and oil-base mud systems.

(4) Sufficient quantities of additives shall be maintained on location for addition to the mud system as needed to neutralize H_2S picked up by the system when drilling in formations containing H_2S.

(5) The application of corrosion inhibitors to the drill pipe to afford a protective coating or their addition to the mud system may be used as an additional safeguard to the normal protection of the metal by pH control and the scavengers mentioned above.

(6) Drilling mud containing H_2S gas shall be degassed at the optimum location for the particular rig configuration employed. The gases so removed shall be piped into a closed flare system and burned at a suitable remote stack.

D. *General Operations*. All personnel in the working area shall utilize H_2S protective-breathing apparatus when required, as specified in paragraph 5A(2). The normal fixed-point monitor system outlined in paragraph 5A(4) may be supplemented with portable H_2S detectors as conditions warrant.

(1) *Drill String Trips or Fishing Operations*. Every effort shall b made to pull a dry drill string while maintaining well control. If it is necessary to pull the drill string wet after penetration of H_2S-bearing zones, increased monitoring of the working area shall be provided and protective breathing apparatus shall be worn under conditions as outlined in paragraph 5A(2).

(2) *Circulating Bottoms-up from a Drilling Break, Cementing Operations, Logging Operations, or Well Circulation While Not Drilling*. After penetration of an H_2S-bearing zone, protective breathing apparatus shall be worn by those personnel in the working area in advance of circulating bottoms-up or when H_2S is indicated by the monitoring system in quantities sufficient to require protective breathing apparatus under paragraph 5A(2), should this condition occur earlier.

(3) *Coring Operations in H_2S-bearing Zones*. Personnel protective-breathing apparatus shall be worn 10-20 stands in advance of retrieving the core barrel. Cores to be transported shall be sealed and marked for the presence of H_2S.

(4) *Abandonment or Temporary Abandonment Operations*. Internal well-abandonment equipment shall be designed for H_2S service.

(5) *Logging Operations after Penetration of Known or Suspected H_2S-bearing Zones*. Mud in use for logging operations shall be conditioned and treated to minimize the effects of H_2S on the logging equipment.

(6) *Stripping Operations*. Displaced mud returns shall be monitored and protective breathing apparatus worn if H_2S is detected at levels outlined for protective breathing apparatus under paragraph 5A(2).

(7) *Gas-cut Mud or Well Kick from H_2S-bearing Zones*. Protective breathing apparatus shall be worn when an H_2S concentration of 20 parts per million is detected. Should a decision be made to circulate out a kick, protective breathing apparatus shall be worn prior to and subsequent to bottoms-up, and at any time during an extended kill operation that the concentration of H_2S becomes hazardous to personnel as defined in paragraph 5A(2)(a).

(8) *Drill String Precautions*. Precautions shall be taken to minimize drill string stresses caused by conditions such as excessive dogleg severity, improper stiffness ratios, improper torque, whip, abrasive wear on tool joints, and joint imbalance. American Petroleum Institute Bulletin RP 7G shall be used as a guideline for drill string precautions. Tool-joint compounds containing free sulphur shall not be used. Proper handling techniques shall be employed to minimize notching, stress concentrations, and possible drill pipe failures.

(9) *Flare System*. The flare system shall be designed to safely gather and burn H_2S gas. Flare lines shall be located as far from the drilling facility as feasible in a manner to compensate for wind changes. The flare system shall be equipped with a pilot and an automatic igniter. Backup ignition for each flare shall be provided.

E. *Kick Detection and Well Control*. In addition to the requirements of paragraph 3B of this Order, all efforts shall be made to prevent a well kick as a result of gas-cut mud, drilling breaks, lost circulation, or trips for bit change. Drilling rate changes shall be evaluated for the possibility of encountering abnormal pressures, and mud weights adjusted in an effort to compensate for any hydrostatic imbalance that might result in a well kick.

In the event of a kick, the disposal of the well influx fluids shall be accomplished by one of the following alternatives, giving consideration to personnel safety, possible environmental damage, and possible facility well equipment damage:

Alternative A. To contain the well fluid influx by shutting in the well and pumping the fluids back into the formation.

Alternative B. To control the kick by using appropriate well-control techniques to prevent formation fracturing in open hole within the pressure limits of well equipment (drill pipe, casing, wellhead, blowout preventers, and related equipment). The disposal of H_2S and other gases shall be through pressured or atmospheric mud-gas separator equipment, depending on volume and pressure of H_2S gas. The equipment shall be designed to recover drilling mud and to vent to the atmosphere and burn the gases separated. The mud system shall be treated to neutralize H_2S and restore and maintain the proper mud quality.

F. *Well Testing in an H_2S Environment*.

(1) *Procedures*.

(a) Well testing shall be performed with a minimum number of personnel in the immediate vicinity of the rig floor and test equipment to safely and adequately perform the test and maintain related equipment and services.

(b) Prior to initiation of the test, special safety meetings shall be conducted for all personnel who will be on the drill facility during the test, with particular emphasis on the use of personnel protective-breathing apparatus, first aid procedures, and the H_2S Contingency Plan.

(c) During the test, the use of H_2S detection equipment shall be intensified. All produced gases shall be vented and burned through a flare system which meets the requirements of paragraph 5D(9). Gases from stored test fluids shall be vented into the flare system.

(d) "No Smoking" rules in the approved Contingency Plan of paragraph 5A(3) of this Order shall be rigorously enforced.

(2) *Equipment*.

(a) Drill-stem test tools and wellhead equipment shall be suitable for H_2S service.

(b) Tubing which meets the requirements for H_2S service shall be used for drill stem testing. Drill pipe shall not be used for drill stem tests without the prior approval of the District Supervisor. The water cushion shall be thoroughly inhibited in order to prevent H_2S corrosion. The test string shall be flushed with treated fluid for the same purpose after completion of the test.

(c) All surface test units and related equipment shall be designed for H_2S service. Only competent personnel who are trained in and knowledgeable of the hazardous effects of H_2S shall be utilized in these tests.

/s/ D. W. SOLANAS
Oil and Gas Supervisor
Field Operations
Gulf of Mexico Area

APPROVED: NOVEMBER 25, 1974

/s/ RUSSELL G. WAYLAND
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION

GULF OF MEXICO AREA

OCS ORDER NO. 3

Effective August 28, 1969

PLUGGING AND ABANDONMENT OF WELLS

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.15. The operator shall comply with the following minimum plugging and abandonment procedures which have general application to all wells drilled for oil and gas. Plugging and abandonment operations must not be commenced prior to obtaining approval from an authorized representative of the Geological Survey. Oral approvals shall be in accordance with 30 CFR 250.13. Any departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

1. *Permanent Abandonment.*

A. *Isolation in Uncased Hole.* In uncased portions of wells, cement plugs shall be spaced to extend 100 feet below the bottom to 100 feet above the top of any oil, gas and fresh water zones so as to isolate them in the strata in which they are found and to prevent them from escaping into other strata.

B. *Isolation of Open Hole.* Where there is open hole (uncased and open into the casing string above) below the casing, a cement plug shall be placed in the deepest casing string by (1) or (2) below, or in the event lost circulation conditions exist or are anticipated, the plug may be placed in accordance with (3) below:

(1) A cement plug placed by displacement method so as to extend a minimum of 100 feet above and 100 feet below the casing shoe.

(2) A cement retainer with effective back pressure control set not less than 50 feet nor more than 100 feet, above the casing shoe with a cement plug calculated to extend at least 100 feet below the casing shoe and 50 feet above the retainer.

(3) A permanent type bridge plug set with 150 feet above the casing shoe with 50 feet of cement on top of the bridge plug. This plug shall be tested prior to placing subsequent plugs.

C. *Plugging or Isolating Perforated Intervals.* A cement plug shall be placed opposite all open perforations (perforations not squeezed with cement) extending a minimum of 100 feet above and 100 feet below the perforated interval or down to a casing plug whichever is less. In lieu of the cement plug, a bridge plug set at a maximum of 150 feet above the open perforations with 50 feet of cement on top may be used provided the perforations are isolated from the hole below.

D. *Plugging of Casing Stubs.* If casing is cut and recovered, a cement plug 200 feet in length shall be placed to extend 100 feet above and 100 feet below the stub. A retainer may be used in setting the required plug.

E. *Plugging of Annular Space.* No annular space that extends to the Gulf floor shall be left open to drilled hole below. If this condition exists, the annulus shall be plugged with cement.

F. *Surface Plug Requirement.* A cement plug of at least 150 feet, with the top of the plug 150 feet or less below the Gulf floor, shall be placed in the smallest string of casing which extends to the surface.

G. *Testing of Plugs.* The setting and location of the first plug below the top 150-foot plug, will be verified by either (1) placing a minimum pipe weight of 15,000 pounds on the plug, or (2) testing with a minimum pump pressure of 1,000 psig with no more than a 10 percent pressure drop during a 15-minute period.

H. *Mud.* Each of the respective intervals of the hole between the various plugs shall be filled with mud fluid of sufficient density to exert hydrostatic pressure exceeding the greatest formation pressure encountered while drilling such interval.

I. *Clearance of Location*. All casing and piling shall be severed and removed to at least 15 feet below the Gulf floor and the location shall be dragged to clear the well site of any obstructions.

2. *Temporary Abandonment*. Any drilling well which is to be temporarily abandoned shall be mudded and cemented as required for permanent abandonment except for requirements F and I of paragraph 1 above. When casing extends above the Gulf floor, a mechanical bridge plug (retrievable or permanent) shall be set in the casing between 15 and 200 feet below the Gulf floor.

/s/ ROBERT F. EVANS
Supervisor

APPROVED: AUGUST 28, 1969

/s/ RUSSELL G. WAYLAND
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION
GULF OF MEXICO AREA

OCS ORDER NO. 4
Effective August 28, 1969

SUSPENSIONS AND DETERMINATION OF WELL PRODUCIBILITY

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.12(d)(1). An OCS lease provides for extension beyond its primary term for as long as oil or gas may be produced from the lease in paying quantities. An OCS lease may be maintained beyond the primary term, in the absence of actual production, when a suspension of operations or production, or both, has been approved. An application for suspension of production for an initial period should be submitted prior to the expiration of the term of a lease. The supervisor may approve a suspension of production provided at least one well has been drilled on the lease and determined to be capable of being produced in paying quantities. The temporary or permanent abandonment of a well will not preclude approval of a suspension of production as provided in 30 CFR 250.12(d)(1). Any departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

A well may be determined to be capable of producing in paying quantities when the requirements of either 1 or 2 below have been met.

1. *Production Tests.*

A. *Oil Wells.* A production test of at least two hours duration, following stabilization, is required.

B. *Gas Wells.* A deliverability test of at least two hours duration, following stabilization, or a four-point back-pressure test, is required.

C. *Witnessing and Results.* All tests must be witnessed by an authorized representative of the Geological Survey. Test data accompanied by operator's affidavit, or third-party test data, may be accepted in lieu of a witnessed test provided prior approval is obtained from the appropriate district office. The results of the witnessed or accepted test must justify a determination that the well is capable of producing in paying quantities.

2. *Production Capability.* Information for determining producibility should be submitted in time to permit one week for evaluation and determination. In cases of urgency, determinations may be conveyed orally. The following may be considered as acceptable evidence that a well is capable of producing in paying quantities:

A. An induction-electric log of the well, clearly showing a minimum of 15 feet of producible sand in one section which does not include any interval which appears to be water saturated. All of the section counted as producible must exhibit the following properties:

(1) Electrical spontaneous potential exceeding 20 negative millivolts beyond the shale base line. If mud conditions prevent a 20 negative millivolt reading beyond the shale base line, a gamma ray log deflection of at least 70 percent of the maximum gamma ray deflection in the nearest clean water bearing sand may be substituted.

(2) A minimum true resistivity ratio of the producible section to the nearest clean water sand of at least 5:1, provided the producible section exhibits a minimum resistivity of 2.0 ohm-meters.

(3) A porosity log indicating porosity in the producible section.

B. Sidewall cores and core analysis which indicates that the section is producible.

C. A wire line formation test or evidence that an attempt was made to obtain such test. The test results must indicate that the section is producible.

D. All logs run must support other evidence that the section is producible.

/s/ Robert F. Evans
Supervisor

Approved: August 28, 1969

/s/ Russell G. Wayland
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION
GULF OF MEXICO AREA

OCS ORDER NO. 5
Effective June 5, 1972

SUBSURFACE SAFETY DEVICES

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.41(b). Section 250.41(b) provides as follows:

(b) Completed Wells. In the conduct of all its operations, the lessee shall take all steps necessary to prevent blowouts, and the lessee shall immediately take whatever action is required to bring under control any well over which control has been lost. The lessee shall: (1) in wells capable of flowing oil or gas, when required by the supervisor, install and maintain in operating condition storm chokes or similar subsurface safety devices; (2) for producing wells not capable of flowing oil or gas, install and maintain surface safety valves with automatic shutdown controls; and (3) periodically test or inspect such devices or equipment as prescribed by the supervisor.

The operator shall comply with the following requirements. All departures from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 250.12(b). All applications for approval under the provisions of this Order shall be submitted to the appropriate District office. References in this Order to approvals, determinations, or requirements are to those given or made by the Supervisor or his delegated representative.

1. *Installation.* All new and existing tubing installations open to hydrocarbon-bearing zones shall be equipped with a subsurface-controlled or a surface- or other remotely controlled subsurface safety device, to be installed at a depth of 100 feet or more below the sea floor unless, after application and justification, the well is determined to be incapable of flowing oil or gas. These installations shall be made as required in subparagraphs A and B below within two (2) days after stabilized production is established, and during this period of time the well shall not be left unattended while open to production.

A. *New Wells.* All tubing installations in wells completed after December 1, 1972, shall be equipped with a surface- or other remotely controlled subsurface safety device; provided, that wells with a shut-in tubing pressure of 4,000 psig or greater shall be equipped with a subsurface-controlled subsurface safety device in lieu of a surface- or other remotely controlled subsurface safety device unless a surface- or other remotely controlled subsurface safety device is approved or required. When the shut-in tubing pressure declines below 4,000 psig, a surface- or other remotely controlled subsurface safety device shall be installed when the tubing is first removed and reinstalled.

B. *Existing Wells.* All tubing installations in wells existing on the date of this Order shall be equipped with a surface- or other remotely controlled subsurface safety device when the tubing is first removed and reinstalled after December 1, 1972; provided, that wells with a shut-in tubing pressure of 4,000 psig or greater shall be equipped with a subsurface-controlled subsurface safety device in lieu of a surface- or other remotely controlled subsurface safety device unless a surface- or other remotely controlled subsurface safety device is approved or required. When the shut-in tubing pressure declines below 4,000 psig, a surface- or other remotely controlled subsurface safety device shall be installed when the tubing is first removed and reinstalled.

Tubing installations in existing wells completed from single-well and multi-well satellite caissons or jackets and sea-floor completions may be equipped with a subsurface-controlled subsurface safety device, in lieu of a surface- or other remotely controlled subsurface safety device, upon application, justification, and approval.

C. *Shut-in Wells.* A tubing plug shall be installed in lieu of, or in addition to, other subsurface safety devices if a well has been shut in for a period of six (6) months. Such plugs shall be set at a depth of 100 feet or more below the sea floor. All retrievable plugs installed after the date of this Order shall be of the pump-through type. All wells perforated and completed, but not placed on production, shall be equipped with a subsurface safety device or tubing plug within two (2) days after completion.

D. *Injection Wells*. Subsurface safety devices as required in subparagraphs A and B above shall be installed in all injection wells unless, after application and justification, it is determined that the well is incapable of flowing oil or gas, which condition shall be verified annually.

2. *Technological Advancement*. As technological research, progress, and product improvement result in increased effectiveness of existing safety devices or the development of new devices or systems, such devices or systems may be required or used upon application, justification, and approval. Applications for routine use shall include evidence that the device or system has been field-tested at least once each month for a minimum of six (6) consecutive months, and that each test indicated proper operation.

3. *Testing and Inspection*. Subsurface safety devices shall be designed, adjusted, installed, and maintained to insure reliable operation. During testing and inspection procedures, the well shall not be left unattended while open to production unless a properly operating subsurface safety device has been installed in the well.

A. *Surface-Controlled Subsurface Safety Devices*. Each surface- or other remotely controlled subsurface safety device installed in a well shall be tested in place for proper operation when installed and thereafter at intervals not exceeding six (6) months. If the device does not operate properly, it shall be removed, repaired, and reinstalled or replaced and tested to insure proper operation.

B. *Subsurface-Controlled Subsurface Safety Devices*. Each subsurface-controlled subsurface safety device installed in a well shall be removed, inspected, and repaired or adjusted as necessary and reinstalled at intervals not exceeding six (6) months; provided, that such removable devices set in a landing nipple shall be removed, inspected, and repaired or adjusted as necessary and reinstalled at intervals not exceeding twelve (12) months. Each velocity-type device shall be designed to close at a flow rate not to exceed the larger of either 150 percent of, or 200 BFPD above, the most recent well-test rate which equals or exceeds the approved production rate. The above closing flow rate shall not exceed the calculated capacity of the well to produce against a flowing wellhead pressure of 50 psig. Each preset tubing-pressure-actuated device shall be designed to close prior to reduction of the flowing wellhead pressure to 50 psig.

C. *Tubing Plugs*. A shut-in well equipped with a tubing plug shall be inspected for leakage by opening the well to possible flow at intervals not exceeding six (6) months. If sustained liquid flow exceeds 400 cc/min., or gas flow exceeds 15 cu. ft./min., the plug shall be removed, repaired, and reinstalled or an additional tubing plug installed to prevent leakage.

4. *Temporary Removal*. Each wireline- or pumpdown-retrievable subsurface safety device may be removed, without further authority or notice, for a routine operation which does not require approval of a Sundry Notice and Report on Wells (Form 9-331) for a period not to exceed fifteen (15) days. The well shall be clearly identified as being without a subsurface safety device and shall not be left unattended while open to production. The provisions of this paragraph are not applicable to the testing and inspection procedures in paragraph 3 above.

5. *Additional Protective Equipment*. All tubing installations made after the date of this Order in which a wireline- or pumpdown-retrievable subsurface safety device is to be installed shall be equipped with a landing nipple, with flow couplings or other protective equipment above and below, to provide for setting of the subsurface safety device. All wells in which a subsurface safety device or tubing plug is installed shall have the tubing-casing annulus packed off above the uppermost open casing perforation. The control system for all surface-controlled subsurface safety devices shall be an integral part of the platform shut-in system, or of an independent remote shut-in system.

6. *Departures*. All departures (or waivers) approved prior to the date of this Order are hereby terminated as of December 1, 1972, unless new applications are submitted prior to that date. All such new applications will be considered for approval pursuant to 30 CFR 250.12(b) and the requirements of this Order. All applications for departures shall include a detailed statement of the well conditions, efforts made to overcome any difficulties, and proposed alternate safety measures.

7. *Emergency Action*. All tubing installations open to hydrocarbon-bearing zones and not equipped with a subsurface safety device as permitted by this Order shall be clearly identified as not being so equipped, and a subsurface safety device or tubing plug shall be available at the field location. In the event of an emergen-

cy, such as an impending hurricane, such device or plug shall be promptly installed within the limits of practicability, due consideration being given to personnel safety.

8. *Records.* The operator shall maintain the following records for a minimum period of one year for each subsurface safety device and tubing plug installed, which records shall be available to any authorized representative of the Geological Survey.

A. *Field Records.* Individual well records shall be maintained at or near the field and shall include, as a minimum, the following information:

(1) A record which will give design and other information; i.e., make, model, type, spacers, bean and spring size, pressure, etc.

(2) Verification of assembly by a qualified person in charge of installing the device and installation date.

(3) Verification of setting depth and all operational tests as required in this Order.

(4) Removal date, reason for removal, and reinstallation date.

(5) A record of all modifications of design in the field.

(6) All mechanical failures or malfunctions, including sandcutting, of such devices, with notation as to cause or probable cause.

(7) Verification that a failure report was submitted.

B. *Other Records.* The following records, as a minimum, shall be maintained at the operator's office:

(1) Verified design information of subsurface-controlled subsurface safety devices for the individual well.

(2) Verification of assembly and installation according to design information.

(3) All failure reports.

(4) All laboratory analysis reports of failed or damaged parts.

(5) Quarterly failure-analysis report.

9. *Reports.* Well completion report (Form 9-330) and any subsequent reports of workover (Form 9-331) shall include the type and the depth of the subsurface safety devices and tubing plugs installed in the well or indicate that a departure has been granted.

To establish a failure-reporting and corrective-action program as a basis for reliability and quality control, each operator shall submit a quarterly failure-analysis report to the office of the Supervisor, identifying mechanical failure by lease and well, make and model, cause or probable cause of failure, and action taken to correct the failure. The reporting period shall begin the first day of the month following the date of this Order. The reports shall be submitted by February 28, May 31, August 31, and November 30 for the periods ending January 31, April 30, July 31, and October 31 of each year.

/s/ ROBERT F. EVANS
Supervisor

APPROVED: JUNE 5, 1972

/s/ RUSSELL G. WAYLAND
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION

GULF OF MEXICO AREA

OCS ORDER NO. 6

Effective August 28, 1969

COMPLETION OF OIL AND GAS WELLS

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.92. Any departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

1. *Wellhead Equipment and Testing Procedures.*

A. *Wellhead Equipment.* All completed wells shall be equipped with casingheads, wellhead fittings, valves and connections with a rated working pressure equal to or greater than the surface shut-in pressure of the well. Connections and valves shall be designed and installed to permit fluid to be pumped between any two strings of casing. Two master valves shall be installed on the tubing in wells with a surface pressure in excess of five thousand pounds per square inch. All wellhead connections shall be assembled and tested, prior to installation, by a fluid pressure which shall be equal to the rated test pressure of the fitting to be installed.

B. *Testing Procedure.* Any wells showing sustained Pressure on the casinghead, or leaking gas or oil between the production casing and the next larger casing string, shall be tested in the following manner: The well shall be killed with water or mud and pump pressure applied. Should the pressure at the casinghead reflect the applied pressure, the casing shall be condemned. After corrective measures have been taken, the casing shall be tested in the same manner. This testing procedure shall be used when the origin of the pressure cannot be determined otherwise.

2. *Storm Choke.* All completed wells shall meet the requirements prescribed in OCS Order No. 5.

3. *Procedures for Multiple or Tubingless Completions.*

A. *Multiple Completions.*

(1) Information shall be submitted on, or attached to, Form 9-331 showing top and bottom of all zones proposed for completion or alternate completion, including a partial electric log and a diagrammatic sketch showing such zones and equipment to be used.

(2) When zones approved for multiple completion become intercommunicated the lessee shall immediately repair and separate the zones after approval is obtained.

B. *Tubingless Completions.*

(1) All tubing strings in a multiple completed well shall be run to the same depth below the deepest producible zone.

(2) The tubing string(s) shall be new pipe and cemented with a sufficient volume to extend a minimum of 500 feet above the uppermost producible zone.

(3) A temperature or cement bond log shall be run in all tubingless completion wells where lost circulation or other unusual circumstances occur during the cementing operations.

(4) Information shall be submitted on, or attached to, Form 9-331 showing the top and bottom of all zones proposed for completion or alternate completion, including a partial electric log and a diagrammatic sketch showing such zones and equipment to be used.

/s/ ROBERT F. EVANS
Supervisor

APPROVED: AUGUST 28, 1969

/s/ RUSSELL G. WAYLAND
Chief Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION
GULF OF MEXICO AREA

OCS ORDER NO. 7
Effective October 1, 1976

POLLUTION AND WASTE DISPOSAL

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.43. The operator shall comply with the following requirements. All departures from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 250.12(b).

1. *Pollution prevention.* In the conduct of all oil and gas operations, the operator shall prevent pollution of the Gulf. Furthermore, the disposal of waste materials into the Gulf shall not create conditions which will adversely affect the public health, life or property, aquatic life or wildlife, recreation, navigation, or other uses of the Gulf.

A. *Liquid disposal.*

(1) Drilling mud containing free oil shall not be disposed of into the Gulf.

(2) The operator shall submit with the Application for Permit to Drill (Form 9-331 C) a detailed list of drilling mud components, including the common chemical or chemical trade name of each component, and a list of the drilling mud additives anticipated for use in meeting special drilling requirements. Disposal of drilling mud shall be by methods which will minimize the adverse effects to marine life. These methods shall be consistent with applicable Federal regulations. Approval of drilling mud disposal procedures will be site specific and on a case-by-case basis.

(3) Curbs, gutters, and drains on platforms and structures shall be installed and maintained in accordance with the provisions of OCS Order No. 8.

(4) Discharges from fixed structures, including sanitary waste, produced water, and deck drainage, are subject to the Environmental Protection Agency's permitting procedures pursuant to the Federal Water Pollution Control Act, as amended.

B. *Solid waste disposal.*

(1) Drill cuttings, sand, and other solids containing oil shall not be disposed of into the Gulf unless all of the free oil has been removed.

(2) Mud containers and other similar solid waste materials shall be incinerated or transported to shore for disposal in accordance with Federal, State, or local requirements.

2. *Personnel, inspections, and reports.*

A. *Personnel.* The operator's personnel shall be thoroughly instructed in the techniques of equipment maintenance and operation for the prevention of pollution. Nonoperator personnel shall be informed in writing, prior to executing contracts, of the operator's obligations to prevent pollution.

B. *Pollution inspections.*

(1) Manned facilities shall be inspected daily.

(2) Unattended facilities, including those equipped with remote control and monitoring systems, shall be inspected at frequent intervals. The District Supervisor may prescribe the frequency of inspections for these facilities.

(3) All production facilities, such as separators, tanks, treaters, and other hydrocarbon handling equipment shall be designed and operated in a manner necessary to prevent pollution. Maintenance or repairs as are necessary to prevent pollution of the Gulf shall be undertaken immediately.

C. *Pollution reports.*

(1) All spills of oil and liquid pollutants shall be recorded showing the cause, size of spill, and action taken, and the record shall be maintained and available for inspection by the District Supervisor. All spills of less than 2.4 cubic meters (15 barrels) shall be reported orally to the District Supervisor within 12 hours and shall be confirmed in writing.

(2) All spills of oil and liquid pollutants of 2.4 to 7.9 cubic meters (15 to 50 barrels) shall be reported orally to the District Supervisor within four (4) hours and shall be confirmed in writing.

(3) All spills of oil and liquid pollutants of more than 7.9 cubic meters (50 barrels) shall be reported orally without delay to the District Supervisor and the Coast Guard. All oral reports shall be confirmed in writing.

(4) Operators shall notify each other upon observation of equipment malfunction or pollution resulting from another's operation.

3. *Pollution-control equipment and oil spill contingency plan.*

A. *Equipment.* Standby pollution-control equipment and materials shall be maintained by, or shall be available to, each operator at an offshore or onshore location. This shall include containment booms, skimming apparatus, cleanup materials, and chemical agents, and shall be available prior to the commencement of operations. The use of chemicals shall be permitted only after approval by the Area Supervisor in accordance with Part 2003.2-1 Annex X, National Oil and Hazardous Substances Pollution Contingency Plan. The equipment and materials shall be inspected monthly and maintained in good condition for use. The results of the inspections shall be recorded and maintained at the site.

B. *Oil spill contingency plan.* The operator shall submit an oil spill contingency plan for approval by the Area Supervisor before consideration can be given to approval of an application for permit to conduct operations. This plan shall contain the following:

(1) Provisions to assure that full resource capability is known and can be committed during an oil discharge situation including the identification and inventory of applicable equipment, materials, and supplies which are available locally and regionally, both committed and uncommitted, and the time required for deployment.

(2) Provisions for varying degrees of response effort depending on the severity of the oil discharge.

(3) Establishment of notification procedures for the purpose of early detection and timely notification of an oil discharge including a current list of names, telephone numbers, and addresses of the responsible persons and alternates on call to receive notification of an oil discharge, as well as the names, telephone numbers and addresses of regulatory organizations and agencies to be notified when an oil discharge is discovered.

(4) Provisions for well defined and specific actions to be taken after discovery and notification of an oil discharge including:

(a) Specification of an oil discharge response operating team consisting of trained, prepared, and available operating personnel.

(b) Predesignation of an oil discharge response coordinator who is charged with the responsibility and delegated commensurate authority for directing and coordinating response operations.

(c) A preplanned location for an oil discharge response operations center and a reliable communications system for directing the coordinated overall response operations.

4. *Spill control and removal.* Immediate corrective action shall be taken in all cases where pollution has occurred. Corrective action taken under the Oil Spill Contingency Plan shall be subject to modification when directed by the Area Supervisor. The primary jurisdiction to require corrective action to abate the source of pollution and to enforce the subsequent cleanup by the lessee or operator shall remain with the Area Supervisor pursuant to the provisions of this Order and the memorandum of understanding between the Department of Transportation (U.S. Coast Guard) and the Department of the Interior (U.S. Geological Survey) dated August 16, 1971.

5. *Annual contingency plan assessment.* Annual contingency plan assessments will be conducted in conjunction with the Plan of Development review. Upon request of the Area Supervisor, revised contingency plans reflecting changes in personnel, equipment, and methods shall be submitted.

/s/ D. W. Solanas,
Area Oil and Gas Supervisor

Approved:

/s/ Russell G. Wayland,
Acting Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION

GULF OF MEXICO AREA

OCS ORDER NO. 8

Effective October 1, 1976

PLATFORMS, STRUCTURES, AND ASSOCIATED EQUIPMENT

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.19(a). Section 250.19(a) provides as follows:

(a) The supervisor is authorized to approve the design, other features, and plan of installation of all platforms, fixed structures, and artificial islands as a condition of the granting of a right of use or easement under Paragraphs (a) and (b) of Section 250.18 or authorized under any lease issued or maintained under the Act.

The operator shall be responsible for compliance with the requirements of this Order in the installation and operation of all platforms and structures, including all facilities installed on a platform or structure, whether or not operated or owned by the operator. All departures from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 250.12(b). All applications for approval under the provisions of this Order shall be submitted to the appropriate District Supervisor. References in this Order to approvals, determinations, or requirements are to those given or made by the Area Oil and Gas Supervisor or his delegated representative.

Following approval of applications, installations and operations shall be performed as approved. If deemed advisable, significant changes to approved applications may be proposed; however, approval of such proposals shall be required prior to implementation. For the purposes of compliance with this paragraph, a significant change in any structural change which materially alters the original plan or any major deviation from operations as originally approved. Any question as to whether a change is significant enough to require approval shall be referred to the USGS. An operator assumes the risk for making changes without approval if he fails to contact the USGS to determine whether a permit is necessary.

The following requirements are applicable to all platforms and structures approved and installed subsequent to the effective date of the Order. When structural or equipment modifications to existing platforms and structures are proposed, only requirements relevant to the modifications shall be applicable.

1. *Platform Design.*

A. *General Design.* A platform or structure shall be designed for safe installation and operation for its intended use and service life at a specific site. Steel structures shall be designed in accordance with those provisions of API RP 2A, "Planning, Designing and Constructing Fixed Offshore Platforms," Seventh Edition, January 1976, or subsequent revisions as approved by the Area Supervisor. The design of structures other than steel shall be evaluated on an individual basis. Consideration shall be given to conditions which may contribute to structural damage such as:

(1) Wind, wave, and current forces and other environmental loading forces.

(2) Functional loading conditions including the weight of the structure and all permanently fixed equipment, and the effects of static and dynamic functional load conditions during installation and the design operational service period.

(3) Water depth, bottom topography, surface and subsurface soil conditions, slope stability, scour conditions, and other pertinent geologic conditions based on information from on-site investigations.

2. *Application.* Prior to installation of a fixed platform or structure, the operator shall submit

for approval, in duplicate, an application showing essential features of the platform or structure and supporting design information as follows:

A. *General Information*

(1) Identification data, which shall include the platform or structure designation, lease number, area name, block number, and operator.

(2) Location data, including plat showing the distance from the nearest two-block lines.

(3) Primary use and other intended functions, including planned drilling, production, and storage operations.

(4) Personnel facilities, personnel access to living quarters, boat landings, and heliports.

(5) Drawings and plats to clearly illustrate essential parts, including number and location of well slots, water depth, nominal size and thickness of jacket and deck column legs, nominal size, thickness, and design penetration of piling.

(6) A description of the method of corrosion protection.

B. *Environmental Information*

(1) List of pertinent environmental data which have a bearing on the installation, operation, or design of the platform or structure, including wave height, current, wind velocity, water depth, storm and astronomical tide data, and factors considered in subparagraph 1.A.(3).

(2) Listing of total design functional loads and wind, wave, and current forces for the following approaches: longitudinal, transversal, and diagonal.

C. *Foundation*

(1) A listing of on-site investigations and tests, and a basic summary of resultant determinations.

(2) A description of foundation loads for environmental and functional forces listed in subparagraphs 2.B (1) and (2).

(3) In areas susceptible to soil movement, an analysis of slope and soil stability in relation to the foundation design loads.

D. *Installation*. A statement shall be submitted to the effect that the installation recommendations contained in API RP 2A, January 1976, or approved revisions, were adopted; or that significant deviations from the recommendations of API RP 2A were adopted and herewith submitted for approval.

E. *Exception to Supporting Design Information Submittal*. The following information shall be developed and utilized in platform design; however, submittal with the installation application is not required. This information shall be made available to the appropriate District Supervisor upon his request.

(1) A description of the critical design loading and design criteria, taking into consideration maximum environmental and operational loading conditions expected over the service life of the platform or structure. This shall include those conditions considered under subparagraphs 1.A (1), (2), and (3) above.

(2) For steel structures, a description of the materials, specifications, strength analyses, and allowable stresses over the service life.

The recommendations of API publications API RP 2A, "Planning, Designing, and Constructing Fixed Offshore Platforms," January 1976, are acceptable practice concerning subparagraphs (1) and (2) above.

(3) For concrete structures, a description of the materials, specification, and strength and serviceability requirements and analyses of the reinforcing systems.

3. *Certification*

A. Detailed structural plans certified by a registered professional structural engineer shall be on file and maintained by the operator or his designee.

B. The following certifications, signed and dated by a company representative, shall accompany the application:

(1) "(Operator) certifies that this platform has been certified by a registered professional structural engineer and the structure will be constructed, operated, and maintained as described in the application and any approved modification thereto. Certified plans are on file at................."

(2) Certification that the mechanical and electrical systems of the facility will be designed and installed under the supervision of appropriate registered professional engineers. Maintenance of these systems shall be by qualified personnel.

4. *Design, installation, and operational features of production facilities.*

A. All production facilities, including separators, treaters, compressors, headers, and pipelines, shall be designed, installed, and maintained in a manner which will facilitate efficient, safe, and pollution-free operation.

B. As soon as practicable, but not later than six months after the effective date of this Order, new platform production facilities shall be protected with a basic and ancillary surface safety system designed, analyzed, installed, tested, and maintained in operating condition in accordance with the provisions of API RP 14C "Analysis, Design, Installation, and Testing of Basic Surface Safety Systems on

Offshore Production Platforms," June 1974, as amended November 1975, or subsequent revisions as approved by the Area Supervisor, and the additional requirements of this Order. For this application, the word "should" contained in API RP 14C shall be read "shall" except for those contained in explanatory statements, paragraphs 3.4(c), page 11 and 4.3(4) (a)-(f), pages 19-20. In the event that processing components are to be utilized other than those for which Safety Analysis Tables (SAT's) and Safety Analysis Checklists (SAC's) are included in API RP 14C, the analysis technique and documentation specified therein shall be utilized to determine the effects and requirements of such components upon the safety system.

Operators may utilize the options contained in API RP 14C during Safety Systems Design; however, options selected and depicted on the schematic flow diagram and Safety Analysis Function Evaluation (SAFE) Chart are subject to approval by the appropriate District Supervisor.

C. Prior to installation, the operator shall submit for approval to the appropriate District Supervisor, in duplicate, information relative to design and installation features, as indicated in subparagraphs (1) through (6) below. This information shall also be maintained at the operator's onshore field engineering office.

(1) A flow schematic showing size, capacity, and design working pressure of separators, treaters, storage tanks, compressors, pipeline pumps, and metering devices.

(2) A schematic flow diagram (Reference API RP 14C, Example Figure E1, page 79) and the related Safety Analysis Function Evaluation (SAFE) Chart (Reference API RP 14C, paragraph 4.3(C), page 20). These shall be developed with consideration of the provisions of API RP 14C and the additional requirements of this Order.

(3) A schematic piping diagram showing the size and design working pressure with reference to welding specification(s) or code(s) used. The recommendations contained in API RP 14E, "Design and Installation of Offshore Production Platform Piping Systems" are acceptable for platform piping systems.

(4) A diagram of the fire-fighting system.

(5) Electrical system information including the following:

(a) Plan view of each platform deck outlinging any nonrestricted area; i.e., areas which are unclassified with respect to electrical equipment installations, and areas in which potential ignition sources, other than electrical, are to be installed. The area outline should include the following information:

(i) Any surrounding production or other hydrocarbon source and a description of deck, overhead, and firewall.

(ii) Location of generators, control rooms, panel boards, major cabling-conduit routes and identification of wiring method.

(b) Elementary electrical schematic of any platform safety-shutdown system with functional legend.

(6) An application for the installation and maintenance of all gas detection systems. The application shall include the following:

(a) Type, location, and number of detection heads.

(b) Type and kind of alarm, including emergency equipment to be activated.

(c) Method used for detection of combustible gases.

(d) Method and frequency of calibration.

(e) Name of organization to perform system inspection and calibration.

(f) A functional block diagram of the gas detection system, including the electric power supply.

(g) Other pertinent information.

D. *Additional safety and pollution control requirements.* The following requirements modify, or are in addition to, those contained in API RP 14C. For platforms installed after the effective date of this Order, compliance is required as soon as practicable, but not later than six months after the effective date. Operators of facilities installed prior to the effective date of this Order shall comply with these requirements at the earliest practicable date, but not later than one year from the effective date, unless otherwise specified herein.

(1) Design and installation.

(a) Pressure vessels

(i) Pressure relief valves shall be designed, installed, and maintained in accordance with applicable provisions of Sections I, IV, and VIII of the ASME Boiler and Pressure Vessel Code, July 1, 1974. All relief valves and vents shall be piped in such a way as to minimize the possibility of fluid striking personnel or ignition sources.

(ii) Steam generators shall be equipped with low-water-level controls in accordance with applicable provisions of Sections I and IV of the ASME Boiler and Pressure Vessel Code, July 1, 1974.

(iii) All relief valves shall conform to the appropriate sizing and relieving requirements of ASME Boiler and Pressure Vessel Codes, July 1, 1974, Sections I, IV, and VIII. The high-pressure shut-in sensor shall activate sufficiently below the design working pressure to positively insure operation before the relief valve starts relieving. The low-pressure shut-in sensor shall activate no lower than 15 percent or 35 kilopascals (k Pa) (5 psi), whichever is greater below the lowest pressure in the operating range.

(iv) Pressure sensors may be of the automatic or nonautomatic reset type, but where the automatic reset types are used, a nonautomatic reset relay shall be installed. All pressure sensors shall be equipped to permit testing with an external pressure source.

(v) All pressure or fired vessels used in the production of oil or gas, installed after the effective date of this Order, shall conform to the requirements stipulated in the edition of the ASME Boiler and Pressure Vessel Code, Sections I, IV, and VIII, as appropriate, in effect at the time the vessel is installed. Uncoded vessels now in use shall have been hydrostatically tested to a pressure 1.5 times their working pressure. The test date, test pressure, and working pressure shall, within six months after the effective date of this Order, be marked on the vessel in a prominent place. A record of the test shall be maintained by the operator.

(b) Flowlines.

(i) All flowlines from wells shall be equipped with high- and low-pressure shut-in sensors located downstream of the well choke. If there are more than 3 meters (10 feet) of line between the wellhead wing valve and the primary choke, an additional low-pressure shut-in sensor shall be installed in this section. The high-pressure shut-in sensor shall be set no higher than 10 percent above the highest operating pressure of the line, but in all cases, it shall be set sufficiently below the maximum shut-in pressure of the well or the gas-lite supply pressure to assure actuation of the surface safety valve. The low-pressure shut-in sensor shall be set no lower than 10 percent or 35 k Pa (5 psi) whichever is greater, below the lowest operating pressure of the line in which it is installed.

(ii) In the event a well flows directly to the pipeline before separation, the flowing and valves from the well located upstream of, and including, the header inlet valve(s), shall be able to withstand the maximum shut-in pressure of the well, unless 1: protected by a relief valve connected to either the platform flare scrubber or some other approved location other than into the departing pipeline, or 2: the flowline is equipped with an additional automatic shut-down valve controlled by an independent high-pressure sensor. The platform flare scrubber shall be designed to handle, without liquid hydrocarbon carryover to flare, the maximum anticipated flow of liquid hydrocarbons which may be relieved to the vessel.

(c) Remote shut-in systems.

(i) Remote shut-in controls shall be quick-opening valves, except those on the boat landing(s), which may be a plastic loop of the control pressure line.

(d) Engine exhausts.

(i) Engine exhausts shall be equipped to comply with the insulation and personnel protection requirements of API RP 14C, Section 4.2.c.(4). Exhaust piping from diesel engines shall be equipped with spark arrestors.

(e) Glycol dehydration units.

(i) A pressure relief valve shall be installed on the glycol reboiler, or at a location approved by the District Supervisor, which will prevent overpressurization of all glycol dehydration units. The set pressure of this valve shall be determined by the operator and approved by the District Supervisor. The discharge of the relief valve must be vented in a non-hazardous manner.

(f) Compressors.

(i) Each compressor installation existing as of the effective date of this Order shall be protected by high-liquid-level shut-in controls and a pressure relief valve on each interstage scrubber. High-temperature shutdown controls shall be installed on the compressor cylinders unless inter-scrubbers are protected by high- and low-pressure shut-in controls. Compliance is required as soon as practical, but no later than six months after the effective date of this Order.

All compressor installations installed after the effective date of this Order shall be protected by high- and low-pressure and high-liquid-level shut-in controls and a pressure relief valve on each interstage scrubber.

All compressor interstage scrubbers shall be protected by low-liquid-level shut-in controls unless dump is through a choke restriction to another pressure vessel.

(ii) In addition to the provisions of API RP 14C, paragraphs A8.3a and A8.3d, high- and low-pressure shut-in sensors and low-liquid-level shut-in controls protecting compressor suction and discharge piping and associated suction and interstage scrubbers shall be designed to actuate automatic isolation valves located in each compressor suction and fuel gas line so that the compressor unit and associated vessels can be isolated from all input sources.

As an alternative, low-liquid-level shut-in control(s) installed in suction and interstage scrubber(s) may be designed to actuate automatic shutoff valve(s) installed in the scrubber dump line(s).

For compressors installed after the effective date of this Order, those compressor units installed in a building shall have the isolation valves located outside the building. Each suction and interstage high-liquid-level shut-in control shall, as a minimum, be designed to shut down the compressor prime mover.

(iii) Compressor installations of 745 kilowatts (1,000 horsepower) or less are excluded from those requirements of API RP 14C, A8.3d, page 54, which provide for installation of a blowdown valve on the discharge line.

(iv) Compressor installations existing prior to the effective date of this Order, and which are installed in a building, are excluded from the requirement of API RP 14C, A8.3b, Flow Safety Devices (FSV), and Section A.8.3.d., Shutdown Devices (SDV), which prescribes that these devices be located outside of the building.

(v) The automatic isolation valves installed in compressor suction and fuel gas piping shall also be actuated by shutdown of the prime mover.

(g) Curbs, gutters and drains

(i) Curbs, gutters, and drains shall be installed in all deck areas in a manner necessary to collect all contaminants, unless drip pans or equivalent are placed under equipment and piped to a sump which will automatically maintain the oil at a level sufficient to prevent discharge of oil into Gulf waters. Sump piles shall not be used as a processing device to treat or skim liquids but shall be used to collect treated produced water, treated sand, liquids from drip pans and deck drains, and as a final trap for hydrocarbon liquids in event of equipment upsets.

(h) Fire-fighting systems.

(i) A fire-fighting water system of rigid pipe with fire hose stations shall be installed and may include a fixed water-spray system. Such a system shall be installed in a manner necessary to provide, needed protection in areas where production-handling equipment is located. A fire-fighting system using chemicals may be used in lieu of a water system if determined to provide equivalent fire protection control.

An alternate fuel or power source shall be installed to provide continued pump operation for the system during platform shut-down, unless an alternate fire-fighting system is provided.

Portable fire extinguishers shall be located in the living quarters and other strategic areas.

A diagram of the fire-fighting system showing the location of all equipment shall be posted in a prominent place on the platform or structure.

(i) Gas detection system

(i) A diagram of the gas detection system showing the location of all gas detection points shall be posted in a prominent place on the platform or structure.

(ii) All gas detection systems shall be capable of continuously monitoring for the presence of combustible gas in the areas in which the detection devices are located. The gas detector power supply shall be from a continually energized power source.

(iii) The use of fuel gas odorant is an acceptable alternate to an automatic gas detection and alarm system in enclosed, continuously manned areas of the facility.

(j) Electrical equipment. The following requirements shall be applicable to all electrical equipment and systems installed:

(i) All engines with ignition systems shall be equipped with a low-tension ignition system of a low-fire-hazard type and shall be designed and maintained to minimize release of sufficient electrical energy to cause ignition of an external, combustible mixture.

(ii) All electrical generators, motors, and lighting systems shall be installed, protected, and maintained in accordance with the edition of the National Electrical Code and API RP 500 B in effect at the time of installation.

(iii) Wiring methods which conform to the National Electrical Code or to IEEE 45, "Recommended Practice for Electric Installations on Shipboard," in effect at the time of installation, are acceptable.

(iv) An auxiliary power supply shall be installed to provide emergency power capable of operating all electrical equipment required to maintain safety of operations in the event of a failure in the primary electrical power supply.

(k) Erosion. A program of erosion control shall be in effect for wells having a history of sand production. The erosion control program may include sand probes, X-ray, ultrasonic, or other satisfactory monitoring methods. An annual report, by lease, on the results of the program shall be submitted by the first of September to the appropriate District Supervisor.

(2) Operations

(a) Any device on wells, vessels, or flowlines temporarily out of service shall be flagged. Safety devices and systems on wells which are capable of producing shall not be bypassed or blocked out of service unless necessary during startup or maintenance operations and then only with personnel on duty aboard the platform.

(b) When wells are disconnected from producing facilities and blind flanged or equipped with a tubing plug, compliance is not required with provisions of API RP 14C and of this Order concerning (a) installation of high- and low-pressure shut-in sensors downstream of the well choke in flow-lines from wells, and (c) installation of check valves in header individual flowlines.

All open-ended lines connected to producing facilities shall be plugged or blind-flanged, except those lines designed to be open-ended, such as flare or vent lines.

(c) Simultaneous operations. Prior to conducting activities, simultaneously with production operations, which could increase the possibility of occurrences of undesirable events such as harm to personnel or to the environment, or damage to equipment, an operator's Contingency Plan shall be filed for approval with the appropriate District Supervisor. The plan shall be filed within 90 days after the effective date of this Order. A plan shall be submitted by each lessee/operator for each platform existing as of the effective date of this Order. The plan shall be modified and updated as appropriate. Activities requiring the plan are drilling, workover, wireline, and major construction operations. The plan shall include:

(i) A narrative description of operations.

(ii) A plan view of each platform deck indicating critical areas of simultaneous activities.

(iii) Procedures for mitigation of potential undesirable events including:

(a) The guidelines the operator will follow to assure coordination and control of simultaneous activities.

(b) Indication as to the person having overall responsibility, as person in charge at the site, for safety of platform operations.

(c) An outline of any additional safety measures that are required for simultaneous operations.

(d) Specification of any added or special equipment or procedural conditions imposed when simultaneous activities are in progress.

(d) Welding practices and procedures. The following requirements shall apply to all platforms and structures, including mobile drilling and workover structures. These requirements shall apply to fixed structures after the drilling out of the drive or structural casing for the first well drilled on the structure, entry into a well to be tied back to the structure, or first flow of combustible fluids to the structure. The period of time during which these requirements are considered applicable to mobile drilling structures is the interval from the drilling out of the drive or structural casing until the blowout-preventer stack and riser are pulled in the final abandonment. suspension, or completion. These requirements shall apply to workover rigs when such rigs are performing remedial work on any wells open to hydrocarbon-bearing zones.

For the purpose of this Order, the term "welding and burning" is defined to include arc or acetylene cutting and arc or acetylene welding.

Each operator shall file for approval by the appropriate District Supervisor a Welding and Burning Safe Practices and Procedures Plan. The plan shall be filed within 90 days after the effective date of this Order and shall include company qualification standards or requirements for personnel and the methods by which the operator will assure that only personnel meeting such standards or requirements are utilized. A copy of this plan shall be available in the field. Any person designated as a welding supervisor shall be thoroughly familiar with this plan.

Prior to welding or burning operations the operator shall establish approved safe welding areas. Such areas shall be constructed to noncombustible or fire-resistant materials free of combustible or flammable contents and be suitably segregated from adjacent areas. National Fire Protection Association Bulletin No. 51B, "Cutting and Welding Processes," 1971, shall be used as a guide to designate these areas. All welding which cannot be done in the approved safe welding area shall be performed in compliance with the procedures outlined below:

(i) Such welding and burning as are necessary on a structure shall adhere to the following practices:

(a) Prior to the commencement of any welding or burning operations on a structure, the operator's designated person-in-charge at the installation shall personally inspect the qualifications of the welder or welders to assure that they are properly qualified in accordance with the approved company qualification standards or requirements for welders. The designated person-in-charge and welders shall personally inspect the area in which the work is to be performed for potential fire and explosion hazards. After it has been determined that it is safe to proceed with the welding or burning operation, the designated person-in-charge shall issue a written authorization for the work.

(b) All welding equipment shall be inspected prior to beginning any welding or burning. Welding machines located on production or process platforms shall be equipped with spark arrestors and drip pans. Welding leads shall be completely insulated and in good condition; oxygen and acetylene bottles secured in a safe place; and hoses leak free and equipped with proper fittings, gauges, and regulators.

(c) During all welding and burning operations, one or more persons as necessary shall be designated as a Fire Watch. Persons assigned as a Fire Watch shall have no other duties while actual welding or burning operations are in progress.

(d) Prior to any welding or burning, the Fire Watch shall have in his possession fire-fighting equipment in a condition ready to use.

(e) No welding shall be done on containers, tanks, or other vessels which have contained a flammable substance unless the contents of the vessels have been rendered inert and determined to be safe for welding or burning by the designated person-in-charge.

(f) In the event drilling, workover, or wireline operations are in progress on the platform, welding operations in other than approved safe welding areas may be conducted only if the well(s) on which work is being done contain noncumbustible fluids, and entry of formation hydrocarbons into the wellbore is precluded by a positive overbalance toward the formation. Also, all other provisions of this section shall be applicable.

(g) All other producible wells shall be shut-in at the surface safety valves while welding or burning in the wellhead or production area.

(3) Safety device testing. The safety system devices required by this Order shall be tested by the operator at the interval specified below or more frequently if operating conditions warrant. Records shall be maintained at the field office for a period of one year, showing the present status and history of each device, including dates and details of inspection, testing, repairing, adjustment, and reinstallation. Such records shall be available to any authorized representative of the Geological Survey. Records shall be analyzed, equipment or system problem areas identified, and action taken to preclude recurrence of these problems.

Testing and reporting shall be accomplished in accordance with API RP 14C, Appendix D, and the following:

(a) All pressure relief valves shall be tested for operation annually. Pressure relief valves shall be either bench-tested or equipped to permit testing with an external pressure source.

(b) All pressure sensors shall be tested at least once each calendar month, but at no time shall more than six weeks elapse between tests.

(c) All automatic wellhead safety devices and check valves on all flowlines shall be checked for operation and holding pressure once each calendar month, but at no time shall more than six weeks elapse between tests. If any wellhead safety valve indicates leakage, it shall be repaired or replaced.

(d) All liquid-level shut-in controls shall be tested at least once within each calendar month, but at no time shall more than six weeks elapse between tests. These tests shall be conducted by raising or lowering the liquid level across the level-control detector.

(e) All automatic inlet shutoff valves actuated by a sensor on a vessel or a compressor shall be tested for operation at least once within each calendar month, but at no time shall more than six weeks elapse between tests.

(f) All automatic shutoff valves located in liquid discharge lines and actuated by vessel low-level sensors shall be tested for operation once within each calendar month, but at no time shall more than six weeks elapse between tests.

(g) The high-temperature shutdown controls installed in all compressors which are protected against abnormal pressures solely by such temperature safety devices shall be tested annually and repaired or replaced as necessary.

(h) All pumps for fire-fighting water systems shall be inspected and test-operated weekly. A record of the tests shall be maintained at the field office for a period of one year.

(i) The Automatic Gas Detection System shall be tested for operation and recalibrated every six months.

(4) Training. Not later than two years after the effective date of this Order, the operator shall ensure that all personnel engaged in installing, inspecting, testing, and routinely maintaining these safety devices will have been qualified under a program as recommended by API RP T-2, September 1974, amended October 1975, or subsequent revisions approved by the Area Supervisor, or an equivalent program, approved by the Area Supervisor. Documented evidence of qualification of individuals performing these functions shall be maintained at the field headquarters and shall be available to any authorized representative of the Geological Survey.

Manufacturers' representatives may work on component equipment supplied by their company, provided they are directly supervised by a qualified person capable of evaluating the impact of the work on the total system. On-the-job trainees working with safety devices shall be directly supervised by a qualified person.

Not later than one year after the effective date of this Order, the operator shall submit for approval, of the appropriate Area Supervisor, a description of the training to be conducted and the methods the operator will utilize to ensure that only persons qualified as above perform these functions. The description shall include:

(a) The operator's organizational element responsible for training and to interface with the Geological Survey in training program matters.

(b) Categories of personnel to be qualified.

(c) Training organizations and courses to be utilized.

(d) Method for ensuring qualification of third-party personnel if utilized.

(e) Method for determining when additional training or requalification is required and for obtaining same.

(f) Method of monitoring operations to ensure that only qualified personnel perform functions.

(g) Method of maintaining documented evidence of qualification at work site.

5. *Crane operations*. Cranes shall be operated and maintained in a manner necessary to ensure the safety of facility operations in accordance with the provisions of API RP 2D, "Operation and Maintenance of Offshore Cranes," October 1972, or other revisions approved by the Area Supervisor.

Records of inspection, testing, and maintenance shall be kept in the field office for a period of one year. API Specification 2C, "Specification for Offshore Cranes," February 1972, or other revisions approved by the Area Supervisor, shall be used as a guideline for the selection of cranes to be used offshore.

6. *Employee orientation and motivation programs for personnel working offshore*.

The operator shall make a planned, continuing effort to eliminate accidents due to human error. This effort shall include the training of personnel in operational aspects of their functions and a program to instill in each individual working offshore a conscious desire to achieve safe and pollution-free operations. Minimum training of personnel going offshore for the first time shall include an orientation in accordance with API RP T-1, "Orientation Program for Personnel Going Offshore the First Time," January 1974, or equivalent. API Bulletin T-5, "Employee Motivation Programs for Safety and Prevention of Pollution in Offshore Operations," September 1974, shall be used as a guide in developing employee safety and pollution-prevention motivation programs. The applicability of any future revisions of the above API documents shall require approval by the Area Supervisor.

7. *Requirements for drilling rigs*. The requirements of subparagraphs 4.D.(1)(g), 4.D.(1)(j), 4.D.(2)(d), and paragraphs 5 and 6 above shall apply to all drilling rigs and mobile drilling units used to conduct drilling or workover operations on the Federal OCS in the Gulf of Mexico.

/s/ D. W. Solanas
Oil and Gas Supervisor
Field Operations
Gulf of Mexico Area

Approved:

/s/ Russell G. Wayland
Acting Chief
Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION
GULF OF MEXICO AREA

OCS ORDER NO. 9

Effective October 30, 1970

OIL AND GAS PIPELINES

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.19(b). Section 250.19(b) provides as follows:

(b) The Supervisor is authorized to approve the design, other features, and plan of installation of all pipelines for which a right of use or easement has been granted under Paragraph (c) of Section 250.18 or authorized under any lease issued or maintained under the Act; including those portions of such lines which extend onto or traverse areas other than the Outer Continental Shelf.

The operator shall comply with the following requirements. Any departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

1. *General Design.* All pipelines shall be designed and maintained in accordance with the following:

A. The operator shall be responsible for the installation of the following control devices on all oil and gas pipelines connected to a platform including pipelines which are not operated or owned by the operator. Operators of platforms installed prior to the effective date of this Order shall comply with the requirements of subparagraphs (1) and (2) within six months of the effective date of this Order. The operator shall submit records semi-annually showing the present status and past history of each device, including dates and details of inspection, testing, repairing, adjustment, and reinstallation.

(1) All oil and gas pipelines leaving a platform receiving production from the platform shall be equipped with a high-low pressure sensor to directly or indirectly shut-in the wells on the platform.

(2) (a) All oil and gas pipelines delivering production to production facilities on a platform shall be equipped with an automatic shut-in valve connected to the platform's automatic and remote shut-in system.

(b) All oil and gas pipelines coming onto a platform shall be equipped with a check valve to avoid backflow.

(c) Any oil or gas pipelines crossing a platform which do not deliver production to the platform, but which may or may not receive production from the platform, shall be equipped with high-low pressure sensors to activate an automatic shut-in valve to be located in the upstream portion of the pipeline at the platform. This automatic shut-in valve shall be connected to either the platform automatic and remote shut-in system or to an independent remote shut-in system.

(d) All pipeline pumps shall be equipped with high-low pressure shut-in devices.

B. All pipelines shall be protected from loss of metal by corrosion that would endanger the strength and safety of the lines either by providing extra metal for corrosion allowance, or by some means of preventing loss of metal such as protective coatings or cathodic protection.

C. All pipelines shall be installed and maintained to be compatible with trawling operations and other uses.

D. All pipelines shall be hydrostatically tested to 1.25 times the designed working pressure for a minimum of 2 hours prior to placing the line in service.

E. All pipelines shall be maintained in good operating condition at all times and inspected monthly for indication of leakage using aircraft, floating equipment, or other methods. Records of these inspections including the date, methods, and results of each inspection shall be maintained by the pipeline operator and submitted annually by April 1. The pipeline operator shall submit records indicating the cause, effect, and remedial action taken regarding all pipeline leaks within one week following each such occurrence.

F. All pipelines shall be designed to be protected against water currents, storm scouring, soft bottoms, and other environmental factors.

2. *Application.* The operator shall submit in duplicate the following to the Supervisor for approval:

A. Drawing on 8″ × 10½″ plat or plats showing the major features and other pertinent data including: (1) water depth, (2) route, (3) location, (4) length, (5) connecting facilities, (6) size, and (7), burial depth, if buried.

B. A schematic drawing showing the following pipeline safety equipment and the manner in which the equipment functions: (1) high-low pressure sensors, (2) automatic shut-in valves, and (3) check valves.

C. General information concerning the pipeline including the following:

(1) Product or products to be transported by the pipeline.

(2) Size, weight, and grade of the pipe.

(3) Length of line.

(4) Maximum water depth.

(5) Type or types of corrosion protection.

(6) Description of protective coating.

(7) Bulk specific gravity of line (with the line empty).

(8) Anticipated gravity or density of the product or products.

(9) Design working pressure and capacity.

(10) Maximum working pressure and capacity.

(11) Hydrostatic pressure and hold time to which the line will be tested after installation.

(12) Size and location of pumps and prime movers.

(13) Any other pertinent information as the Supervisor may prescribe.

3. *Completion Report.* The operator shall notify the Supervisor when installation of the pipeline is completed and submit a drawing on 8″ × 10″ plats showing the location of the line as installed, accompanied by all hydrostatic test data including procedure, test pressure, hold time, and results.

/s/ Robert F. Evans
Supervisor

Approved: October 30, 1970

/s/ Russell G. Wayland
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION

GULF OF MEXICO AREA

OCS ORDER NO. 10

Effective August 28, 1969

SULPHUR DRILLING PROCEDURES

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.34, 250.41, and 250.91. All exploratory core holes for sulphur and all sulphur development wells shall be drilled in accordance with the provisions of this Order, except that development wells shall be drilled in accordance with field rules when established by the supervisor. Each Application to Drill (Form 9–331C) shall include all information required under 30 CFR 250.91 and the integrated casing, cementing, mud, and blowout prevention program for the well. The operator shall comply with the following requirements. Any departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

1. *Well Casing and Cementing.* All wells shall be cased and cemented in accordance with the requirements of 30 CFR 250.41(a)(1). Special consideration to casing design shall be given to compensate for effects caused by subsidence, corrosion, and temperature variation. All depths refer to true vertical depth (TVD).

A. *Drive or Structural Casing.* This casing shall be set by drilling, driving, or jetting to a minimum depth of 100 feet below the Gulf floor, or to such greater depth required to support unconsolidated deposits and to provide hole stability for initial drilling operations. If drilled in, the drilling fluid shall be a type that will not pollute the Gulf, and a quantity of cement sufficient to fill the annular space back to the Gulf floor must be used.

B. *Conductor Casing.* This casing shall be set and cemented before drilling into shallow formations known to contain hydrocarbons or, if unknown, upon encountering such formations. Conductor casing shall extend to a depth of not less than 350 feet nor more than 750 feet below the Gulf floor. A quantity of cement sufficient to fill the annular space back to the Gulf floor must be used. The cement may be washed out or displaced to a depth of 40 feet below the Gulf floor to facilitate casing removal upon well abandonment.

C. *Caprock Casing.* This casing shall be set at the top of the caprock and be cemented with a quantity of cement sufficient to fill the annular space back to the Gulf floor. Stage cementing or other cementing method shall be used to insure cement returns to the Gulf floor.

2. *Blowout Prevention Equipment.* Blowout preventers and related well control equipment shall be installed, used, and tested in a manner necessary to prevent blowouts. Prior to drilling below the conductor casing, blowout prevention equipment shall be installed and maintained ready for use until drilling operations are completed, as follows:

A. *Conductor Casing.* Before drilling below this string, at least one remotely controlled bag-type blowout preventer and equipment for circulating the drilling fluid to the drilling structure or vessel shall be installed. To avoid formation fracturing from complete shut-in of the well, a large diameter pipe with control valves shall be installed on the conductor casing below the blowout preventer so as to permit the diversion of hydrocarbons and other fluids; except that when the blowout preventer assembly is on the Gulf floor, the choke and kill lines shall be equipped to permit the diversion of hydrocarbons and other fluids.

B. *Caprock Casing.* Before drilling below this string, the blowout prevention equipment shall include a minimum of: (1) three remotely controlled, hydraulically operated, blowout preventers with a working pressure which exceeds the maximum anticipated surface pressure, including one equipped with pipe rams, one with blind rams, and one bag-type; (2) a drilling spool with side outlets, if side outlets are not provided in the blowout preventer body; (3) a choke manifold; (4) a kill line; and (5) a fill-up line.

C. *Testing*. Ram-type blowout preventers and related control equipment shall be tested with water to the rated working pressure of the stack assembly, or to the working pressure of the casing, whichever is the lesser, (1) when installed; (2) before drilling out after each string of casing is set; (3) not less than once each week while drilling; and (4) following repairs that require disconnecting a pressure seal in the assembly. The bag-type blowout preventer shall be tested to 70 percent of the above pressure requirements.

While drill pipe is in use ram-type blowout preventers shall be actuated to test proper functioning once each day. The bag-type blowout preventer shall be actuated on the drill pipe once each week. Accumulators or accumulators and pumps shall maintain a pressure capacity reserve at all times to provide for repeated operation of hydraulic preventers. A blowout prevention drill shall be conducted weekly for each drilling crew to insure that all equipment is operational and that crews are properly trained to carry out emergency duties. All blowout preventer tests and crew drills shall be recorded on the driller's log.

D. *Other Equipment*. A drill string safety valve in the open position shall be maintained on the rig floor at all times while drilling operations are being conducted. Separate valves shall be maintained on the rig floor to fit all pipe in the drill string. A Kelly cock shall be installed below the swivel.

3. *Mud Program—General*. The characteristics, use, and testing of drilling mud and the conduct of related drilling procedures shall be such as are necessary to prevent the blowout of any well. Quantities of mud materials sufficient to insure well control shall be maintained readily accessible for use at all times. The following mud control and testing equipment requirements are applicable to operations conducted prior to drilling below the caprock casing.

A. *Mud Control*. Before starting out of the hole with drill pipe, the mud shall be circulated with the drill pipe just off bottom until the mud is properly conditioned. When coming out of the hole with drill pipe, the annulus shall be filled with mud before the mud level drops below 100 feet, and a mechanical device for measuring the amount of mud required to fill the hole shall be utilized. The volume of mud required to fill the hole shall be watched, and any time there is an indication of swabbing, or influx of formation fluids, the drill pipe shall be run to bottom, and the mud properly conditioned. The mud shall not be circulated and conditioned except on or near bottom, unless well conditions prevent running the pipe to bottom.

B. *Mud Testing and Equipment*. Mud testing equipment shall be maintained on the drilling platform at all times, and mud tests shall be performed daily, or more frequently as conditions warrant.

The following mud system monitoring equipment must be installed (with derrick floor indicators) and used throughout the period of drilling after setting and cementing the conductor casing:

(1) Recording mud pit level indicator to determine mud pit volume gains and losses. This indicator shall include a visual or audio warning device.

(2) Mud volume measuring device for accurately determining mud volumes required to fill the hole on trips.

(3) Mud return indicator to determine that returns essentially equal the pump discharge rate.

/s/ Robert F. Evans
Supervisor

Approved: August 28, 1969

/s/ Russell G. Wayland
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVSION

GULF OF MEXICO AREA

OCS ORDER NO. 11

Effective May 1, 1974

OIL AND GAS PRODUCTION RATES, PREVENTION OF WASTE, AND PROTECTION OF CORRELATIVE RIGHTS

This Order is established pursuant to the authority prescribed in 30 CFR 250.1, 30 CFR 250.11, and in accordance with all other applicable provisions of 30 CFR Part 250, and the notice appearing in the Federal Register, dated December 5, 1970 (35 F.R. 18559), to provide for the prevention of waste and conservation of the natural resources of the Outer Continental Shelf, and the protection of correlative rights therein. This Order shall be applicable to all oil and gas wells on Federal leases in the Outer Continental Shelf of the Gulf of Mexico; provided, however, that it shall not apply to oil and gas wells on a lease of which any part lies within the disputed area referred to in paragraph 4 of the Supplemental Decree of December 20, 1971, in United States vs. Louisiana, et al., 404 U.S. 388 (1971). All departures from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 250.12(b). References in this Order to approvals, determinations, and requirements for submittal of information or applications for approval are to those granted, made, or required by the Oil and Gas Supervisor or his delegated representative.

1. *Definition of Terms.* As used in this Order, the following terms shall have the meanings indicated:

A. *Waste of Oil and Gas.* The definition of waste appearing in 30 CFR 250.2(h) shall apply, and includes the failure to timely initiate enhanced recovery operations where such methods would result in an increased ultimate recovery of oil or gas under sound engineering and economic principles. Enhanced recovery operations refers to pressure maintenance operations, secondary and tertiary recovery, cycling, and similar recovery operations which alter the natural forces in a reservoir to increase the ultimate recovery of oil or gas.

B. *Correlative Rights.* The opportunity afforded each lessee or operator to produce without waste his just and equitable share of oil and gas from a common source of supply.

C. *Maximum Efficient Rate (MER).* The maximum sustainable daily oil or gas withdrawal rate from a reservoir which will permit economic development and depletion of that reservoir without detriment to ultimate recovery.

D. *Maximum Production Rate (MPR).* The approved maximum daily rate at which oil may be produced from a specified oil well completion or the maximum approved daily rate at which gas may be produced from a specified gas well completion.

E. *Interested Parts.* The operators and lessees, as defined in 30 CFR 250.2(f) and (g), of the lease or leases involved in any proceeding initiated under this Order.

F. *Reservoir.* An oil or gas accumulation which is separated from and not in oil or gas communication with any other such accumulation.

G. *Competitive Reservoir.* A reservoir as defined herein containing one or more producible or producing well completions on each of two or more leases, or portions thereof, in which the lease or operating interests are not the same.

H. *Property Line.* A boundary dividing leases, or portions thereof, in which the lease or operating interest is not the same. The boundaries of Federally approved unit areas shall be considered property lines. The boundaries dividing leased and unleased acreage shall be considered property lines for the purpose of this Order.

I. *Oil Reservoir.* A reservoir that contains hydrocarbons predominantly in a liquid (single-phase) state.

J. *Oil Well Completion.* A well completed in an oil reservoir or in the oil accumulation of an oil reservoir with an associated gas cap.

K. Gas Reservoir. A reservoir that contains hydrocarbons predominantly in a gaseous (single-phase) state.

L. *Gas Well Completion.* A well completed in a gas reservoir or in the gas cap of an oil reservoir which an associated gas cap.

M. *Oil Reservoir with an Associated Gas Cap.* A reservoir that contains hydrocarbons in both a liquid and a gaseous state (two-phase).

N. *Producible Well Completion.* A well which is physically capable of production and which is shut in at the wellhead or at the surface, but not necessarily connected to production facilities, and from which the operator plans future production.

2. *Classification of Reservoirs.*

A. *Initial Classification.* Each producing reservoir shall be classified by the operator, subject to approval by the Supervisor, as an oil reservoir, an oil reservoir with an associated gas cap, or a gas reservoir.

(1) The initial classification of each reservoir from which production is commenced subsequent to the date of this Order shall be submitted for approval with the initial submittal of MER data for the reservoir.

(2) Each reservoir from which production commenced on or prior to the date of this Order shall be classified by the operator, based on existing reservoir conditions. Such classification shall be determined and submitted to the Supervisor within six (6) months of the date of this Order.

B. *Reclassification.* A reservoir may be reclassified by the Supervisor, on his own initiative or upon application of an operator, during its productive life when information becomes available showing that such reclassification is warranted.

3. *Oil and Gas Production Rates.*

A. *Maximum Efficient Rate (MER).* The operator shall propose a maximum efficient rate (MER) for each producing reservoir based on sound engineering and economic principles. When approved at the proposed or other rate, such rate shall not be exceeded, except as provided in paragraph 4 of this Order.

(1) *Submittal of Initial MER.* Within 45 days after the date of first production or such longer period as may be approved, the operator shall submit a Request for Reservoir MER (Form 9-1866) with appropriate supporting information.

(2) *Revision of MER.* The operator may request a revision of an MER by submitting the proposed revision to the Supervisor on a Request for Reservoir MER (Form 9-1866) with appropriate supporting information. The Operator shall obtain approval to produce at test rates which exceed an approved MER when such testing is necessary to substantiate an increase in the MER.

(3) *Review of MER.* The MER for each reservoir will be reviewed by the operator annually, or at such other required or approved interval of time. The results of the review, with all current supporting information, shall be submitted on a Request for Reservoir MER (Form 9-1866).

(4) *Effective Date of MER.* The effective date of an MER, or revision thereof, will be determined by the Supervisor and shown on a Request for Reservoir MER (Form 9-1866) when the MER is approved. The effective date for an initial MER shall be the first day following the completion of an approved testing period. The effective date for a revised MER shall be the first day following the completion of an approved testing period, or if testing is not conducted, the date the revision is approved.

B. *Maximum Production Rate (MPR).* The operator shall propose a maximum production rate (MPR) for each producing well completion in a reservoir together with full information on the method used in its determination. When an MPR has been approved for a well completion, that rate shall not be exceeded, except as provided in paragraph 4 of this Order. The MPR shall be based on well tests and any limitations imposed by (1) well tubing, safety equipment, artificial lift equipment, surface back pressure, and equipment capacity; (2) sand producing problems; (3) producing gas-oil and water-oil ratios; (4) relative structural position of the well with respect to gas-oil or water-oil contacts; (5) position of perforated interval within total production zone; and (6) prudent operating practices. The MPR established for each well completion shall not exceed 110 percent of the rate demonstrated by a well test unless justified by supporting information.

(1) *Submittal of Initial MPR.* The operator shall have 30 days from the date of first continuous production within which to conduct a potential test, as specified under subparagraphs 5.B and 6.B of this Order, on all new and reworked well completions. Within 15 days after the date of the potential test, the operator shall submit a proposed MPR for the individual well

completion on a Request for Well Maximum Production Rate (MPR) (Form 9-1867), with the results of the potential test on a Well Potential Test Report (Form 9-1868). Extension of the 30-day test period may be granted. The effective date for any approved initial MPR shall be the first day following the test period. During the 30-day period allowed for testing, or any approved extensions thereof, the operator may produce a new or reworked well completion at rates necessary to establish the MPR. The operator shall report the total production obtained during the test period, and approved extensions thereof, on the Well Potential Test Report (Form 9-1868).

(2) *Revision of MPR Increase.* If necessary to test a well completion at rates above the approved MPR to determine whether the MPR should be increased, notification of intent to test the well at such higher rates, not to exceed a stated maximum rate during a specified test period, shall be filed with the Supervisor. Such tests may commence on the day following the date of filing notification, unless otherwise ordered by the Supervisor. If an operator determines that the MPR should be increased, he shall submit, within 15 days after the specified test period, a proposed increased MPR on a Request for Well Maximum Production Rate (MPR) (Form 9-1867), and any other available data to support the requested revision, including the results of the potential test and the total production obtained during the test period on a Well Potential Test Report (Form 9-1868). Prior to approval of the proposed increased MPR, the operator may produce the well completion at a rate not to exceed the proposed increased MPR of the well. The effective date for any approved increased MPR shall be the first day following the test period. If testing rates or increased MPR rates result in production from the reservoir in excess of the approved MER, this excess production shall be balanced by underproduction from the reservoir under the provisions of subparagraph 4.B of this Order.

(3) *Revision of MPR Decrease.* When the quarterly test rate for an oil well completion or the semiannual test rate for a gas well completion required under subparagraphs 5.C and 6.C of this Order is less than 90 percent of the existing approved MPR for the well, a new reduced MPR will be established automatically for that well completion equal to 110 percent of the test rate submitted. The effective date for the new MPR for such well completion shall be the first day of the quarter following the required date of submittal of periodic well-test results under subparagraphs 5.C and 6.C of this Order. Also, the operator may notify the Supervisor on a Request for Well Maximum Production Rate (MPR) (Form 9-1867) of, or the Supervisor may require a downward revision of a well MPR at any time when the well is no longer capable of producing its approved MPR on a sustained basis. The effective date for such reduced MPR for a well completion shall be the first day of the month following the date of notification. (4) *Continuation of MPR.* If submittal of the results of a quarterly well test for an oil completion or a semiannual well test for a gas well completion, as provided for in subparagraphs 5.C and 6.C of this Order, cannot be timely, continuation of production under the last approved MPR for the well may be authorized, provided an extension of time in which to submit the test results is requested and approved in advance.

(5) *Cancellation of MPR.* When a well completion ceases to produce, is shut in pending workover, or any other condition exists which causes the assigned MPR to be no longer appropriate, the operator shall notify the Supervisor accordingly on a Request for Well Maximum Production Rate (MPR) (Form 9-1867), indicating the date of last production from the well, and the MPR will be canceled. Reporting of temporary shut-ins by the operator for well maintenance, safety conditions, or other normal operation conditions is not required, except as is necessary for completion of the Monthly Report of Operations (Form 9-152).

C. *MER and MPR Relationship.* The withdrawal rate from a reservoir shall not exceed the approved MER and may be produced from any combination of well completions subject to any limitations imposed by the MPR established for each well completion. The rate of production from the reservoir shall not exceed the MER although the summation of individual well MPR's may be greater than the MER.

4. *Balancing of Production.*

A. *Production Variances.* Temporary well production rates resulting from normal variations and fluctuations exceeding a well MPR or reservoir MER shall not be considered a violation of this Order, and such production may be sold or transferred pursuant to paragraph 8 of this Order. However, when normal variations and fluctuations result in production in excess of a reservoir MER, any operator who is overproduced shall balance such production in accordance with subparagraph 4.B below. Such operator shall advise the Supervisor of the amount of such excess production from the reservoir for the month at the same time as Form 9-152 is filed for that month.

B. *Balancing Periods.* As of the first day of the month following the month in which this Order becomes effective, all reservoirs shall be considered in balance. Balancing periods for overproduction of a reservoir MER shall end on January 1, April 1, July 1, and October 1 of each year. If a reservoir is produced at a rate in excess of the MER for any month, the operator who is overproduced shall take steps to balance production during the next succeeding month. In any event, all overproduction shall be balanced by the end of the next succeeding quarter following the quarter in which the overproduction occurred. The operator shall notify the Supervisor at the end of the month in which he has balanced the production from an overproduced reservoir.

C. *Shut-in for Overproduction.* Any operator in an overproduction status in any reservoir for two successive quarters which has not been brought into balance within the balancing period shall be shut in from that reservoir until the actual production equals that which would have occurred under the approved MER.

D. *Temporary Shut-in.* If, as a result of storm, hurricanes, emergencies, or other conditions perculiar to offshore operations, an operator is forced to curtail or shut in production from a reservoir, the Supervisor may, on request, approve makeup of all or part of this production loss.

5. *Oil Well Testing Procedures.*

A. *General.* Tests shall be conducted for not less than four consecutive hours. Immediately prior to the 4-hour test period, the well completion shall have produced under stabilized conditions for a period of not less than six consecutive hours. The 6-hour pretest period shall not begin until after recovery of a volume of fluid equivalent to the amount of fluids introduced into the formation for any purpose. Measured gas volumes shall be adjusted to the standard conditions of 15.015 psia and 60°F. for all tests. When orifice meters are used, a specific gravity shall be obtained or estimated for the gas and a specific gravity correction factor applied to the orifice coefficient. The Supervisor may require a prolonged test or retest of a well completion if such test is determined to be necessary for the establishment of a well MPR or a reservoir MER. The Supervisor may approve test periods of less than four hours and pretest stabilization periods of less than six hours for well completions, provided that test reliability can be demonstrated under such procedures.

B. *Potential Test.* Test data to establish or to increase an oil well MPR shall be submitted on a Well Potential Test Report (Form 9-1868). The total production obtained from all tests during the test period shall be reported on such form.

C. *Quarterly Test.* Tests shall be conducted on each producing oil well completion quarterly, and test results shall be submitted on a Quarterly Oil Well Test Report (Form 9-1869). Testing periods and submittal dates shall be as follows:

Testing Period	Latest Date for Submittal of Test Results	For Quarter Beginning
Sept. 11—Dec. 10	Dec. 10	Jan. 1
Dec. 11—Mar. 10	Mar. 10	April 1
Mar. 11—June 10	June 10	July 1
June 11—Sept. 10	Sept. 10	Oct. 1

There shall be a minimum of 45 days between quarterly tests for an oil well completion.

6. *Gas Well Testing Procedures.*

A. *General.* Testing procedures for gas well completions shall be the same as those specified for oil well completions in subparagraph 5.A except for the initial test which shall be a multi-point back-pressure test as described in paragraph 6.D.

B. *Potential Test.* Test data to establish or to increase a gas well MPR shall be submitted on a Well Potential Test Report (Form 9-1868).

C. *Semiannual Test.* Tests shall be conducted on each producing gas well completion semiannually, and test results shall be submitted on a Semiannual Gas Well Test Report (Form 9-1870). Testing periods and submittal dates shall be as follows:

Testing Period	For Submittal of Test Results	For Semi-Annual Period Beginning
June 11—Dec. 10	Dec. 10	Jan. 1
Dec. 11—June 10	June 10	July 1

There shall be a minimum of 90 days between semiannual tests for a gas well completion.

D. *Back-Pressure Tests.* A multi-point back-pressure test to determine the theoretical open-flow potential of gas wells shall be conducted within thirty days after connection to a pipeline. If bottom-hole pressures are not measured, such pressures shall be calculated from surface pressures using the method, or other similar method, found in the Interstate

Oil Compact Commission (IOCC) Manual of Back-Pressure Testing of gas wells. The results of all back-pressure tests conducted by the operator shall be filed with the Supervisor, including all basic data used in determining the test results. The Supervisor may waive this requirement if multi-point back-pressure test information has previously been obtained on a representative number of wells in a reservoir.

7. *Witnessing Well Tests*. The Supervisor may have a representative witness any potential or periodic well tests on oil and gas well completions. Upon request, an operator shall notify the appropriate District office of the time and date of well tests.

8. *Sale or Transfer of Production*. Oil and gas produced pursuant to the provisions of this Order, including test production, may be sold to purchasers or transferred as production authorized for disposal hereunder.

9. *Bottom-Hole Pressure Tests*. Static bottom-hole pressure tests shall be conducted annually on sufficient key wells to establish an average reservoir pressure in each producing reservoir unless a different frequency is approved. The Operator may be required to test specific wells. Results of bottom-hole pressure tests shall be submitted within 60 days after the date of the test.

10. *Flaring and Venting of Gas*. Oil- and gas-well gas shall not be flared or vented, except as provided herein.

A. *Small-Volume of Short-Term Flaring or Venting*. Oil- and gas-well gas may be flared or vented in small volumes or temporarily without the approval of the Supervisor in the following situations:

(1) *Gas Vapors*. When gas vapors are released from storage and other low-pressure production vessels if such gas vapors cannot be economically recovered or retained.

(2) *Emergencies*. During temporary emergency situations, such as compressor or other equipment failure, or the relief of abnormal system pressures.

(3) *Well Purging and Evaluation Tests*. During the unloading or cleaning up of a well and during drillstem, producing, or other well evaluation tests not exceeding a period of 24 hours.

B. *Approval for Routine or Special Well Tests*. Oil- and gas-well gas may be flared or vented during routine and special well tests, other than those described in paragraph A above, only after approval of the Supervisor.

C. *Gas-Well Gas*. Except as provided in A and B above, gas-well gas shall not be flared or vented.

D. *Oil-Well Gas*. Except as provided in A and B above, oil-well gas shall not be flared or vented unless approved by the Supervisor. The Supervisor may approve an application for flaring or venting of oil-well gas for periods not exceeding one year if (1) the operator has initiated positive action which will eliminate flaring or venting, or (2) the operator has submitted an evaluation supported by engineering, geologic, and economic data indicating that rejection of an application to flare or vent the gas will result in an ultimate greater loss or equivalent total energy than could be recovered for beneficial use from the lease if flaring or venting were allowed.

E. *Content of Application*. Applications under paragraph D above for existing operations, as of the date of this Notice, shall be filed within three months from the effective date of this Order. Applications under paragraph D(2) above shall include all appropriate engineering, geologic, and economic data in an evaluation showing that absence of approval to flare or vent the gas will result in premature abandonment of oil and gas production or curtailment of lease development. Applications shall include an estimate of the amount and value of the oil and gas reserves that would not be recovered if the application to flare or vent were rejected and an estimate of the total amount of oil to be recovered and associated gas that would be flared or vented if the application were approved.

11. *Disposition of Gas*. The disposition of all gas produced from each lease shall be reported monthly on, or attached to, Form 9-152. The report shall be submitted in the following manner:

	Oil-Well Gas (MCF)	Gas-Well Gas (MCF)
Sales	....	....
Fuel	....	....
*Injected	....	....
Flared	....	....
Vented	....	....
Other (Specify)	....	....
Total	....	....

*Gas produced from the lease and injected on or off the lease.

12. *Multiple and Selective Completions*.

A. *Number of Completions*. A well bore may contain any number of producible completions when justified and approved.

B. *Numbering Well Completions*. Well completions made after the date of this Order shall be designated using numerical and alphabetical nomenclature. Once designated as a reservoir completion, the well completion number shall not change. Appendix A contains a detailed explanation of procedures for naming well completions.

C. *Packer Tests.* Multiple and selective completions shall be equipped to isolate the respective producing reservoirs. A packer test or other appropriate reservoir isolation test shall be conducted prior to or immediately after initiating production and annually thereafter on all multiply completed wells. Should the reservoirs in any multiply completed well become intercommunicative the operator shall make repairs and again conduct reservoir isolation tests unless some other operational procedure is approved. The results of all tests shall be submitted on a Packer Test (Form 9-1871) within 30 days after the date of the test.

D. *Selective Completions.* Completion equipment may be installed to permit selective reservoir isolation or exposure in a well bore through wireline or other operations. All selective completions shall be designated in accordance with subparagraph 12.B when the application for approval of such completions is filed.

E. *Commingling.* Commingling of production from two or more separate reservoirs within a common well bore may be permitted if it is determined that, collectively, the ultimate recovery will not be decreased. An application to commingle hydrocarbons from multiple reservoirs within a common well bore shall be submitted for approval and shall include all pertinent well information, geologic and reservoir engineering data, and a schematic diagram of well equipment. For all competitive reservoirs, notice of the application shall be sent by the applicant to all other operators of interest in the reservoirs prior to submitting the application to the Supervisor. The application shall specify the well completion number to be used for subsequent reporting purposes.

13. *Gas-Cap Well Completions.* All existing and future wells completed in the gas cap of a reservoir which has been classified and approved as an associated oil reservoir shall be shut in until such time as the oil is depleted or the reservoir is reclassified as a gas reservoir; provided, however, that production from such wells may be approved when (1) it can be shown that such gas-cap production would not lead to waste of oil and gas, or (2) when necessary to protect correlative rights unless it can be shown that this production will lead to waste of oil and gas.

143. *Location of Wells.*

A. *General.* The location and spacing of all exploratory and development wells shall be in accordance with approved programs and plans required in 30 CFR 250.17 and 250.34. Such location and spacing shall be determined independently for each lease or reservoir in a manner which will locate wells in the optimum structural position for the most effective production of reservoir fluids and to avoid the drilling of unnecessary wells.

B. *Distance from Property Line.* An operator may drill exploratory or development wells at any location on a lease in accordance with approved plans; provided that no well directionally or vertically drilled and completed after the date of this Order in which the completed interval is less than 500 feet from a property line shall be produced unless approved by the Supervisor.

For wells drilled as vertical holes, the surface location of the well shall be considered as the location of the completed interval but shall be subject to the provisions of 30 CFR 250.40(b). An operator requesting approval to produce a directionally drilled well in which the completed interval is located closer than 500 feet from a property line, or approval to produce a vertically drilled well with a surface location closer than 500 feet from a property line, shall furnish the Supervisor with letters expressing acceptance or objection from operators of offset properties.

15. *Enhanced Oil and Gas Recovery Operations.* Operators shall timely initiate enhanced oil and gas recovery operations for all competitive and noncompetitive reservoirs where such operations would result in an increased ultimate recovery of oil or gas under sound engineering and economic principles. A plan for such operations shall be submitted with the results of the annual MER review as required in paragraph 3A(3) of this Order.

16. *Competitive Reservoir Operations.* Development and production operations in a competitive reservoir may be required to be conducted under either pooling and drilling agreements or unitization agreements when the Conservation Manager determines, pursuant to 30 CFR 250.50 and delegated authority, that such agreements are practicable and necessary or advisable and in the interest of conservation.

A. *Competitive Reservoir Determination.* The Supervisor shall notify the operators when he has made a preliminary determination that a reservoir is competitive as defined in this Order. An operator may request at any time that the Supervisor make a preliminary determination as to whether a reservoir is competitive. The operators, within thirty (30) days of such preliminary notification or such extension of time as approved by the Supervisor, shall advise of their concurrence with such determination, or submit objections with supporting evidence. The Supervisor will make a final determination and notify the operators.

B. *Development and Production Plans*. When drilling and/or producing operations are conducted in a competitive reservoir, the operators shall submit for approval a plan governing the applicable operations. The plan shall be submitted within ninety (90) days after a determination by the Supervisor that a reservoir is competitive or within such extended period of time as approved by the Supervisor. The plan shall provide for the development and/or production of the reservoir, and may provide for the submittal of supplemental plans for approval by the Supervisor.

(1) *Development Plan*. When a competitive reservoir is still being developed or future development is contemplated, a development plan may be required in addition to a production plan. This plan shall include the information required in 30 CFR 250.34. If agreement to a joint development plan cannot be reached by the operators, each shall submit a separate plan and any differences may be resolved in accordance with paragraph 17 of the Order.

(2) *Production Plan*. A joint production plan is required for each competitive reservoir. This plan shall include (a) the proposed MER for the reservoir, (b) the proposed MPR for each completion in the reservoir, (c) the percentage allocation of reservoir MER for each lease involved, and (d) plans for secondary recovery or pressure maintenance operations. If agreement to a joint production plan cannot be reached by the operators, each shall submit a separate plan, and any differences may be resolved in accordance with paragraph 17 of this Order.

C. *Utilization*. The Conservation Manager shall determine when conservation will be best served by unitization of a competitive reservoir, or any reservoir reasonable delineated and determined to be productive, in lieu of a development and/or production plan or when the operators and lessees involved have been unable to voluntarily effect unitization. In such cases, the Conservation Manager may require that development and/or production operations be conducted under an approved unitization plan. Within six (6) months after notification by the Conservation Manager that such a unit plan is required, or within such extended period of time as approved by the Conservation Manager, the lessees and operators shall submit a proposed unit plan for designation of the unit area and approval of the form of agreement pursuant to 30 CFR 250.51.

17. *Conferences, Decisions and Appeals*. Conferences with interested parties may be held to discuss matters relating to applications and statements of position filed by the parties relating to operations conducted pursuant to this Order. The Supervisor or Conservation Manager may call a conference with one or more, or all, interested parties on his own initiative or at the request of any interested party. All interested parties shall be served with copies of the Supervisor's or Conservation Manager's decisions. Any interested party may appeal decisions of the Supervisor or Conservation Manager pursuant to 30 CFR 250.8l. Decisions of the Supervisor or Conservation Manager shall remain in effect and shall not be suspended by reason of any appeal, except as provided in that regulation.

/s/ J. B. Lowenhaupt
Oil and Gas Supervisor
Production Control
Gulf of Mexico Area

Approved: May 1, 1974

/s/ Russell G. Wayland
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION
GULF OF MEXICO AREA

OCS ORDER NO. 11
APPENDIX A

Subparagraph 12.B.: "Numbering Well Completions. Well completions made after the date of this Order shall be designated using numerical and alphabetical nomenclature. Once designated as a reservoir completion, the well completion number shall not change..."

The intent of this subparagraph is not necessarily to change the existing well completion names but to change the method of naming well completions after the effective date of this Order in order to insure that a completion in a given reservoir and a specific well bore will be assigned a unique name and will retain that name permanently. For further clarification, the following guidelines and examples are offered:

1. Each well bore will have a distinct, permanent number.
2. Each reservoir completion in a well bore will have a unique permanent designation which includes the well bore number in its nomenclature.
3. For the purpose of this subparagraph, a "completion" is defined as all perforations in a given reservoir in a specific well bore and is not necessarily associated with a tubing string or strings.
4. If more than one completion is made in a well bore, an alphabetical suffix must be used in the nomenclature to differentiate between completions.
5. An alphabetical prefix may be utilized to designate the platform from which the well will be produced.

Example No. 1: The first well drilled from the A platform is a single completion.

Well No. A-1

(Should an operator wish to use an alphabetical suffix with a single completion, he may do so.)

Example No. 2: A well drilled by a mobile rig need not carry an alphabetical prefix.

Well No. 1

(If the well is later connected to and produced from a production platform, the well shall be redesignated to reflect an alphabetical prefix.)

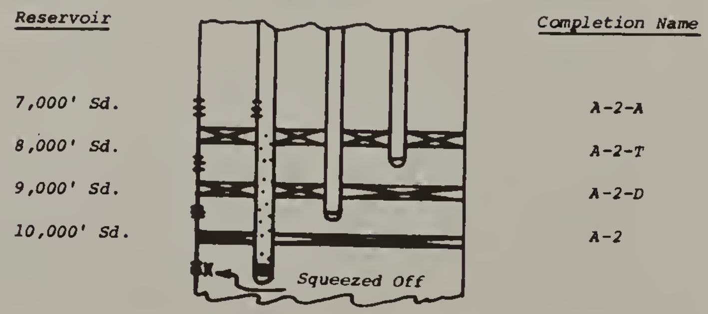
Example No. 3: The second well drilled from the A Platform is a triple completion.

First Completion	Second Completion	Third Completion
A-2	A-2-D	A-2-T

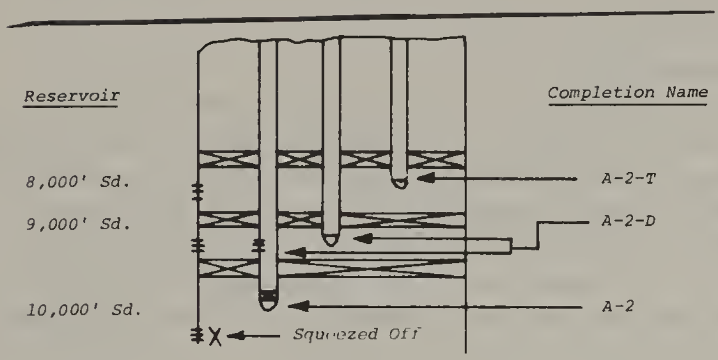
(In the above example, the letters "D" and "T" were used in naming the second and third completions utilizing current industry practice, although the intent is not to restrict operators to the use of these particular alphabetical suffixes. Any alphabetical suffix may be used as long as it is unique to the completion in that reservoir.)

Example No. 4: The drawing is shown to illustrate the fact that once a completion in a specific well bore is designated in a given reservoir, it will retain that name permanently. Let us consider the A-2 completion shown in Example No. 3. Should a recompletion be made in a different reservoir at a later date, it shall be renamed; however, the production from the reservoir associated with the original A-2 completion will always be identified with the A-2 completion. Once the A-2 completion in the 10,000′ sand is squeezed and plugged off and the recompletion made to the 7,000′ sand, the completion in the 7,000′ sand would be designated A-2-A (or some other alphabetical suffix other than the "D" or "T" presently associated with other completions in the 9,000′ and 8,000′ sands).

The Sundry Notices and Reports on Wells (Form 9-331) submitted to obtain approval for the workover shall be the vehicle for naming the new completion.



Example No. 5: If the A-2 completion in Example No. 4 had been recompleted from the 10,000′ sand to the 9,000′ sand (where the A-2-D is currently completed), the completion would still be named A-2-D as both tubing strings would be considered one completion for purposes of this Order.



UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION
GULF OF MEXICO AREA

OCS ORDER NO. 12

Effective February 1, 1975

PUBLIC INSPECTION OF RECORDS

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.97 and 43 CFR 2.2, and supersedes OCS Order No. 12, dated August 13, 1971. Section 250.97 of 30 CFR provides as follows:

Public Inspection of Records. Geological and geophysical interpretations, maps, and data required to be submitted under this part shall not be available for public inspection without the consent of the lessee so long as the lease remains in effect or until such time as the supervisor determines that release of such information is required and necessary for the proper development of the field or area.

Section 2.2 of 43 CFR provides in part as follows:

Determinations as to Availability of Records. (a) Section 552 of Title 5, U.S. Code, as amended by Public Law 90-23 (the act codifying the "Public Information Act") requires that identifiable agency records be made available for inspection. Subsection (b)[1] of section 552 exempts several categories of records from the general requirement but does not require the withholding from inspection of all records which may fall within the categories exempted. Accordingly, no request made of a field office to inspect a record shall be denied unless the head of the office or such higher field authority as the head of the bureau may designate shall determine (1) that the record falls within one or more of the categories exempted and (2) either that disclosure is prohibited by statute or Executive Order or that sound grounds exist which require the invocation of the exemption. A request to inspect a record located in the headquarters office or a bureau shall not be denied except on the basis of a similar determination made by the head of the bureau or his designee, and a request made to inspect a record located in a major organizational unit of the Office of the Secretary shall not be denied except on the basis of a similar determination by the head of that unit. Officers and employees of the Department shall be guided by the "Attorney General's Memorandum on the Public Information Section of the Administrative Procedure Act" of June 1967.

(b) An applicant may appeal from a determination that a record is not available for inspection to the Solicitor of the Department of the Interior, who may exercise all of the authority of the Secretary of the Interior in this regard. The Deputy Solicitor may decide such appeals and may exercise all of the authority of the Secretary in this regard.

The operator shall comply with the requirements of this Order. Any departures from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 250.12(b).

1. *Availability of Records Filed on or after December 1, 1970.* It has been determined that certain records pertaining to leases and wells in the Outer Continental Shelf and submitted under 30 CFR 250 shall be made available for public inspection, as specified below, in the Area Office, Metairie, Louisiana.

A. *Form 9-152—Monthly Report of Operations.* All information contained on this form shall be available, except the information required in the Remarks column.

B. *Form 9-330—Well Completion or Recompletion Report and Log.*

(1) Prior to commencement of production, all information contained on this form shall be available, except Item 1a, Type of Well; Item 4, Location of Well, At top prod. interval reported below; Item 22, if Multiple Compl., How many; Item 24, Producing Interval; Item 26, Type Electric and Other Logs Run; Item 28, Casing Record; Item 29, Liner Record; Item 30, Tubing Record; Item 31, Perforation Record; Item 32, Acid, Shot, Fracture, Cement Squeeze, etc.; Item 33, Production; Item 37, Summary of Porous Zones; and Item 38, Geologic Markers.

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[1] Subsection (b) of section 552 provides that:

(b) This section does not apply to matters that are—

* * *

(4) Trade secrets and commercial or financial information obtained from a person and privileged or confidential;

* * *

(9) Geological and geophysical information and data, including maps, concerning wells.

(2) After commencement of production, all information shall be available, except Item 37, Summary of Porous Zones; and Item 38, Geologic Markers.

(3) If production has not commenced after an elapsed time of five years from the date of filing Form 9-330 as required in 30 CFR 250.38(b), all information contained on this form shall be available, except Item 37, Summary of Porous Zones; and Item 38, Geologic Markers. Within 90 days prior to the end of the 5-year period, the lessee or operator shall file a Form 9-330 containing all information requested on the form, except Item 37, Summary of Porous Zones; and Item 38, Geologic Markers, to be made available for public inspection. Objections to the release of such information may be submitted with the completed Form 9-330.

C. *Form 9-331—Sundry Notices and Report on Wells.*

(1) When used as a "Notice of Intention to" conduct operations, all information contained on this form shall be available, except Item 4, Location of Well, At top prod. interval, and Item 17, Describe Proposed or Completed Operations.

(2) When used as a "Subsequent Report of" operations, and after commencement of production, all information contained on this form shall be available, except information under Item 17 as to subsurface locations and measured and true vertical depths for all markers and zones not placed on production.

D. *Form 9-331C—Application for Permit to Drill, Deepen or Plug Back.* All information contained on this form, and location plat attached thereto, shall be available, except Item 4, Location of Well, At proposed prod. zone; and Item 23, Proposed Casing and Cementing Program.

E. *Form 9-1869—Quarterly Oil Well Test Report.* All information contained on this form shall be available.

F. *Form 9-1870—Semi-Annual Gas Well Test Report.* All information contained on this form shall be available.

G. *Multi-point Back Pressure Test Report.* All information contained on this form used to report the results of required multi-point back pressure test of gas wells shall be available.

H. *Sales of Lease Production.* Information contained on monthly Geological Survey computer printout showing sales volumes, value, and royalty of production of oil, condensate, gas and liquid products, by lease, shall be made available.

2. *Filing of Reports.* All reports on Forms 9-152, 9-330, 9-331, 9-331C, 9-1869, 9-1870, and the forms used to report the results of multi-point back pressure tests, shall be filed in accordance with the following: All reports submitted on these forms after the effective date of this Order shall include a copy with the words "Public Information" shown on the lower right-hand corner. All items on the form not marked "Public Information" shall be completed in full; and such forms, and all attachments thereto, shall not be available for public inspection. The copy marked "Public Information" shall be completed in full, except that the items described in 1(A), (B), (C), and (D) above, and the attachments relating to such items, may be excluded. The words "Public Information" shall be shown on the lower right-hand corner of this set. This copy of the form shall be made available for public inspection.

3. *Availability of Records Filed Prior to December 1, 1970.* Information filed prior to December 1, 1970, on Forms 9-152, 9-330, 9-331, and 9-331C is not in a form which can be readily made available for public inspection. Requests for information on these forms shall be submitted to the Supervisor in writing and shall be made available in accordance with 43 CFR Part 2.

4. *Availability of Inspection Records.* All accident investigation reports, pollution incident reports, facilities inspection data, and records of enforcement actions are also available for public inspection.

/s/ D. W. Solanas
Oil and Gas Supervisor
Field Operations

Approved: January 27, 1975

/s/ Russell G. Wayland
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION
GULF OF MEXICO AREA

OCS ORDER NO. 13

Effective October 1, 1975

PRODUCTION MEASUREMENT AND COMMINGLING

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.45, 250.60, and 250.61, and 250.68.

Section 250.60 provides as follows:

Measurement of oil. The lessee shall gauge and measure all production in accordance with methods approved by the Supervisor. The lessee shll provide tanks suitable for measuring accurately the crude oil produced from the lease (exact copies of 100 percent capacity tank tables to be furnished to the Supervisor) or may arrange with the Supervisor for other acceptable methods of measuring, storing, and recording production. The quantity and quality of all production shall be determined in accordance with the standard practices, procedures, and specifications generally used by the industry.

Section 250.61 provides as follows:

Measurement of gas. The lessee shall measure all gas production in accordance with methods approved by the Supervisor, and the measured volumes shall be adjusted to the standard pressure base of 10 ounces above the atmospheric pressure of 14.4 pounds per square inch, a standard temperature of 60° Fahrenheit, and for deviation from Boyle's law. If gas is being disposed of at a different pressure base, the Supervisor may require that gas volumes be adjusted to conform to such base.

Section 250.68 provides as follows:

Commingling production. Subject to such conditions as he may prescribe for measurement and allocation of production, the Supervisor may authorize the lessee to move production from the lease to a central point for purposes of treating, measuring, and storing, and in moving such production, the lessee may commingle the production from different wells, leases, pools and fields, and with production of other operators. The central point may be on shore or at any other convenient place selected by lessee.

The operator shall be responsible for compliance with the requirements of this Order in the installation and operation of all terminals or offshore sales points, including all facilities installed at measurement terminals or offshore sales points, whether or not operated or owned by the operator. Any departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

1. *Definition of Terms.* As used in this Order, the following terms shall have the meanings indicated:

A. *Terminal.* Any onshore facility used in measuring the quantity and quality of produced liquids from Gulf of Mexico OCS leases for the purpose of computing royalties due the United States.

B. *Offshore Sales Point.* Any facility located on an offshore structure, at which point the produced fluids are measured by automatic custody transfer equipment, tank gauges, or meters for the purpose of computing royalties due the United States.

2. *Liquid Sales Meters.* The following requirements shall apply to all sales meters located at terminals and offshore sales points. Operators of sales meters at terminals and offshore sales points shall comply with the requirements of subparagraphs A through C by the first day of the month following six months after the date of this Order.

A. *Equipment Requirements.* Metering facilities at terminals or offshore sales points shall include the following components, which shall be compatible with the systems to which they are connected:

(1) *Meter.* Positive-displacement meter or other liquid meter approved by the Supervisor, equipped with a nonreset totalizer to remain sealed while the meter is in service. A temperature or other compensator, or a recorder, may be a component of the meter, but all such devices shall be sealed or shall be tamper proof while in service. The piping system shall be arranged to

prevent reversal of flow of liquid through the meter. Meters subjected to pressure pulsation or surges shall be adequately protected by surge tanks, expansion chambers, or similar devices. No meter shall be subjected to shock pressures which are greater than its maximum-rated working pressure. All meter installations shall be designed to operate within the gravity range specified by the meter manufacturer. The pressure and flow rate through each meter shall be maintained within manufacturer's maximum and minimum specifications for rates capacity. There shall be no bypasses around the meter.

(2) *Meter Prover*. Calibrated prover tank, master meter, or mechanical displacement proved.

(3) *Sampler*. Proportional-to-flow sampling device, with sampling point immediately upstream of the meters and downstream of any diverter valve installed upstream of the meters. The sample container shall be vaportight, with a mixing device to permit complete mixing of the sample prior to removal from the container. The sampler probe shall extend into the center of the flow piping in a vertical run. The probe shall always be in a horizontal position. The composite sample accumulated in a run period, which is the basis of the gravity and BS&W measurements, shall be representative of all crude oil delivered.

(4) *Deaerator*. When a deaerator is utilized, it shall be located upstream of the meters and shall in no case be of a smaller rated maximum capacity than that of the pump or feed lines and shall provide complete air elimination.

(5) *BS&W Monitor*. When a BS&W monitor is used it shall be installed upstream of the meters and sampling device, and designed to sound an alarm, shut down the pumps, or to divert the liquid stream back to the treater vessels, water separation tanks, or bad-oil tank in the event excessive BS&W content is detected in the oil.

B. *Gravity, BS&W, and Temperature Determinations*. The volume of metered oil shall be corrected, using factors determined as follows:

(1) *API Gravity*. The hydrometer method is the most suitable for determining the API gravity of crude petroleum. The testing procedure shall be in accordance with API Standard 2544 and ASTM Designation D287-67, Standard Method of Test for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method), 1967.

(2) *BS&W*. Determination of water and sediment in crude oils shall be in accordance with API Standard 2542 and ASTM Designation D96-68, Standard Methods of Test for Water and Sediment in Crude Oils (1968).

(3) *Temperature*. Determination of the average temperature necessary to calculate volumes at a standard temperature of 60° Fahrenheit shall be in accordance with API Standard 2543 and ASTM Designation D1086-64, American Standard Method of Measuring the Temperature of Petroleum and Petroleum Products (1964), except when the volume is determined from a temperature-compensated or temperature-recording meter.

C. *Sales Meter Proving Requirements*. The following meter proving procedures shall be followed by all operators of liquid sales meters. Calibration of the sales meters shall be witnessed by purchaser (if different from the seller), USGS, or other party acceptable to the Supervisor.

(1) *Certification*. The integrity of the calibration of each mechanical displacement prover or prover tank or master meter must be traceable to test measures which have been certified by the National Bureau of Standards.

(2) *Frequency*. Each operating meter or master meter shall be proved every month within a tolerance of fifteen (15) days, or at any other time upon request of the Supervisor.

(3) *Establishing Meter Factors*.

(a) *Prover Tank*. In establishing the meter factor with a prover tank, proof runs shall be made and recorded until two (2) consecutive runs have results within a tolerance of 0.0005 (.05 percent) prover tank volume. An average of the results of these two (2) runs will be used for the meter factor.

(b) *Master Meter*. In establishing the operating meter factor with a master meter, the master meter shall first be operating within manufacturer's specifications, calibrated with similar gravity crude and flow rate. Proof runs shall be made until three (3) consecutive runs have results within a tolerance of 0.0002. The volume of each run shall be at least ten (10) percent of the hourly rated capacity of the operating meter but must be of sufficient amount for determination of an accurate operating meter factor. The master metering installation shall include:

(i) A back-pressure valve downstream of the operating and master meter.

(ii) A check valve to prohibit back flow.

(c) *Mechanical-Displacement Prover.* In establishing the operating meter factor with a mechanical-displacement prover, a minimum of five (5) out of six (6) consecutive runs for an unidirectional prover or round trips for a bidirectional prover shall be within a tolerance of 0.0005. An average of these five runs will be used to compute the meter factor.

(d) *Preliminary Run.* For any of the three methods of proving the operating meter (prover tank, master meter, or mechanical-displacement prover), a preliminary unrecorded run should be made to equalize temperatures, displace vapors or gases, and wet the interior of the prover, where necessary. More than one run may be made. If four consecutive prover runs are made without any two consecutive runs checking within the 0.0005 tolerance, the installation shall be inspected; and if inspection discloses mechanical defects, necessary repairs shall be made.

(e) *Fluid Compressibility.* In calibrating meters with a mechanical-displacement prover, or master meter, or pressurized prover tank (volumetric provers) fluid compressibility shall be taken into account (API Standard 1101, Table II). This factor is referred to as Cpl.

(f) *Other Required Considerations.* In calibrating meters with a mechanical-displacement prover or pressurized prover tank, the following correction factors shall be taken into account:

(i) The change in prover volume due to pressure in the steel pipe (API Standard 2531, USA Standard for Mechanical-Displacement Meter Provers, Table II, Steel Correction Factor for Pressure, Cps (1963)). This correction factor is referred to as Cps and will always be unity or greater.

(ii) The change in volume of the test liquid with change in temperature as determined from API Standard 2540 and ASTM-D1250, Table 6, "Reduction of Volume to 60° F against API gravity at 60° F," (1952) or expanded tables based on the same. This correction factor is referred to as Ctl.

(iii) The change in tank shell dimensions with change in temperature (API Standard 2531, "USA Standard for Mechanical Displacement Meter Prover," Table I, "Steel Correction Factor for Temperature, Cts.," App. B (1963)). This correction factor is referred to as Cts.

(iv) API Standard 2541 and ASTM Designation D1750-62, "Standard Tables for Positive Displacement Meter Prover Tank" (1966), Table A, or expanded tables based on same, may be used where applicable. This table is a combined factor for temperature correction of liquid and steel (API Standard 2540 and ASTM Designation D1250-56, "Standard Petroleum Measurement Tables" (1966), Table 6, "Reduction of Volume to 60° F against API Gravity at 60° F," combined with a temperature factor for the cubical expansion of mild steel).

(g) *Deviation and Meter Factor.* A maximum deviation of ±0.0025 in any factor obtained since a meter was last proved or repaired, or from the original factor with a new meter, will be allowed without declaration of a malfunction. Any factor which exceeds this limit will be declared a malfunction factor. It shall be clearly indicated on the proving report when a malfunction factor has been obtained. If a malfunction factor occurs, the operator shall submit a Meter Adjustment Ticket (Form 9-1910) to adjust the volume of oil run during the period ending with the malfunction factor. The factor obtained at the beginning of the run will be used on the current ticket in the meter printer. Adjustments to the calculated run volume will be indicated on the Meter Adjustment Ticket and will eliminate the necessity of changing or adjusting the total production figure shown on the meter totalizer.

(4) *Meter Malfunction.* After a malfunction, an operating meter shall be repaired or adjusted, and recalibrated as required. The proving report must indicate the repairs or maintenance which were performed. The operator shall have a run ticket made within 24 hours after proving any sales meter and shall submit copies of all such run tickets to the Area office within 7 days after completion.

(5) *Proving Report Forms.* Meter Proving Report A (Form 9-1912) shall be used when proving meters using mechanical-displacement prover. Meter Proving Report B (9-1913) shall be used when performing meter provings using prover tanks or master meter. The operator shall submit a copy of the official proving record to the Area office within seven days after proving a meter.

3. *Sale Tanks.* Operators of liquid sales tanks and facilities shall comply with the following:

A. *Equipment Requirements.* To reduce evaporation losses, sales tank facilities shall be equipped with a pressure-vacuum thief hatch and vent-line valve, and a fill line designed to minimize free fall and splashing.

B. *Calibration Chart.* A complete set of calibration charts (tank tables) for each tank shall be submitted to the Area office. Tank calibrations shall be according to API Standard 2550 and ASTM Designation D1220-65, "Measurement and Calibration of Upright Cylindrical Tanks" (1966) and shall be performed by qualified personnel, subject to witnessing by representatives of the purchaser, seller, and USGS.

C. *Gauging and Sampling.* Gauging of storage tanks shall be performed according to API Standard 2545, and ASTM Designation D1085-65, "USA Standard Method of Gauging Petroleum and Petroleum Products" (1965), and sampling of petroleum and petroleum products in accordance with API Standard 2546 and ASTM Designation D270-65, "Standard Method of Sampling Petroleum and Petroleum Products" (1965).

D. *Temperature Correction.* The change in volume of the liquid with the change in temperature shall be determined from API Standard 2540 and ASTM Designation D1250, Table 6, "Reduction of Volume to 60° F against API Gravity at 60° F" (1952), or expanded tables based on the same. Reduction for BS&W shall be made after making the correction for temperature.

4. *Allocation Meter Facilities.* Allocation meter facilities shall include the following components:

A. *Meter.* Positive-displacement meter, positive volume meter, turbine meter, or other acceptable measurement equipment.

B. *Meter Prover.* Calibrated mechanical-displacement prover, master meter, or prover tank.

C. *Sampler.* Equipment for continuous or periodic liquid sampling.

5. *Gas Measurement.* The operator shall be responsible for compliance with the requirements of this Order pertaining to all sales meters at their delivery points and all meters used for allocation purposes.

A. *Standards for Measurement.* The following requirements shall apply to all meters:

(1) *Equipment.* The measuring equipment so installed shall conform to and shall be operated in accordance with the specifications and the recommendations contained in the American Gas Association publication Orifice Metering of Natural Gas, Gas Measurement Committee Report No. 3, including the appendix as published September 1969.

(2) *Deliveries.* The volume of gas delivered shall be in accordance with the specifications and the recommendations contained in said Gas Measurement Committee Report No. 3.

B. *Specifications for Measurement.* The following requirements shall apply to all gas meters:

(1) *Sales Unit.* For purposes of reporting sales, the measurement unit shall be one MCF of gas (1,000 cubic feet).

(2) *Unit of Volume.* For purposes of Calculation, the unit of volume shall be one cubic foot at a base temperature of 60° Fahrenheit and at a base pressure of 15.025 pounds per square inch absolute.

(3) *Pressure Base.* For purposes of measurement and meter calibration, the atmospheric or barometric pressure shall be assumed to be constant at 14.7 pounds per square inch absolute.

(4) Test Frequency. The accuracy of the measuring equipment at the point of delivery or allocation shall be tested at reasonable intervals, not to exceed forty-five (45) days.

(5) *Malfunction.* If at any time the measuring equipment is found to be out of service or not registering within the limits prescribed by the manufacturer, it shall be repaired or adjusted to read accurately. If the error in the measuring equipment is found to be within two percent, previous readings of such equipment shall be considered correct in computing the deliveries of gas thereunder. If the error in the measuring of equipment is found to be more than two percent, the volume measured since the last calibration shall be corrected. The volume adjustment should be calculated from the time the error occurred, if such time is ascertainable, and if not ascertainable, then back one-half of the time elapsed since the last date of calibration or as much as 23 days. If for any reason the measuring equipment is out of service or malfunctioning with the result that the quantity of gas delivered is not known, the volume of gas delivered through the period during which such equipment is out of service or malfunctioning shall be estimated on the basis of the best data available, using one of the following methods in order of priority.

(a) By using the registration of any check-measuring equipment if installed and accurately registering; or

(b) By correcting the error if the percentage of error is ascertainable by calibration, test, or mathematical calculations; or

(c) By estimating the quantity of delivery by reference to actual deliveries during preceding periods under similar conditions when the unserviceable equipment was registering accurately.

C. *Witnessing*. The tests and calibrations made under Paragraph B above shall be run by qualified personnel. Representatives of the seller, buyer, and USGS shall have the right to witness such tests and calibrations.

D. *Record Retention*. The operator shall preserve or cause to be preserved all test data, meter reports, charts, or other similar records for a period of not less than one year. At any time within such period, the Supervisor may request such records and charts, subject to return within 20 days from receipt thereof.

E. *Record Submittal*. Upon request, one copy of the meter reports specified in D above shall be forwarded to the Supervisor. No special form is required, but all meter report forms shall include the following information where applicable:

(1) *Producer or Seller.*

(2) *Purchaser.*

(3) *OCS lease number or other identifying designation.*

(4) *Station or meter number.*

(5) *Time and date of test.*

(6) *Location.*

(7) *Meter data (make, serial number, differential range, static range).*

(8) *Type connections (flange or pipe).*

(9) *Orifice data ("found" and "left" for line size and orifice size).*

(10) *Zero data for differential and for static spring.*

(11) *Calibration data ("found" and "left" for differential and for static).*

(12) *Remarks.*

(13) *Signature and affiliation of tester.*

(14) *Signature and affiliation of witness.*

6. *Commingling of Production*. Commingling production of different ownership and/or from different leases prior to sales shall be subject to the approval of the Supervisor prior to the actual commingling. Unless otherwise established, the sales delivery shall be considered on the lease and appropriate measurement shall be provided. Well production test may be approved for allocation purposes.

A. *Applications*. Applications for approval of a commingling procedure shall contain the following information:

(1) An accurate description of any measuring devices and samplers, including schematics of the total system, and detailed sections.

(2) A list of the leases and fields involved.

(3) The estimated amounts and types of production involved.

(4) Details of the allocation procedure.

(5) Description of calibration equipment and intervals.

(6) Sales contract, agreement for disposal, or posted price.

B. *Allocation Schedule*. If production from more than one lease or owner is measured by the same sales meter, an allocation schedule of the monthly sales volume of commingled production shall be furnished to the Supervisor. The allocation schedule shall contain:

(1) Total sales volume.

(2) All storage volumes located upstream of the sales meter on the first and last day of the month.

(3) Total lease production from actual allocation meter readings with appropriate corrections (if allocated by meter measurements).

(4) Total lease production calculated from required well tests (if allocated by well test).

(5) Final allocation of actual sales to contributing leases.

7. *Automatic Custody Transfer*. Automatic custody transfer shall be subject to approval of the Supervisor.

A. *Application*. An application to the Supervisor for approval of the meter measurement and facilities shall include:

(1) Flow schematic of the ACT Unit showing and labeling all components.

(2) Leases and fields involved.

(3) Estimated amounts and types of production involved.

(4) Calibration documents for the prover.

B. *ACT Failure*. Any ACT failure, such as electrical, meter, prover loop, or other failure (this does not include malfunction as defined in subparagraph 2.C.(4) of the Order), which may require other methods of measurement shall be reported to the Supervisor within 24 hours. The Supervisor shall approve other methods of measurement during the ACT failure period. A complete, detailed report shall be submitted to the Supervisor within 10 days.

8. *Accidents*. Any accident causing fire, damage to equipment, serious injuries, or pollution shall be reported to the Supervisor within 24 hours. A complete, detailed report shall be submitted to the Supervisor within 10 days.

/s/ J. B. Lowenhaupt
Oil and Gas Supervisor
Production Control
Gulf of Mexico Area

Approved:

/s/ Russell G. Wayland
Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION
GULF OF MEXICO AREA

OCS ORDER NO. 14

Effective January 1, 1977

APPROVAL OF SUSPENSIONS OF PRODUCTION

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.12(d).

If the Supervisor in his discretion approves a request for suspension of production pursuant to 30 CFR 250.12(d)(1), the terms of the lease will not be deemed to expire as long as the suspension remains in effect.

The Supervisor may not approve a request for a suspension of production to facilitate proper development of a lease because of a lack of transportation facilities unless he is satisfied that the lessee: (1) has made the request in good faith; and (2) is taking and will continue to take all reasonable actions to place the leasehold on production in accordance with applicable laws and regulations.

1. *Suspension of Production to Facilitate Proper Development*. A lease on which a well has been drilled and determined by the Supervisor to be capable of being produced in paying quantities according to the provisions of OCS Order No. 4 and thereafter temporarily abandoned or permanently plugged and abandoned is being properly developed if the lessee:

A. is waiting for completion of drilling platform construction and installation or delivery of equipment or facilities which are necessary for production and for which the lessee has signed a contract that specifies a delivery date; or

B. has pending before any Federal, State, or local government authority, an application for a permit which is necessary before the lessee can produce oil or gas from the lease; or

C. has submitted to the Department of the Interior a development plan or unitization agreement for the lease and is waiting for the Department to complete action on the plan or agreement; or

D. has submitted to the Department of the Interior and is actually conducting a geological and geophysical exploration or development program that includes drilling to develop sufficient reserves to produce either from the lease alone or in connection with other leases. For purposes of receiving a suspension under this provision, drilling activity on one lease may be determined by the Supervisor to be activity on all leases which are to be considered as a unit for purposes of providing sufficient reserves to establish economic justification for development wells, structures, facilities, and/or pipelines to recover, process, and transport such reserves as necessary; or

E. because of water depth or bottom conditions, is developing new and special production equipment, apparatus devices, or techniques in order to obtain, bring about, or create actual production capability.

2. *Suspension of Production Because of Lack of Transportation Facilities*. A lease on which a well has been drilled and determined by the Supervisor to be capable of being produced in paying quantities, according to the provisions of OCS Order No. 4, and thereafter temporarily abandoned or permanently plugged and abandoned and cannot be produced because of lack of transportation facilities, is being properly developed if the lessee:

A. is waiting for the completion of pipeline construction or delivery of pipeline equipment or facilities which are necessary for the transportation of oil and gas and for which the lessee has signed a contract that specifies the completion or delivery date; or

B. has pending before any Federal, State, or local government authority, an application or a permit which is necessary before the lessee can transport oil and gas from the lease; or

C. has a contract to use an existing pipeline, but is unable to use the pipeline for reasons beyond the lessee's control.

/s/ J. B. Lowenhaupt
Oil and Gas Supervisor
Production Control
Gulf of Mexico Area

Approved:

/s/ Russell G. Wayland
Acting Chief, Conservation Division

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Outer Continental Shelf Oil and Gas Operations

PROPOSED OCS ORDER NO. 15

Information Concerning Development Plans

Notice is hereby given that, pursuant to 30 CFR 250.11 and in accordance with the revision of 30 CFR 250.34, draft OCS Order 15, "Submittal of Information Concerning Development Plans to Coastal States" is proposed as set forth below.

The Federal Register publication, of November 4, 1975 (40 FR 51199), setting forth the revisions of 30 CFR 250.34 announced the intent to draft an OCS Order to implement the provisions of this revised regulation. OCS Order 15 is proposed for the purpose of defining more specifically the content and timing of information to be provided by lessees and operators to the States.

Interested persons may submit written comments and suggestions on the proposed Order to the Chief of the Conservation Division, U.S. Geological Survey, National Center, 12201 Sunrise Valley Drive, Reston, Virginia 22092, on or before January 1, 1977.

Pursuant to Executive Order 11821 and OMB Circular A–107, this proposal has been reviewed and a determination has been made that it is minor.

/s/ V. E. McKelvey
Director

Submittal of Information Concerning Development Plans to Coastal States

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.34, and applies to those States without a coastal zone management program approved by the Secretary of Commerce in accordance with the Coastal Zone Management Act of 1972 and amended in 1976. Section 250.34, as revised November 4, 1975 (40 FR 51199), provides in part as follows:

Development Plan. Prior to commencement of a development program on a lease, a plan of development shall be submitted to the Supervisor for approval. On leases issued after November 4, 1975, the Supervisor shall furnish a copy of the plan to the Governors of directly affected States except for that information identified by the Freedom of Information Act (P.L. 90–23) as being excluded from disclosure. The Governors shall have 60 days from receipt of this information in which to review and comment on the proposed plan.

Information for States. For any lease issued after November 4, 1975, the lessee shall deliver to the Governor of each directly affected State information concerning the onshore and offshore impact of the proposed plan of development. Such delivery shall be made 30 days before submission of the relevant development plan. The lessee shall notify the Governor and the Supervisor when final delivery of this information has been made.

The operator shall comply with the following requirements. Any departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

1. *Directly Affected States.* For the purpose of this Order, the States considered affected by operations in the Area are listed in Appendix A.

2. *Information to be Submitted to the States.* At least 30 days prior to submitting a plan of development for lease or unit operations to the Supervisor for approval, the lessee or operator shall furnish the Governor, or his designated representative, of each directly affected State and the Supervisor its assessment of the following information:

A. *Location*. The location, as to county, parish or general purpose local government, the size of any offshore and land-based facilities to be constructed, leased, or otherwise acquired or expanded, or offshore and land-based operations to be conducted or contracted for as a result of the proposed lease activity shall be identified and include:

(1) The amount of acreage required within the State for facilities and storage, right of way, and easements.

(2) The means to be used to transport oil and gas to shore, the routes such transportation will follow, and where possible, the estimated quantity of the oil and gas moving along such routes.

(3) An estimate of the frequency of boat and aircraft departures and arrivals, on a monthly basis, the onshore location of terminals, and the normal routes to be followed by each mode of transportation.

B. *Resource Requirements*. The requirements for land, labor, materials, and energy for the items identified in paragraph A above shall be stated and include:

(1) The approximate number of persons who will be engaged in onshore support activities and transportation, the approximate number of local personnel who will be employed for or in support of the development programs, indicating the major skills or crafts required from local sources and the estimated number of each such skill needed, and the approximate total number of persons who will be employed for the development programs.

(2) The approximate addition to the population of the local jurisdiction because of the development programs and the approximate number of persons needing housing and other facilities.

(3) An estimate of any significant quantity of natural resources including water, aggregate, or other major supplies and equipment to be procured within the States.

(4) The types of contractors or vendors which will be needed, although not specifically identified, which will place a demand on local goods and services such as transportation, food services, security, etc.

C. *Timeframes*. The timing of the development operations shall be estimated including:

(1) Sequence of events.

(2) Best estimate of time involved to complete the operations.

(3) When the actions are most likely to occur onshore and offshore.

D. *Personnel Involved*. List the names and addresses of the companies or contractors, known or anticipated, who will be conducting the various activities.

E. *Alteration of Plans*. Events that may with a reasonably good probability occur to significantly alter the proposed operations with respect to onshore impacts, including changes in oil and gas transportation operations, shall be described as well as how such operations shall be altered.

F. *Responsibility*. The lessee shall name a responsible individual knowledgeable in the provisions of the development plan with whom inquiries may be made by States representatives for purposes of clarification or explanation of the information provided. However, any request for additional information must be made to the Supervisor.

3. *Adequacy of Information*. If the Governor of an affected State, or his designated representative, advises the Supervisor within 30 days of receipt of the information provided by the lessee or operator that in the judgment of the State the requirements of paragraph 2 above have not been fulfilled, the Supervisor shall forward the information furnished by the lessee or operator, the comments from the State representative, and the stated position of the lessee or operator through the Regional Conservation Manager and the Chief, Conservation Division, to the Director for his determination as to the adequacy of the information.

The State representative and the lessee or operator shall be advised by the Supervisor of the Director's findings. If additional information is required to be submitted by the lessee or operator, the 60-day period of time for review by the States of a subsequently submitted plan of development shall not be considered to have commenced until such information has been received by the State.

4. *Development Plan*. The lessee or operator shall submit development plans for lease or unit areas at least six months in advance of the contemplated date for commencement of operations in order to allow time for an adequate review by personnel from the States and the Supervisor.

A. *Certification of Information*. The lessee or operator shall certify on each plan of development for a lease or unit area submitted for approval that the directly affected States have received the information set forth in paragraph 2 above at least 30 days prior to submission of the plan of development to the Supervisor. If any State does not desire the information, this fact should be stated and appropriate evidence from the State should be furnished.

B. *Proprietary Information*. The lessee or operator shall identify the information in the plan of development which, in his opinion, is excluded from required public disclosure by Subsection 552(b)(4) and (9) of the

Public Information Act, e.g., (1) trade secrets and commercial or financial information and (2) geological and geophysical information, data, and maps concerning wells.

C. *State Review of Development Plans*. The plan of development, excluding that information identified in paragraph 4.B. which is approved for exclusion by the Supervisor shall be provided by the Supervisor to the Governor, or designated representative, of each directly affected State. No approval action on the plan will be taken by Supervisor until comments are received from the appropriate State personnel or 60 days have elapsed from the date on which the State received the plan.

D. *Amendments to Plans of Development*. The operator shall submit amendments to a plan of development, including amendments which are determined to be minor, to the Supervisor and to the Governor or designated representative of each directly affected State. If the amendment is considered significant by the Supervisor, the review period may be extended for a period not to exceed 60 days from the States' receipt of the amendment.

An amendment may be considered significant if it results in an alteration of facilities or operations onshore and offshore that would change the impact.

5. *Modifications of Approved Plans of Development*. The lessee or operator shall submit to the Supervisor for approval a request for modification of an approved plan of development. If such modification, in the opinion of the Supervisor, would result in significant alteration of facilities or operations onshore and offshore, the procedures specified in the preceding paragraphs shall be followed.

6. *Extension of Leases*. Upon request of a lessee, the Supervisor may approve a suspension of operations for a nonproducing lease equal to the period of time in excess of 60 days which may be required for the previously described review, if such delay is not caused by the lessee and is in the interest of conservation.

/s/ SUPERVISOR

Approved:

Chief, Conservation Division

Appendix A

Mid-Atlantic (Sales 40 and 49)—New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina.

North Atlantic (Sales 42 and 52)—New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine.

South Atlantic (Sales 43 and 54)—North Carolina, South Carolina, Georgia, and Florida.

Pacific (Sales 35, 48, and 53)—California.

Pacific (Sale 53)—Oregon and Washington.

Gulf of Mexico (East) (Sales 41, 45, 47, and 51)—Mississippi, Alabama, and Florida.

Gulf of Mexico (Central) (Sales 41, 44, 45, 47, and 51)—Louisiana.

Gulf of Mexico (West) (Sales 41, 44, 47, and 51)—Texas.

Gulf of Alaska, Cook Inlet, Kodiak, Beaufort Sea, (Sales 39, CI, 46, and 50)—Alaska.

DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

(30 CFR Part 250)

Oil and Gas and Sulphur Operations in Outer Continental Shelf

Proposed Modifications of Regulations To Provide for Issuance of National Outer Continental Shelf (OCS) Orders

AGENCY: Department of the Interior, Geological Survey.

ACTION: Proposed rule.

SUMMARY: A Department of the Interior regulatory improvement review indicates that a majority of the requirements existing OCS orders are common to all areas of the OCS. In order to simplify the regulatory process, this proposal would allow the issuance of National OCS Orders combining common requirements in a single document.

DATE: Comments must be received on or before July 29, 1977.

ADDRESS: Director, U.S. Geological Survey, National Center, Mail Stop 101, 12201 Sunrise Valley Drive, Reston, Virginia 22092.

FOR FURTHER INFORMATION CONTACT—Richard B. Krahl, Chief, Branch of Marine Oil and Gas Operations, Conservation Division, U.S. Geological Survey, Mail Stop 620, Reston, Virginia 22092 (703-860-7531).

SUPPLEMENTARY INFORMATION:

The Department of the Interior has undertaken a complete review of applicable regulations and lease terms to determine what changes could be made to improve the regulation of exploration, development, and production of oil and gas from OCS lands under lease. This review indicated that the majority of the requirements of the existing OCS Orders are common to all areas of the OCS, and that only a minority of the requirements arise from environmental, geological, geophysical, or geographical differences between the various areas.

It was determined that the implementation of requirements which are common to all areas of the OCS could be covered in a set of National OCS Orders with appendices to cover the specific local requirements of each area of the OCS.

This review indicated that the Department has sufficient authority to issue National Orders for the OCS under section 5(a)(1) of the Outer Continental Shelf Lands Act (43 U.S.C. 1334(a)(1)). However, it became apparent that clarification of some of the regulations in 30 CFR Part 250 is needed. In order to accomplish this, it is proposed to amend 30 CFR 250.2(j), 250.11, and 250.12(a) and to add a new Section, 30 CFR 250.3.

Upon adoption of the amended regulations, a set of National OCS Orders will be issued with appendices covering specific local requirements which vary among the geographic regions.

The proposed National OCS Orders Nos. 1, 3, and 4 are being published concurrently as a Notice with an invitation to comment.

It is proposed to amend 30 CFR Part 250 in the manner set forth below.

Note.—The Department of the Interior has determined that this document does not contain a major proposal requiring preparation of an Inflation Impact Statement under Executive 11821 and OMB Circular A-107. Dated: June 23, 1977.

/S/ JOAN M. DAVENPORT,
Assistant Secretary of the Interior.

In sec. 250.2, paragraph (j) is amended to read as follows:

Sec. 250.2 Definitions.

(j) *OCS Order.*—(1) *National OCS Order.* A formal numbered Order issued by the Chief, Conservation Division, Geological Survey, that implements the regulations in this part and applies to all Areas of the Outer Continental Shelf. National OCS Orders are supplemented by Area OCS Orders for specific local requirements which vary among the geographic areas.

(2) *Area OCS Order.* A formal numbered Order issued by the Supervisor and available in his office, with the prior approval of the Chief, Conservation Division, Geological Survey, that implements the regulations in this part and applies to operations in a region or major portion thereof. Area OCS Orders supplement National OCS Orders by providing for specific local requirements which vary among the geographic areas.

A new sec. 250.3 is added to read as follows:

Sec. 250.3 Issuance of OCS Orders.

In order to implement the requirements of regulations of this part, the Area Oil and Gas Supervisor and the Chief of the Conservation Division, Geological Survey, may issue Area OCS Orders and National OCS Orders as defined in sec. 250.2(j) and as prescribed below:

(a) *Issuance of National OCS Orders.* The Chief, Conservation Division, Geological Survey, may issue National OCS Orders implementing the requirements of the regulations of this part when such implementations apply to all regions of the Outer Continental Shelf. Prior to the issuance of National OCS Orders, the Chief, Conservation Division, Geological Survey, may consult with, and receive comments from, lessees, operators, and other interested parties.

(b) *Issuance of Area OCS Orders.* Subject to the approval of the Chief, Conservation Division, Geological Survey, the Supervisor may issue Area OCS Orders implementing the requirements of the regulations of this part when such implementation applies to an entire region or a major portion thereof. Prior to the issuance of Area OCS Orders, the Supervisor may consult with, and receive commments from, lessees, operators, and other interested parties.

Section 250.11 is amended to read as follows:

Sec. 250.11 General Functions.

The Supervisor is authorized and directed to act upon the requests, applications, and notices submitted under the regulations in this part and to require compliance with applicable statutes, lease terms, applicable regulations, and OCS Orders to the end that all operations shall be conducted in a manner which will protect the natural resources of the Outer Continental Shelf and result in the maximum economic recovery compatible with sound conservation practices. Subject to the approval of the Chief, Conservation Division, Geological Survey, the Supervisor may issue Area OCS Orders implementing the requirements of the regulations of this part when such implementations apply to an entire region or a major portion thereof. The Supervisor may issue written or oral orders to govern lease operations. Oral orders shall be confirmed in writing by the Supervisor as promptly as possible. The Supervisor may issue other orders and rules to govern the development and method of production of a pool, field, or area. Prior to the issuance of Area OCS Orders and other orders and rules, the Supervisor may consult with, and receive comments from lessees, operators, and other interested parties. Before permitting operations on the leased land, the Supervisor may require evidence that a lease is in good standing, that the lessee is authorized to conduct operations, and that an acceptable bond has been filed.

Paragraph (a) of sec. 250.12 is amended to read as follows:

Sec. 250.12 Regulation of Operations.

(a) *Duties of Supervisor.* The Supervisor, in accordance with the regulations in this part, shall inspect and regulate all operations and is authorized to issue Area OCS Orders and other orders and rules necessary for him to effectively supervise operation and to prevent damage to, or waste of, any natural resource, or injury to life or property. The Supervisor shall receive and shall, when in his judgment it is necessary, consult with or solicit advice from lessees, field officials of interested Departments and Agencies, including the Bureau of Land Management, Coast Guard, Corps of Engineers, Council on Environmental Quality, Department of Commerce, Department of Defense, Environmental Protection Agency, Federal Power Commission, Fish and Wildlife Service, Materials Transportation Bureau, and representatives of State and local Governments.

GEOLOGICAL SURVEY
OUTER CONTINENTAL SHELF (OCS)

Proposed National Orders Governing Oil and Gas Lease Operations

Notice is hereby given that, pursuant to revisions of 30 CFR 250.2(j), 250.3, 250.11, and 250.12, National Orders for the Outer Continental Shelf governing oil and gas lease operations are proposed as set forth below. The proposed revisions of these regulations are published concurrently in the Proposed Rules Section of the FEDERAL REGISTER.

As a result of the efforts of the Conservation Division task force for reviewing the OCS Operations Safety Program, it was determined that the existing Orders for individual areas of the OCS should be standardized. The task force concluded that the majority of the requirements of the existing OCS Orders are common to all areas of the OCS and that only a minority of the requirements arise from environmental, geological, geophysical, or geographical differences between the various areas.

The standardization of OCS Orders will be accomplished by the issuance of National OCS Orders which contain the requirements that are common to all areas of the OCS and Appendices which contain specific local requirements for each area. The National OCS Orders Nos. 1, 3, and 4, as proposed below, do not constitute additional requirements over the existing OCS Orders other than revisions to the existing requirements to incorporate new technological advances and improvements or changes in the regulations.

The proposed National OCS Order Nos. 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15 are currently being developed and will be published at a later date. The existing OCS Orders will remain in effect until such time as all of the proposed National Orders are published in final form in the FEDERAL REGISTER.

Interested persons may submit written comments and suggestions on the proposed National OCS Orders to the Acting Chief, Conservation Division, U.S. Geological Survey, MS600, National Center, 12201 Sunrise Valley Drive, Reston, Virginia 22092, on or before July 29, 1977.

Note.—The Geological Survey has determined that this document does not contain a major proposal requiring preparation of an Inflation Impact Statement under Executive Order 11821 and OMB Circular A-107.

/s/ V. E. McKelvey,
Director.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION

National Order

OCS ORDER NO. 1

Effective

Identification of Wells, Platforms, Structures, and Subsea Objects

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.37.

The operator shall comply with the following requirements. All departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

1. *Identification of Fixed Platforms or Structures*. Platforms and structures shall be identified at two diagonal corners by a sign with letters and figures not less than 30 centimeters (12 inches) in height with the following information: The name of lease operator, the area name shown on OCS Official Protraction Diagrams (or, where no name has been assigned, the Protraction Diagram number), the block number in which the platform or structure is located, and the platform or structure designation. The information shall be abbreviated as in the following example:

   The Blank Oil Company operates "C" platform on Block 999 of the Salisbury Area.

   The identifying sign on the platform would indicate: BOC-SAL-999-C.

2. *Identification of Nonfixed Platforms or Structures*. Floating semi-submersible platforms, bottom-setting mobile rigs, and drilling ships shall be identified by one sign with letters and figures not less than 30 centimeters (12 inches) in height affixed to the derrick so as to be visible from off the vessel and containing the following information: The name of the lease operator, the area designation based on OCS Official Leasing Maps, the block number, the OCS lease number, and the well number.

3. *Identification of Wells*. The OCS lease and well number shall be painted on, or a sign affixed to, each singly completed well. In multiple completed wells, each completion shall be individually identified at the well head. All identifying signs shall be maintained in a legible condition.

4. *Identification of Subsea Objects*. All subsea objects resulting from lease operations, and presenting a hazard to navigation or to deployment of commercial fishing devices, shall be identified with navigational markings. Such identification shall be in accordance with an approved Coast Guard design. These navigational markings shall be maintained on-site and operable at all times as long as the obstruction remains.

Approved:

Acting Chief, Conservation Division.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION

National Order

OCS ORDER NO. 3

Effective

Plugging and Abandonment of Wells

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.15. The operator shall comply with the following minimum plugging and abandonment procedures which have general application to all wells drilled for oil and gas. Plugging and abandonment operations must not be commenced prior to obtaining approval from an authorized representative of the Geological Survey. Oral approvals shall be in accordance with 30 CFR 250.13. All departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

1. *Permanent Abandonment.*

1.1 *Isolation in Uncased Hole.* In uncased portions of wells, cement plugs shall be spaced to extend 30 meters (100 feet) below the bottom to 30 meters (100 feet) above the top of any oil, gas, and fresh water zones so as to isolate them in the strata in which they are found and to prevent them from escaping into other strata. Additional cement plugs may be required to protect other minerals or to prevent migration of fluids in the well bore.

1.2 *Isolation of Open Hole.* Where there is open hole below the casing, a cement plug shall be placed in the deepest casing string by methods (a) or (b) below or, in the event lost circulation conditions exist or are anticipated, the plug may be placed in accordance with (c) below:

(a) A cement plug placed by displacement method so as to extend a minimum of 30 meters (100 feet) above and 30 meters (100 feet) below the casing shoe.

(b) A cement retainer with effective back pressure control set not less than 15 meters (50 feet), nor more than 30 meters (100 feet), above the casing shoe with a cement plug calculated to extend at least 30 meters (100 feet) below the casing shoe and 15 meters (50 feet) above the retainer.

(c) A permanent type bridge plug set within 45 meters (148 feet) above the casing shoe with 15 meters (50 feet) of cement on top of the bridge plug. This plug shall be tested prior to placing subsequent plugs.

1.3 *Plugging or Isolating Perforated Intervals.* A cement plug shall be placed opposite all open perforations (perforations not squeezed with cement) extending a minimum of 30 meters (100 feet) above and 30 meters (100 feet) below the perforated interval or down to a casing plug, whichever is less. In lieu of the cement plug, the following two methods are acceptable, provided the perforations are isolated from the hole below:

(a) A cement retainer with effective back pressure control set not less than 15 meters (50 feet) nor more than 30 meters (100 feet) above the top of the perforated interval with a cement plug calculated to extend at least 30 meters (100 feet) below the bottom of the perforated interval and 15 meters (50 feet) above the retainer.

(b) A permanent type bridge plug set within 45 meters (148 feet) above the top of the perforated interval with 15 meters (50 feet) of cement on top of the bridge plug.

1.4 *Plugging of Casing Stubs.* If casing is cut and recovered thereby leaving a stub inside the next larger string, a cement plug will be set so as to extend 30 meters (100 feet) above and 30 meters (100 feet) below the stub, or a retainer set 15 meters (50 feet) above the stub with 45 meters (150 feet) of cement set below and 15 meters (50 feet) above. A permanent bridge plug set 15 meters (50 feet) above the stub and capped with

15 meters (50 feet) of cement shall be used if the foregoing methods cannot be used. However, if the stub is below the next larger string, plugging must be accomplished in accordance with subparagraphs 1.1 and 1.2 above.

1.5 *Plugging of Annular Space.* No annular space that extends to the ocean floor shall be left open to drilled hole below. If this condition exists, the annulus shall be plugged with cement.

1.6 *Surface Plug Requirement.* A cement plug of at least 45 meters (148 feet), with the top of the plug 45 meters (148 feet) or less below the ocean floor, shall be placed in the smallest string of casing which extends to the surface.

1.7 *Testing of Plugs.* The setting and location of the first plug below the top 45-meter (148-foot) plug will be verified by either (1) placing a minimum pipe weight of 6,800 kilograms (15,000 pounds) on the plug or, where this plug is placed utilizing a cement retainer or bridge plug, it is only necessary that the setting of the retainer or bridge plug be verified by placing at least 6,800 kilograms (15,000 pounds) on it prior to placing cement on top, or (2) testing with a minimum pump pressure of 6,900 kPa (1,000 psi) with no more than a 10-percent pressure drop during a 15-minute period.

1.8 *Mud.* Each of the respective intervals of the hole between the various plugs shall be filled with mud fluid of sufficient density to exert hydrostatic pressure exceeding the greatest formation pressure encountered while drilling such interval.

1.9 *Clearance of location.* All casing and piling shall be severed and removed to a depth of at least 5 meters (16 feet) below the ocean floor or at a depth as approved by the District Supervisor after a review of data on the ocean bottom conditions. The operator shall verify that the location has been cleared of all obstructions.

2. *Temporary abandonment.* Any drilling well which is to be temporarily abandoned shall be mudded and cemented as required for permanent abandonment except for requirements 6 and 9 of section 1 above. When casing extends above the ocean floor, a mechanical bridge plug (retrievable or permanent) shall be set in the casing between 5 and 60 meters (16 and 197 feet) below the ocean floor.

Approved:

Acting Chief, Conservation Division.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY—CONSERVATION DIVISION

National Order

OCS ORDER NO. 4

Effective

Suspension and Determination of Well Producibility

This Order is established pursuant to the authority prescribed in 30 CFR 250.11 and in accordance with 30 CFR 250.12(d)(1). An OCS lease provides for extension beyond its primary term for as long as oil or gas may be produced from the lease in paying quantities. The term "paying quantities" as used herein means production in quantities sufficient to yield a return in excess of operating costs. An OCS lease may be maintained beyond the primary term, in the absence of actual production, when a suspension of production has been approved in accordance with OCS Order No. 14. All departures from the requirements specified in this Order must be approved pursuant to 30 CFR 250.12(b).

To provide data necessary to determine that a well may be capable of producing in paying quantities, the following are minimum requirements:

1. *Oil Wells.* A production test of at least 2-hour duration, following stabilization of flow.
2. *Gas Wells.* A deliverability test of at least 2-hour duration, following stabilization of flow, or a four-point back-pressure test.
3. *Production Capability.* All pertinent engineering, geologic, and economic data shall be submitted to the District Supervisor and will be considered in determining whether a well is capable of being produced in paying quantities. Refer to Appendix I for specific well data requirements for the Gulf of Mexico Area.
4. *Witnessing and Results.* All tests must be witnessed by an authorized representative of the Geological Survey. Test data accompanied by operator's affidavit, or third-party test data, may be accepted in lieu of a witnessed test provided prior approval is obtained from the District Supervisor.

Approved:

Acting Chief, Conservation Division.

Appendix I

OCS Orders Governing Oil and Gas Lease Operations in the Outer Continental Shelf
Gulf of Mexico Area
OCS Orders
United States Department of the Interior
Geological Survey Conservation Division
United States Department of the Interior
Geological Survey
Conservation Division
Gulf of Mexico Area
OCS Order No. 4
Effective

Suspension and Determination of Well Producibility

The preamble to this Order is common to all areas of the Outer Continental Shelf. Refer to National OCS Order No. 4.

1. *Oil Wells.* Refer to National OCS Order.
2. *Gas Wells.* Refer to National OCS Order.
3. *Production Capability.* The following may be considered as acceptable evidence that a well is capable of producing in paying quantities:
   A. A resistivity log of the well showing a minimum of 15 feet of producible sand in one section which does not include any interval which appears to be water saturated. All of the section counted as producible shall exhibit the following properties:
      (1) Electrical spontaneous potential exceeding 20 negative millivolts beyond the shale base line. If mud conditions prevent a 20 negative millivolt reading beyond the shale base line, a gamma ray log deflection of at least 70 percent of the maximum gamma ray deflection in the nearest clean water-bearing sand may be substituted.
      (2) A minimum true resistivity ratio of the producible section to the nearest clean-water sand of at least 5:1.

(3) A porosity log indicating porosity in the producible section.

B. Side wall cores and core analysis which indicates that the section is producible.

C. The aforementioned criteria will absolutely ascertain that a well is producible. However, recognizing the fact that rocks in the Gulf of Mexico Area do not possess the same physical properties and therefore do not lend themselves to one single method of log analysis, the Geological Survey may, at its discretion, accept sound log interpretation techniques which conclusively demonstrate that a well would produce water-free hydrocarbons in its particular area, even though it might not qualify under A and B. The operator can support its interpretation by submitting further evidence such as wireline formation tests and/or mud logging analysis.

4. *Witnessing and Results.* Refer to National OCS Order.

/s/ D. W. SOLANAS,
Area Oil and Gas Supervisor.

Approved:

Acting Chief, Conservation Division.

Appendix C

Matrix Analysis of Potential Impacts on Major Resources and Activities

1. Purpose

The purpose of this matrix analysis is to analyze some of the potential impacts of the proposed OCS sale in an attempt to provide the decision-maker and reviewer with an array of factors which must be considered in order to form value judgments concerning the importance of these interactions.

In this section, each tract is included in a table designed to describe its distance from shore, water depth, and expected type of production. In addition, the sensitivity of major resources and activities to the impact of an oil spill, should one occur, and to impacts of structures, should the tract be developed, is evaluated by means of a sensitivity rating for both spills and structures.

2. Significant Resource Factors

The matrix analysis examines major resource categories which could sustain negative impacts as a result of the development of the tracts included in the proposed sale. Significant resource factors appear on the horizontal axis of each matrix, and for purposes of this analysis have been identified to consist of:

littoral systems-all shoreline features
reefal systems-high relief banks with dense epifaunal communities
other benthic systems—ecosystems composed of bottom-living organisms
endangered species—critical habitat of those species considered endangered by the U.S. Fish and Wildlife Service
commercial and sport fishing—shrimp, menhaden, industrial fish and hook and line fishing offshore
shipping—major shipping lanes aesthetics—visibility of exploratory drilling rigs, production platforms, and other structures outdoor recreation—inshore hunting, fishing, and boating
cultural resources—potential nearshore archaeological sites

All evaluations of the above categories were based on measurement from the edge of the tract closest to the resource potentially affected. 3. Impact Producing Factors

This evaluation considers the sensitivity of significant resources and activities to the occurrence of oil spills and structures within the proposed sale area. "Oil spills" in this context refers to spills of 100,000 gallons (2,381 bbls) or more (the volume designated as a major spill by the National Oil and Hazardous Substances Pollution Contingency Plan), and structures include platforms or other fixed structures and artificial islands.

Other impact-producing factors, such as debris resulting from drilling activities, and pipeline construction, cannot be analyzed on a tract-by-tract basis, and therefore, are not included in this matrix section. However, these and other related factors were discussed on the basis of this proposed sale in previous parts of this ES, particularly in the Environmental Impact of the Proposed Sale section.

4. Sensitivity Rating

Each tract has been assigned sensitivity values for oil spills and structures based primarily on the distance from a particular resource.

A series of scales has been devised for the purpose of assigning a range of values to indicate sensitivity to each impact-producing factor. These scales are presented below and consist of three levels of potential magnitude of impact.

3-Maximal potential impact
2-Moderate potential impact
1-Minimal potential impact

The judgment of the importance of any specific impact is at the discretion of the decisionmaker or reviewer.

A. STRUCTURES

An estimate of the importance of the impact of structures on the environment consists of two factors: quantity, in this case it is estimated that all tracts 2,023 hectares or more in size will average two structures per tract, even though some tracts may never be developed; and time, all structures will remain on site for an average period of fifteen to twenty years.

Structures are considered to be potentially negative impacts to four of the significant resource factors mentioned previously: reefal systems, commercial and sport fishing, shipping, and aesthetics.

Reefal systems containing coral and associated organisms are very sensitive to disturbances such as the turbidity created by the discharge of drill muds and cuttings. Also, nektonic population distribution may be affected by the presence of a structure. Therefore, the sensitivity ratings for reefal systems reflects these considerations and is purposely conservative due to our lack of information with regard to the distribution of drill muds and cuttings under operational conditions in marine systems.

Structures interfere with commercial fishing by removing trawling and purse seining areas. Approximately 70 percent of the catch by these two methods in the Gulf of Mexico is shoreward of the 20 m isobath. The remainder of the catch by these methods is concentrated between the 20 m and the 200 m isobath with only nominal effort expended beyond these depths.

Structures pose a collision hazard to shipping and boating in general but are especially hazardous when placed near fairways or anchorage areas and are rated accordingly.

The aesthetic sensitivity ratings are based on the visibility from sea level of a 33 m tall structure. Within 16 km of shore, such a structure would be obvious, whereas 17 to 25 km from shore, the structure would be hardly visible, and, greater than 25 km from shore, the aesthetic impact would be negligible except from the point of view of the boating community.

The above considerations resulted in the following sensitivity rating for structures:

Reefal systems

- 3—1.5 km or less from known reef
- 2—1.6 to 5 km from known reef
- 1—greater than 5 km from known reef

Sport and Commercial Fishing

- 3—within 20 m depth contour
- 2—within 200 m depth contour
- 1—outside 200 m depth contour

Shipping

- 3—within 1.5 km of fairway or anchorage
- 2—1.5 to 5 km of fairway or anchorage
- 1—greater than 5 km from fairway or anchorage

Aesthetics

- 3—within 16 km of shore
- 2—17 to 25 km from shore
- 1—greater than 25 km from shore

b. Oil Spills

The factors for estimating the importance of oil spills on the environment are: Quantity—our analysis is based on all spills of 100,000 gallons or more (2,381 bbls); and Time—the toxicity of oil is known to decrease with weathering. For analytical purposes, we have assumed a rate of drift of an oil spill of 0.5 knots which for weathering times of 24, 48, and 72 hours gives impact zones of 12, 24, and 36 nautical miles (19.3, 38.6, 57.9 kilometers). Using toxicity at 24 hours as a base, laboratory bioassays indicate that after at 48 hours weathering the toxicity will be 0.90 of that base and after 72 hours will be 0.54. Therefore, assigned sensitivity values of biological systems are adjusted from a potential spill site by the appropriate weathering factor.

Oil spills are considered to be potentially damaging to all of the previously listed resource factors except shipping.

If a spill were to occur within 16 km (10 miles) of any resource, it probably could not be effectively contained before contacting the resource. For this reason, the highest sensitivity rating was established for 16 km or less from littoral systems, reefal systems, endangered species, aesthetics, outdoor recreation, and cultural resources. Within 17 to 32 km the probability that oil would contact a resource is sufficient enough to warrant concern. Beyond 32 km the possibility of contact still exists but is considered to be minimal.

The sensitivity ratings for benthic systems and sport and commercial fishing is based upon depths to which oil can be expected to be entrained in the Gulf of Mexico. In nearshore areas 10 m or less in depth, a spill will almost certainly contact bottom sediments increasing the potential for damage to benthic systems and tainting of demersal fish species. Under extreme conditions of mixing energy, the depth to which oil might be entrained can be assumed to be 20 m or less. Sediments at depths greater than 20 m have little chance of being contaminated except in the immediate vicinity of the spill site.

The above considerations resulted in the following sensitivity rating for oil spills:

Littoral system

- 3—within 16 km of shore
- 2—17-32 km from shore
- 1—greater than 32 km from shore

Reefal systems

- 3—within 16 km of known reef
- 2—17-32 km from reef
- 1—greater than 32 km from reef

Benthic system

- 3—10 m depth or less
- 2—11-20 m depth
- 1—greater than 20 m depth

Endangered species

- 3—within 16 km of critical habitat
- 2—17-32 km from critical habitat
- 1—greater than 32 km from critical habitat

Sport and Commercial fishing

- 3—10 m depth or less
- 2—11-20 m depth
- 1—greater than 20 m depth

Aesthetics

- 3—within 16 km of shore
- 2—17-32 km from shore
- 1—greater than 32 km from shore

Outdoor recreation

- 3—within 16 km of shore
- 2—1732 km from shore
- 1—greater than 32 km from shore

Cultural resources

3—within 16 km of shore
2—17-32 km from shore
1—greater than 32 km from shore

5. Summary of Matrix Analysis

The matrix presents the impact of structures and oil spills upon applicable resources and activities based on the sensitivity scales and, in the case of oil spill, weathering as it applies to potential impact upon living resources.

Impacts upon individual resource categories are totaled resulting in a cumulative impact. This is divided by the total possible value, resulting in an impact index. For example, tract number 1 has a cumulative impact for structures of 9 out of 12 possible for an impact index of .75 for structures. The same tract has a cumulative impact rating of 20 for oil spills out of a total possible of 24 for an impact index of .83. These are summed for an additive impact of 1.58.

The impact index and additive impact rating can be evaluated as follows:

Impact Index

1.00-0.78 Maximal potential impact
0.77-0.56 Moderate potential impact
0.55-0.33 Minimal potential impact

Additive Impact

2.00-1.44 Maximal potential impact
1.43-0.89 Moderate potential impact
0.88-0.33 Minimal potential impact

Table C-1 summarizes the tracts which fall into the categories of minimal, moderate, and maximum additive potential impact.

Table C-2 groups those tracts which have a maximal potential impact (sensitivity rating of 3) on specific resources or activities identified in the matrix.

Table C-1. Summary of Additive Impacts

Additive Impact	Tract Number	Total Tracts
2.00-1.44 (maximum)	1, 2	2
1.43-0.89 (moderate)	3-17, 29, 32-34, 36, 89-93	25
0.88-0.33 (minimal)	18-28, 30, 31, 35, 37-88, 94-116	89

Table C-2. Summary of Tracts With Maximal Potential Impacts on Specific Resources or Activities

Resource or Activity	Tracts Affected	Total Tracts
Littoral Systems	1, 2	2
Reefal Systems		0
Other Benthic Systems		0
Endangered Species		0
Sport and Commercial Fishing	89-93	5
Shipping	29, 32, 33, 34, 36	5
Aesthetics	1, 2	2
Outdoor Recreation	1, 2	2
Cultural Resources	1, 2	2

LEASE AREA IDENTIFICATION

PS - South Padre Island Area
PN - North Padre Island Area
MU - Mustang Island Area (Includes East Addition)
MI - Matagorda Island Area
BA - Brazos Area (Includes South Addition)
GA - Galveston Area (Includes South Addition)
HI - High Island Area (Includes East Addition, South Extension, South Addition)
WC - West Cameron Area (Includes West Addition, South Addition)
EC - East Cameron Area (Includes South Addition)
VR - Vermilion Area
SM - South Marsh Island Area (Includes South Addition)
EI - Eugene Island Area (Includes South Addition)
SS - Ship Shoal Area
PL - South Pelto Area
ST - South Timbalier Area
GI - Grand Isle Area (Includes South Addition)
WD - West Delta Area
SP - South Pass Area
MP - Main Pass Area
VK - Viosca Knoll Area (Formerly Mobile South No. 1)
MC - Mississippi Canyon Area (Formerly Mobile South No. 2)
PA - Pensacola
DD - Destin Dome
DC - DeSoto Canyon
FM - Florida Middle Ground
TS - Tarpon Springs
SP - St. Petersburg
CH - Charlotte Harbor
TE - The Elbow
VN - Vernon

CODE FOR ABBREVIATIONS ON MATRIX TABLES:

G - Gas prone tract
O - Oil prone tract
OG - Oil and gas prone tract
NA - Not Applicable
/ - Upper portion of each block pertain to impact from structures, lower portion pertaine to impacts from possible oil spills.

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
1 PA 882	16	20	DG	NA/3	1/1	NA/2	NA/3	3/2	2/NA	3/3	NA/3	NA/3	9/20	.75/.83	1.58
2 PA 883	16	20	DG	NA/3	1/1	NA/2	NA/3	3/2	2/NA	3/3	NA/3	NA/3	9/20	.75/.83	1.58
3 PA 884	18	21	DG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	2/2	NA/2	NA/2	6/13	.5D/.54	1.04
4 PA 885	19	23	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	2/2	NA/2	NA/2	6/13	.50/.54	1.04
5 PA 886	19	24	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	2/2	NA/2	NA/2	6/13	.50/.54	1.04
6 PA 926	24	23	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	2/2	NA/2	NA/2	6/13	.50/.54	1.04

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
7 PA 927	23	24	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	2/2	NA/2	NA/2	6/13	.50/.54	1.04
8 PA 928	23	25	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	2/2	NA/2	NA/2	6/13	.50/.54	1.04
9 PA 929	24	26	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	2/2	NA/2	NA/2	6/13	.50/.54	1.04
10 PA 930	26	27	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	1/2	NA/2	NA/2	5/13	.42/.54	.96
11 PA 970	26	25	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	1/2	NA/2	NA/2	5/13	.42/.54	.96
12 PA 971	27	26	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	1/2	NA/2	NA/2	5/13	.42/.54	.96

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
13 PA 972	29	26	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	1/2	NA/2	NA/2	5/13	.42/.54	.96
14 PA 973	29	29	DG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	1/2	NA/2	NA/2	5/13	.42/.54	.96
15 PA 974	29	30	DG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	1/2	NA/2	NA/2	5/13	.42/.54	.96
16 DD 2	32	26	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	1/2	NA/2	NA/2	5/13	.42/.54	.96
17 DD 3	32	27	OG	NA/2	1/1	NA/1	NA/2	2/1	1/NA	1/2	NA/2	NA/2	5/13	[illegible]/.54	.96
18 DD 4	34	28	OG	NA/1	1/1	NA/1	NA/1	2/1	1/NA	1/1	NA/1	NA/1	5/8	.42/.33	.75

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
19 DD 5	34	31	OG	NA/1	1/1	NA/1	NA/1	2/1	1/NA	1/1	NA/1	NA/1	5/8	.42/.33	.75
20 DD 6	35	32	OG	NA/1	1/1	NA/1	NA/1	2/1	1/NA	1/1	NA/1	NA/1	5/8	.42/.33	.75
21 DD 313	36	4D	DG	NA/1	1/1	NA/1	NA/1	2/1	1/NA	1/1	NA/1	NA/1	5/8	.42/.33	.75
22 DD 314	68	50	OG	NA/.54	1/.54	NA/1	NA/.54	2/1	1/NA	1/1	NA/1	NA/1	5/6.6	.42/.28	.70
23 DD 357	71	51	OG	NA/.54	1/.54	NA/1	NA/.54	2/1	1/NA	1/1	NA/1	NA/1	5/6.6	.42/.28	.70
24 DD 358	72	60	OG	NA/.54	1/.54	NA/1	NA/.54	2/1	1/NA	1/1	NA/1	NA/1	5/6.6	.42/.28	.70

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
25 DD 473	77	110	DG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
26 DD 474	74	90	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
27 DD 518	74	100	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
28 DD 519	69	90	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
29 DD 529	89	70	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	3 / NA	1 / 1	NA / 1	NA / 1	7 / 6.6	.58 / .28	.86
30 DD 562	76	120	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
31 DD 563	71	110	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
32 DD 573	93	80	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	3 / NA	1 / 1	NA / 1	NA / 1	7 / 6.6	.58 / .28	.86
33 DD 574	93	90	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	3 / NA	1 / 1	NA / 1	NA / 1	7 / 6.6	.58 / .28	.86
34 DD 618	98	120	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	3 / NA	1 / 1	NA / 1	NA / 1	7 / 6.6	.58 / .28	.86
35 DD 661	101	160	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	2 / NA	1 / 1	NA / 1	NA / 1	6. / 6.6	.50 / .28	.78
36 DD 662	103	200	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	3 / NA	1 / 1	NA / 1	NA / 1	7 / 6.6	.58 / .28	.86

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
37 DC 436	134	348	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
38 DC 437	132	345	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
39 DC 480	138	350	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
40 DC 481	137	349	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
41 FM 358	119	225	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
42 FM 359	118	200	DG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
43 FM 397	13D	3D1	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
44 FM 398	129	300	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
45 FM 399	127	290	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
46 FM 400	126	265	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
47 FM 4D1	126	250	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
48 FM 402	124	235	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species ..	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
49 FM 403	122	200	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
50 FM 404	122	198	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
51 FM 405	121	190	OG	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
52 FM 441	135	325	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
53 FM 442	132	310	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
54 FM 443	132	300	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species ..	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
55 FM 444	130	275	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
56 FM 445	128	260	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
57 FM 446	128	240	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
58 FM 447	127	225	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
59 FM 486	137	325	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
60 FM 487	135	315	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species ..	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
61 FM 488	135	300	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
62 FM 489	134	280	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
63 FM 490	132	260	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
64 FM 491	132	245	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
65 FM 430	142	350	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
66 FM 431	140	335	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species ..	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additiv Impact
67 FM 432	138	315	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
68 FM 433	138	300	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
69 FM 434	137	280	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
70 FM 435	135	260	OG	NA / .54	1 / .54	NA / 1	NA / .54	1 / 1	1 / NA	1 / 1	NA / 1	NA / 1	4 / 6.6	.33 / .28	.61
71 TE 567	127	70	O	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
72 TE 609	137	80	O	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
73 TE 696	143	90	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
74 TE 697	140	85	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / –	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
75 TE 739	150	100	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / –	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
76 TE 783	151	100	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / –	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
77 TE 827	153	110	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / –	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
78 TE 871	155	110	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / –	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
79 VN 258	161	120	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
80 VN 259	158	110	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
81 VN 312	163	130	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
82 VN 303	159	120	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
83 VN 609	187	150	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
84 VN 610	182	140	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
85 VN 611	177	135	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
86 VN 653	188	155	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
87 VN 654	184	154	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
88 VN 697	192	155	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
89 TS 233	58	20	OG	NA / .54	1 / .54	NA / 2	NA / .54	3 / 2	1 / NA	1 / 1	NA / 1	NA / 1	5 / 8.6	.50 / .36	.86
90 TS 234	56	20	OG	NA / .54	1 / .54	NA / 2	NA / .54	3 / 2	1 / NA	1 / 1	NA / 1	NA / 1	5 / 8.6	.50 / .36	.86

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
91 TS 277	63	20	OG	NA / .54	1 / .54	NA / 2	NA / .54	3 / 2	1 / NA	1 / 1	NA / 1	NA / 1	6 / 8.6	.50 / .36	.86
92 TS 278	60	20	OG	NA / .54	1 / .54	NA / 2	NA / .54	3 / 2	1 / NA	1 / 1	NA / 1	NA / 1	6 / 8.6	.50 / .36	.86
93 TS 279	58	18	OG	NA / .54	1 / .54	NA / 2	NA / .54	3 / 2	1 / NA	1 / 1	NA / 1	NA / 1	6 / 8.6	.50 / .36	.86
94 SP 661	126	75	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
95 SP 662	121	70	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
96 SP 705	126	75	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70

TRACT DATA				RESOURCE AND ACTIVITIES									IMPACT		
Tract Number Lease Block Location	Distance from Shore (kilometers)	Approximate Depth (meters)	Estimated Type of Production	Littoral Systems	Reefal Systems	Other Benthic Systems	Endangered Species	Sport and Commercial Fishing	Shipping	Aesthetics	Outdoor Recreation	Cultural Resources	Cumulative Impact	Impact Index	Additive Impact
97 SP 706	122	70	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
98 SP 753	111	60	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
99 SP 754	105	59	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
100 SP 797	111	60	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
101 SP 798	106	59	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
102 CH 143	103	55	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
103 CH 144	101	53	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
104 CH 145	97	50	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
105 CH 187	106	56	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
106 CH 188	103	53	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
107 CH 221	151	100	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
108 CH 231	109	58	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
109 CH 265	153	99	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
110 CH 266	148	109	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
111 CH 627	127	60	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
112 CH 628	122	59	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
113 CH 671	128	60	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
114 CH 672	124	59	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
115 CH 715	130	60	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
116 CH 716	126	59	0	NA / .54	1 / .54	NA / 1	NA / .54	2 / 1	1 / NA	1 / 1	NA / 1	NA / 1	5 / 6.6	.42 / .28	.70
			0	NA		NA	NA		NA		NA	NA			
			0	NA		NA	NA		NA		NA	NA			
			0	NA		NA	NA		NA		NA	NA			
			0	NA		NA	NA		NA		NA	NA			

Appendix D

U.S.G.S. Resource Report

REPORT ON ESTIMATES FOR THE PROPOSED EASTERN GULF OF MEXICO OCS SALE NO. 65

UNITED STATES DEPARTMENT OF THE INTERIOR

Geological Survey

Reston, Virginia 22092

August 23, 1977
Memorandum
TO: Director, Bureau of Land Management
THROUGH: Assistant Secretary—Energy and Minerals; Assistant Secretary—Land and Water Resources
FROM: Director, Geological Survey
SUBJECT: Request for data required for the draft environmental statement for OCS Lease Sale No. 65, Eastern Gulf of Mexico

In response to your request of July 29, 1977, we are enclosing the information needed for the preparation of the draft environmental impact statement for OCS Lease Sale No. 65. Information requested in items 4(a) and 4(b) in your request is not enclosed since it is the same as previously reported for OCS Lease Sale Nos. 41, 44, 45, 47, and 51.

A copy of the subject information was provided to your field office in New Orleans on August 17, 1977.

/s/ M. R. Klepper
Acting Director

Enclosure

INFORMATION REQUESTED FOR DRAFT ENVIRONMENTAL STATEMENT FOR PROPOSED OCS LEASE SALE NO. 65, GULF OF MEXICO (Numbers refer to BLM Memo of July 28, 1977, reprinted in full at the end of this Appendix.)

1. A tract-by-tract identification as to its being gas prone, oil prone, or oil and gas prone, is indicated on the enclosed tentative tract list.

2. Estimates of the reserves of oil and gas that may be discovered as a result of this sale are:

Oil 15-150 million barrels
Gas 20-175 billion cubic feet

3. Estimates of the facilities required:

a. Number of exploratory wells—15-75
b. Number of development wells—30-225
c. Number of platforms—5-25
d. Number of underwater completions—0-1
e. Number, types, and possible locations of facilities required for the support of drilling and for production operations: (none)
f. Number and possible locations of terminals and storage facilities required for the production of oil and gas anticipated as a result of this sale. (0-2 onshore)
g. The possible locations, and mileage, of pipelines required together and transport produced oil and gas to offshore or onshore storage, refineries and/or transhipment facilities: (400-700 miles of pipeline consisting of main lines as well as connecting lines. Both gas and oil lines are needed and would come ashore generally in the Pensacola and Tampa, Fla. areas).
h. A time of development, indicating the estimated time required between the lease sale and the completion of test wells, platforms, development wells, production facilities, and the beginning of production of oil and gas (see Table 1).
i. The possible onshore locations and estimated land acreage required for support facilities, pipelines, and production, treating and storage facilities, refineries and natural gas processing facilities.

Location, Mobile, Ala.; Acreage, 600; Type, Terminal and Storage.

Location, Tampa, Fla.; Acreage, 600; Type, Terminal and Storage.

j. The estimated daily rates of production of oil and gas that may be expected from this sale: (As this is the most virgin area in the GOM, little information is available to use in projecting production rates. However, as a rough estimate, the proposed leases may produce 2500-24,000 BOPD and 4-32 MMCFD after development and production stabilizes.)
k. The estimated cost of exploration wells, development wells, platforms, pipelines, terminals, and support facilities:

Expenditures—Range (MM Dollars)

1. Well Drilling
   Exploratory Wells, 10-100
   Development Wells, 30-300
   Total Well Drilling Costs, 40-400
2. Platforms, 35-240
3. Pipelines, 240-650
4. Terminals and Support, 5-15
   Totals, 320-1305

Paragraph 4)c.

As of April 30, 1977, there were 804 producing leases in the Gulf of Mexico OCS comprising a total of 3,419,272.845 acres.

The most recent annual report (10-1-76) of produced waste water discharged into Federal Gulf of Mexico waters indicates that there were 346 discharge points for produced brines in the OCS with 356,642 barrels per day of produced water being discharged.

In addition to the discharge into OCS waters there were, as of October 1, 1976, 33 locations in non-OCS areas, e.g., onshore locations to which the wastewater is piped, at which a total of 328,470 barrels per day of produced water were being discharged.

It is inappropriate to state herein the quantity of reservoir brines to be produced from the acreage obtained and successfully developed by the operators from this lease sale since the number of

TENTATIVE TRACT LIST
SALE NO. 65

OCS OFFICIAL PROTRACTION DIAGRAM, PENSACOLA NH 16-5
(Approved October 10, 1972; Revised December 2, 1976)

Tract No.		Block	Description	Acreage
65-1	O&G	882	All	5760
65-2	O&G	883	All	5760
65-3	O&G	884	All	5760
65-4	O&G	885	All	5760
65-5	O&G	886	All	5760
65-6	O&G	926	All	5760
65-7	O&G	927	All	5760
65-8	O&G	928	All	5760
65-9	O&G	929	All	5760
65-10	O&G	930	All	5760
65-11	O&G	970	All	5760
65-12	O&G	971	All	5760
65-13	O&G	972	All	5760
65-14	O&G	973	All	5760
65-15	O&G	974	All	5760

OCS OFFICIAL PROTRACTION DIAGRAM, DESTIN DOME NH 16-8
(Approved October 10, 1972; Revised August 1, 1973; December 2, 1976)

Tract No.		Block	Description	Acreage
65-16	O&G	2	All	5760
65-17	O&G	3	All	5760
65-18	O&G	4	All	5760
65-19	O&G	5	All	5760
65-20	O&G	6	All	5760
65-21	O&G	313	All	5760
65-22	O&G	314	All	5760
65-23	O&G	357	All	5760
65-24	O&G	358	All	5760
65-25	O&G	473	All	5760
65-26	O&G	474	All	5760
65-27	O&G	518	All	5760
65-28	O&G	519	All	5760
65-29	O&G	529	All	5760
65-30	O&G	562	All	5760
65-31	O&G	563	All	5760
65-32	O&G	573	All	5454.72
65-33	O&G	574	All	5760
65-34	O&G	618	All	5760
65-35	O&G	661	All	5760
65-36	O&G	662	All	5760

OCS OFFICIAL PROTRACTION DIAGRAM, DE SOTA CANYON NH 16-11
(Approved June 5, 1974; Revised December 2, 1976)

Tract No.		Block	Description	Acreage
65-37	O&G	436	All	5760
65-38	O&G	437	All	5760
65-39	O&G	480	All	5760
65-40	O&G	481	All	5760

OCS OFFICIAL PROTRACTION DIAGRAM, FLORIDA MIDDLE GROUND NH 16-12
(Approved October 10, 1972; Revised August 1, 1973; December 2, 1976)

Tract No.		Block	Description	Acreage
65-41	O&G	358	All	5760
65-42	O&G	359	All	5760
65-43	O&G	397	All	5760
65-44	O&G	398	All	5760
65-45	O&G	399	All	5760
65-46	O&G	400	All	5760
65-47	O&G	401	All	5760
65-48	O&G	402	All	5760
65-49	O&G	403	All	5760
65-50	O&G	404	All	5760
65-51	O&G	405	All	5760
65-52	O&G	441	All	5760
65-53	O&G	442	All	5760
65-54	O&G	443	All	5760
65-55	O&G	444	All	5760
65-56	O&G	445	All	5760
65-57	O&G	446	All	5760
65-58	O&G	447	All	5760
65-59	O&G	486	All	5760
65-60	O&G	487	All	5760
65-61	O&G	488	All	5760
65-62	O&G	489	All	5760
65-63	O&G	490	All	5760
65-64	O&G	491	All	5760
65-65	O&G	530	All	5760
65-66	O&G	531	All	5760
65-67	O&G	532	All	5760
65-68	O&G	533	All	5760
65-69	O&G	534	All	5760
65-70	O&G	535	All	5760

OCS OFFICIAL PROTRACTION DIAGRAM, THE ELBOW NG 16-3
(Approved October 10, 1972; Revised August 1, 1973; December 2, 1976)

Tract No.		Block	Description	Acreage
65-71	0	567	All	5134.56
65-72	0	609	All	5760
65-73	0	696	All	5760
65-74	0	697	All	5760
65-75	0	739	All	5760
65-76	0	783	All	5760
65-77	0	827	All	5760
65-78	0	871	All	5760

OCS OFFICIAL PROTRACTION DIAGRAM, NG16-6
(Approved June 5, 1974; Revised December 2, 1976)

Tract No.		Block	Description	Acreage
65-79	0	258	All	5760
65-80	0	259	All	5760
65-81	0	302	All	5760
65-82	0	303	All	5760
65-83	0	609	All	5760
65-84	0	610	All	5760
65-85	0	611	All	5760
65-86	0	653	All	5760
65-87	0	654	All	5760
65-88	0	697	All	5760

OCS OFFICIAL PROTRACTION DIAGRAM, TARPON SPRINGS NH 17-10
(Approved October 10, 1972; Revised December 2, 1976)

Tract No.		Block	Description	Acreage
65-89	O&G	233	All	5760
65-90	O&G	234	All	5760
65-91	O&G	277	All	5760
65-92	O&G	278	All	5760
65-93	O&G	279	All	5760

OCS OFFICIAL PROTRACTION DIAGRAM, ST. PETERSBURG NG 17-1
(Approved October 10, 1972; Revised December 2, 1976)

Tract No.		Block	Description	Acreage
65-94	0	661	All	5760
65-95	0	662	All	5760
65-96	0	705	All	5760
65-97	0	706	All	5760
65-98	0	753	All	5760
65-99	0	754	All	5760
65-100	0	797	All	5760
65-101	0	798	All	5760

OCS OFFICIAL PROTRACTION DIAGRAM, CHARLOTTE HARBOR NG 17-4
(Approved October 10, 1972; Revised December 2, 1976)

Tract No.		Block	Description	Acreage
65-102	0	143	All	5760
65-103	0	144	All	5760
65-104	0	145	All	5760
65-105	0	187	All	5760
65-106	0	188	All	5760
65-107	0	221	All	5760
65-108	0	231	All	5760
65-109	0	265	All	5760
65-110	0	266	All	5760
65-111	0	627	All	5760
65-112	0	628	All	5760
65-113	0	671	All	5760
65-114	0	672	All	5760
65-115	0	715	All	5760
65-116	0	716	All	5760

Table 1.

Year	Exploratory Wells	Platforms	Development Wells	Beginning of Production
1	2 - 10	0	0	0%
2	4 - 15	0 - 2	0	0%
3	4 - 20	1 - 3	2 - 5	0%
4	3 - 20	1 - 5	3 - 20	10%
5+	2 - 10	3 - 15	25 - 200	100%

leases to be obtained therefrom are not presently known, nor can such be anticipated.

PARAGRAPH 4)D,H.

CURRENT ACCIDENT DATA AND OTHER INFORMATION AVAILABLE TO GULF OF MEXICO OCS OPERATIONS

2490 slicks of unknown origin sighted during the period November 1, 1972, through June 30, 1977.

Information related to oil spills which occurred from June 1, 1976 through June 30, 1977, is summarized in Table 2.

A sampling of 4 of the 84 spills which occurred during the period June 1, 1976, through June 30, 1977, is described below giving a brief description of the cause of the spill:

1. The triplex pipeline pump crosshead broke during pumping allowing 4 barrels of oil to spill. The E.S.D. was activated and the pump was isolated until repaired.
2. Three barrels of condensate spilled into the Gulf when the body of the dump valve on the main production separator was cut out by sand erosion.
3. The failure of the sump pump allowed 4 barrels of oil to overflow into the Gulf.
4. Five barrels of oil spilled when a 12-inch oil sales line hose ruptured.

The total numbers of warnings issued and suspensions ordered for infractions of OCS Orders which occurred during normal daily inspections from December 1, 1972, through June 30, 1977, are as follows:

Warnings—Drilling, 126; Workover, 17; Production, 6513.
Suspensions—Drilling, 67; Workover, 7; Production, 5879.

During the period of June 1, 1976, through June 30, 1977, there were five significant pollution spills of more than 15 barrels reported:

1. Several high level control failures caused 16 barrels of oil to flow into the Gulf from a skim pile.
2. Three hundred barrels of diesel fuel spilled into the Gulf when a loading hose broke while pumping the fuel onto a platform.
3. A shrimp trawl drug across the tie-in of Placid's 10-inch pipeline and Pennzoil's 14-inch Bonito pipeline pulling loose a one inch ball valve and nipple allowing 4000 barrels of oil to spill into the Gulf.
4. A mud slide caused the rupture of a 12¾-inch pipeline allowing 200 barrels of oil to spill into the Gulf.
5. The high level sensor on a stock tank failed allowing 35 barrels of oil to overflow from the tank.

Approximately 346 on-site inspections of pollution incidents were made from December 1, 1972, through June 30, 1977, in response to reports submitted by operators.

Listed below are the results of on-site inspections performed in response to the observations made during pollution surveillance flights conducted from December 1, 1972, through June 30, 1977.

Pollution Inspections, 180; No. of Platforms, 298.
No. of Wells, 2143; Warnings, 43; Suspensions, 53.

The Geological Survey Inspector Force in the Gulf of Mexico has increased from 7 technicians and 5 engineers as of July 1, 1969, to 39 technicians and 29 engineers as of June 30, 1977.

During the period from November 1, 1972, through June 30, 1977, technicians spent 22,667 inspection days or 199,146 man-hours, and engineers 1,907 inspection days or 16,584 man-hours in the field.

Detailed inspections were conducted on 6684 major producing platforms and 4508 minor platforms in the Gulf of Mexico from December 1, 1972, through June 30, 1977. Also during this period, 3615 inspections of single wells or satellites were made by boat. Approximately ninety-five percent of these inspections were unannounced. Included in these inspections were 73,808 well completions. Also during this period, 8526 inspections of drilling rigs were conducted. As of June 30, 1977, there were 10,790 completions capable of producing oil and gas on OCS lands offshore Louisiana and Texas. One hundred one mobile drilling rigs were operating in the Gulf of Mexico OCS waters at the end of June 1977. During the period of January 1, 1973, through June 30, 1977, 11,446 pollution flights were made. The helicopters chartered by the Geological Survey for use of the inspecting personnel flew a total of 30,788 hours.

From January 1, 1971, through June 30, 1977, there were approximately 50,000 barrels of oil produced per barrel of oil spilled (see Table 3).

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Table 2.

Month	No. Spills	Vol. Crude (barrels)	Vol. Other	No. Spills One Barrel or Less	No. Slicks Sighted
June 76	6	26		80	45
July 76	5	25		110	61
Aug. 76	5	26	12 diesel	85	50
Sept. 76	7	11	2 condensate 2 diesel	67	53
Oct. 76	9	18	315 diesel	72	20
Nov. 76	4	11		60	22
Dec. 76	12	4,043	2 diesel	59	27
Jan. 77	7	25	12 diesel	51	19
Feb. 77	5	25		51	13
Mar. 77	8	230	2 diesel	66	36
April 77	3	29		63	19
May 77	4	15		92	34
June 77	9	74		89	36
	84	4,558	2 condensate 345 diesel	945	435
Total since November 1972	540	50,763	64 condensate 990 diesel 47 oil base mud 3 distillate 10 corrosion inhibitor 2 methanol	2,932	2,490

Table 3. Equipment Malfunctions Detected During Complete and Partial Inspections During the Period January 1975 Through May 1977

Items	No. Checked	Operable	Inoperable or not With Acceptable Tolerance*	Percent Failures or Malfunction
Surface Safety Valves	20,825	20,232	593	2.8%
Flowline	41,052	40,604	448	1.1%
Check valves	19,764	18,527	1,237	6.2%
<u>Pressure Vessels</u>				
High Pressure Sensors	16, 976	16,550	426	2.5%
Low Pressure Sensors	13,941	13,702	239	1.7%
High Level Shut-in	14,640	14,346	294	2.0%
Low Level	8,549	8,271	278	3.2%

*Items which did not operate within an acceptable tolerance during inspection. It should be understood that these items did not fail and cause an undesirable event.

INTRODUCTION

This report presents a summary of the geology of the Eastern Gulf of Mexico based on published sources and unpublished sub-surface geologic and geophysical data in Federal Government files. It includes a qualitative assessment of the future hydrocarbon potential of unleased acreage in the MAFLA area.

GENERAL GEOLOGY

The Gulf of Mexico is a subsiding ocean basin in which terrigenous clastics (interbedded sand, silt, and clay), carbonates, and evaporites have been deposited since early Mesozoic times. However, a controversy exists over the assumption that the Gulf has been a permanent ocean basin. Wilhem and Ewing (1972) believe that the oceanic crust beneath the abyssal Gulf was developed in the later Paleozoic time (Table 4). Very little is known of the geologic history of the Gulf prior to Jurassic time.

During the Jurassic (about 180 to 150 million years ago), the Gulf was a shallow enclosed sea, similar to the Caspian, in which extensive evaporites of salt and anhydrite (e.g., the Louann Salt and the Buckner Anhydrite) were deposited. A considerable amount of limestone, known as the Smackover and Cotton Valley Formations, was deposited in late Jurassic time.

The isolation of the Gulf waters may have been caused by the extensive deposition of carbonates across the West Florida Shelf and the Yucatan Peninsula. During early Cretaceous time the southeastern part of the Gulf underwent subsidence. Data from wells drilled in southern Florida indicates that the Gulf of Mexico subsided as much as 10,000 feet during the Cretaceous. The Florida Platform and the Yucatan Platform comprise shallow water carbonate and anhydrite rocks deposited behind growing barrier reefs. In this slowly subsiding basin the area seaward of the barrier reef became increasingly deeper as the subsidence continued.

The opening of the Gulf occurred during the Cretaceous-Paleocene Laramide mountain-building episode when carbonate growth was retarded. Later erosion between Florida and Yucatan resulted in the development of an extensive opening to the Gulf (Figure 1). Since Jurassic time, nearly continuous sedimentation has occurred for a large part of the Gulf.

The continental shelf in the Eastern Gulf of Mexico is a gently sloping submarine plain (less than 1°) of varying width forming part of the border of the continent out to a water depth of approximately 450 feet, at which point the continental slope begins. The continental slope has a steeper gradient (approaching 5°) extending from the continental shelf to the oceanic depths. The northeastern Gulf shelf varies in width from about 12 miles off the Mississippi River delta to about 140 miles off Crystal River, Florida.

MAJOR STRUCTURAL ELEMENTS

The major structural features in the northeastern Gulf include the Peninsular Arch, the Ocala Uplift, the Southwest Georgia Embayment, the DeSoto Canyon, and the South Florida Basin (Figure 1).

The major positive subsurface structural feature in the region is the northwest southeast trending Peninsular Arch which existed as a topographic high during Early Cretaceous and early Late Cretaceous time. An auxiliary structure, the Ocala Uplift, extends from the Peninsular Arch towards the Gulf. The Ocala Uplift probably formed during the Miocene.

The Southwest Georgia Embayment extends across the northeastern Florida Panhandle into southern Georgia and Alabama. Onshore wells in this area have revealed a Cretaceous-Miocene sedimentary rock section almost 9000 feet thick. Rainwater (1971) and Maher (1971) estimate that the thickness of the offshore section may exceed 15,000 feet.

The DeSoto Canyon is located on the western flank of the Southwest Georgia Embayment. This canyon forms a boundary in the older rock sequences (Cretaceous and older) from clastic sediments to the west and carbonate sediments to the east.

The South Florida Basin is located farther south on the West Florida Shelf. Geophysical surveying and onshore drill data have revealed a southward-thickening section of the Mesozoic-Cenozoic shallow-water carbonate and evaporite strata beneath the South Florida Platform. The thick southern sequence accumulated in a subsiding depositional trough (South Florida Basin) which extended over much of the southern Florida shelf and eastward to the Bahamas.

Table 4. Geologic Time Chart

EPOCH	PERIOD	ERA
Holocene Pleistocene	Quaternary	CENOZOIC 63 Million Years Ago
Pliocene Miocene Oligocene Eocene Paleocene	Tertiary	
	Cretaceous Jurassic Triassic	MESOZOIC 230 Million Years Ago
	Permian Pennsylvanian Mississippian Devonian Silurian Ordovician Cambrian	PALEOZOIC 600 Million Years Ago
		LATE PRECAMBRIAN EARLY PRECAMBRIAN

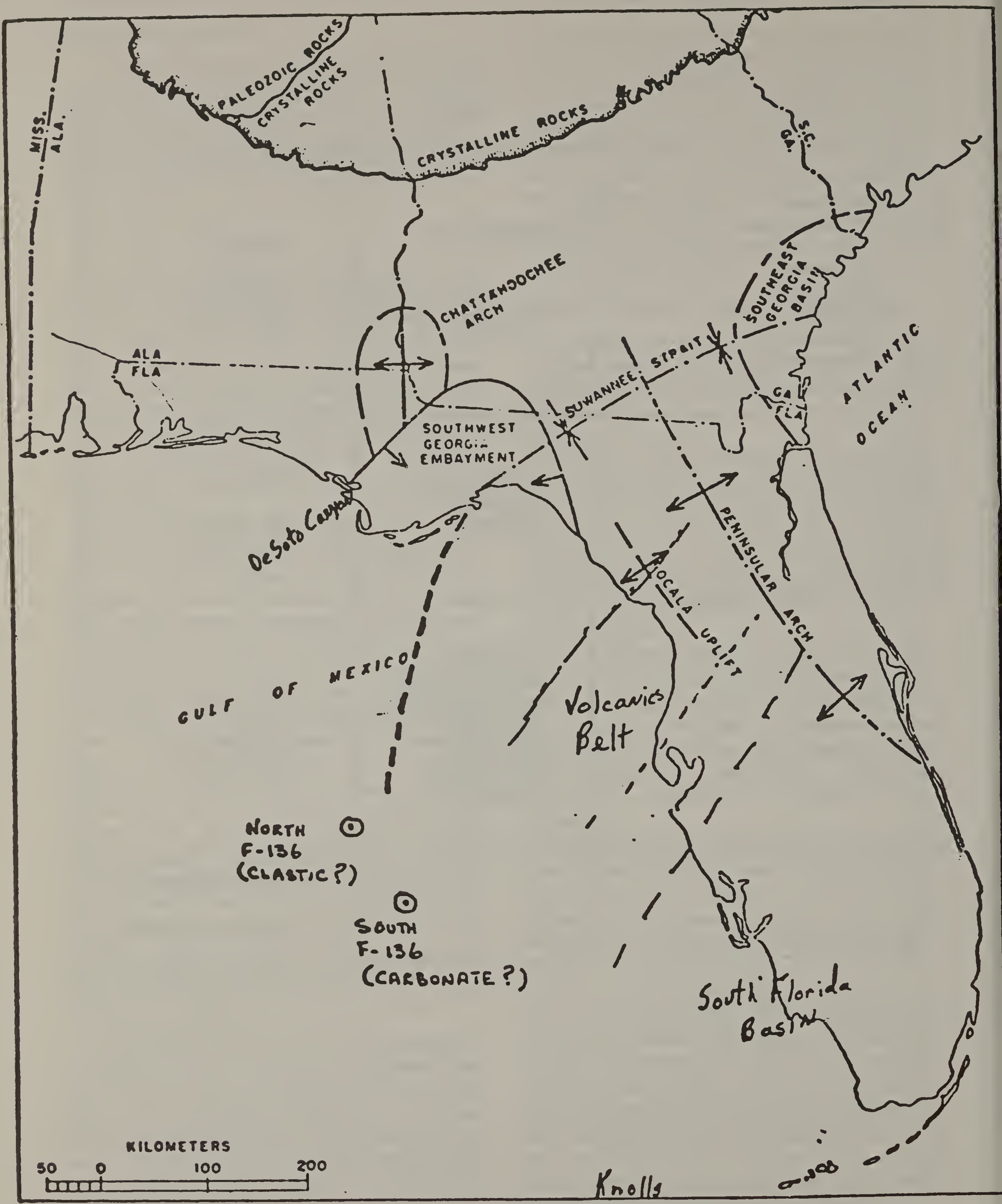


Figure 1 Regional geologic features.

STRATIGRAPHY

The oldest sedimentary rocks penetrated by exploratory wells drilled in the northeastern Gulf are Upper Jurassic in age. They lie for the most part on a Paleozoic basement complex. The subsurface sediments of the eastern region, together with their associated hydrocarbon production, are separated into trends: Upper Jurassic, Lower Cretaceous, Upper Cretaceous, and Tertiary.

A. Upper Jurassic Section

The known thickness of Upper Jurassic sediments is over 7000 feet and the production is from both limestone and detrital marine sandstone. Potential reservoirs are located in oolitic and pellet limestones, dolomite, and sandstone facies. The Upper Jurassic trend swings from an east-west direction in north Louisiana to a southeasterly direction through Mississippi and Alabama and there is a strong possibility the trend will continue to extend southeastward down the entire Florida shelf. Several fairly large fields have been found in this trend. Of approximately 50 Jurassic fields from the Texas-Louisiana border to the Florida Panhandle, four contain more than 100 million barrels of hydrocarbons. Of these four, three are in north Louisiana and the fourth, Jay Field, located in Escambia County, Florida, is believed to have an ultimate recovery of over 250 million barrels. The recoverable reserves from the Jurassic trend in Mississippi, Alabama, and western Florida is estimated to be 550 million barrels. It is not known how far south these potential Jurassic rocks extend.

B. Lower Cretaceous Section

Lower Cretaceous rocks attain a thickness in excess of 8000 feet beneath the Florida shelf. Production in the Lower Cretaceous is mostly associated with detrital marine and deltaic sandstones. In Hancock County, Mississippi, where rocks are dominantly carbonate, production occurs from a sandstone facies. However, there are two exceptions: (1) the production from the reef facies of the Sligo Formation at Black Lake Field in Natchitoches Parish, Louisiana; and (2) the production from rudist bioherms of the Sunniland Limestone in Collier and Dade Counties, Florida. The reef trend in the Lower Cretaceous runs from Mexico through Texas, central Louisiana, then southeast to Hancock County, Mississippi, and seismic evidence strongly suggests its presence offshore south of the DeSoto Canyon along the Florida Escarpment as far as latitude 25° N. Although evidence for the presence of the Lower Cretaceous reef trend along the Florida Escarpment is strong, production from the onshore portion of this trend has been very limited to date. There are over 300 fields from Mexico to southwestern Alabama producing from Lower Cretaceous rocks, but only two giant fields, Golden Lane offshore Mexico and Black Lake in central Louisiana, are producing from reef facies. Production from a third reef, the Edwards Reef in south Texas, is not significant. Most fields in this trend are productive in the marine detrital facies. The production from the Sunniland Limestone in southern Florida could trend offshore along the northern edge of the South Florida Basin.

Although the Lower Cretaceous trend appears to have the most potential, the results from a few exploratory wells onshore and offshore are disappointing.

C. Upper Cretaceous Section

The Upper Cretaceous section, though productive elsewhere on the Gulf Coast, is not considered to be very prospective beneath the Florida shelf with the possible exception of the Lower Tuscaloosa Sandstone. Regionally, the Upper Cretaceous grades laterally from clastic rocks in northwest Florida, to carbonates in south Florida. The Upper Cretaceous in onshore Mississippi, Alabama, and Louisiana is no more than 3000 feet thick and most of the production is from sandstones that appear to be grading into a now nonproductive facies carbonate on the Florida shelf.

D. Tertiary Section

The Tertiary rocks of the Florida shelf are considered to be the least prospective. Although there are about 8000 feet of Tertiary rocks just south of the Mississippi coast, this sequence of rocks thins to 6000 feet or less on the Florida shelf. Sediments of Tertiary age are not now considered prospective with the exception of some possible reef traps in the Paleocene.

OIL AND GAS POTENTIAL

Production in the MAFLA area occurs from onshore carbonate trends of Lower Cretaceous and Upper Jurassic age. These productive trends can be projected offshore; however, limited drilling on Federal acreage has failed to establish any offshore production. Estimates of the oil and gas potential for the MAFLA area are highly speculative because of the sparse well control. Extensive additional drilling is necessary to explore for stratigraphic traps and delineate the Lower Cretaceous and Upper Jurassic prospective trends in the Outer Continental Shelf.

OTHER MINERAL DEPOSITS

Other materials which may have economic value on the Outer Continental Shelf are sulfur, heavy minerals and shell deposits.

Sulfur is present in the cap rock of salt domes less than 3000 feet deep and is also produced from gas wells as hydrogen sulfide. In Alabama and western Florida sulfur is being extracted from some gas produced from Jurassic rocks.

Twenty-six types of heavy minerals occur along the beaches of the Mississippi Sound and along parts of the Florida Panhandle. The average concentration of heavy minerals in beach sand of the Mississippi Sound ranges from two to six percent. Concentrations of one to three percent of certain heavy minerals are mined profitably in Florida.

POSSIBLE GEOLOGIC HAZARDS

The Florida shelf is a stable area or platform which contrasts markedly with the unstable Texas-Louisiana offshore area. With no major tectonic activity taking place in the Eastern Gulf of Mexico, there are few, if any, potential geologic hazards known.

The lack of extensive sedimentation by rivers in the MAFLA area differs greatly with the western and central Gulf of Mexico. Sediment instabilities encountered around the large river deltas in the western Gulf are not a problem in the Mississippi-Alabama-Florida area. The seafloor is characterized by firm sediment which is composed of semiconsolidated carbonate particles that rapidly change to limestone at depth. Foundations for the legs of offshore structures may be drilled into the seafloor.

Additional geologic hazards to be mentioned are the submerged karst topography (irregular topography developed by the solution of limestone rock by surface and cavernous limestone at the base of the Eocene, which presents a potential lost-circulation zone during drilling operations. Although current geologic and geophysical investigations are unable to identify specific typical potential drilling, adequate drilling technology is available to identify such conditions during drilling operations and suitable accommodations necessary to preclude any hazardous conditions can be implemented.

Many wells penetrating Mesozoic rocks in the State of Mississippi have encountered geopressures well above the 0.65 psi/ft. gradient which is considered the lower limit of the over-pressured section in the Tertiary of the Gulf Coast. Wells in updip locations encounter hydrostatic pressures while those in down dip, or seaward, locations encounter geopressures. Whether these geopressures extend through Alabama and Florida is not known at this time, but the Jay Field (in the Florida Panhandle), which produces from the Jurassic Smackover Formation, does not encounter these geopressures.

In addition to geopressures, hydrogen sulfide (H_2S), which does extend into Alabama and Florida, is hazardous to those people working on the rigs and to nearby communities.

4)i. Number of Structures, 2,130; Average rate installing (1976), 100; Average yearly rate of removal (1976) 40.

4)j. Structures removed from the Gulf of Mexico are brought to shore, sold for scrap, or sold to another lessee.

UNITED STATES DEPARTMENT OF THE INTERIOR

Bureau of Land Management

Washington, D.C. 20240

July 28, 1977
Memorandum
TO: Director, Geological Survey
FROM: Director, Bureau of Land Management
SUBJECT: Data Input Required from the Geological Survey for Preparation of the Draft Environmental Statement for OCS Sale No. 65 Offshore Mississippi, Alabama, and Florida

We are currently gathering data for incorporation in the subject draft environmental statement (DES). We request that you provide us with the following information as soon as possible in accordance with prior agreement. We need this information in a timely manner so that analysis of environmental and socioeconomic effects can be completed in time to be included in the DES. We will notify you when our tract selection agreement has been completed.

1. A tract-by-tract identification of tracts as being oil prone, gas prone, or oil and gas prone.

2. An estimate of the reserves of oil and gas that may be discovered as a result of this sale.

3. As soon as possible following the tract selection process, estimates of the following facility requirements:

a. Number of exploratory wells.
b. Number of development wells, both productive and dry.
c. Number of platforms.
d. Number of underwater completions.
e. Number, types, and possible locations of facilities required for the support, drilling, and/or production operations.
f. Number, and possible locations, of terminals and storage facilities required for the production of oil and gas anticipated as a result of this sale. If the use of offshore storage terminals is possible, an approximate location for these terminals would be required. If tankers or barges for transporting crude resources to refining or processing centers are considered to be required, the approximate locations of receiving and off-loading points, and estimated volumes handled would be required.
g. The possible locations and mileage of pipelines required to gather and transport produced oil and gas to offshore or onshore storage, refineries, and/or transshipment facilities.
h. A timetable of development, indicating the estimated time required between the lease sale and the completion of test wells, platforms, development wells, production facilities, and the beginning of production of oil and gas.
i. The possible onshore locations and land acreage required for support facilities, pipelines, and production, treating and storage facilities, refineries, and natural gas processing facilities.
j. The estimated daily rates of production of oil and gas that may be expected from this sale.
k. The estimated cost of exploration wells, development wells, platforms, pipelines, terminals, and support facilities.

4. Additional information or data that would serve to update or supplement the information received for inclusion in previous OCS Sale statements would be required in the following categories. This additional information would be helpful as soon as it can be obtained.

a. Estimated quantities of commercial mud materials that will be used in each well.
b. Estimated quantities of drill cuttings from each well.
c. Estimated quantities of oil reservoir brines that may be produced.
d. Current accident data applicable to OCS operations such as frequency and number of deaths, collisions, blowouts, inadvertent operations, and a summary of current environmental surveillance activities and results of inspections, including those conducted under special stipulations.
e. The data required for the section of the draft impact statement entitled Description of the Environment, with subsections within the topic of Geology, including geologic history, subsurface geology, bottom sediments, hydrocarbon potential, prospective horizons, structure and structural trends, other mineral resources, and a bibliography of the appropriate references.
f. The applicable engineering, geological and geophysical information similar to that provided for previous environmental impact statements including descriptions of geophysical exploration by both industry and the Geological Survey, topographic features, and areas subject to potential environmental hazards due to geological conditions, such as fault movement of the sea floor, mass movement of sediments, sediment failure or the loss of loadbearing strength, and areas where the shallow sediments may be nearly saturated with methane gas.
g. The status of leasing and five-year projection of acres under lease, reserves of oil and gas, remaining reserves, number of wells, platforms, miles of pipelines, and onshore terminals and storage facilities.
h. Information relative to Gulf of Mexico operations updating the occurrence of slicks and oil spills, and the causes of these spills, and the results of the Geological Survey daily, special and pollution inspection programs.
i. A separate listing of structures and multiwell platforms currently in the Gulf of Mexico and the avearge rate at which each type are currently being removed.
j. The disposition of structures and platforms currently being removed from the Gulf of Mexico.

Please provide the above requested data to the Director (732) in part or in whole, as it becomes available.

/S/ DONALD P. TRUESDELL
Deputy Assistant

4)g.

SALE NO. 65

1978 through 1983

STATUS OF OCS LEASING AND FIVE-YER PROJECTION

	This Proposed Sale	Current Status	Increments: 1/ Five-Year Schedule	1983 Status
a. Acres under lease (million)	.200 2/	7.7 5/	0.8 - 1.5	.7 - 10 3/
b. Reserves to be developed:				
- Oil (million bbl.)	15 - 150		500 - 1000	
- Gas (billion cu. ft.)	20 - 175		7 - 12	
c. Remaining Reserves:				
- Oil (billion bbl.)		2.5		2.0 - 3.5
- Gas (trillion cu. ft.)		30.0		20 - 40
d. Wells	30 - 225	14,272 5/	1,500 - 3,000	15,500 - 17,000
e. Platforms	5 - 26	2,144	100 - 300	2,200 - 2,600
f. Miles of Pipelines	400 - 700	8,300 4/	600 - 1,000	8,000 - 9,000
g. Onshore Terminal/Storage Facilities	0 - 2	52	6 - 10	55 - 65

1/ All figures are for development over the life of the leases issued during the five-year period.

2/ Estimated that .30 of the acreage proposed for offering in this sale will lease.

3/ This assumes that some leases will have expired or will have been relinquished.

4/ Includes approximately 3,100 miles of common carrier pipeline.

5/ U. S. Geological Survey monthly report. May 1977.

(All data for this table supplied by the U. S. Geological Survey)

Appendix E

Overview of Drilling Fluids Use and Disposal on the O.C.S.

OVERVIEW OF DRILLING FLUIDS USE AND DISPOSAL ON THE OCS

I. History

The first drilling fluids were simply those muds created by the action of the rotary drill bit on the formation it happened to be penetrating. Drilling fluids were introduced to the dry hole (cable tool) method of drilling in 1913 because wells drilled by this technique did not produce large quantities of fluid and were therefore prone to blowouts due to insufficient hydrostatic head to balance formation pressures.

By 1921, drilling fluid properties were being controlled through the use of additives purchased specifically for that purpose. Iron oxide was first used as a weighting agent and was soon replaced by barium sulfate. For a short period during World War II barium sulfate was in short supply and was replaced by strontium sulfate. Since barium sulfate again became available, it has been used almost exclusively as the weighting agent in drilling fluids.

Subsequent development of techniques for the testing of fluid properties spurred the use of more complex fluids so that by 1947, when the first offshore well out of sight of land was drilled, drilling fluid engineering was an established field. Today, there are over one thousand tradename products available for drilling fluids formulation (World Oil, 1977).

II. Drilling Fluids Functions, Components, and Drilling Practices

Drilling fluids are used today in the drilling of oil and gas wells to:

a. Cool and lubricate the drilling bit and drill pipe,
b. Transport drill cuttings to the surface,
c. Be thixotropic, so that cuttings will remain suspended when circulation is interrupted,
d. Have sufficient density to provide hydrostatic pressures higher than formation pressures,
e. Coat the wellbore wall with a filter cake to prevent fluid loss to permeable formations,
f. Have low viscosity while flowing,
g. Not interfere with interpretation of geological and electrical information required for lithology and logging evaluations, and
h. Minimize corrosion.

To accomplish these various tasks, the drilling fluid must be carefully matched to the subsurface formations and drilling conditions encountered. As noted above, there are hundreds of components available for fluids formulation; but the basic fluid is a water-based clay suspension with ferrochrome or chrome lignosulfonate added to control viscosity and fluid loss and barium sulfate added to increase fluid density. Some special application drilling fluids are either oil based or invert emulsion types and will not be treated here since they are not disposed of into the marine ecosystem. Table I lists the more common components of drilling fluids by function and their primary application.

The following description of drilling fluids practice probably typifies wells drilled on the OCS although most productive horizons would be at shallower depths than the maximum indicated; and would therefore result in less fluid disposal.

The first 150 ± feet is drilled or jetted with sea water and the resulting sea water mud is returned directly to the sea floor without being pumped to the rig. While drilling to 1,000 feet, typically only seawater is used as a drilling fluid and it is discharged overboard. If the formation clays do not make a viscous enough mud, bentonite is added to the system. Approximately 7000 barrels (1106 m^3) of water is discharged as a result of this operation and it contains mostly formation muds generated by drilling. Before running the conductor pipe to 1,000 feet, approximately six tons of bentonite is added to the 1,000 barrel (159 m^3) saltwater system. When the conductor pipe is cemented, this bentonite is discharged overboard.

While drilling the remainder of the hole, the drilling fluid is continuously cycled back through the mud system. Some fluid is discharged with the drill cuttings as they come off of the shale shaker; and periodically drilling fluid is discharged overboard as excess amounts are generated from the formation. The maximum discharge does not exceed 200 barrels (31.8 m^3) a day while drilling to 5,000 feet and 50 barrels (7.95 m^3) a day from 5,000 to 10,000 feet. During approximately 20 days of drilling to 10,000 feet, some 2,000 barrels (318 m^3) of bentonite-lignosulfonate mud will be discharged overboard. It is possible for the drilling fluid system to be converted from a seawater gel mud to a lignosulfonate treated freshwater mud at around 6,000 feet. This decision is based on the relative economics of transporting freshwater from shore versus the higher maintenance costs of seawater mud. During the additional 70 days of operations while drilling from 10,000 to 18,000 feet, the discharge rate will not exceed 50 barrels a day; and approximately 4,000

Table I - Common Drilling Fluid Components

Description	Primary Application
	Weighting Agents And Viscosifiers
Barite	For increasing mud weight up to 20 lbs/gal.
Calcium Carbonate	For increasing weight of oil muds up to 10.8 lbs/gal.
Bentonite	Viscosity and filtration control in water base muds.
Sub-Bentonite	For use when larger particle size is desired for viscosity and filtration control.
Attapulgite	Viscosifier in salt water muds.
Beneficiated Bentonite	Quick viscosity in fresh water upper hole muds with minimum chemical treatment.
Asbestos Fibers	Viscosifier for fresh or salt water muds.
Bacterially Produced Large Organic Polymer	Viscosifier and fluid loss control additive for low solids muds.
	Dispersants
Sodium Tetraphosphate	Thinner for low pH fresh water muds.
Sodium Acid Phyrophosphate	For treating cement contamination.
Quebracho Compound	Thinner for fresh water and lime muds.
Causticized Quebracho	1-2 ratio caustic-Quebracho for thinning low pH fresh water muds.
Hemlock Extract	Thinner for fresh water muds and in muds containing salt (10,000 to 15,000 ppm).
Modified Tannin	Thinner for fresh and salt water muds alkalized for pH control.
Mined Lignite	Dispersant, emulsifier and supplementary additive for fluid loss control.
Causticized Lignite	1-6 ratio caustic-lignite dispersant, emulsifier and supplementary fluid loss additive.
Calcium Lignosulfonate	Thinner for SCR and lime muds.
Modified Lignosulfonate	Dispersant and fluid loss control additive for water base muds.
Blended Lignosulfonate Compound	Dispersant, fluid loss agent and inhibitor for RD-111 mud systems.
	Fluid Loss Reducers
Pregelatinized Starch	Controls fluid loss in saturated salt water, lime and SCR muds.
Sodium Carboxymethyl Cellulose	For fluid loss control and barite suspension in water base muds.
Sodium Carboxymethyl Cellulose	For fluid loss control and viscosity building in low solids muds.

Description	Primary Application
Fluid Loss Reducers Continued	
Sodium Carboxymethyl Cellulose	For fluid loss control in gyp, sea water and fresh water muds.
Polyanionic Cellulosic Polymer	For fluid loss control and viscosifier in salt muds.
Sodium Polyacrylate	For fluid loss control in calcium free low solids muds.
Sodium Polyacrylate	For fluid loss control in low solids muds.
Lubricants, detergents, emulsifiers	
Extreme Pressure Lubricants	Used in water base muds to impart extreme pressure lubricity.
Processed Hydrocarbons	Used in water base muds to lower down-hole fluid loss and minimize heaving shale.
Oil Dispersible Asphalts	Used in water base muds to aid in controlling heaving shale.
Oil Soluble Surfactants	Used for spotting around differentially stuck pipe.
Detergent	Used in water base muds to aid in dropping sand. Emulsifies oil, reduces torque and minimizes bit balling.
Non-Ionic Emulsifier	Emulsifier for surfactant muds.
Blend of Anionic Surfactants	Emulsifier for salt and fresh water muds.
An Organic Entity Neutralized with Amines	Non-Polluting Lubricant for water base muds.
Blend of Fatty Acids Sulfonates, Asphaltic Materials	Used for spotting around differentially stuck pipe where weights in excess 10 ppg are required.
Defoamers, Flocculants, Bactericides	
Aluminum Stearate	Defoamer for lignosulfonate muds.
Sodium Alkyl Aryl Sulfonate	Defoamer for saturated salt muds.
Flocculating Agent	Used to drop drilled solids where clear water is desirable for a drilling fluid.
Paraformaldehyde	Prevents starch from fermenting when used in muds of less than saturation or alkalinity less than 1 cc.
Sodium Pentachlorophenate	Bactericide used to prevent fermentation.
Lost Circulation Materials	
Fibrous Material	Filler as well as matting material.

Description	Primary Application
	Lost Circulation Materials - Continued
Fibrous Mineral Wool	Often used in areas where acids are later employed to destroy the material.
Walnut Shells-	
Fine	Most often used to prevent lost circulatior
Medium	Used in conjunction with fibers or flakes to regain lost circulation.
Coarse	Used where large crevices or fractures are encountered.
Ground Mica-	
Fine	Used for prevention of lost circulation.
Coarse	Forms a good mat at face of well bore.
Cellophane	Used to regain lost circulation.
Combination of granules, flakes and fibrous materials of various sizes in one sack.	Used where large crevices or fractures are encountered.
Blended high fluid loss soft plugging material	One sack mixture for preparing soft plugs for severe lost circulation.
	Specialty Products
Shale Control Reagent	Calcium chloride mud for inhibiting the swelling of bentonitic shales.
Bentonite Extender	Increases yield of bentonite to form very low solids drilling fluid.
Non-Ionic Surfactant	Primary surfactant for formulating surfactant muds. May be used in hot holes for viscosity stability.
Filming - Amine	Corrosion inhibitor.
	Commercial Chemicals
Sodium Chromate	Used in water base muds to prevent high temperature gelation and as a corrosion inhibitor.
Sodium Hydroxide	For pH control in water base muds.
Sodium Carbonate	For treating out calcium sulfate in low pH muds.
Sodium Bicarbonate	For treating out calcium sulfate or cement in high pH muds.
Barium Carbonate	For treating out calcium sulfate (pH should be above 10 for best results).
Calcium Sulfate	Source of calcium for formulating gyp muds.
Calcium Hydroxide	Source of calcium for formulating lime muds.

Description	Primary Application
Commercial Chemicals - Continued	
Sodium Chloride	For saturated salt muds and resistivity control
Potassium Hydroxide	For pH stability and inhibition.
Chrome Alum (chromic chloride)	For use in cross-linking XC Polymer systems.
Oil Base and Invert Emulsion Muds	
Invert Emulsion (Water in Diesel Oil)	Protects sensitive producing formulations.
Oil Base Mud	Basically same application as Ken-X.
Gelatinous Oil Base Fluid	For casing recovery, corrosion control and protection of fresh water sands.
Emulsifiers for Invert Emulsions	
Primary Emulsifier	Primary additives to form stable water-in-oil emulsion.
Viscosity and Gel Builder	Provides weight suspension.
Hi-Temperature Stabilizer	Improves emulsion under high temperature conditions.
Hi-Temperature Stabilizer	Improves emulsion, weight suspension and fluid loss under high temperature conditions.

barrels (636 m^3) of lignosulfonate drilling fluid is discharged overboard. When the well is completed, the drilling fluid which remains in the surface system (approximately 800 barrels (127.2 m^3) is discharged overboard (Otteman, 1976). The typical compositions of the drilling fluids mentioned above are presented in Table II.

From the above information, the calculated weights of the various components which are discharged for an 18,000 foot well are presented in Table III.

Bactericides are frequently added to drilling fluids to prevent microbial degradation of organic additives and to suppress the formation of hydrogen sulfide by sulfate-reducing bacteria. The types of bactericides currently used in drilling and completion fluids are presented in Table IV. Pentachlorophenate is recommended by the manufacturer to be used in drilling fluid systems at a concentration range of from .25 to .50 pounds per barrel.

III. Environmental Effects

A. Acute Toxicity

McAuliffe and Palmer (1976), have summarized some of the published toxicity data on drilling fluid components and this information is presented in Table V. Most of these components are relatively non-toxic. Since bactericides are especially toxic, they deserve special consideration here. A summary of the published toxicity data for the types of bactericides used in drilling fluids is presented in Table VI. Of significant concern is the use of pentachlorophenate as a bactericide. This chlorinated hydrocarbon has been shown to have severe environmental effects, and as noted above, the recommended concentrations for use combined with current drilling fluid disposal practice could result in the introduction of large quantities of this chlorinated hydrocarbon into the marine ecosystem.

Since synergistic effects between drilling fluid components could increase or decrease toxicity, it is important to consider the toxicity of drilling fluids as they enter the marine ecosystem. The Offshore Operators Committee (1976) summarized some of the toxicity data on whole fluids as seen in Table VII, the 96 hour TL_{50} concentrations range from 8,300 to 120,000 parts per million. More recently (EG & G, 1976) the toxicity of whole drilling fluids was tested with sensitive marine organisms. The results of these tests are presented in Table VIII. Thompson and Bright (1977) tested the effects of two drilling fluid components and a whole fluid on the clearing rate of three species of coral. All three species could effectively clear barite and aquagel but were unable to clear the used drilling fluid which proved lethal.

Theoretical dilution ratios have predicted dilutions of 1,000 to 1 at approximately 1,000 feet from the outfall for a typical (40 bbl/hr) drilling discharge and field observations have found even greater actual dilutions (OOC, 1976). Therefore, drilling fluids for the most part would be expected to have little acutely toxic effect on marine ecosystems.

B. Field Studies

Due to the lack of scientifically generated information with regard to the fate and effects of drilling fluids disposed of into the marine ecosystem, several field studies have been conducted in an effort to determine the effects of such discharges *in situ*.

Mobil Oil Corporation funded a monitoring study of their drilling operations near the East Flower Garden Bank offshore Texas. Sediment and sea water were analyzed for barium, chromium, iron, lead and hydrocarbons before, during and after drilling operations; and observations of the coral reef were made. There was a marked elevation of barium, iron and lead in sediments at the drill site during and after drilling. Barium increased from 22 to 425 parts per million, iron increased from 8.5 to 13,000 ppm, and lead increased from 4.6 to 12.7 ppm. Hydrocarbon levels in sediments did not indicate any effect from drilling operations. The drilling fluids outfall was located near the bottom and the chemical analyses indicate that this served to concentrate them near the drill site and prevented them from reaching the coral reef (Continental Shelf Associates, 1975).

Union Oil Company funded a monitoring study of their drilling activities near the West Flower Garden Bank offshore Texas to assess the deleterious effect, if any, of their operations on this coral reef. The drilling fluid outfall was placed near the sea floor as a precautionary measure to protect the coral reef. On the basis of repetitive observations involving quadrat counts of benthonic organisms, quantitative assessment of fish populations, quantitative and qualitative

TABLE II - TYPICAL MUD COMPOSITIONS (OTTEMAN, 1976)

SEAWATER GEL MUD

This type mud is typically used to drill from the base of the conductor casing to the surface casing point. Generally, the seawater gel system will be used from less than 1000 feet to a maximum of 4500 feet. The components used to make up and maintain the required characteristics of this mud system are:

Mud Components	Lbs/Bbl of Mud
1. Drilled Solids	48-60
2. Bentonitic Clay	30-40
3. Caustic - Sodium Hydroxide	0.5-1.5
4. Mica Flakes (Lost Circulation Material)	0.0-.5
5. Cellulose Polymer	0.0-.25
6. Seawater	As required - approx. 10#/bbl salt from the sea water

LIGHTLY TREATED LIGNOSULFONATE SEAWATER/FRESHWATER MUD

As the hole is deepened below surface casing it becomes necessary to start adding additional materials to maintain the desired mud characteristics. Slowly fresh water is substituted for sea water as the depth and temperature increase. A typical 10.0-10.5 pound per gallon lightly treated lignosulfonate system used to about 10,000 feet would include:

Mud Components	Lbs/Bbl of Mud
1. Drilled Solids	55-70
2. Bentonitic Clay	20-30
3. Barium Sulfate - Weight Material	45-60
4. Caustic - Sodium Hydroxide	1.0-2.0
5. Lignosulfonate	4-6
6. Lignite	0.0-3.0
7. Cellulose Polymer	0.0-.25
8. Seawater/Freshwater	As required - approx. 5#/bbl salt from 50/50 seawater-freshwater.

LIGNOSULFONATE FRESHWATER MUD

The deep portion of a typical well (below approximately 10,000 ft.) would require a freshwater lignosulfonate mud system in order to maintain the mud properties as desired for proper hole maintenance. A typical 10.0-11.0 pound per gallon lignosulfonate treated mud system would include:

Mud Components	Lbs/Bbl of Mud
1. Drilled Solids	65-80
2. Bentonitic Clay	20-30
3. Barium Sulfate - Weight Material	55-150
4. Caustic Sodium Hydroxide	1-2
5. Lignosulfonate	4-8
6. Lignite	3-8
7. Defoamer/Detergents	0.5
8. Fresh water	As required

Table III - Drilling Fluid Components Discharged for an 18,000 foot well

Material	Weight (short tons)
barium sulfate	375.0
drilled solids	269.5
bentonite clay	125.5
lignosulfate	20.7
lignite	20.0
sodium hydroxide	6.8
defoamer/detergent	1.2
cellulose polymer	0.3

Table IV - Types of Bactericides Currently Used in Drilling Fluids

Aldehydes	- Formaldehyde, paraformaldehyde, gluteraldehyde
Chlorinated Phenols	- Pentachlorophenol, alkyl dichlorophenol, sodium salts of phenols
Quaternary Amines	- Alkyl dimethyl ammonium chloride, coco dimethyl benzyl ammonium chloride
Diamine Salts	- Acetate salts of coco or tallow diamines
Other	- Caustic, alkyl phosphates, heavy metal salts

Table V - Summary of Published Drilling Fluid Component Toxicities
(Adapted from McAuliffe and Palmer, 1976)

Test Material	Bioassay** Media	Test Organism	Toxicity LC_{50}-96[(a)], ppm [(b)] (Unless otherwise indicated)
Adgo F28	F	Rainbow trout	480,000
Ammomium phosphate	F	Rainbow trout	100 (toxic)
Ammomium sulphate	F	Rainbow trout	100 (toxic)
Aqugel (Wyoming Bentonite)	M	American oyster	7,500 (nontoxic)
Barite	M	American oyster	50-60 (LC_{50}-216)
	M	Various organisms	7,500
	F	Sailfin molly	100,000
	M	Sailfin molly	100,000
	F	Rainbow trout	7,500 (threshold LC_{50})
	F	Rainbow trout	24,000
Barite fluid extract	F	Rainbow trout	nontoxic
Bark extract modified hemlock	M	White shrimp	265
Baroyd	M	American oyster	nontoxic
Ben-Ex	F	Rainbow trout	527-836*
Bentonite	F	Rainbow trout	10,000
Bentonite	M	American oyster	110-119 (LC_{50}-192 day)
Bentonite fluid extract	F	Rainbow trout	28,570 (nontoxic)
B-Free	F	Rainbow trout	5.6-10* (LC_{50}-10 day)
Calcium carbonate	F	Sailfin molly	100,000 (100% Survival)
	M	Sailfin molly	100,000
Calcium chloride	F	Water flea (Daphnia)	920 (Threshold immobilization)
Calcium chloride	F	Mosquito fish	13,400
Calcium chloride	F	Bluegill	10,650
Capryl alcolhol	F	Rainbow trout	56-100*
Carbonox (lignitic material)	M	Various organisms	7,500
Carboxy methyl cellulose, regular	F	Rainbow trout	10,000
Carboxy methyl cellulose, Hi-Vis	F	Rainbow trout	10,000

Table V (continued)

Test Material	Bioassay** Media	Test Organism	Toxicity LC50-96[a], ppm[b] (Unless otherwise indicated)
Caustic soda (NaOH)	F	Rainbow trout	730
Cellulose-calcium carbonate workover additive	M	White shrimp	1,925
Cement (oil well)	M	Various organisms	70-450
Chromate Cr^{+6}, soft water	F	Mosquito fish	107
Chrome lignosulfonate	F	Sailfin molly	7,800
Chrome lignosulfonate	F	Rainbow trout	5,600
Chrome lignosulfonate	M	White shrimp	465
Chrome Lignosulfonate	M	Sailfin molly	12,200
Crude oil	F	Rainbow trout	400 (lethal)
Diatomaceous earth fluid extract	F	Rainbow trout	14,285 (not lethal)
Dichromate Cr^{+6}, hard water	F	Bluegill	133
Dichromate Cr^{+6}, soft water	F	Mosquito fish	100
	F	Bluegill	118
Dodecyl sodium sulphate	F	Rainbow trout	5-7
Dominion rig wash	F	Rainbow trout	10-18
Ferrochrome lignosulfonate	M	Rainbow trout	1,140-2,050
Fibertex	M	Various organisms	7,500
Formaldehyde	F	Water flea (Daphnia)	2 (48-hr threshold conc.)
	M&F	Salmon	28 (critical)
Gilsonite, powdered	F	Rainbow trout	100 (nontoxic)
Gypsum	F	Rainbow trout	756,000
Imperes (progelantinized startch)	M	Various organisms	500-7,500
Iron Carbonate (siderite)	F	Sailfin molly	100,000
Iron lignosulfonate	M	White shrimp	2,100

Table V (continued)

Test Material	Bioassay** Media	Test Organism	Toxicity LC_{50}-96[a], ppm[b] (Unless otherwise indicated)
Jelflake (shredded cellophane)	M	Various organisms	7,500
Kelzan-XC (polymer Xanthum gum)	F	Rainbow trout	320-560*
Lignite	F	Sailfin molly	24,500
Lignite	M	Sailfin molly	15,000 (100% survival)
Lignosulfonate thinners	F	Rainbow trout	100 (toxic)
Metso beads	F	Rainbow trout	100-560*
Mica (mica flakes)	M	Various organisms	7,500
Montmorillonite clay	F	Water flea	100 (toxic)
Oilfos (sodium tetraphosphate)	M	Various organisms	7,500
Paraformaldehyde	F	Rainbow trout	46-78*
Phosphoric acid ester dispersant	F	Rainbow trout	10 (toxic)
Polyacrylamide bentonite flocculent	F	Rainbow trout	100 (nontoxic)
Polyacrylate, low molecular wt.	M	White shrimp	3,500
Potassium chloride	F	Water flea (Daphnia)	432 (threshold conc.)
	F	Water flea (Daphnia)	317 (LC_{50}-48)
Potassium chloride	F	Mosquito fish	920
Potassium chloride	F	Bluegill	2,010
Potassium chloride	F	Rainbow trout	1,920-2,090*
Potassium chloride, reagent grade	F	Rainbow trout	1 (lethal)
Potassium chromium sulphate	F	Rainbow trout	560-1,000*
Potassium chromic sulphate Cr^{+3}, soft water	F	Bluegill	8.5
Potassium chromic sulphate Cr^{+3}, hard water	F	Bluegill	72

Table V (continued)

Test Material	Bioassay** Media	Test Organism	Toxicity LC_{50}-96(a), ppm(b) (Unless otherwise indicated)
Quadrafos	M	Various organisms	500-7,500
Quebracho	F	Sailfin molly	135
Rig wash compound	F	Rainbow trout	7,200 (lethal)
Skot-free	F	Rainbow trout	36-76*
Sodium acid pyrophosphate	F	Various organisms	500 (toxic)
Sodium acid pyrophosphate	F	Sailfin molly	1,200
Sodium bicarbonate	F	Rainbow trout	7,500
Sodium chloride	F	Water flea (Daphnia)	3,680 (threshold conc.)
	F	Water flea (Daphnia)	4,625 (LC_{50}-48)
Sodium chloride	F	Mosquito fish	17,550
	F	Bluegill	12,946
Sodium pyrophesphate	F	Rainbow trout	662-1,140*
Sump fluid, composite	F	Lake chub	225,000
Sump fluid, surface	F	Lake chub	810,000
Swift's rig wash	F	Rainbow trout	11-42*
Tanino	M	American oyster	90-170 (LC_{50}-108)
Torq-trim	F	Rainbow trout	1,580-3,250*
Tricron	F	Rainbow trout	46-87*
White lime	M	Various organisms	70-450

(a) LC_{50}-X or TL_m-X = lethal or median concentration giving 50% mortality in X hours
(b) ppm is mg/l or ul/l
* range of 95% confidence level
** F = Freshwater
M = Estuarine or marine water

Table VI. Toxicities of Bactericides Used in Drilling Fluids (Adapted from Robichaux, 1975)

Bactericide Type	TL50 (ppm) Fish	LD50 (gm/kg) Birds
Aldehydes	50-400	5-15+
Chlorinated Phenols	0.2-1	5-15+
Quaternary Amines	0.2-5	>5
Diamine Salts	0.4-4	>5

Table VII - Static Acute Toxicity Bioassays on Drilling Fluids (Adapted from OOC, 1976)

Test Material	Test Fish	96-hr TL_{50}, ppm
Rig 51 drilling fluid	Lake chub	120,000
	Rainbow trout	8,300
	Ninespine sticklebacks	103,000
	Rainbow trout	112,000
	Rainbow trout	53,000
	Lake chub	35,500
	Rainbow trout	42,000
Immerk B-48 drilling fluid	Lake whitefish	25,000
	Rainbow trout	75,000
Shell Kipnik drilling fluid	Lake whitefish	25,000
	Rainbow trout	42,000
Immerk B-48 mud filtrate	Lake whitefish	50,000

Table VIII - Acute Toxicity of Drilling Fluids to Sensitive Marine Organisms
(Adapted from EG&G, 1976)

	96-hr EC_{50} or LC_{50} (ppm)*		
Strictly Regulated Material	Alga (EC_{50})	Copepod (LC_{50})	Atlantic Silverside (LC_{50})
Drilling Muds			
Mud No. 1 (saltwater gel mud)	100 1,000**	100	100,000
Mud No. 2 (lightly treated ferrochromelignosulfonate saltwater/freshwater mud)	3,700	10,000	48,500
Mud No. 3 (ferrochromelignosulfonate freshwater mud)	320 560**	100	100,000

* EC_{50} (median effective concentration) is concentration of material that produced 0.50 reduction of cell numbers as compared to a control. LC_{50} (median lethal concentration) is concentration of material that caused 0.50 mortality of test organisms.

** These values are conservative approximations of EC_{50}. Conventional estimates of EC_{50} could not be derived because of unusual response pattern of organisms during bioassays.

assessments of coral behavior and stress reactions and determinations of "health" and pathological conditions among hermatypic corals and other epibenthic organisms, the investigation found no discernible effect on the reefal communities.

Post drilling barium analyses indicated major amounts to the north and east-southeast of the drill site within 300 meters of the site. Transmissivity measurements during drilling indicated a turbid water plume that extended over 1,000 meters to the south of the drill site toward the reef (Marine Technical Consulting Services, 1976).

Continental Oil Company funded a study of their drilling operations near Baker Bank offshore Texas. In this case, the drilling fluids were disposed of at the sea surface. On the basis of sediment barium levels before and after drilling, a major increase in barium was found at the drill site. Pre-drilling barium levels ranged from 344 to 419 parts per million. Post-drilling levels were as high as 1618 parts per million at a distance of 500 meters from the drill site but decreased to a maximum of 678 ppm at a distance of 1,000 meters (Continental Shelf Associates, 1976a).

Burmah Oil and Gas Company funded an investigation of their drilling operations near Stetson Bank, offshore Texas. The drilling fluids outfall was located near the seafloor to protect the bank. Significant increases in sediment barium concentrations were limited to within 300 meters of the well site and no increase was noted on the bank itself (Continental Shelf Associates, 1976b).

In a BLM funded study offshore Texas, sediment barium levels were found to increase during drilling throughout the 1,000 meter sampling radius. Post-drilling samples taken 3 months after the termination of drilling showed somewhat decreased barium levels with the high levels remaining at the drill site. Presumably, the barium sulfate deposited during the drilling operation had been redistributed and diluted prior to the post drilling analysis (SUSIO, 1976).

In another BLM funded study offshore Texas, sediment concentrations of zinc, barium and cadmium increased markedly at the drill site compared to pre-drilling levels (Univ. of Texas, 1977).

IV. Discussion

Drilling fluids are one of the necessary materials for drilling wells in the search for oil and gas resources on the Outer Continental Shelf. Except for those which contain oil, these fluids have historically been disposed of into the marine ecosystem. Acute toxicity bioassays indicate that most drilling fluid components are relatively non-toxic; however, certain minor constituents, such as the chlorinated hydrocarbon bactericides, are toxic and persistent. Field studies indicate that the initial dilution and subsequent dispersion of drilling fluids results in minor changes in the chemical composition of the surrounding sediments. When drilling fluids are disposed of at or near the sea surface, then the radius of the impact zone is at least 1 km; however, if the outfall is located near the sea bottom, the radius of the zone of impact is generally less than 300 m. This latter disposal method has been found to be useful when drilling near biotic communities which are sensitive to turbidity.

V. Conclusions

Through consideration of the above information, the following conclusions can be arrived at:

a. Non-oil-based drilling fluids are relatively non-toxic.
b. The disposal of these drilling fluids into the marine ecosystem can be accomplished with little or no environmental degradation with the exception of those which contain chlorinated hydrocarbon bactericides.
c. Drilling fluids which contain chlorinated hydrocarbon bactericides should not be disposed of into the marine ecosystem.
d. Near-bottom disposal is an effective means of limiting initial impacts of drilling fluids to within 300 meters of the drill site.

REFERENCES

Continental Shelf Associates. 1975. East Flower Garden Bank environmental survey. Lease OCS G-2759 for Mobil Oil Corporation.

Continental Shelf Associates, 1976a. Survey report for Continental Oil Company. Block A-85, Mustang Island Area, East Addition.

Continental Shelf Associates, 1976b. Survey report for Burmah Oil and Gas Company. High Island Area, South Addition, Block A-502.

EG & G, 1976. Compliance with ocean dumping final regulations and criteria of proposed discharges from exploratory drilling rigs on the Mid-Atlantic Outer Continental Shelf. 18 p. 2 appendices.

Marine Technical Consulting Services, 1976. Ecological assessment of drilling activities, well no. 1, Block 584, High Island, for Union Oil Company of California.

McAuliffe, C.D., and L. L. Palmer, 1976. Environmental aspects of offshore disposal of drilling fluids and cuttings. Society of Petroleum Engineers of AIME. Paper No. SPE 5864.

Offshore Operators Committee, 1976. Environmental aspects of drilling muds and cuttings from oil and gas extraction operations in offshore and coastal waters.

Otteman, L.G., 1976. Letter commenting on DES for OCS Sale No. 44 to New Orleans OCS Office, BLM.

Robichaux, T.J. 1975. Bactericides used in drilling and completion operations. Proceedings of EPA Conf. on Env. Aspects

of Chemical Use in Well Drilling Operations. Houston, Texas.
SUSIO, 1976. Rig monitoring, Volume VI of Baseline Monitoring Studies, MAFLA OCS, 1975-1976.
Thompson, J.H., and T.J. Bright, 1977. Effects of drill mud on sediment clearing rates of certain hermatypic corals. Proceedings 1977 Oil Spill Conference. p. 495-498.
University of Texas, 1977. Environmental Studies, South Texas Outer Continental Shelf, rig monitoring program, Draft Report.
World Oil, 1977. World Oil's 1977-78 Guide to drilling, workover, and completion fluids. Gulf Publishing Co., Houston.

Appendix F

Benthic Survey—Tarpon Springs Area

Benthic Survey, Tarpon Springs Area

I. Introduction

On May 27, 1977 the Bureau of Land Management issued a call for nominations of potential oil and gas leases for proposed OCS Sale No. 65 in the eastern Gulf of Mexico. Among those tracts nominated were five tracts in the Tarpon Springs Area about which the State of Florida expressed environmental concern (see Figure 1). The area was thought to contain extensive grass beds and was known to be the site of blue crab spawning and migration. In addition, the circulation pattern in the area was insufficiently known.

In situations of this nature, it is common practice for the Bureau to delete those tracts for which coastal states express substantial reservations and for which data are lacking upon which to base management decisions. However, in this case the State of Florida recommended that, instead of deleting the tracts, efforts be made to obtain sufficient information so that sound management decisions could be made.

The State of Florida agreed to take the lead in designing these efforts and called together, on September 1, 1977, a group of experts for recommendations as to the scientific design of these studies. The initial recommendation was that a reconnaissance survey of the area be conducted by the Bureau of Land Management to document the nature of the benthic environment in the area. What follows will describe that benthic survey.

II. Materials and Methods

A visual survey was determined to be the most efficient and cost effective method to be employed. These were important considerations given the rapid turn around desired and the limited funding available for a project of this sort.

A team of 4 diving scientists from the Florida State University Scientist-in-the-Sea Program volunteered their expertise and equipment and were joined by a team of 3 diving scientists from the Bureau of Land Management. This provided 3 teams of divers and an alternate and allowed a deck crew of five including dive master, timekeeper, tender, stand-by boat operator, and stand-by diver. A towable underwater sled capable of "flying" two SCUBA equipped divers at continuously variable depths in the water column and equipped with pilot-to-tow vessel voice communications was provided by the FSU team. The R/V Bellows was chartered for a support vessel and since it was uncertain as to whether this ship was capable of towing slowly enough, an 18 foot outboard-powered boat was also acquired; fortunately, the Bellows satisfied all requirements without resorting to the smaller craft.

Transects were established which paralleled the NE to SW trending Loran A lines to provide more precise navigational control. The transects crossed the lease blocks diagonally from the NE corner to SW corner as shown in Figure 2.

Divers were towed along the transects, which totaled approximately 50 miles, by the R/V Bellows at a comfortable speed of 1.5 to 2.1 knots. Depths in the area varied from 10 to 22 meters and all dives were conducted within standard safe-diving procedures with mechanisms for emergency release of the sled; and contingencies for lost communication, decompression, and a chase boat with stand-by diver and boat operator. As the divers were towed at distances varying from 0 to 2 meters above the sea floor, the pilot transmitted continuous observations of benthic community type and extent, and the observer acquired specimens for identification, and photographs of representative community types. At the end of each dive the divers recorded pertinent observations in their logs. During each dive, the on-deck crew recorded the time, the pilot's observations, a continuous fathometer profile, ship speed, and 15 minute interval Loran A fixes. In this manner, the sea floor was mapped along the transects.

III. Results

Loran A was exclusively used for navigation. Following the cruise, a navigation post plot was compiled using the 15-minute Loran A fixes (Figure 3).

The navigational accuracy afforded by Loran A in this area is fair along a northwest-southeast direction (± approximately 100 m), whereas the accuracy along the northeast-southwest loran lines was relatively poor (± approximately 400 m).

A slight westerly current was revealed by the post-plot on transect H-I. The current was consistant at around 1.0 knots. On September 22, at 1253, the tow was stopped to repair a parted communications cable. The ship drifted in little or no wind during the repair and when a fix was taken when the cable was repaired at 1455, the ship was located some two miles from the position at which the tow was terminated.

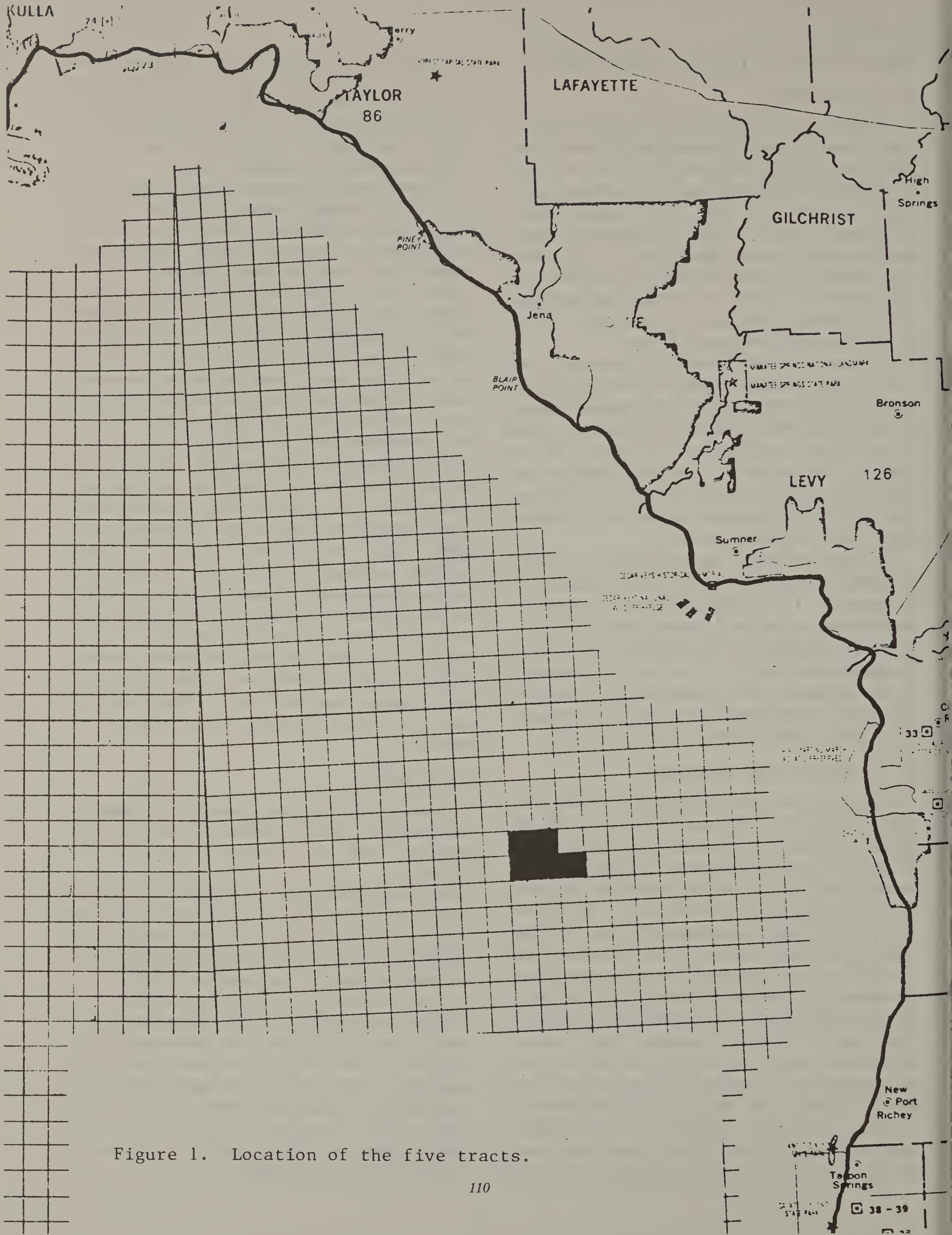


Figure 1. Location of the five tracts.

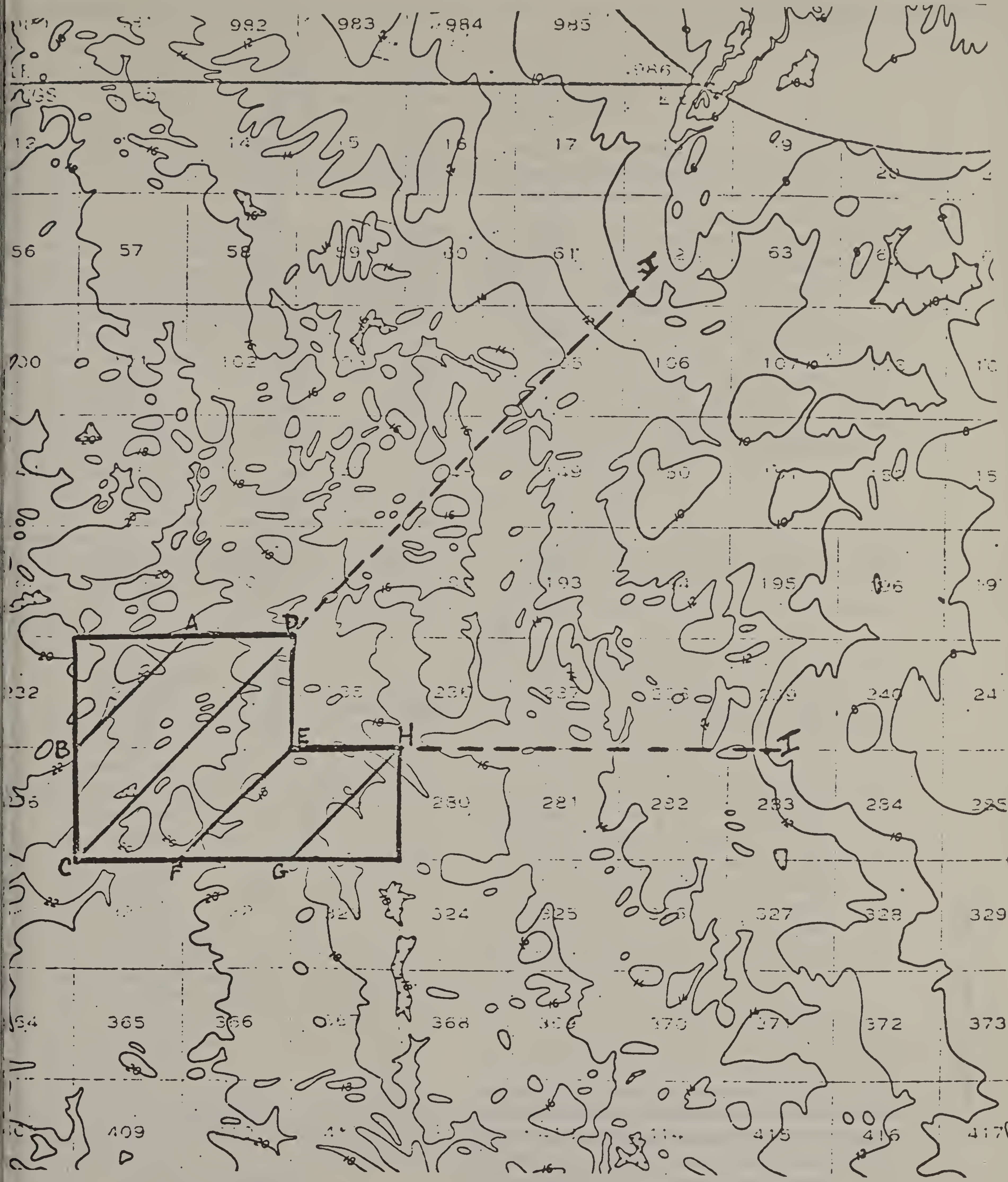
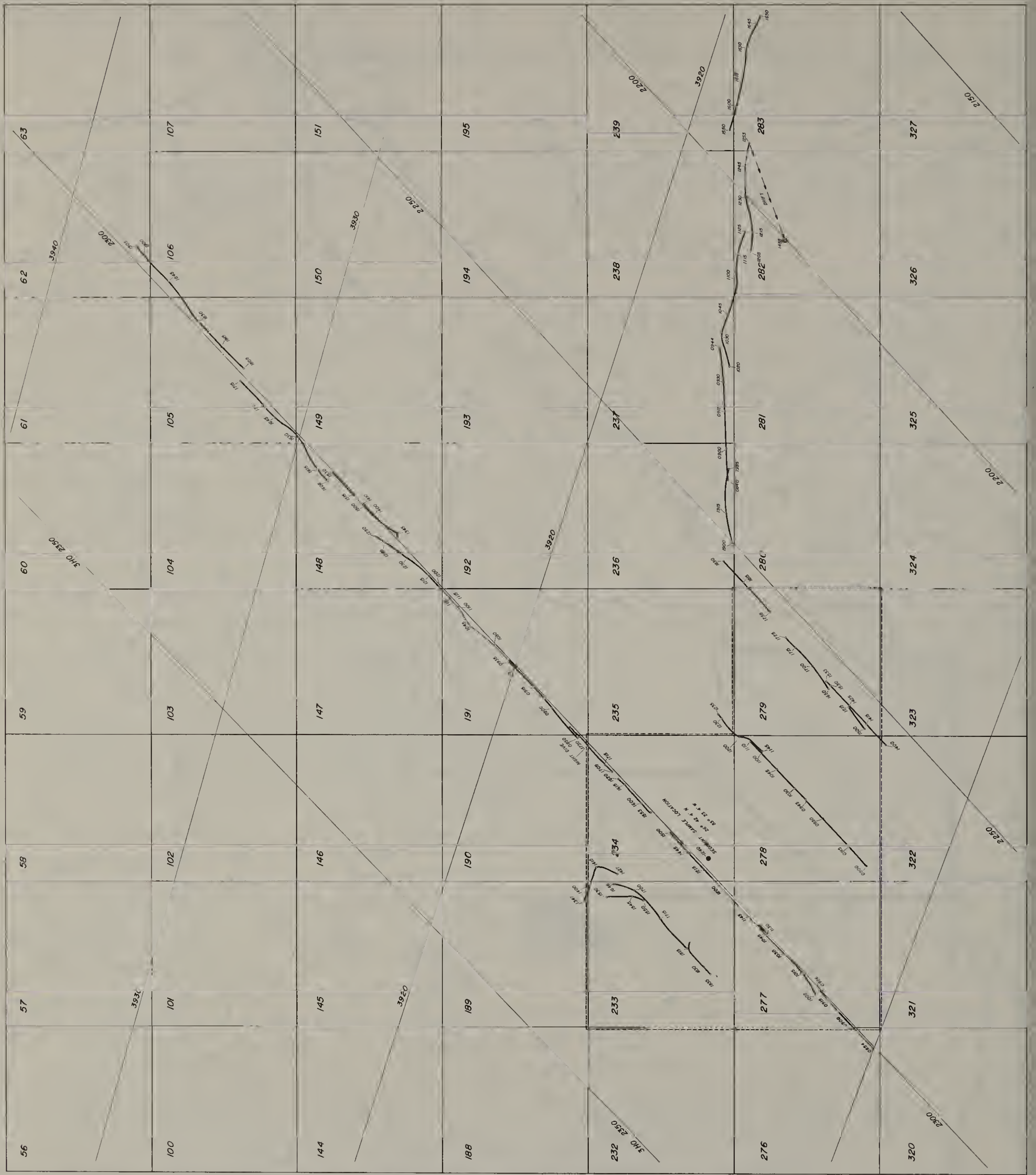


Figure 2. Survey transects.

TARPON SPRINGS AREA



Benthic community types observed along the transects fall into 5 arbitrary categories and 4 densities. The categories were established by listing the dominant species of epifauna or epiflora in the community. The densities were estimates provided by the sled pilot. The map depicting the distribution of these community types constitutes Figure 4.

The most common benthic community type consisted of a medium to coarse carbonaceous sand and/or shell hash which was essentially barren of epifauna or flora. Figure 5 is a photograph of a typical barren sand bottom and Figure 6 is a photograph of a typical barren shell hash bottom.

Also common was sand bottom with varying densities of the algae *Udotea* and *Caulerpa* sometimes interspersed with the seagrass *Halophila*. Figures 7 through 9 are representative photographs of this bottom type.

Less common was sand bottom with small patches of epifauna consisting of various combinations of sponges, gorgonians, and corals, representatives of which are shown in Figures 10 and 11. These are thought to occur in those areas where a thin veneer of sand overlies the limestone layer, which allows the organisms to attach to the limestone, and this was observed to be the case on a few occasions.

Occasionally, limestone outcrops contained dense communities composed of gorgonians, sponges, and calcareous algae. The stone crab *Menippe* was observed to be a common inhabitant of this habitat type. Demersal and reef fishes observed to be associated with this habitat type included those listed below:

Raja texana—roundel skate
Muraenidae—moray
Synodus spp.—lizardfish
Arius felis—sea catfish
Opsanus spp.—toadfish
Ogcocephalus spp.—batfish
Hippocampus spp.—seahorse
Diplectrum formosum—sand perch
Centropristis striata—black seabass
Serranus subligarus—belted sandfish
Epinephelus morio—red grouper
Ryticus maculatus—soapfish
Lutjanus griseus—gray snapper
Lutjanus spp.—snapper
Gerreidae—mojarra
Haemulon plumieri—white grunt
Calamus bajonado—jolthead porgy
Diplodus holbrooki—spottail pinfish
Calamus spp.—porgy
Equetus punctatus—highhat
Pseudupeneus maculatus—spotted goatfish
Pomacentrus variabilis—cocoa damselfish
Lachnolaimus maximus—hogfish
Hemipterus novacula—pearly razorfish
Halichoeres bivittatus—slippery dick
Opistognathus—jawfish
Ioglossus calliurus—blue gaby
Balistidae—file fishes
Lactophrys spp.—cow fish

Representative photographs of this community type are shown in Figures 12 and 14.

A rather uncommon but important benthic community type consisting of beds of the calico scallop *Argopecten* were observed on sand and shell-hash substrates. The density of these beds was as high as 10 per m^3 in some areas. A representative bed is shown in Figure 15.

Turbidity of the water was minimal in most cases and did not appear to limit community development. However, in certain areas bottom sediment drift appeared to be of a magnitude which could affect substrate stability as shown in the photograph of sand encroaching over the gorgonians in Figure 6.

IV. Discussion

As pointed out in the introduction, this effort was brought about primarily due to the concern that extensive seagrass beds existed in the surveyed area. Seagrasses were not common in the area.

The apparent dominant variable which primarily influences benthic community type in this area is the depth of the sand/shell covering over the limestone basement; and much of the patchiness of the epifaunal communities can probably be related to this. This is especially evident in those areas where limestone outcrops form small ledges which provide the habitat diversity upon which rich epifaunal communities may develop.

This survey provided a characterization of the benthic community types which occur in this proposed lease area so that responsible state and federal officials could decide if they would recommend whether oil and gas leasing should be allowed in this area.

After having reviewed the results of this survey, the concensus of opinion among the various reviewing agencies was that oil and gas leasing could be allowed in the area given adequate safeguards to prevent damage to the marine ecosystem; these safeguards to be provided in the form of a lease stipulation which would require the lessee to map the lease block using geophysical techniques. If the lessee then wished to drill near what had been mapped as limestone ledges or outcrops, he would have to provide photodocu-

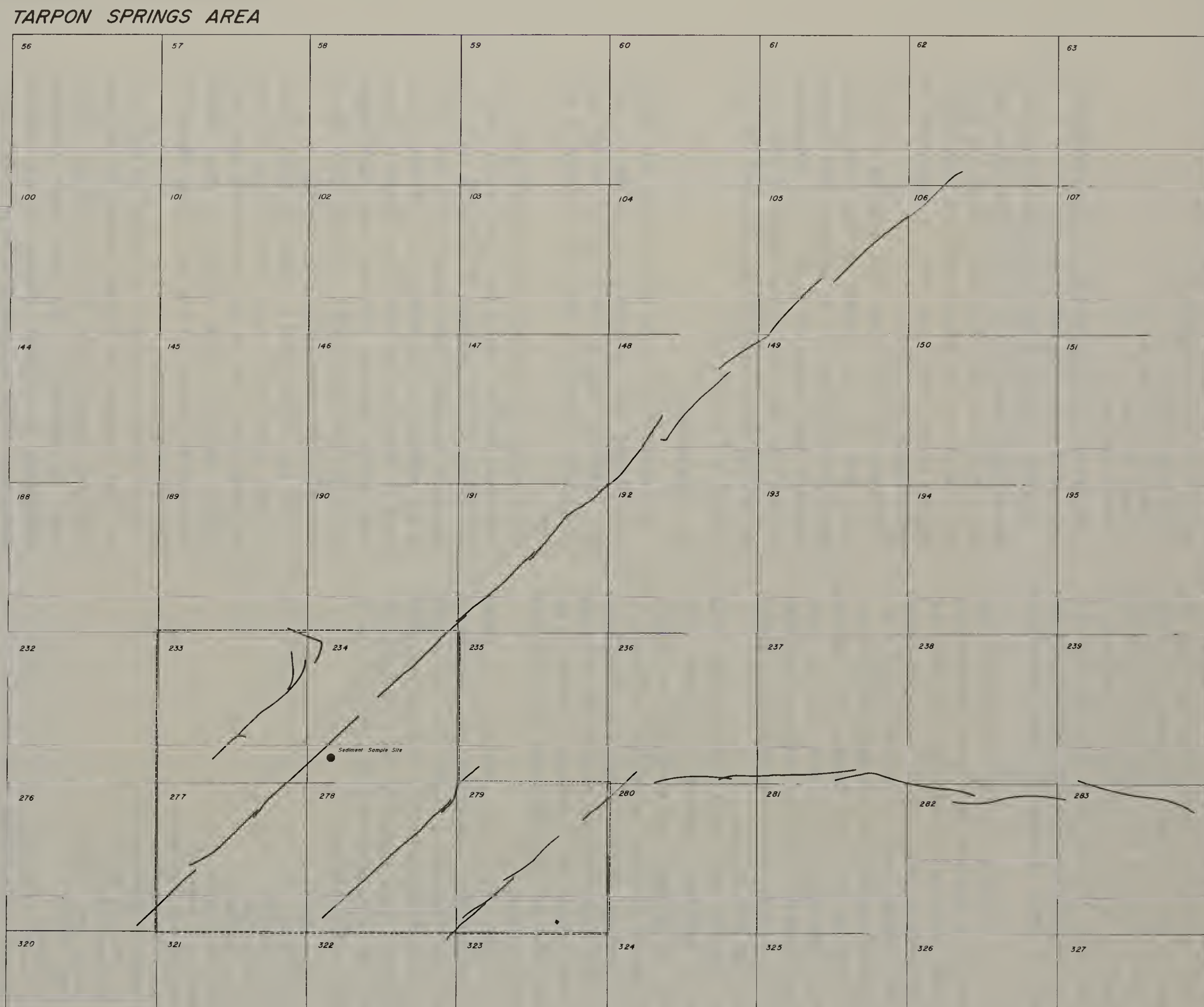


Figure 4. Bottom type map (Note: Due to time constraints in completing this draft environmental statement, final analysis of data to complete the bottom type map was not possible. However, the

Figure 5. Typical barren sand bottom.

Figure 6. Typical barren shell hash bottom.

Figure 7. Sand bottom with the algae *Udotea*.

Figure 8. Sand bottom with the algae *Caulerpa* and *Udotea* and the seagrass *Halophila*.

Figure 9. Sand bottom with the seagrass *Halophila*.

Figure 10. Sand bottom with small coral heads, gorgonians, and a vase sponge.

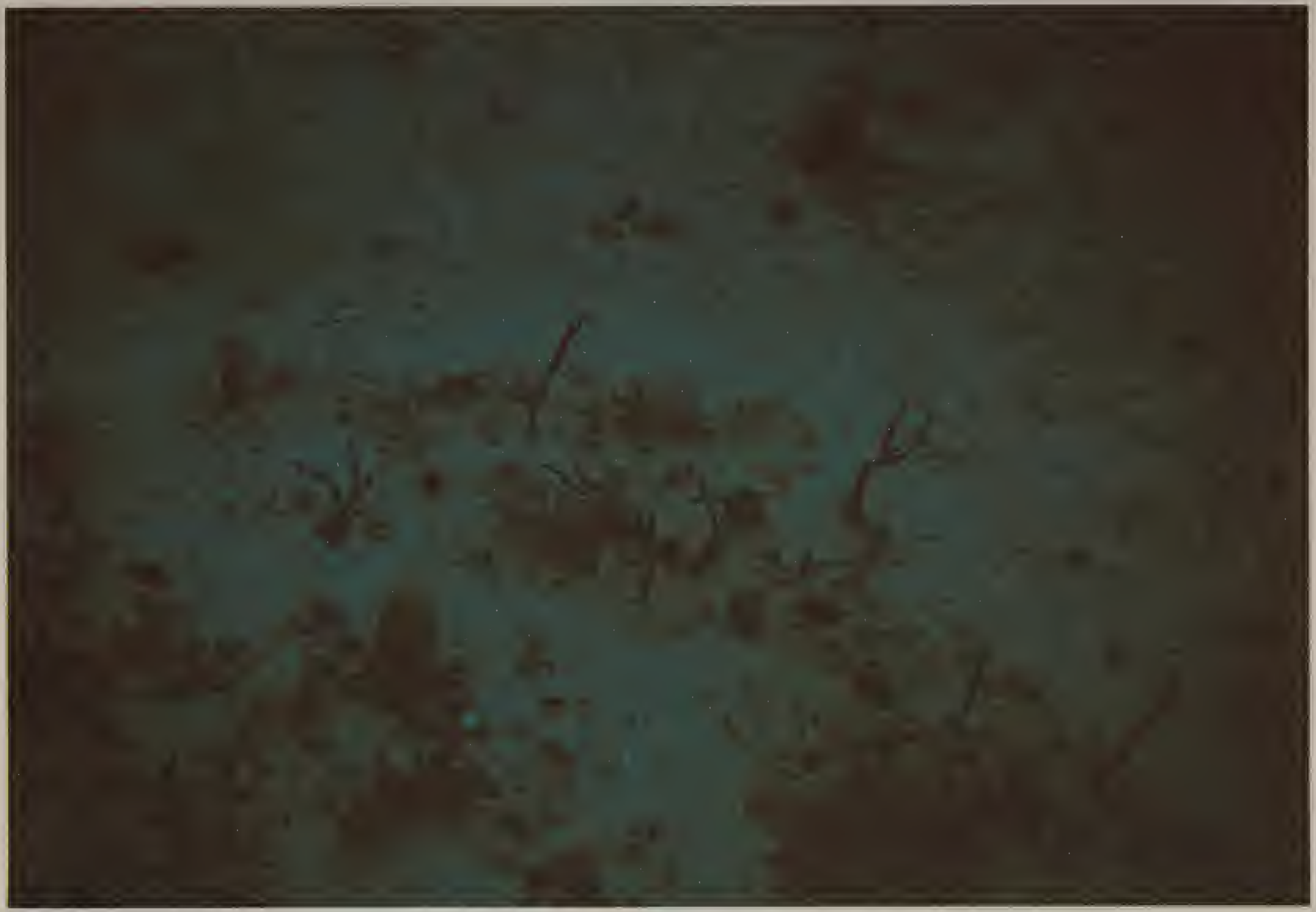


Figure 10a. Sand bottom with coral, sponges, and gorgonians.

Figure 11. Sand bottom with gorgonians. Note sand beginning to encroach upon the gorgonians. (This figure is erroneously referred to as Figure 6 in the text.)

Figure 12. Limestone outcrops with dense epifaunal accumulation.

Figure 13. Limestone outcrop with dense epifaunal accumulation. Note current, estimated at 0.5 knots, affecting the gorgonians.

Figure 14. Limestone ledge approximately 1 m in height. Object in left foreground is part of sled.

Figure 15. Bed of calico scallop, *Argopectin*, on sand substrate.

mentation of the benthic communities at the drill site. This information would then be used by decision-makers to determine if drilling would be allowed at the proposed site; and if so, what operational constraints would be imposed. Stipulation No. 2 as presented in Section IV.D.8. of the DES is the recommended method of accomplishing this protective measure within the survey lease blocks as well as in other blocks which are thought to contain similar communities.

Appendix G

The Influences of Petroleum Hydrocarbons and Heavy Metals on Marine Food Webs

APPENDIX G

THE INFLUENCES OF PETROLEUM HYDROCARBONS AND HEAVY METALS ON MARINE FOOD WEBS

1. Biogenic and Petroleum Hydrocarbons

Marine organisms contain and synthesize hydrocarbons under natural conditions. Some of the biogenic hydrocarbons which are important to the survival of the organism can be the same as or similar to the petroleum hydrocarbons (PHC) found in crude or refined oil. This fact has several implications. The detection of the origin of hydrocarbons can be difficult for the analytical chemist. Misidentification by consuming organisms or interference with chemical cues can have pronounced ecological effects. Because many petroleum hydrocarbons are natural components of the biosystem, they may be incorporated in the system without the interference or harm caused by others such as chlorinated hydrocarbons. Other petroleum hydrocarbons, however, may cause harm or interference with certain biological processes.

Examination of crude oils and most refined products indicates that they are extremely complex mixtures of organic compounds of which hydrocarbons comprise the most numerous and abundant fractions.

In their extensive literature review, Anderson, Clark and Stegeman (1974) indicated some basic differences between biogenic and petroleum hydrocarbons. Crude oil and oil products are varied mixtures that contain molecules of different size in fairly even distribution ratios. Conversely, organisms possess specific biosynthetic pathways which favor the production of hydrocarbons in preferred and consequently narrower size ranges. Petroleum hydrocarbons are rich in toxic aromatic hydrocarbons and cycloparaffins. They also contain isoprenoid hydrocarbons (alkanes with methyl branches) ranging from about C_{11} to C_{22} and beyond, while organisms are limited to isoprenoids in the range C_{19} to C_{20}. Crude oil is devoid of the olefins or alkenes which are abundant in most organisms.

Anderson et al. (1974) summarized the occurrence of the various classes of hydrocarbons from petroleum and biological origins.

a. Saturated hydrocarbons (alkanes or paraffin)

Both short and long-chain alkanes occur naturally in marine organisms. They are not as toxic to organisms at low concentrations as the aromatics are, but they may cause anaesthesia and narcosis or interfere directly with reception of the chemical cues. They can interfere with feeding, nutrition and communication in aquatic organisms (Goldacre, 1968; Whittle and Blumer, 1970; Blumer et al., 1972). Branched alkanes including pristane, an isoprenoid, have been found in marine macroorganisms. In some plankton and fish, pristane is the most abundant alkane present. In organisms, the biogenic alkanes of C_{60} and smaller are predominantly odd-numbered chains, while in petroleum odd and even numbered chains occur in a 1:1 ratio.

Petroleum contains abundant amounts of saturated hydrocarbons. Crude oil and most refined oil contain a series of n-alkanes with chain lengths of C_1 to C_{60}. Branched alkanes, including the isoprenoids pristane, farnsane and phytane, are also present. Long chain saturated hydrocarbons occur in petroleum and refined products except for lubricating oil.

b. Unsaturated hydrocarbons (olefins or alkanes)

Alkenes often account for a major percentage of the hydrocarbons found in aquatic organisms, and include squalene in basking shark liver oil and cod liver oil, and the polyolefins, hexeicosahexane and carotene, prevalent in algae. According to Blumer (1969) alkenes may serve in biochemical communications, but their exact biological roles are poorly understood.

Olefinic hydrocarbons are rarely present in crude oils, but are formed in some refining processes and are present in gasoline and cracked petroleum products.

c. Alicyclic hydrocarbons

Hydrocarbons containing one to three non-aromatic rings are present in several herbs and other land plants. Most are classified as terpenes because of their biosynthetic origin from isoprene.

d. Aromatic hydrocarbons

Although Gerarde and Gerarde (1961) reported several instances of low-boiling aromatic hydrocarbons in land plants, the occurrence of aromatics in marine organisms is debatable. Blumer et al. (1969) did not isolate aromatic hydrocarbons from plankton, and DiSalvo et al. (1975) were unable to detect aromatics in mussels (*Mytilus californianus*) taken from unpolluted environments. As suggested by Borneff et al. (1968), higher boiling aromatics may be synthesized by marine organisms. Many species, including bacteria, metabolize polynuclear aromatics and excrete the oxidation products.

Aromatics, particularly naphthalenes, have repeatedly been reported as the most toxic of the hydrocarbons. Their interference with feeding activities and other biological processes is important and should be given prime consideration.

Aromatic hydrocarbons represent a large percentage of the components of crude oil and an even larger percentage of the components of a refined product.

e. Nonhydrocarbon compounds in petroleum

Although more than 75% of most petroleum is composed of hydrocarbons, many other compounds (some toxic) are present in varying concentrations. These include cresols, xylenols, naphthols, quinolines, pyridines and hydroxybenzoquinolines which are of particular concern because of their great toxicity and solubility in water.

Apparently, except for the UV-fluorescent examinations by Zitko and Carson (1970), no analyses of nonhydrocarbon components for use in estimating petroleum contamination of aquatic organisms have been reported. Unfortunately, no degradation studies using these compounds are in the commonly-accessible literature (Anderson et al. 1974).

2. Uptake of Petroleum Hydrocarbons

Hydrocarbons are available to marine organisms in several different physical and chemical forms and uptake is greatly influenced by these factors. Hydrocarbons are essentially hydrophobic compounds and consequently have very low solubilities in water, generally in the part per million (ppm) to part per billion (ppb) range (National Academy of Sciences, 1975). Because of this hydrophobic characteristic, most of the oil in a slick will remain on the ocean surface or adsorb to particulate matter and become incorporated into the bottom sediments instead of dissolving in the water column. The relative percentages of hydrocarbons involved in each of these processes depend upon environmental variables such as temperature, wind speed, wave action, etc. Various types of hydrocarbons in the petroleum mixture, in other words, low molecular weight paraffins (alkanes) and aromatics, have relatively high solubilities in water, however, these compounds are relatively volatile and are for the most part, lost to the atmosphere by evaporation. Petroleum, therefore, is presented to pelagic organisms in dissolved, dispersed, or suspended (floating tar lumps) forms and to benthic organisms in dissolved, dispersed, suspended or sedimented forms.

Petroleum hydrocarbons (PHC) may enter the food web by several means. Petroleum adsorbed to living or dead particles may be ingested. Uptake of PHC by the ingestion of prey species which have accumulated PHC within the body tissues can also occur. Another method is the uptake of dissolved or dispersed petroleum via the gills or body surface.

The importance of several of these uptake methods is still largely unknown, but will vary with the species involved, the method of feeding and respiration of the organisms involved, the habitat, the state of the sea, and the petroleum itself. Evidence indicates that the majority of hydrocarbons enter molluscs, crustaceans and fish via gill membranes (Anderson, Clark, and Stegeman, 1974). It would seem logical then that this would also be an important method of uptake in other marine groups, although the relative importance of transport through the body surface of marine worms with exposed soft bodies is unknown. Although ingestion of contaminated food and sediment particles may be important in marine mammals and some fish, its relative relationship to the transport across body surface membranes is still unknown.

According to the National Academy of Sciences report (1975):

> Equlibration of hydrocarbons can occur between organisms and the seawater that passes over their gills or other membranes exposed to seawater. This may be the most important route for most aquatic animals since they process such large amounts of water during food collection and respiration. One can calculate from the hydrocarbons measured in coastal waters (Stegeman and Teal, 1973; Brown et al. 1973) of 10 μg/liter and a level in food of 10 mg/g that an animal would be exposed to more than an order of magnitude larger amount of hydrocarbons in the water processed to obtain oxygen for metabolism of the food than that amount present in the food itself. Stegeman and Teal believe that uptake from the water is the major route by which oysters accumulated hydrocarbons from the water. In other situations, uptake from sediments could also be important.

Dissolved hydrocarbons were taken up by the gill tissue of the mussel *Mytilus edilus*, and then transferred to other tissues (Lee et al. 1972a). Electron microscopic studies on the uptake of iron suggest that the gill tissue of this mussel has a micellar layer on the surfaces of the gill that is responsible for the adsorption of hydrophobic compounds (Pasteels, 1968). Work on the uptake of dissolved hydrocarbons by marine fish also demonstrated the entrance of hydrocarbon through the gills (Lee et al. 1972b).

Yevich and Barry (1970) reported on tissue damage brought about by exposure to crude oils and other pollutants; such damage includes sloughing of the epithelium and atypical basal cell hyperplasia of the ciliated inner gills of quahogs (*Mercenaria mercenaria*). The question also arises, then, as to the effect the loss of the protective membrane coatings of the gills has on the rate of absorption of hydrocarbons from water.

Invertebrates such as molluscs and barnacles, which have the ability to isolate themselves from the environment through shell closure may employ a behavior mechanism which protects them for limited amounts of time from excessive uptake of PHC. Stegeman and Teal (1973) exposed oysters, *Crassostrea virginica*, to varying concentrations of No. 2 fuel oil for two days. The data suggested that, for concentrations up to 450 ug/l (ppb), there was a direct relationship between the hydrocarbon concentration in the water and uptake rate, while at higher concentrations the rate of uptake fell (Figure I-1). The reason for this was that the oysters remained tightly closed when exposed to concentrations of 900 mg/l. Even though oysters can tolerate many forms of environmental irritants so common in estuaries by shell closure and similar behavior mechanisms (Menzel, 1955), other marine molluscs may not exhibit the same degree of adaptability.

Even though PHC are taken into the gut through ingestion, they may not necessarily become incorporated into body tissues, but may instead be passed directly through the organism as feces. Following the *Arrow* incident in Chedabucto Bay, plankton were observed to ingest large quantities of Bunker C oil and eliminate them in the form of fecal matter (up to 7% Bunker C oil by weight) (Conover, 1971). The plankton always voided the small "oil" particles within 24 hrs. and showed no signs of stress when viewed under a dissecting microscope. No chemical analysis of the fecal matter or of the whole copepods was reported, however, which might have provided some indication of whether and what degree of degradation or partitioning of the oil took place.

Parker (1970) also demonstrated the presence of considerable quantities of oil in the guts and fecal pellets of copepods and barnacle larvae. The fact that the oil passes unchanged into the fecal material is of considerable interest since oil from a slick can be grazed by the plankton and the ingested oil concentrated in the feces. Parker (1971) calculated that copepods (*Calanus finmarchicus*) could encapsulate up to 1.5 X 10^4 g of oil per day per individual. For example, a population of 2,000 individuals/m^3 covering an area of 1 km^2 to a depth of 10 m could remove as much as three tons of oil daily if the oil's concentration is 1.5 ppm or greater. Fecal pellets can then be eaten by other members in the food web.

Alyakrinskaya (1966) found that the mussel *Mytilus galloprovincialis* in the Black Sea could tolerate high concentrations of oil (up to 20 ml/liter of an undefined type of oil). During filtration of oil-polluted water, the molluscs formed pseudofeces from oil connected by mucous—to a degree comparable with transferring the oil to large, denser particles as Conover and Parker have suggested for copepods.

According to Anderson et al. (1974), a significant amount of PHC is taken up and accumulated, at least temporarily, within the body tissues of most fishes and invertebrates during spills. Data shown in Table I-1 (presumably contaminated tissues) and Table I-2 (natural tissue hydrocarbon levels) should be treated with a certain amount of caution, however, because of the number of variables involved. The methods of analyses, UV absorption spectrophotometry, infrared spectrometry, mass spectrometry and the various chromatography proceudres, measure hydrocarbons in a different manner and consequently produce slightly different results. The other significant variable is the composition of the oil itself.

According to Anderson et al. (1974)

> Levels of PHC contamination in a wide variety of edible marine organisms are listed in Table I-1. The data shown in this table relate to organisms collected from localities presumed to be high in PHC contamination, and therefore the compounds detected are likely to be petroleum derived. These samples, presumed by

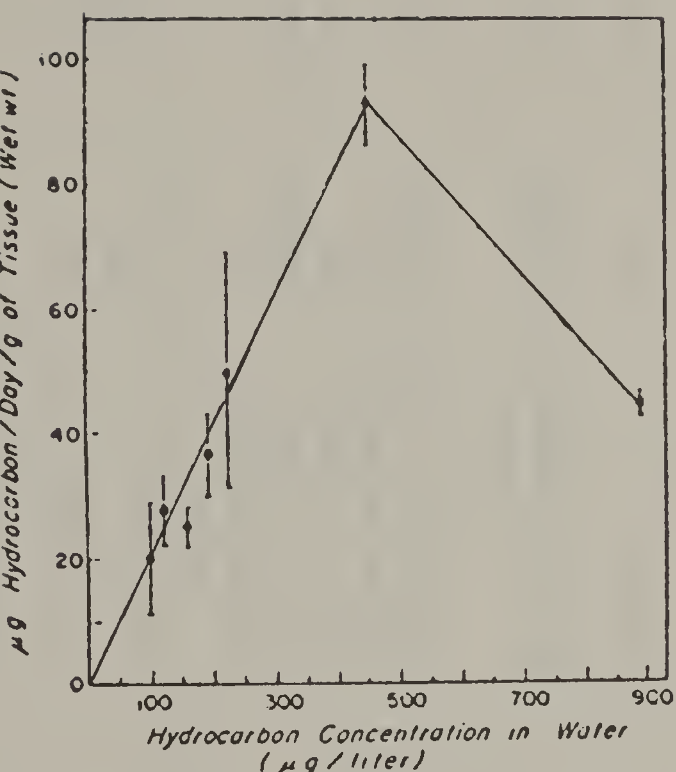


Fig I–1 *Crassostrea virginica*. Initial rate of petroleum hydrocarbon uptake by oysters versus hydrocarbon concentration in the water. Oysters were assayed after 2 days exposure at indicated hydrocarbon concentration. Each point represents average of 2 determinations using high fat-content oysters

Table I-1 Tissue Samples - Presumably Contaminated (from Anderson et al., 1974)

SPECIES	PROBABLE SOURCE	HC TYPE 1/	ANALYSIS	WET ug/g	REFERENCE
Macro algae					
Fucus sp.	Spill - Bunker C	n-paraffins	GC	5.8	Clark *et al.*, 1973
Snails					
Littorina littorea	Spill	Bunker C aromatics	Fluoro	27-600	Scarratt & Zitko, 1972
Thais lamellosa	Spill -#2 fuel oil	n-paraffins	GC	5.4	Clark, 1974
Clams					
Mercenaria mercenaria	Sewage effluent	C_{16-32}	GC	16	Farrington & Quinn, 1973
Mya arenaria	Spill	#2 fuel oil	GC/MS	26	Blumer *et al.*, 1970b
Oysters					
Crassostrea vriginica	Chronic	paraffins, mono & di-aromatics	GC/MS TLC	236	Ehrhardt, 1972
	Harbor	C_{17-32}	GC	10	Stegeman, 1974
	Spill	#2 fuel oil	GC/MS	70	Blumer et al., 1970a
	Chronic	Polynuclear aromatics	UV	1	Cahnmann & Kuratsane, 1957
	Chronic-harbor	Saturates	GC/MS	15	Meiggs, 1973 (Galveston)
	" "	"	GC	13-29	" " (San Francisco)
	" "	Total HC	GC	160	R.D.Anderson, 1973 (Galveston Red Bluff Reef)
	" "	Saturates, C_{12-24}	GC	11.2	R.D.Anderson, 1973 (Galveston Halfway Reef)
		Dimethylnaphthalenes	GC	0.6	"
		Trimethylnaphthalenes	GC	0.6	"
Mussels					
Modiolus modiolus	Spill	#2 fuel oil	GC	218	Burns & Teal, 1971
	Spill	Bunker C aromatics	Fluoro	21-372	Scarratt & Zitko, 1972

1/ Though only n-paraffins were indicated in some cases, the probable presence of other petroleum-type hydrocarbons, e.g. aromatics, is not to be excluded.

Table I-1 (continued)

SPECIES	PROBABLE SOURCE	HC TYPE	ANALYSIS	WET ug/g	REFERENCE
Mytilus edulis	Spill	Bunker C aromatics	Fluoro	77-103	Zitko, 1971
	Chronic harbor	n-paraffins	GC	0.97	Clark & Finley, 1973b
	Spill-#2 fuel oil	"	GC	1.4	"
Mytilus californianus	Spill-Bunker C	"	GC	0.87	"
Scallops					
Acquipecten irradians muscle	Spill	#2 fuel oil	GC	7-14	Blumer *et al.*, 1970b
Barnacles					
Mitella polymerus	Spill-Bunker C	n-paraffins	GC	11.8	Clark *et al.*, 1973
Crabs					
Cancer irroratus	Spill	Bunker C aromatics	Fluoro	7-11	Scarratt & Zitko, 1972
Hemigrapsus nudus	Spill-Bunker	n-paraffins	GC	2.9	Clark *et al.*, 1973
Lobster					
Homarus americanus-gut	Spill	Bunker C aromatics	Fluoro	103-130	Scarratt & Zitko, 1972
stomach	"	"	"	15-230	"
claw-muscle	"	"	"	2-3	"
Abdominal muscle	"	"	"	1-4	"
Urchins					
Stronglyocentrotus droebachiensis	Spill-Bunker C	Bunker C aromatics	Fluoro	17-94	Scarratt & Zitko, 1972
Mullet					
Mugil cephalus-flesh	Chronic-harbor	Kerosene taint	GC/MS	~860	Shipton *et al.*, 1970
Whitefish-flesh	Spill	Diesel oil	GC	29-88	Ackman & Noble, 1973
Flatfish	Chronic-coast	C_{14-20}	GC	4	Bowen, 1971

TABLE I-2 Natural Tissue Hydrocarbon Levels (from Anderson et al., 1974)

SPECIES	LOCALITY	HC TYPE	ANALYSIS	WET ug/g	REFERENCE
Macro Algae					
Nereocystus'(kelp)	Puget Sound,Wash.	n-paraffins	GC	0.74	Clark, 1974
Ulva sp. (sea lettuce)	"	"	"	20.3-23.0	"
Fucus sp.	Puget Sound, Wash.	n-paraffins	GC	3.03-55.7	"
	Washington Coast	"	"	9.51-57.2	"
	New Hampshire	"	"	8.96	Clark & Blumer, 1967
	Woods Hole, Mass.	"	"	34.9	"
	Falmouth, Mass.	"	"		"
Snails					
Thais lamellosa	Puget Sound, Wash.	n-paraffins	GC	0.06-1.5	Clark, 1974
Littorina littorea	Eastern Canada	Aromatics	Fluoro	11	Zitko, 1971
Littorina sp.	Valdez, Alaska	n-paraffins	GC	16.1	Clark, 1974
Limpets					
Notoacmea scutum	Puget Sound, Wash.	n-paraffins	GC	2.5	Clark, 1974
Chiton					
Mopalia sp.	Puget Sound, Wash.	n-paraffins	GC	0.50	Clark, 1974
Clams					
Mercenaria mercenaria	Narrangansett Bay,R.I.	Total HC	GC	2.9	Farrington & Quinn, 1973
Mya arenaria	Eastern Canada	Aromatics	Fluoro	8	Zitko, 1971
Mya sp.	Valdez, Alaska	C_{16-28}	GC	1.1	Kinney, 1973
Rangia cuneata	Trinity Bay in Galveston, Texas	Naphthalene	UV Spec	0.16	Cox & Anderson, 1974
		Methylnaphthalene	"	0.11	"
		Dimethylnaphthalene	"	0.06	"
Oysters					
Crassostrea virginica	Redfish Reef in Galveston Bay	Saturated HC	GC/MS	1.5	Meiggs, 1973
	Aransas Bay, Texas	Saturated HC	GC/MS	1	Meiggs, 1973
	Quisset, Mass.	Total HC	GC	1-2	Stegeman & Teal, 1973
	Galveston Island				
	East Lagoon	Total HC	GC	<2.0	R.D.Anderson, 1973
	Eight Mile Road Reef	"	"	<2.0	"

Table I-2 (continued)

SPECIES	LOCALITY	HC TYPE	ANALYSIS	WET ug/g	REFERENCE
	Eight Mile Road Reef	Saturated	GC	<0.1	R.D. Anderson, 1973
	"	Aromatics	"	<0.1	R.D. Anderson, 1973
Ostrea edulis	Newport, Oregon	n-paraffins	GC	0.35	Clark *et al.*, 1974
Mussels					
Mytilus edulis	Puget Sound, Wash.	n-paraffins	GC	0.37-21.6	Clark, 1974
	Valdez, Alaska	"	"	0.40-0.95	"
	Newport, Oregon	"	"	0.34	Clark *et al.*, 1974
	Eastern Canada	Aromatics	Fluoro	3	Zitko, 1971
	Valdez, Alaska	C_{16-28}	GC	1.9	Kinney, 1973
Mytilus californianus	Washington coast	n-paraffins	GC	0.45	Clark & Finley, 1973b
	Puget Sound, Wash.	"	"	0.088-0.58	Clark, 1974
Barnacles					
Mitella polymerus	Washington coast	n-paraffins	GC	1.41	Clark *et al.*, 1973
	Puget Sound, Wash.	"	"	1.22-4.54	Clark, 1974
Balanus cariosus	Washington coast	n-paraffins	GC	0.66	Clark, 1974
Scallop					
Acquipecten irradians	Waquoit Bay, Mass.	Saturates	GC	2.3-55	Blumer *et al.*, 1970a
Shrimp					
Pandalis borealis	North Atlantic	Saturates	GC	43.6	IDOE, 1972
Unidentified species	Artic Ocean	n-paraffins	GC	0.37-21.6	Clark, 1974
Palaemonetes pugio	Galveston Island Marsh at Eight Mile Road	Saturated Total (C_{20-31})	GC	24.8	Tatem & Anderson, 1974
		(C_{22-26},each)	"	3.1-3.9	"
		C_{23}	"	3.8	"

Table I-2 (continued)

SPECIES	LOCALITY	HC TYPE	ANALYSIS	WET ug/g	REFERENCE
Palaemonetes pugio	Marsh at Eight Mile Rd	Saturated Total (C_{21-26})	GC	10.9	Tatem & Anderson, 1974
		C_{23}	"	3.9	"
Penaeus setiferus (postlarvae)	Mariculture by Dow Chemical	Saturated Total	GC	15.0	Cox & Anderson, 1974
		Aromatics Total	"	8.0	"
Crabs					
Hemigrapsus nudus	Washington coast	n-paraffins	GC	0.28	Clark *et al.*, 1973
	Puget Sound, Wash.	"	"	0.082-3.65	Clar, 1974
Cancer irroratus	Eastern Canada	Aromatics	Fluoro	7	Zitko, 1971
Uca minax		Naphthalene	UV Spec	0.24	Cox & Anderson, 1974
		Methylnaphthalene	"	0.15	"
		Dimethylnaphthalene	"	0.09	"
Sesarma cinereum	Trinity Bay in Galveston Bay	Naphthalenes	UV Spec	0.22	Cox & Anderson, 1974
		Methylnaphthalenes	"	0.10	"
		Dimethylnaphthalenes	"	0.08	"
Lobster					
Homarus americanus					
stomach	Eastern Canada	Aromatics	Fluoro	19	Zitko, 1971
gut	"	"	"	57	"
claw muscle	"	"	"	4	"
abdominal muscle	"	"	"	5	"
Urchin					
Strongylocentrotus sp.	Eastern Canada	Aromatics	Fluoro	22	Zitko, 1971
S. purpuratus	Washington coast	n-paraffins	GC	0.18	Clark, 1974
Flounder					
Syncium gunteri	Gulf of Mexico	n-paraffins	GC	8.7	IDOE, 1972
Unidentified species	Alaska	"	"	8.0	"

Table I-2 (continued)

SPECIES	LOCALITY	HC TYPE	ANALYSIS	WET ug/g	REFERENCE
Pseodopleuronectes americanus	Eastern Canada				
gut		Aromatics	Fluoro	21	Zitko, 1971
skin and flesh		"	"	0	"
Perch					
Sebastes marinus-livers	North Atlantic	Hydrocarbons	GC	110	IDOE, 1972
	George Bank	"	"	20.6	"
Haddock					
Gadus aeglefinus-livers	North Atlantic	Hydrocarbons	GC	210	IDOE, 1972
	George Bank	"	"	252	"
Pollock					
Pollachius verins-livers	Georges Banks	Hydrocarbons	GC	262	IDOE, 1972
Greenland halibut					
Reinhandtius hippolossoides-livers	North Atlantic	Hydrocarbons	GC	230	IDOE, 1972
	Gulf of Maine	"	"		
Whitefish-flesh	Alberta, Canada	Diesel oil-like	GC	4-14	Ackman & Noble, 1973
Yellow sole					
Lamanda	Valdez, Alaska	C_{16-28}	GC	0.15-0.97	Kinney, 1973
Herring eggs					
Clupea pallasil	Puget Sound, Wash.	n-paraffins	GC	3.1	Clark, 1974
Cod					
Gadus callarias-livers	North Atlantic	Saturates	GC	128-345	IDOE, 1972
Gadus morhua-livers	"	"	"	332	"
Boreogadus esmarki	"	"	"	117	"
	Arctic Ocean	n-paraffins	"	12.6	Clark, 1974

Table I-2 (continued)

SPECIES	LOCALITY	HC TYPE	ANALYSIS	WET ug/g	REFERENCE
Mackerel *Scomberomorus cavalla*	Gulf of Mexico	n-paraffins	GC	11.3	IDOE, 1972
Barracuda *Sphyraena barracuda*	Texas	n-paraffins	GC	22.6	IDOE, 1972
Atlantic salmon *Salmo salar*	Eastern Canada	Aromatics	Fluoro	10	Zitko, 1971

the authors to be contaminated with petroleum, were in general judged so based on the types of hydrocarbons present, keeping in mind the differences between petroleum and biogenic mixtures. The hydrocarbon types are listed in Table I-1 as indicated by the authors, and though only one class, or a range, of hydrocarbons is given for some samples, it does not exclude the presence of other types of compounds in the sample. Usually the samples analyzed by fluorescence yield low numbers and in most samples the concentration would be much higher if compounds other than polycyclic aromatic hydrocarbons were included. Those samples listing only ''paraffins'' should also be considered as reflecting a very small part of the total hydrocarbons. This is perhaps especially true for shellfish (Stegeman, 1974).

It is evident that high concentrations of PHC can be found in organisms from spill areas as well as areas of chronic contamination. In many cases, the hydrocarbon level of the waters from which organisms have been taken have not been reported. In other cases, under prolonged exposures, the concentrations could have fluctuated over such a wide range that such information would not realistically reflect the true exposure concentrations. The relative amount of accumulation varies greatly with the organism involved, concentration of hydrocarbon in the water, and composition of the petroleum, etc. On a dry weight basis, the actual amount accumulated can be quite substantial. Di Salvo et al. (1975) reported a preliminary determination of surface hydrocarbons showed the presence of 1.25 ppb while dry weight tissue from mussels, *Mytilus edulis,* exposed for 90 days was recorded as 300 ppm.

In contrast to the PHC concentrations in presumably contaminated organisms, concentrations of hydrocarbons in supposedly uncontaminated populations (Table I-2) are consistently much lower. This is particularly true for the molluscs, where concentrations of 1 to 2 ppm or less are approximately 10 to 100 times lower than those of the contaminated organisms. ''Natural'' concentrations in some fish and crustaceans appear somewhat higher and in a few cases might be suspect, although these samples were all considered uncontaminated by the authors based on parameters other than the total hydrocarbon content (Anderson et al. 1974).

A striking feature of Table I-2 is that these low levels occur in organisms from all coastal regions of the continent. The concentrations from 0.01 to 10 ppm are the lower limits of analysis based on current techniques and may in many cases represent mostly biogenic compounds. In such cases a few compounds can be expected to constitute the major portion of the hydrocarbon components.

There have to date been a number of studies describing the experimental accumulation of PHC by marine organisms. Table I-3 summarizes results of most of these studies and indicates tissue levels of PHC which can be achieved under a variety of exposure conditions (Anderson et al. 1974). Most of the studies in Table I-3 were performed under static conditions for relatively short periods, i.e. hours to days. The majority used very high exposure levels of emulsions, dispersions, water soluble fractions or slicks ranging from approximately 50 to 10,000 ppm.

These could be taken as partially resembling the situation early in the history of an oil spill. Others were very brief status exposure to single compounds (Lee et al. 1972a), or long term exposure to low levels of whole fuel oil in a flow-through system (Stegeman and Teal, 1973). The last experiment could be considered to represent the conditions of an exposure to chronic sources of contamination in harbors, etc. In fact, the 335 ppm total hydrocarbon accumulated by oysters after seven weeks (Stegeman and Teal, 1973) was not very different from the 236 ppm total hydrocarbons in oysters from the Houston ship channel (Ehrhardt, 1972) shown in Table I-1.

Based on dry tissue weight, Di Salvo et al. (1975) found hydrocarbon concentrations as high as 530 ppm in mussels exposed to low level chronic oil pollution in San Francisco Bay.

3. Storage and Metabolism

Although it has been demonstrated that hydrocarbons concentrate in certain organs, it is actually with the lipids that they become associated (Blumer et al. 1972). Stegeman and Teal (1973) found a direct relation between the lipid content of oysters and the amount of hydrocarbons accumulated. Shipton et al. (1970) reported the dark meat and the fatty layer adjacent to the skin were more severely tainted with a hydrocarbon similar to kerosene than the white meat, and that the tainted flesh had a higher fat content than

Table I-3 Tissue Hydrocarbon Levels Resulting from Laboratory Exposure

SPECIES	EXPOSURE CONDITIONS	HC TYPE	ANALYSIS	WET ug/g	REFERENCE
Clams *Rangia cuneata*	1000 ppm #2 fuel oil, 48 hr	Total saturated	GC	26	Anderson, 1973
		Mono- & diarom.	"	481	"
		Poly aromatics	"	34	"
Mya arenaria	Bunker C	Aromatics	Fluoro	87	Zitko, 1971
Oysters *Crassostrea virginica*	1000 ppm #2 fuel oil. 48 hr	Total saturated	GC	4	Anderson, 1973
		Mono- & diarom.	"	121	"
		Poly aromatics	"	5	"
	1000 ppm #2 fuel oil,	Total saturated	"	3.1	"
		Naphthalenes	"	84.1	"
		Triaromatics	"	9.5	"
	106 ppb #2 fuel oil, 7 weeks	Saturates & arom.	"	335	Stegeman & Teal, 1973
	1000 ppm Kuwait crude, 96 hr	Total saturated	"	46.0	Anderson, 1973
		Naphthalenes	"	55.1	"
		Triaromatics	"	6.0	"
Crassostrea gigas	50 ppm #2 fuel oil, 11 days	Saturated	GC	1.3	Vaughn, 1973
Ostrea lurida	10% outboard motor effluent, 10 days	n-paraffins	GC	0.96	Clark et al., 1974
Mussels *Mytilus edulis*	0.1 ppm mono- & diaromatics 4-24 hrs	Same	Radio.	6	Lee et al., 1972a
	0.1 ppm poly aromatics	"	"	0.6	"
	Slick, #2 fuel oil 48 hrs.	n-paraffins	GC	7.9	Clark & Finley, 1974
	Slick, #5 fuel oil 32 hrs.	"	"	7.4	"
	1C% outboard motor 1 day	"	"	1.10	Clark et al., 1974

(From Anderson et al., 1974).

Table I-3 (continued)

SPECIES	EXPOSURE CONDITIONS	HC TYPE	ANALYSIS	WET ug/g	REFERENCE
Shrimp					
<u>Penaeus aztecus</u>	20% WSF[1] #2 fuel oil, 24 hr.	Sat. (individual peaks)	GC	0.1	Cox & Anderson, 1974
		Nephthalenes	"	0.1	"
		Methylnaphthalenes	"	1.4	"
		Dimethylnaphthalenes	"	0.3	"
		Trimethylnaphthalenes	"	0.6	"
<u>Penaeus aztecus</u>	Underslick of #2 fuel oil for 24 hr in a pond exposure	Saturated Total	GC		Cox & Anderson, 1974
		(C_{13-24})	"	6.2	"
		(C_4-Benzenes)	"	1.2	"
		Naphthalene	"	3.3	"
		1-Methylnaphthalenes	"	8.0	"
		2-Methylnaphthalenes	"	8.9	"
		Dimethylnaphthalenes	"	19.2	"
		Trimethylnaphthalenes	"	4.2	"
		Pheanthrenes	"	12.7	"
<u>Palaemonetes pugio</u>	0.9 ppm OWD[2] #2 fuel oil for 2 hr.	Naphthalenes	GC	3.1	Tatem & Anderson, 1974
	6 hr.	Naphthalenes	GC	5.5	"
	10 hr.	Naphthalenes	UV	4.0	"
Lobster					
Homarus americanus gut	10,000 ppm Bunker C 6 1/2 days	Aromatics	Fluoro	1,810	Scarrett & Zitko, 1972
stomach		"	"	2,840	"
abdominal muscle		"	"	137	"
claw muscle		"	"	33	"

1/ A water-soluble fraction (WSF) was prepared by mixing 1 part oil over 9 parts water for 20 hours, and the water phase was diluted to 20% of its original concentration of hydrocarbons (see Anderson et al., 1974)

2/ Oil was added to water such that 500 ml contained 0.9 ppm of oil. This mixture was shaken at 200 chcles/min. for 5 min. and after 60 min. the animals were placed in the mixture.

Table I-3 (continued)

SPECIES	EXPOSURE CONDITIONS	HC TYPE	ANALYSIS	WET ug/g	REFERENCE
Perch					
Cymatogaster aggregata	50 ppm #2 fuel oil,	Saturated	GC	2.3	Vaughn, 1973
	96 hr	Diaromatics	"	19	"
Flounder					
Pseudopleuronectes	Bunker C				
americanus Gut		Aromatics	Fluoro	622	Zitko, 1971
skin		"	"	182	"
flesh		"	"	7	"

the untainted flesh of fish caught at the same time. Vale et al. (1970) examined livers with optical and electron microscopes and found excessive amounts of free fat, typical of fatty infiltration, in tainted fish as compared with untainted mullet. Fatty liver in higher animals can be caused by petroleum distillates (Browning, 1953).

Roubal (1973), working with excised spinal cord tissues of coho salmon, indicated that hexane and similar hydrophobic compounds are directed away from nerve membrane surface to sites in the lipid bilayer of the membrane, while aromatic hydrocarbons and benzyl alcohol contribute to membrane surface changes. The complex lipoproteins of plasma membranes and organelle membranes of all tissues are possible storage sites (NAS, 1975).

According to a summary paper by Anderson et al. (1974a), accumulated petroleum hydrocarbons are rapidly transferred to the gall bladder, brain and other neural tissues, and the liver of fish and to the digestive gland of shrimp. Damage to fish having concentrations of petroleum hydrocarbons in the nervous system can be seen as an increase in nonadaptive behavior responses.

Lee et al. (1972b) and Anderson et al. (1974a) found localization of hydrocarbons in the gall bladder, liver, and brain of marine fish. During depuration in clean water the hydrocarbons were apparently transported to the liver and gall bladder for detoxification and excretion. A significant amount of contamination remained in the heart and brain until the point of final release. Since the compounds are transported by the blood, it is not surprising that the concentration in the heart is high, but an explanation for high levels in the brain requires further investigation.

Cox and Anderson (1974) reported that brown shrimp, *Penaeus aztecus*, accumulate the naphthalene fraction of hydrocarbons primarily in the digestive gland or hepatopancreas throughout the exposure period. The content of these compounds in the other organs and tissues decreases steadily, even during exposure. The gill tissue maintains a relatively consistent level of contamination (approximately 0.6 ppm) during the depuration until the point of final release by the digestive gland (about 250 hours). Since the gills are richly supplied with blood, the contamination level found may well represent contamination level in the blood of the shrimp.

Scarratt (1971) reported commercial species of scallops which had ingested Bunker C oil had a detectable amount of Bunker C hydrocarbons in the mantle, digestive gland, adductor mussel and gonad. Di Salvo et al. (1975) reported hydrocarbons in the gonads of mussels. Operation Oil (1970) reported that oil was present in the muscle tissue, digestive tract and other organs in scallops, periwinkles, sea urchins, and other intertidal benthos examined after Bunker C oil had been spilled in the *Arrow* accident. Blumer and Sass (1972a) also reported hydrocarbons in adductor muscles of oysters after the West Falmouth spill.

The danger to the human consumer from PHC-contaminated sea food is lessened because hydrocarbons are primarily concentrated in certain organs such as the liver, gall bladder, and much of the nervous system which are discarded prior to consumption. The danger to humans who consume contaminated oysters, which are eaten in their entirety, would be significantly greater. Apparently some danger of oil contamination can occur from eating other molluscs which may have accumulated oil in muscle tissue.

Metabolism of hydrocarbons is discussed in the summary paper by the National Academy of Sciences (1975).

> The metabolic pathways involving oxidases and other enzymes, important in the degradation of aromatic and paraffinic hydrocarbons by mammalian systems, have been well studied. In the case of aromatic hydrocarbons, hydroxylation is followed by conjugation with sulfate or glucose and finally excretion of the water-soluble product. Straight chain hydrocarbons are hydroxylated at the terminal end and further oxidized to the fatty acid that can be broken down by b-oxidation. Highly branched chain hydrocarbons, such as pristane and phytane, are probably oxidized to an acid (e.g. phytanic acid), which can be further oxidized by a combination of a and b oxidation.

Metabolism of hydrocarbons in marine organisms is less well understood, but several studies have been conducted. Degradation of sizeable quantities (between 10 and 500 ug) of aromatic and paraffinic hydrocarbons did occur in marine fish and some marine invertebrates (Stegeman and Teal, 1973; Lee et al., 1972a,b). Other benthic marine invertebrates, phytoplankton, and some zooplankton, over a period of a month, were unable to oxidize either paraffinic or aromatic hydrocarbons. Several species of copepods were unable to metabolize hydrocarbons but could degrade paraffinic hydrocarbons (National Academy of Science, 1975). The liver or the liver-like organ in some invertebrates, the hepatopancreas, is assumed to be the site of hydrocarbon degradation. Unaltered hydrocarbons are sent to these organs where hydroxylation and other detoxification reactions occur. In those invertebrates where degradation does not occur, some of the detoxifying microsomal oxidases in the hepatopancreas may be missing.

A somewhat less efficient and slower hydrocarbon metabolizing system has been reported in crustaceans (Anderson et al., 1974a). Studies with molluscs have failed to demonstrate the presence of any hydroxylase activity (Carlson, 1972a) also failed to observe formation of metabolites of hydrocarbons by mussels.

According to Anderson et al. (1974a)

> Though it is clear that levels accumulated vary with exposure conditions, some generalizations can be made: (1) In all types of exposures high levels of PHC can be found in the organisms. Here again the listing of only one type of hydrocarbon does not mean that other types of hydrocarbon were not present. In fact, the identification of only saturated compounds may yield numbers much lower than the total PHC present. (2) Mono-aromatics and diaromatics appear to be more readily accumulated than either saturated compounds or PAH. In addition, long term exposure results indicate that changes in the composition of the retained hydrocarbons, especially a relative decrease in paraffins, occur throughout the exposure period. (3) It appears that the muscle tissue of fish and crustaceans accumulate relatively low levels of hydrocarbons. With the exception of molluscs which are entirely consumed by man, muscle is generally the edible portion of marine organisms.

4. Discharge or Depuration of Hydrocarbons

Throughout the relatively short period since studies on oil accumulation in aquatic organisms began, evidence confirming and denying the ability to depurate accumulated hydrocarbons has been presented.

Blumer et al. (1970) reported that when oysters *Crassostrea virginica* are exposed to water-oil mixtures, they nonselectively accumulate a wide variety of PHC in their tissues which are retained for several months or perhaps indefinitely.

Results from Blumer and Sass (1972b) study on highly aromatic No. 2 fuel oil suggest that oil becomes part of the organism's lipid (fatty) pool. Blumer noted that the oil in specimens observed from a Massachusetts oil spill remained relatively unchanged in composition or quantity. He reasoned that if the oil were localized within the digestive tract, a shellfish could eliminate it rapidly. But the persistence of the hydrocarbon over a time period of six months, its presence in adductor muscle tissue, and the lack of further degradation of these hydrocarbons indicated that it becomes part of the organism's lipid pool.

Lee et al. (1972a) exposed the mussel *Mytilus edulis* to isotopically labeled petroleum-derived alkanes and aromatic hydrocarbons and showed that the molluscs released more than 90% of the accumulated hydrocarbons within two weeks of return to isotope free sea water.

Simulating the conditions of an oil spill, Anderson et al. (1974a) have presented evidence that estuarine fish and macroinvertebrates completely depurate accumulated hydrocarbons after short term exposures of four days or less.

Anderson (1973) presented the detailed hydrocarbon composition of clam *Rangia cuneata* and oyster *Crassostrea virginica* tissue exposed to crude and refined oils for periods up to four days. The subsequent release of HC's accumulated from No. 2 fuel oil and South Louisiana crude oil by oysters was also reported. The levels of tissue contamination decreased to less than detectable concentrations (0.1 ppm) in from 24 to 52 days (Figure I-2). The aromatic hydrocarbons were accumulated to the greatest extent and retained the longest in these studies.

Anderson and Neff (1974b) have shown comparative data for the uptake and release of naphthalenes from No. 2 fuel oil by clams, fish, and shrimp. While approximately 0.8 ppm of total naphthalenes was still present in the clams *Rangia cuneata* at 360 hours, the fish *Fundulus similis* and shrimp *Penaeus aztecus* had released the hydrocarbons to background levels. It is interesting that even during the 24 hours of exposure the concentration in shrimp tissue dropped from about 70 ppm at 1 hour to approximately 3 ppm of total naphthalenes after 24 hours.

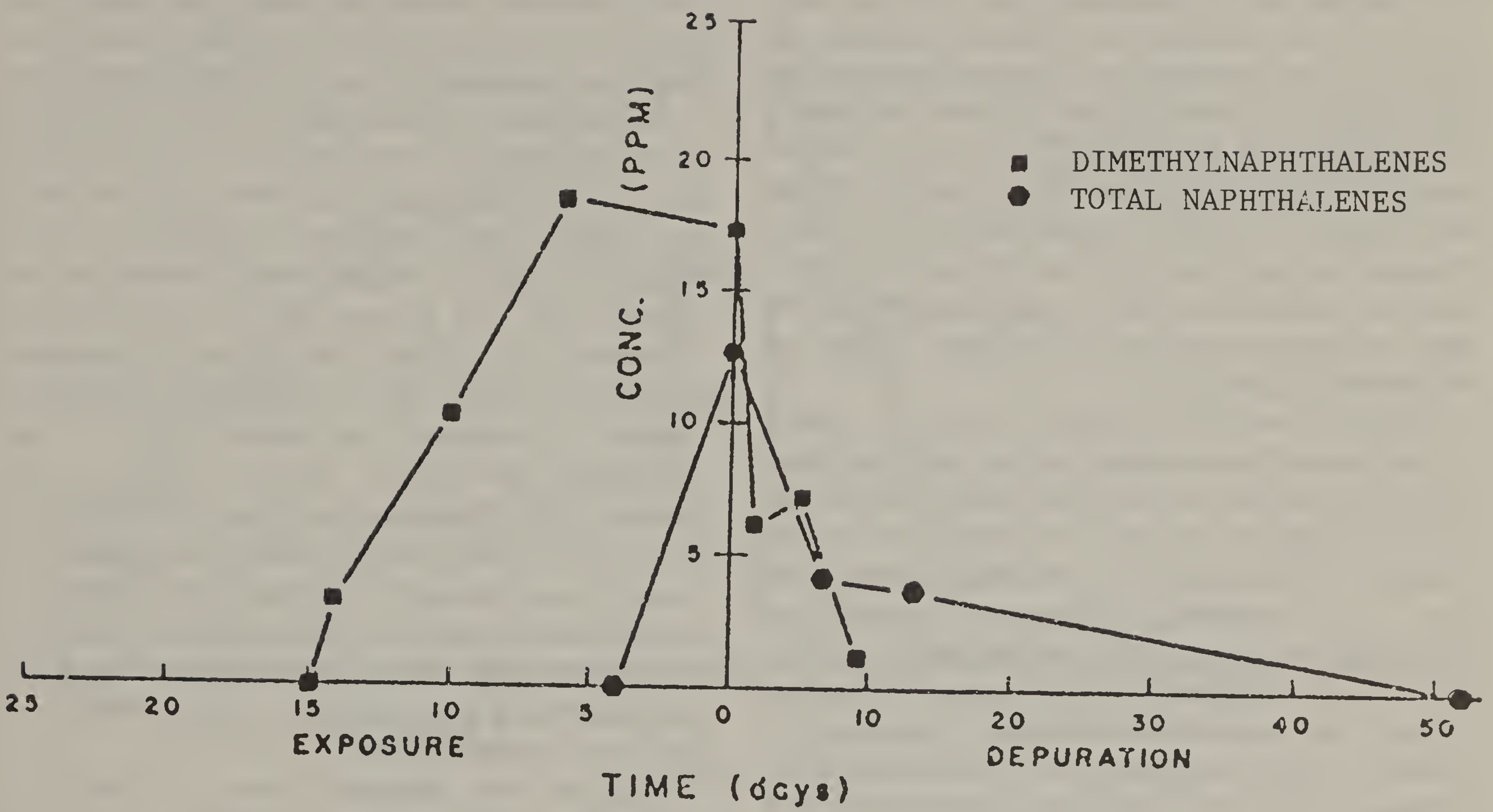


Figure I-2 Levels of petroleum hydrocarbons in the tissues of marine organisms after various periods of exposure and depuration (in clean water). The levels of dimethylnaphthalenes in the tissues of Pacific oysters exposed to 50 ppm of South Louisiana crude oil (Vaughan, 1973); exposure of the American oyster, Crassostrea virginica, to an oil-water dispersion of #2 fuel oil total naphtalenes (Anderson, 1973). All data are expressed in µg/g fresh weight of organisms (ppm). (From Anderson et al. 1973).

Further evidence of the importance of naphthalenes in the contamination of the marine organisms is shown by the work of Vaughan (1973). During 15 days of exposure to oil, Pacific oysters were found to accumulate significant amounts of dimethylnaphthalenes. On removal from the contaminated water, the tissue content of dimethylnaphthalenes decreased to a level slightly above the background within nine days in clean flowing sea water (Figure I-2).

It should not be assumed that only aromatic HC's are accumulated by marine animals, as Clark and Finley (1974) have demonstrated uptake of paraffins by mussels *Mytilus edulis* reaching a level of 112 ppm dry weight (7.9 mg/g wet weight) after 48 hours of exposure to No. 2 fuel oil. While the majority of these accumulated HC's were released during the first two weeks of maintenance in clean sea water, approximately 6 ppm (dry weight) was present at 14 and 35 days of depuration (Figure I-3).

Mussels collected at Scripps showed a buildup of petroleum hydrocarbons for several days after a fuel oil spill. But three weeks later, none of the material could be found in the mussels (Lee and Benson, 1973). Fish from Alaskan waters were able to completely depurate accumulated hydrocarbons after short term exposures (Rice, 1975). Several studies either designed to simulate chronic oil pollution or actually conducted in chronic field conditions, have indicated that, although over 90% efficient, molluscs do not completely depurate accumulated hydrocarbons.

Stegeman and Teal (1973) exposed oysters, *Crassostrea virginica*, to No. 2 fuel oil at a concentration of 106 ug/l (ppb) for 50 days. In terms of total wet body weight, hydrocarbon accumulation increased rapidly for 13 days, then more slowly until equilibrium was reached in five to six weeks. In terms of lipid content, equilibrium was not reached during the 50 day exposure period. The amount of accumulation was dependent upon the fat content of the oysters, reaching 334 mg/g (ppm) in high fat oysters but only 161 mg/g (ppm) in low fat oysters. When placed in clean water having a background hydrocarbon level of 11 ug/l (ppb), oysters depurated 90% within the two week holding period, but retained a concentration of 34 mg/g (ppm), a concentration of over 30 times that before exposure (Figures I-3 and I-4). They concluded that at least some of the PHC had become a stable component having a slow turnover rate. There is a physiological advantage for marine organisms to avoid loss by equilibration of important biogenic hydrocarbons, and a certain amount of petroleum hydrocarbons were probably confused with biogenic hydrocarbons and retained this way.

Working with mussels, *Mytilus edulis* and *M. californianus*, in the natural environments of polluted (San Francisco Bay) and unpolluted (Northern California coast) areas, Di Salvo et al. (1975) reported incomplete depuration when mussels held in polluted areas for 90 days were transferred to nonpolluted areas and held for 10 weeks.

The evidence indicated there may be two forms of hydrocarbons accumulation in bivalve molluscs; (1) A short-term form where PHC are taken up rapidly and depurated completely or to background levels within several weeks to two months (Lee and Benson, 1973; Rice, 1975 and Anderson et al., 1974a). This reflects the response during an oil spill. (2) A long-term hydrocarbon burden accumulated in tissues that is not completely discharged (Blumer et al., 1970; Blumer, 1969; Stegeman and Teal, 1973; Di Salvo et al., 1975). This reflects chronic oil pollution exposure when primarily aromatic hydrocarbons are accumulated in lipids. A similar residual hydrocarbon burden may be present in certain species of zooplankton, if it is possible to expose them to oil for a long enough period.

Because they apparently have the ability to metabolize hydrocarbons, shrimp, fish, and marine mammals would probably not retain the residual hydrocarbon concentration as do the molluscs.

The National Academy of Sciences (1975) reported on the avenues of depuration of accumulated hydrocarbons. In molluscs and certain zooplankton which cannot degrade hydrocarbons, bile salts or some other natural detergents are able to emulsify hydrocarbons and allow passage through the gut and into the feces or pseudofeces. Fish make water soluble products from the hydrocarbons, and the main avenue of discharge appears to be through the urine via the gall bladder and kidney. In mammals, aromatic hydrocarbons are also converted to water soluble products that go through the bile and into the feces and urine. The avenue for the discharge of hydrocarbons by the lobster and related invertebrates has not been determined.

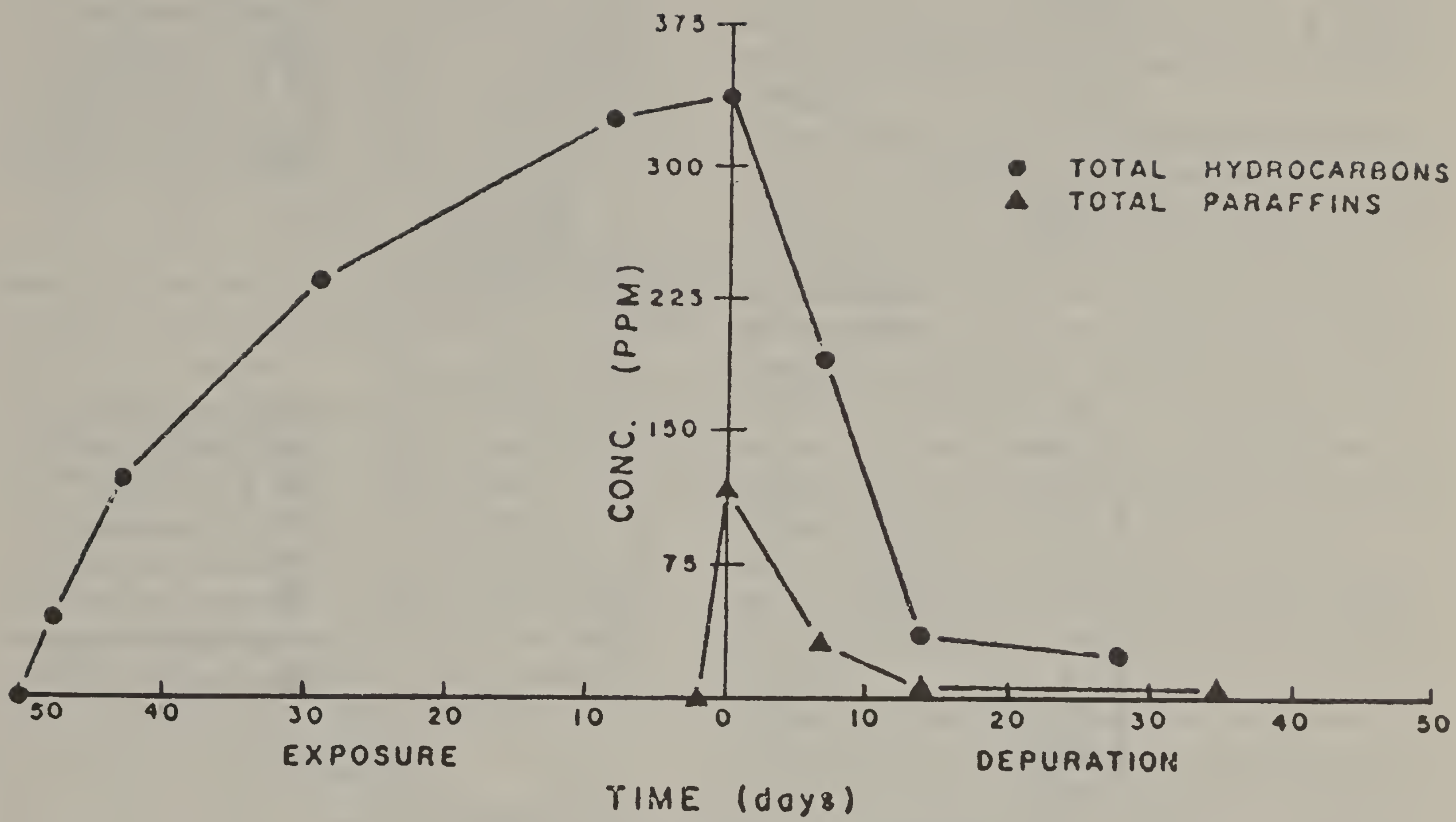


Figure 1-3 Levels of petroleum hydrocarbons in the tissues of marine organisms after various period of exposure and depuration (in clean water). Exposure of oysters to #2 fuel oil in a flowing system at a concentration of 106 ppb total hydrocarbons (Stegeman and Teal, 1973); the mussel, Mytilus edulis, exposed for 48 hours to surface oil slick total paraffins (Clark and Finley, 1974). With the exception of the data points for Mytilus which are expressed in µg/g dry weight of tissue, all additional data are expressed in terms of µg/g fresh weight of organism (ppm). (From Anderson et al. 1973).

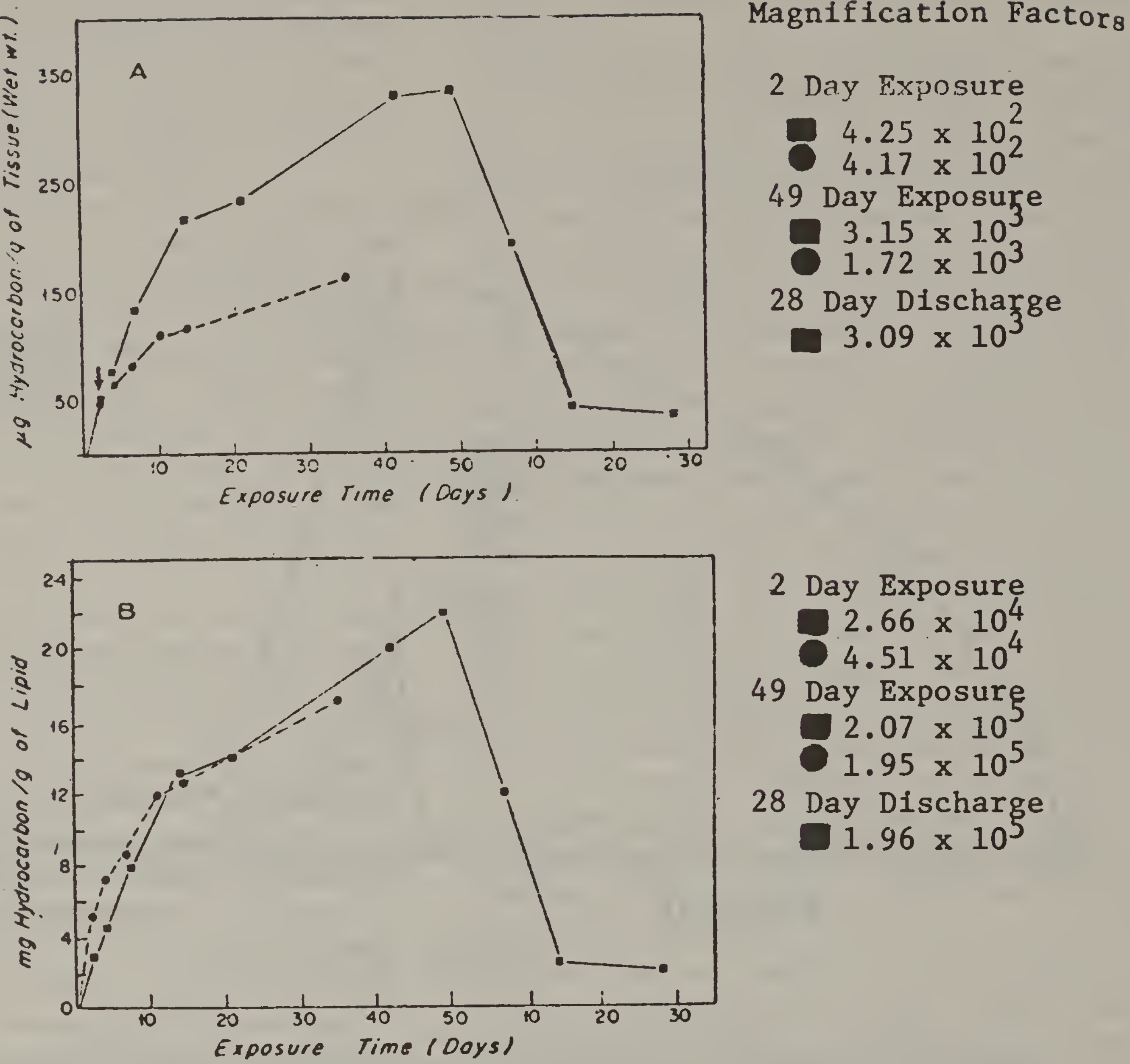


Figure I-4 Crassostrea virginica. Uptake and release of petroleum hydrocarbons by high fat-content (squares) and low fat-content (circles) oysters. Concentration of hydrocarbons expressed on (A) wet-weight basis, (B) lipid basis. The concentration of hydrocarbons in the water was 106 μg/l. At Day 50, high fat-content oysters were transferred to system with 11 μg hydrocarbon/l water. Each point represents determination of hydrocarbons in 3 oysters, with determinations in duplicate samples of three at Days 2 and 14. Magnification factors refer to concentration in the water. Concentration in low-fat oysters at Day 49 was determined by extrapolation.
(From Stegeman and Teal, 1973).

Di Salvo et al. (1975) mention that another potential for the release of hydrocarbons may be in the eggs which, in mussels, were found to be enriched particularly with aromatic hydrocarbons compared to the total body concentration.

The present knowledge of depuration of petroleum hydrocarbons in marine animals is summarized by Anderson et al. (1974a).

It would seem that reduction of a body burden of hydrocarbons by metabolisms could have possible significance in fish, but probably not crustaceans or molluscs. As indicated above, however, all three groups are capable of disposing of accumulated PHC. The mechanisms responsible for disposal have yet to be clearly defined, particularly for crustaceans and molluscs, and for all three groups the real extent to which disposal occurs by release across gill membranes is still an unanswered question. With fish, where metabolism is a distinct possibility, there is information for only a few species and that very cursory. Rates of PHC metabolism in vivo under various environmental conditions are at this point impossible to guess. Furthermore, in terms of the consumer, we have no information regarding what percentage of PHC metabolites, some of which may be toxic, are retained or excreted by fish under varied conditions.

5. Food Web Magnification

There is increasing evidence that classical food web magnification (an increasing concentration of hydrocarbons per weight of tissue or lipid at successively higher trophic levels) of petroleum hydrocarbons does not occur. The principal evidence for this is: (1) Organisms so far tested have the ability to depurate at least the majority of accumulated hydrocarbons. Food chain magnification is dependent upon long term retention of the pollutant in tissues. (2) Much of the hydrocarbon ingested by zooplankton and other organisms passes through the gut without ever becoming accumulated into the body tissues. (3) The most important method of hydrocarbon accumulation is apparently transference across the gill surface. According to the National Academy of Sciences (1975) "Apparent food chain magnification may more likely be a function of the ability of different species to accumulate hydrocarbons from the water than a function of their position in the food web."

The possibility exists of some selective hydrocarbon buildup in the food chain in chronically polluted areas through molluscs which retain a portion of the toxic aromatic hydrocarbons. Although magnification would not occur, greater than normal levels of aromatic hydrocarbons could be passed on to the next trophic level. The resultant damage to the predator is not known, but would depend upon the concentration of aromatics in the prey, frequency of consumption, and toxicity or carcinogenicity of the particular aromatic hydrocarbons with the tissue of the prey organism.

The fact that the animals tested do accumulate hydrocarbons in rather large quantities in a relatively short time indicates that temporary food chain buildup can occur. The naphthalenes, which are among the most toxic petroleum fractions, remain within the prey species the longest (Anderson et al., 1974a). The carcinogen benzo-a-pyrene acts similarly to naphthalenes in animal tissues. If the temporary accumulation of naphthalenes and/or benzo-a-pyrene reached high enough concentrations in predators, death or cancer could result. The impacts would be of far shorter duration and of less impact on the marine ecosystem than if the classical food web buildup did occur.

There are other nonhydrocarbon components of oil (including but not limited to those discussed in Section 1) which could be magnified through the food web. Very little information is available for many of these compounds and, although most occur in small concentrations, the long range effects are not completely understood.

Another possible implication of oil spills in the marine environment is a decrease in the available food supply due to the death of prey species which have succumbed to the toxic fractions of oil. A detailed discussion of this factor is beyond the scope of this paper.

6. Microbial Decomposition

A necessary part of the food cycle in all systems is the decomposition of organic matter. Decomposition of petroleum hydrocarbons will be briefly discussed.

According to the report by the National Academy of Science (1975),

> It must be emphasized that with this multivariable system it is impossible to predict with either ease or accuracy the rate of microbial oil

removal. Few reliable field measurements have been made in the marine environment (Blumer et al., 1972c; Robertson et al., 1973); laboratory experiments, in which conditions, are optimal for oxidation can only give some indication of maximum rates. Even under laboratory conditions, the various fractions of oil or oil products will disappear at rates that can be measured on a time scale of weeks in some instances and that are immeasurable slow in others. Environmental stresses such as temperature and salinity changes, wave action, and sunlight not only directly affect the growth and metabolism of the microorganisms but also alter the physical state (for example, emulsification) and ultimately the chemical nature (for example, oxidation) of the hydrocarbons.

In sediments, chemical degradation of oil can occur but is restricted to the layer of the bottom penetrated by ultraviolet light. Ahearn and Meyers (1973) stated that research on microbial utilization of hydrocarbons for treatment of oily pollutants in the environment, though more intensive in recent times, is still in an early stage of development. It is known that microorganisms can degrade much of a crude oil, particularly the less toxic paraffinic compounds. No single species can degrade all the compounds, but many different species together can metabolize a large number of the compounds.

Microbial degradation is principally aerobic and large quantities of oxygen are needed. It has been estimated, for instance, that complete oxidation of 1 gallon of crude oil would require all of the dissolved oxygen in 320,000 gallons of water. It is reasonable to assume, however, that an oxygen deficient environment could occur under some oil slicks and in oil contaminated sediments. Much of the oil from the Santa Barbara blowout, for example, is believed to have settled in the Santa Barbara Channel (Battelle Northwest, 1970) where oxygen is already deficient and is probably insufficient for further decomposition.

Blumer and Sass (1972b) noted that "The preservation of hydrocarbons in marine sediments for geologically long time spans is one of the accepted key facts in current thought on petroleum formation." However, in spite of the stability of hydrocarbons in marine sediments, there are characteristic differences between hydrocarbons found in polluted and unpolluted areas. Tissier and Oudin (1973) found that hydrocarbons in polluted sediments differed from those of unpolluted sediments by having lower percentages of heavy components having an odd carbon dominance in the n-alkanes, and having polycyclic aromatic hydrocarbons with alkyl sidechains.

Numerous intermediates and end products have been identified in laboratory experiments (Friede et al., 1972; Klug and Markovetz, 1971), some of which may be disruptive to chemotaxic mechanisms of marine forms (Mitchell et al., 1972; Zafiriou, 1972). The microorganisms that digest oil may be pathogenic or produce toxins (Traxler, 1973).

The influences of environmental factors on decomposition rates has been summarized by the National Academy of Science (1975) report.

> Temperature increases may accelerate growth rates, thereby increasing biodegradation (Friede et al., 1972; ZoBell, 1973). A rise in temperature also increases the rate of evaporation of more volatile components, some of which are degradable and some of which are toxic (Atlas and Bartha, 1972b; see also previous section). Viscosity is lower at higher temperatures, thereby increasing the chance of emulsification and increasing the surface area available for microbial activity and solubility (ZoBell, 1973). Temperature decreases may not necessarily reduce the overall rate of microbial biodegradation significantly if special psychrophilic cultures develop (Robertson et al., 1973; Traxler, 1973).

Oxygen content is probably always sufficient for degradation of oil at the surface layer and in the upper water column in the open ocean (Friede et al., 1972). The degree of turbulence directly affects the availability of oxygen, as well as the physical dispersion and emulsification of the oil. If the water or sediments become anoxic, then rates of biodegradation will be markedly reduced (Davis, 1967).

Nitrogen and phosphorus concentrations strongly influence the rate of oxidation in laboratory experiments (Gunkel, 1967, 1968; Atlas and Bartha, 1972a). These nutrients may more commonly be limiting in the open oceans than in inshore regions.

Numerous other factors influence biodegradation, for example, presence of sufficient hydrocarbon substrate to develop a viable culture, presence of alternative carbon sources and microbial predators (Gunkel, 1968; Friede et al., 1972), but data are generally insufficient to precisely determine in situ effects on microbial oil utilization.

7. Carcinogenicity

As far as man is concerned, some doubt remains as to the direct carcinogenicity of crude oil and crude oil residues in marine organisms.

A literature search and evaluation conducted for the U.S. Coast Guard by Batelle Memorial Institute (1967) noted that shellfish, although alive, may have been unfit for consumption because of the carcinogenic hydrocarbon 3, 4-benzopyrene in their bodies. Oysters that were heavily polluted and contaminated with ship fuel oil were reported to contain 3, 4-benzopyrene. The Batelle review also reported that barnacles attached to creosoted poles contained the same carcinogenic hydrocarbon. Sarcomas were developed when extracts from the barnacles were injected into mice.

The carcinogenic benzo-a-pyrene behaves similarly to naphthalenes in pattern of uptake, retention, and release in clams (Anderson and Neff, 1974). As indicated earlier, they reported that organisms accumulated naphthalenes in tissues in greater amounts than the other hydrocarbons and released them more slowly.

Hyperplasia (increase in the rate of cell division) in reproductive cells of bryozoan in response to the addition of coal tar derivatives was reported by Powell, et al. (1970).

They noted that similar abnormalities may have occurred in coastal fauna exposed to spills such as the *Torrey Canyon* and the Santa Barbara blowout. However, most observations of these spills were concerned with mortality and may not have detected the sublethal effects. Straughan and Lawrence (1975) investigated the response of a number of bryozoan species to exposure to natural oil seepage, but found normal cell formation.

ZoBell (1971) reported the natural synthesis and metabolism of carcinogenic hydrocarbons by several marine organisms. Thus, oil pollution is certainly not the only source for carcinogenic hydrocarbon introduction into marine food webs. Suess (1972) recognized that carcinogens were in seafoods but concluded that they would probably not be dangerous unless the foods contained an excess amount of polynuclear aromatic hydrocarbon carcinogens. Carcinogenesis from oil contaminated marine organisms has not been proven, but Ehrhardt (1972) expressed a need for carcinogenic testing of hydrocarbon fractions extracted from marine organisms contaminated by exposure to oil.

According to the National Academy of Sciences (1975) workshop on petroleum in the marine environment:

> Although our information is limited, the effect of oil contamination on human health appears not to be cause for alarm. From our calculation, we estimate that the carcinogen benzo-a-pyrene concentration on a dry weight basis arising from a high level of contamination by petroleum is comparable with that of common terrestrial foods. We, of course, do not recommend eating contaminated seafood, but in most cases, because of the taste factor, not many will be tempted to do so. It is clear that this is an area in which our knowledge is grossly inadequate and that the contamination of seafood by oil is clearly undesirable.

Recent work by Yevich, of the National Marine Water Quality Laboratory in Naragansett, Rhode Island, has further implicated petroleum as a carcinogen. During two oil spills involving No. 2 fuel oil and a No. 5 diesel oil, he found two types of cancer in soft shell clams. One type forms in gonadal tissue and quickly spreads to other organs, while the other is a blood cell form similar to leukemia (Yevich, in press).

If Yevich's results prove to be valid, there should be greater cause for alarm than indicated by the National Academy of Science report.

8. Heavy Metals

a. Natural occurrence and sources from offshore petroleum operations

Heavy metals occur naturally in sea water in relatively low concentrations. Table I-4 lists average background concentrations in the open ocean for several heavy metals that have been associated with offshore petroleum operations. The residence time of the metal ions and their complexes is an estimate of turnover time in the marine environment. It must be emphasized that there are many dynamic physical and biological processes in the ocean that continually affect these ''average'' concentrations. Generally the concentrations in Table I-4 would be applicable to the open ocean area away from the direct influence of the coastal zone. In the coastal zone, especially in estuaries, near river mouths and in areas of high levels of industrial or municipal

Table I-4 Background Concentrations of Most Heavy Metals in the Ocean

Element	Seawater conc. ug/l (ppb)	Principal Dissolved Species	Residence Time in Ocean (Years)
- V	2	$VO_2\ (OH)^{-2}$	8.0×10^4
- Cr	0.5	CrO_4^{-2}, Cr^{+3}	2.0×10^4
- Mn	2	Mn^{+2}	1.0×10^4
- Fe	3	-	2.0×10^2
- Co	0.4	Co^{+2}	1.6×10^5
- Ni	7	Ni^{+2}	9.0×10^4
- Cu	3	Cu^{+2}	2×10^4
- Zn	10	Zn^{+2}	2×10^4
- As	2.6	$HAs\ O_4^{-2}$ $H_2As\ O_4^{-1}$	5×10^4
- Cd	0.1	Cd^{+2}	-
- Ba	20	Ba^{+2}	4×10^4
- Hg	0.2	$Hg\ Cl_4^{-2}$, $Hg\ Cl^o_2$	8×10^4
- Pb	0.03	Pb^{+2}	2.0×10^3
- Ag	0.04	Ag^{+1}	2.1×10^6

Modified from: Goldberg et al. (1971)

discharges, the concentrations can be several times higher.

Natural sources of heavy metals to the ocean are river water, wind blown material from land following the weathering of rocks and tectonically active ridges where heavy metals are emitted in heavy brines. In coastal regions, additional major sources of heavy metals include sewage discharges, industrial effluents and atmospheric pollution. As an example of the atmospheric source, Patterson and Settle (1974, as cited by NSF/IDOE, 1974) found that atmospheric particle input is a major source of industrial lead in the Southern California Bight, comparable to the input of lead from storm runoff, rain and sewage. The atmospheric lead originates from cars burning leaded gasoline.

Many heavy metals in trace amounts are essential for animal and plant life. At present 14 trace elements are known to be essential for animal life: iron, zinc, copper manganese, cobalt, iodine, molybdenum, selenium, chromium, tin, nickel, fluorine, silicon and vanadium. These elements serve as components of enzymes or enzyme systems, enzyme activators, and components of vitamins, hormones and respiratory pigments. A few heavy metals such as arsenic, lead, cadmium and mercury are often referred to as toxic elements since they are toxic to marine organisms at relatively low concentrations and have no other known biological significance (Underwood, 1974). However, any of the heavy metals normally accumulated by marine organisms can be toxic if they are ingested or taken up at sufficiently high levels for long enough periods. Heavy metals and other trace metals in marine organisms are held by strong chemical bonds and are not readily released into the marine environment (Goldberg, 1965).

Offshore petroleum operations are potential sources of heavy metals to the coastal waters. Heavy metals are present in petroleum, formation waters (oil field brines) and drilling fluids. Crude oils vary greatly in trace element composition, and variations in trace element groups can occur from well to well in a particular geological formation (Filby and Shah, 1971). Concentrations of heavy metals and other trace elements in several crude oils are presented in Table I-5. Nickel (Ni) and vanadium (V) are generally the most abundant metallic elements in crude, but as shown in Table I-5, cobalt (Co), mercury (Hg), iron (Fe) and zinc (Zn) can be abundant in some crudes, in this case California crude. According to Filby and Shah (1971), very little is known of the forms of occurrence of trace elements other than Ni and V in crude oil. Ni and V occur partly as porphyrin complexes and partly in non-porphyrin type compounds associated with the high-molecular-weight material of the oil. The resins and aspahltenes contain most of the trace elements. These groups are not definite classes of compounds but are colloidal materials covering broad molecular-weight and polarity ranges (Filby and Shah, 1971).

Formation waters contain heavy metals in various concentration ranges. Formation waters are either discharged into the ocean after separation of oil fractions or reinjected into formation reservoirs. Median concentrations of various trace metals in formation waters are given in Table I-6.

Drilling muds used during drilling operations may be discharged periodically or accidentally into the ocean. Because of this, concern has been expressed over the introduction into the marine environment of toxic substances since the two major components of drilling mud are barite (barium sulfate) and ferrochrome lignosulfonate which contain the elements barium and chromium, known to be toxic in certain of their elemental states. A recent conference on the environmental aspects of chemical use in well-drilling operations in May, 1975 in Houston, Texas addressed these and other problems. The following information can be found in the report of the conference.

Barium sulfate, used as a weighting agent during drilling, is also used as a contrast medium for roentgenographic purposes and as an antidiarrheal and demulcent powder. Toxicity studies using *Mollienisias latipinna* (mollies) show that heavy concentrations of barium sulfate (up to 100,000 ppm for 96 hrs) exhibit no toxicity to fish (Grantham and Sloan, 1975).

Another report shows low toxicity but some physical problem with *Salmo salar*, Atlantic salmon because of suspended solids (Zitko, 1975). Concentrations of these magnitudes would exist only at the point of discharge.

Ferrochrome lignosulfonate is used as a deflocculant or thinning agent in drilling muds. Whereas chromium itself is highly toxic to certain species, when bound it is less toxic (Zitko, 1975) and it has been shown that in ferrochrome lignosulfonate the chromium is firmly chelated and may

Table I-5 Trace Element Contents of 6 Crude Oils[a]

Elemental Conc (ug/g)[b]	Oil Number					
	RF-1	RF-2	RF-3	RF-4	RF-5	RF-6
Ni	93.5	113.0	78.6	116.8	1.28	20.5
V	7.5	6.0	4.9	112.0	26.0	8.2
Co	12.7	13.9	14.5	0.198	0.001	0.0354
Hg	21.2	1.49	1.46	0.139	0.0143	0.0898
Fe	73.1	77.2	89.5	36.9	<5.0	4.94
Zn	9.32	19.50	19.60	2.619	<0.0907	9.08
Cr	0.634	0.685	0.729	0.380	<0.1	0.081
Mn	2.54	3.10	2.96	0.21	<1.50	0.79
As	0.656	1.63	0.67	1.20	<0.2	0.0773
Au	$2.8x10^{-6}$	......	....	$3.0x10^{-6}$	$<10^{-7}$	$6.4x10^{-5}$
Sb	0.0517	0.061	0.11	0.273	$<10^{-3}$	0.055
Se	0.364	0.484	0.333	0.369	0.009	0.128
Sc	$8.8x10^{-3}$	$9.0x10^{-3}$	$4.6x10^{-3}$	$4.4x10^{-3}$	$9.5x10^{-5}$	$<10^{-5}$
Cu	0.93	1.25	1.13	0.21	<0.2	0.19
Na	11.1	65.2	15.5	25.0	<1.0	13.0
Ca	192.0	75.1	103.0	150.0	<20.0	<20.0

[a]Oils RF-1, 2, 3 from California; RF-4, Venezuela; RF-5, Louisiana and RF-6, Libya

[b]Conc = concentrations in ppm

From Filby and Shah (1971)

TABLE I-6. MEDIAN CONCENTRATION OF TRACE METALS IN PRODUCED WATERS[1/]

Median Concentration (equaled or exceeded by 50% of the samples) in Each Area[2/]

	Number of Samples	Total Solids (madian) (g/1)	Co	Cr	Cu	K	Li	Mg	Mn	Ni	Sn	Sr	Ti	V	Zr
Illinois Basin	22	98	ND	2p	10p	300	15	6,000	175p	ND	< 1p	300	<10p	ND	<10p
Louisiana and Texas Gulf Coast	79	69	ND	<1p	<25p	300	ND	250	3.5	<1p	< 1p	85	<10p	ND	<10p
East Texas	88	66	ND[3/]	ND	< 1	<50	ND	250	3.3	<1p	3p	350	ND[3/]	ND[3/]	ND
North Texas	24	222	ND	<1p	150p	300	ND	5,000	45	15p	12p	450	7p	ND	<10p
West Texas and New Mexico	148	111	ND	2p	1p	350	15	1,000	1.8	<1p	< 1p	200	<10p	ND	ND
Fermian only	74	143	ND	2p	2p	400	10	1,000	1.7	<1p	< 1p	90	<10p	< 1p	ND
Pennsylvania only	34	115	ND	3p	< 1p	300	10	1,000	2.8	<1p	< 1p	300	<10p	< 1p	ND
Silurian-Devonian only	15	55	ND	2p	4p	300	10	400	300p	<1p	1p	90	<10p	ND	ND
Ordovician-Cambrian only	21	67	ND	<2p	4p	400	15	800	400p	<1p	1p	250	<10p	ND	ND
Anadarko Basin[4/]	118	137	ND	10p	10p	250	10	1,550	5.6	6p	2p	300	<10p	< 1p	<10p
Williston Basin, post-Paleozoic	25	59	<5p	<2p	<25p	300	ND	250	300p	<3p	< 1p	100	ND	< 1p	ND
Williston Basin, Paleozoic	55	173	ND	3p	3p	800	35	600	660p	ND	< 1p	95	<10p	< 1p	ND
Powder River Basin	22	5	<5p	<2p	<25p	300	ND	40	450p	<3p	< 1p	25	<10p	< 1p	<10p
Other Wyoming	28	5	ND	ND	ND	300	ND	100	300p	ND	< 1p	20	<10p	< 1p	ND
Colorado	18	5	<5p	ND	<25p	300	ND	30	300p	<3p	<10p	20	<10p	< 1p	<10p
California	116	18	ND	5p	5p	45	ND	90	950p	10p	2.5p	10	<10p	< 1p	ND
Seawater	-	35	0.27p	0.04p-0.07p	1p-15p	380	0.1	1,272	1p-10p	5.4p	3p	13	Present	0.3p	ND
Estimated Detection Limit	-	-	1p	1p	1p	50	2	10	1p	1p	1p	16	10p	1p	10p

1/ Taken from Rittenhouse, Fulton, Grabowski, and Bernard

2/ ND = below detection limits; p = concentration in parts per billion, otherwise parts per million

3/ No data; less sensitive methods of analysis used.

4/ Includes Oklahoma Platform and Ardmore Basin.

Source: "Environmental Aspects of Produced Waters from Oil and Gas Extraction Operations in Offshore Coastal Waters, prepared by OOC, Sept., 1976.

not be removed from the lignosulfonate complex even by strong ion-exchange resins and that the chromium is in the trivalent oxidation state (McAtee and Smith, 1969). Toxicity studies using *Mollienisias latipinna* (mollies) have indicated that the compound itself is of low toxicity (killed some test animal at 70 to 450 ppm concentrations). These concentrations could be found near discharge points (Hollingworth and Lockhart, 1975).

Heavy metals can also be introduced into sea water by the dissolution of drilling platform legs and pipelines. The metals released would be iron with lesser amounts of nickel and molybdenum. The time required for metal decomposition through chemical and microbial erosion is not presently known, but with present safeguards, may be around ten years. Dissolution would occur at a very slow rate and should not appreciably add to the concentration of heavy metals around platforms and pipelines in the water column or in sessile marine organisms, although this has yet to be demonstrated.

Concerning the levels of concentration of heavy metals in the marine environment, IDOE (1972) concluded that with the possible exception of lead, the current levels of heavy metals in marine ecosystems are derived primarily from natural rather than technological sources. However, local inputs in the estuarine and coastal environments can increase the levels in the water column, sediments and marine organisms. In a study of the effects of offshore petroleum operations on the environment, in the Gulf of Mexico, the Gulf Universities Research Consortium (GURC) concluded that all the heavy metals observed in the water column were in the ranges reported for oceanic waters except for barium for which the results were inconclusive. A zinc concentration gradient was found that decreased with distance from the oil platforms (GURC, 1974). However, the investigation did not analyze distribution of heavy metals in the marine organisms or in the sediments.

b. Uptake

Marine organisms can accumulate heavy metals by absorption across body surfaces and gills from the water or by ingestion of food containing heavy metals. Food sources can include heavy metals absorbed onto suspended particles or plankton, heavy metal compounds that have precipitated into the sediments and been ingested by deposit feeders, and heavy metals concentrated by organisms and preyed upon by other organisms in higher levels of the food web.

Once heavy metals are introduced into the ocean, concentrations are lowered by dilution and removed from sea water by precipitation, absorption, and absorption by marine organisms. The amount of dilution depends on the currents, mixing and circulation patterns in the area of discharges as well as the medium in which the metals are discharged. For example, heavy metals introduced in crude oil or formation water of greater density than the surrounding water would probably tend to mix less with the ambient water mass and retain their higher concentrations for a longer period of time. The use of diffuser technology in many sewage outfalls helps to dilute the effluents faster and prevents a large dose of highly concentrated effluent impacting one area at one time.

Precipitation of a metal to the sediments occurs if the concentration of the metal is higher than the solubility of the least soluble compound that can be formed between the metal and anions in the water such as carbonate, hydroxyl or chloride. The concentrations of heavy metals which can remain in solution are orders of magnitude higher than those usually found in the sea and normally the sea is considerably undersaturated with heavy metals (Bryan, 1971).

Adsorption of metals can occur on the surfaces of suspended and deposited particulate matter such as clays, phytoplankton, hydrated ferric oxide and hydrated manganese dioxide. However, all heavy metals are not equally readily absorbed. Zinc, copper and lead are probably readily adsorbed by both hydrated ferric oxide and hydrated manganese dioxide, but cobalt and nickel prefer hydrated manganese dioxide while silver is not readily adsorbed by either (Bryan, 1971). According to Lowman et al. (1971), surface adsorption, including ion exchange, is probably an important uptake path for phytoplankton. Glooschenko (1969) found that the greatest uptake of mercury-203 (^{203}Hg) per cell in a population of coastal marine diatoms (*Chaetoceros costatum*) was by adsorption onto a population killed with formalin rather than uptake by absorption of living cells. This passive uptake for the dead cells could also be due to increased membrane permeability to the mercury. In either case, the uptake by adsorption was greater than the active adsorption process of live cells.

It has been found that heavy metals in natural waters are predominantly associated with particles suspended in water. Whenever attempts have been made in the natural environment to detect the amounts of heavy metals in solution versus the amount adsorbed onto or part of particles, investigators have discovered that only a small percentage of the heavy metals are in solution. It is not known if the particles that have adsorbed the heavy metals can be absorbed. It is generally thought that the particles must be ingested or taken into cells by phagocytosis and that the metal must be solubilized to be absorbed in solution (Hartung, 1972).

Uptake by absorption from sea water through the gills, body surface or gut wall is an important pathway for heavy metals to enter marine organisms. As noted by Anderson et al. (1974a), the accumulation of heavy metals by marine organisms from dilute sea water solutions has been well demonstrated. The amount of heavy metal absorbed depends on many physical and chemical factors such as the concentration of the heavy metal in solution, the chemical form of the complex, the ligands available for complexing the metals, particle size, the nature of the particles available for adsorption in the water, pH and alkalinity. Biological characteristics of the organism also affect the absorption rate and amount: the species of the organism, age, metabolic rate, and previous health (Hartung, 1972). A further complicating factor is that an equilibrium may be established between the organism, its food and the concentration of the heavy metal in the water (Lowman et al., 1971).

Concentration factors for various marine organisms for several elements including heavy metals are given in Table I-7. It can be seen that these factors range up to more than a million or more for the heavy metals. Concentration factor is defined as "the ratio of the concentration of an element or radionuclide in an organism or its tissues to that concentration directly available from the organism's environment under equilibrium or steady-state conditions" (Lowman et al., 1971). However, marine organisms accumulate heavy metals and other elements from many sources including food, water, suspended particles and deposited sediments. Therefore, the concentration factors listed should be viewed as indicators that can be changed by biological and environmental factors.

Absorption from solution through the gills of the lobster *Homarus vulgaris* results in a concentration of 7ppm of zinc in the lobster blood flowing through the gills, or 10^3 to 10^4 times the concentration in sea water. Before the zinc diffuses through the gill epithelium probably attached to proteins, zinc is first adsorbed onto the cuticle covering of the gills (Bryan, 1971). Anderson et al. (1974a) summarized recent studies of heavy metal uptake from sea water in marine animals as follows:

> Among the more recent studies, Eisler et al. (1972) have shown that mummichogs or common killifish, *Fundulus heteroclitus*, scallops, *Aquipecten irradians*, oysters, *Crassostrea virginica* and northern lobsters, *Homarus americanus*, exposed for 21 days to flowing sea water containing 10 ug/L (ppb) of cadmium accumulated the metal to levels equivalent to 45, 114, 352 and 41 percent, respectively, higher per unit wet weight than baseline levels of cadmium in the controls. Pentreath (1973) determined that exposure of the estuarine mussel, *Mytilus edulis* to zinc, manganese, iron and cobalt in sea water solution for 49 days resulted in maximum concentration factors of approximately 500, 250, 5000, 1000 respectively. Vernberg and O'Hara (1972) studied the effects of temperature-salinity stress on mercury uptake and accumulation in the gill and hepatopancreas tissues of the fiddler crab *Uca pugilator* and found significant uptake over 72 hours of exposure, with gill tissue accumulating greater amounts than hepatopancreas under all conditions.
>
> The NSF/IDOE (National Science Foundation/International Decade of Ocean Exploration) Pollutant Transfer Workshop reported on more recent findings of heavy metal uptake by marine organisms. The Skidaway group at the University of Georgia found that the marine plant *Spartina alterniflora* takes up mercury through its roots. Subsequently, the mercury is transferred to the leaves and then released to estuarine waters. The root system apparently concentrates inorganic mercury, while the leaves concentrate methylmercury (NSF/IDOE, 1974). Eelgrass (*Zostera marina*) in the coastal waters of Alaska absorb trace metals from the water and sediments and concentrate zinc, copper and cadmium in their roots, rhizomes and leaves. The eelgrass helps to recycle these trace elements in the food web that would normally be lost to the sediments (NSF/IDOE, 1974).

At the California Institute of Technology it has been discovered that the form of the heavy metal lead in sea water is critical to the knowledge of its behavior in the food chain. For example, the investigators found that much of the lead in sea water may be adsorbed on the mucilage of algae (NSF/IDOE, 1974). This is consistent with the findings of Flooschenko (1969) discussed earlier for the marine diatom *Chaetoceros costatum*. Chow et al. (1974) have also discovered that excessive amounts of lead collect on the epidermal mucous of fish. These observations are important since the biologically active fraction of lead in marine organisms might be small compared to the large

TABLE I-7 Ranges of Element Concentration Factors[a] in Marine Organisms at Various Trophic Levels[b]

Element	Algae: Sessile	Algae: Plankton (Phytoplankton and Sargassum)	Grazers: Plankton (Copepods, Pteropods, Salps, Doliolid)	Grazers: Shellfish	Predators: Plankton [Euphausiids, Planktonic Amphipods, Shrimp (Acanthephyra, Paleomonetes)]	Predators: Fish	Predators: Squid
Ag	(18) 100-1,000	(1) <100-220	(1) <100	(2) 330-2 x 10^4	(1) <45-900		(1) 900-3,000
Cd	(12,13) 11-20	(1) <350-6,000	(1) <80-10^5	(2) 10^5-2 x 10^6	(1) <300-10^4	(12) >10	(1) 2,800
Ce	(14) 100-3,300[c]	(4) 2,000-4,500[c]		(14) 40-300[c]		(14) 5-12[c]	
Co	(13,14,16) 15-740	(1,13,17) 75-1,000	(1) <110-10^4	(7) 24-260 (14) 18[c]	(1) <70-1,300	(14) 28-560	(1) <200-5 x 10^4
Cr	(14) 100-500	(1) <70-600	(1) <15-10^4	(2) 6 x 10^4-3 x 10^5	(1) <55-3,900	(8) 3-30	(1) <70
Cs	(14) 16-50	(14) 16-22	(3) 6-15[c]	(14) 3-15[c]		(14) 6-10	
Fe	(14) 10^3-5 x 10^3	(1) 750-7 x 10^4	(1) 440-6 x 10^4	(2) 7 x 10^4-3 x 10^5	(1) 3 x 10^3-3 x 10^4	(14) 400-3 x 10^3	(1) 10^3-3 x 10^3
I	(14) 160-7 x 10^3			(14) 40-70		(14) 10	
Mo	(9,16) 10-200	(1) <3-17	(1) 2-175	(2) 30-90	(1) <2-14	(9) ~200	(1) <10
Mn	(14) 20-2 x 10^4	(1,14) 300-7 x 10^3	(1) 21-4 x 10^3	(2,14) 3 x 10^3-6 x 10^4	(1) 270-1,600	(14) 95-10^5	(1) 10^3
Ni	(13,16) 50-10^3	(1) 25-300	(1) 2-10^3	(2) 4 x 10^3-10^4	(1) 17-90		(1) 30-80
Pb	(13) 8 x 10^3-2 x 10^4	(1,17) 10^3-3 x 10^6	(1) 3 x 10^3-2 x10^6	(2,6) 39-5 x 10^3	(1,15) 200-6 x 10^4	(10) 5-10^4	(1,15) 100-2 x 10^5
	(14)			(14)	(11)	(14)	

TABLE I-7 (continued)

Ru	$100-10^{3c}$			$1-16^{c}$	10^{c}	10^{c}	
	(18) <200-1,200	(1) <200	(1) <10-6 x 10^{3}		(1) <160-2,400		(1) <400-2,100
Sr	(14) 0.1-90	(1) 0.9-54	(1) 1-85	(5) ~50^{c}	(1) 1.2-10	(14) 4-5	(1) 0.9-1.2
Ti	(18) 200-3 x 10^{4}	(1) 600-10^{4}	(1) 28->3 x 10^{4}		(1) 110-2 x 10^{4}		(1) 300-3,000
Zn	(14,16) 80-3,000	(1) 200-1,300	(1) 125-500	(2,14) 1,400-10^{5}	(17) ~50	(14) 280-2 x 10^{4}	(1) 2,500
Zr	(14) 200-3,000^{c}	(1) <1,000-2 x 10^{4}	(1) 360-3 x 10^{4}	(14) 8-36^{c}	(1) <800-4 x 10^{4}	(14) 5^{c}	(1) 2 x 10^{4}

a Concentration in whole, fresh organism versus concentration in seawater.
b Literature references are shown in parentheses in upper left of box and listed below. No attempt has been made to achieve completeness; the ranges of concentration factors are for illustration, but are believed to be representative.
c Concentration from radionuclide tracer experiments.

(1) Bowen et al., unpublished; some data from Nicholls et al., 1959.
(2) Brooks and Rumsby, 1965.
(3) Bryan, 1963.
(4) Chapman, 1958.
(5) Cigna et al., 1963.
(6) Costa and Molina, 1957.
(7) Fukai, 1968.
(8) Fukai and Broquet, 1965.
(9) Fukai and Meinke, 1962.
(10) Goldberg, 1962.
(11) Hiyama and Khan, 1964.
(12) Hiyama and Shimizu, 1964.
(13) Ishibashi et al., 1964.
(14) Polikarpov, 1966.
(15) Tamotsu et al., 1964.
(16) Young and Langille, 1958.
(17) Vinogradova and Kovalskiy, 1962.
(18) Black and Mitchell, 1952.

From Lowman et al. (1971)

amounts of biologically inactive adsorbed lead on these organisms. This distinction has often been ignored in the past (NSF/IDOE, 1974).

The path of uptake can also depend on the element itself. Bryan (1964) found that zinc and copper were absorbed indirectly from the water into the lobster *Homarus vulgaris*, while Bryan and Ward (1965) discovered that manganese uptake was mostly from food for the same species of lobster. Pentreath (1973) investigated uptake of radioisotopes of zinc manganese, cobalt and iron by the mussel *Mytilus edulis* and reported that accumulation from sea water was minor compared to food accumulation. Pentreath indicated that uptake was from food particles as well as from mucous accumulation of metals in soluble form. Results of Hoss (1964) as reported by Bryan (1971) using zinc-65 in the flounder, *Paralychthys*, suggest that food is a more important source of zinc than sea water. Likewise, Preston and Jeffries (1969, as cited by Bryan, 1971) have shown that zinc and cobalt are absorbed from ingested particles through the gut rather than from sea water solution for the oyster *Ostrea edulis*.

In contrast, Polikarpov (1966) contends that chemical mineral substances are more generally accumulated directly from water than indirectly through the food chain. According to Lowman et al. (1971) the degree to which a trace element is taken up in a marine organism depends on the relative concentrations of the element in the water and food. When an element is concentrated in food only slightly above its concentration in water, the food supplies a relatively low fraction of the element for marine organisms. However, when the element is highly concentrated in food compared to sea water, a major fraction of the element may be accumulated from the food through the gut. The relative importance of uptake of heavy metals from water compared to uptake from food is still being studied and is by no means resolved for marine organisms. As mentioned above, it probably varies for different elements and organisms as well as for various relative concentrations.

Bryan (1973) reported a seasonal variation in the concentrations of trace metals in two scallop species from the English Channel. Variations between species were observed, but the highest values of metals occurred in the autumn and winter when phytoplankton productivity was low, while the values decreased when phytoplankton production increased. The metals looked at were Ag, Co, Cr, Cu, Mn, Ni, Pb, Zn, Al, Cd and Fe and they were concentrated in the kidneys and digestive glands to the greatest extent. Bryan reasoned that the seasonal variation was due to three factors:

1) More food from increased phytoplankton productivity in spring and summer results in increased metabolic activity for the scallop and increased excretion of wastes, including excess heavy metals.
2) The uptake of metals by phytoplankton decreases the concentration in the water. Also extracellular products from the phytoplankton may chelate metals in the water thereby reducing their availability to the scallops.
3) In the times of high productivity, the amount of metal/phytoplankton cell decreases, since the cell members increase and the metal concentrations remain virtually the same.

Other organisms besides particle feeders like the scallops probably have seasonal variations in their uptake of heavy metals, although there has been little investigation to date of this environmental variable.

Storage and Metabolism

Once heavy metals are taken up by marine organisms they are usually used in enzyme systems or stored in a particular body tissue, sometimes for just a temporary period. The place of storage in the organism and its subsequent pathway through the organism is dependent on several variables including the type of metal, the form of the metal complex, the method of uptake, species and the age of the organism. In general, elements that are concentrated in marine organisms can be grouped into one of the five categories: (1) structural elements—carbon, nitrogen and phosphorus (silicon, calcium and strontium, in some cases); (2) catalyst elements—iron, copper, zinc, manganese and cobalt (nickel, chromium, cadmium and silver may follow these elements); (3) elements easily hydrolyzed at sea water pH; (4) heavy halogens; and (5) heavy divalent ions—barium, radium and lead (Lowman et al., 1971). Most of the heavy metals of concern occur in the catalyst element group.

Different groups of marine organisms are able to accumulate and store heavy metals in their tissues depending on their ability to regulate the concentration in their body compared to the environmental concentration. This involves not only uptake and storage of heavy metals but also release of the metals back to the environment. For example, according to Bryan (1971) when the concentrations of metals such as zinc or copper in sea water are increased, the concentrations in oysters increased appreciably while the concentrations in the flesh of crustaceans such as crabs or lobsters remain relatively constant. Storage sites for most organisms include the digestive glands, muscle tissue, skeletal tissue and gills.

For small marine crustaceans (*Euphausia pacifica*, *Thysanoessa spinifera*, *Pandulus stenolepis* and *P. platyceros*) Fowler et al. (1970) found that zinc-65 fed through a food chain accumulated primarily in the interstitial spaces between muscle fibers, in the eye, within the exoskeleton and on the interior surface of the exoskeleton. These locations were the same as those for storage of zinc-65 from water absorption processes. However, the source of the zinc affected the saturation levels of the tissues. When uptake was from food, the muscle tissue (and hepatopancreas at times) contained a higher percentage of the total zinc level in shrimps and euphausiids than the exoskeleton. When uptake was from water, the percentage of total zinc level was higher in the exoskeleton. The fact that a significant percentage of zinc was located in the exoskeleton from labelled food uptake suggests that the zinc was transported rapidly by the haemolymph from the gut to the exoskeleton (Fowler et al., 1970). The investigators concluded that since most of the zinc-65 was located between cells rather than inside of cells, most ingested zinc apparently accumulates in excess of the animals' needs and is not used metabolically.

In other marine crustaceans primary storage has been found to occur in the hepatopancreas for excess zinc in lobster blood and for excess copper in the shrimp *Crangon vulgaris* (Bryan, 1971). Another crustacean, the fiddler crab *Uca pugilator*, concentrated mercury primarily in the gill tissues with lesser amounts in the hepatopancreas and green gland. Very small amounts were found in the carapace and muscle tissues (Vernberg and Vernberg, 1972). See Figure I-5. The mode of uptake by the crab, however, was absorption of mercury from sea water.

Molluscs accumulate heavy metals in the digestive glands and kidneys primarily (Bryan, 1971; Bryan, 1973; Pentreath, 1973). Anderlini (1974) discovered high concentrations of cadmium (up to 1400 ppm) in the digestive glands of the red abalone *Haliotis rufescens* from samples along the California coast. He looked at eight heavy metals (silver, cadmium, chromium, copper, lead, mercury, nickel and zinc) and reported varying concentrations in the gills, mantle, digestive gland and foot muscle. The concentrations in the different tissues varied with the metal type, the concentrations of the metal in the sea water and the method of uptake. For example, nickel had the highest concentrations in the gill (up to 100 ppm), more than 2-3 times the nickel levels in other tissues. This was probably due to absorption and accumulation of nickel into the mucous sheets of the gills as well as absorption by the gills themselves (Anderlini, 1974). An investigation of several heavy metals in North Atlantic finfish revealed that muscle tissue of these Osteichthys species concentrated arsenic, cadmium, copper, mercury and zinc in varying amounts. Mercury and cadmium concentrations in muscle tissues of Chondrichthys species studied tend to be higher than those of Osteichthys while arsenic concentrations were definitely higher. The liver of Chondrichthys had higher concentrations of arsenic, cadmium, copper and zinc compared to other Chondrichthys tissues (Windom et al., 1973a). Silver, cadmium, chromium, copper, nickel, lead and zinc concentrate mainly in the gonads and liver of the Dover sole with smaller amounts in the epidermis. Specimens were taken from outfall and control areas off Southern California (SCCWRP, 1974). Chow et al. (1974) found lower concentrations of lead in tuna muscle than had been reported previously. Muscle tissue contained about 0.003 ppm of lead while epidermis had about 2 ppm in wet tissue. High concentrations in fish fins from tuna is due to the mucin secreted by the mucous cells of the epidermis which forms a mucous slime from a glycoprotein. The authors conclude that it is likely that strong heavy metal complexing sites in the proteins take up leak from sea water and incorporate it into the slime. They conclude that most of the lead in time is probably contained in this epidermal mucous layer and that it is unlikely that much lead passes through the skin barrier from sea water (Chow et al., 1974). Analysis of epidermal mucous and kidneys from an adult sculpin (*Scopaena guttata*) exposed to large concentrations of lead acetate over three months resulted in accumulation of lead in the mucous. The lead did not increase in the muscle tissue, but did increase in the kidney and bone. Apparently the kidney is metabolizing the accumulated lead and some of it is deposited in the bone (NSF/IDOE, 1974).

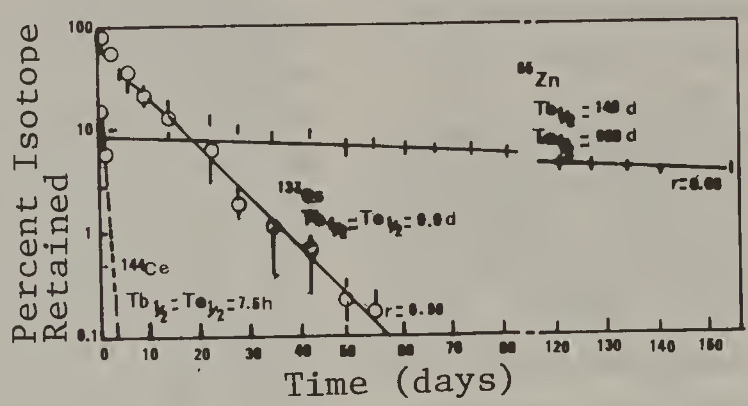


Figure I-5 Euphausia pacifica. Loss of three radionuclides from similar-sized euphasiids (Mean dry weight 2.4 mg). ^{65}Zn, n-3; ^{137}Cs, n-5; ^{144}Ce, n-2; r: correlation coefficient. Bars indicate ranges of animal activity. All data were corrected for physical decay of the isotope except ^{137}Cs. Tb½: biological half-life; Te½: effective half-life; 10°C. d: days. (From Fowler et al. 1971).

Evidence that the form of the metal compound is important for the storage site derives from observations of 70% of the total mercury in carnivorous fish muscle occurring as methylmercury. For invertebrate omnivores, the percentage of methylmercury is less. Samples of liver and spleen from sharks contained low amounts of methylmercury compared to total mercury (NSF/IDOE, 1974). At the cellular level, the distribution of lead-210 in sea cucumber embryos (*Strongylocentrotus purpuratus*) has been investigated by Nash (1975). He reported that embryos can absorb significant amounts of lead from levels as low as 4.81×10^{-6} ppm. Most of the absorbed lead was concentrated in the nuclear portion of the cell homogenate.

All of these investigations indicate that there are many variables involved in the storage and metabolism of heavy metals in marine organisms. At present little is still known about the pathways of uptake, metabolism, storage and release of heavy metals and their transport through the marine ecosystems.

c. Discharge and release into the marine environment

There have been few studies to date of the release or depuration of heavy metals from marine organisms to the marine environment. Although data on retention times are scanty, there are indications that metals concentrated in animal tissues are retained at significant concentrations for several months (Andersen et al., 1974b). Discharge of heavy metals from marine organisms can take place by ion exchange across cell membranes of gill and body surfaces, loss by molting exoskeletons that have concentrated heavy metals, excretion of heavy metals into the gut and loss by feces and excretions in the urine. All of these processes help an organism to regulate the concentration of heavy metals and other substances accumulated from sea water or food, but the extent and rate of their release is poorly known for heavy metals.

Bryan (1971) reports that excretion of metals across the gills appears to occur: in the shore crab, *Carcinus maenas*, and in the rainbow trout, *Salmo gairdnerii*. The cypiid larva of the barnacle, *Balanus amphitrite niveus*, excretes excess copper into the lumen of the gut and the octopus, *Octopus dofleini*, excretes both copper and zinc into the rectal fluid. Crustaceans can excrete copper, zinc, cobalt, manganese and mercury in the urine. Little information is known about excretion of heavy metals from fish except that excretion of zinc in the urine of the rainbow trout is relatively unimportant (Bryan, 1971). The rate of loss of methyl mercury from species of carnivorous fish is very slow. Methyl mercury in fish has a half-life of about two years according to Miettinen et al. (1971, as cited by Hartung, 1972).

A long-term experiment concerning the elimination of zinc-65, cesium-137 and cerium-144 by euphausiid shrimps determined that approximately 96% of the initial body concentration was eliminated over a five month period (Fowler et al., 1971). The biological half-life of ^{65}Zn was 140 days, and the percentage of ^{65}Zn lost in molts compared to the total in the organism was 1%. Assuming that loss through fecal pellets is small, the major mechanism for ^{65}Zn loss for euphausiids would be isotopic exchange with the water. From Figure I-5 it can be observed that approximately 90% of the ^{65}Zn was lost after 30 days.

In a study of the mussel, *Mytilus edulis*, and its accumulation of some heavy metal isotopes from sea water, Pentreath (1973) observed that the greatest accumulation was in the stomach and digestive gland for all isotopes. However, after two weeks iron-59 occurred in the mussel foot in the byssus gland area that attaches the mussel to the substrate. Following another two week period, the iron-59 clusters disappeared. The author postulated that the iron might be secreted into new byssus threads. After 42 days in filtered sea water, the loss of the metals from the stomach and digestive gland was as follows:

Percent loss in dry weight from stomach and digestive gland: Zinc, 23.1; Manganese, 14.3; and Iron, 52.2.

There was no loss from the adductor muscle (Pentreath, 1973). Yound and Folsom (1967, as cited by Pentreath, 1973) recorded a long half-life for zinc-65 in the mussel, *Mytilus californianus*, as 76 ± 3.5 days.

Other observations of release of heavy metals by molluscs include a biological half-life of 193 days for manganese excretion from scallops (Bryan, 1973). No appreciable decrease in the concentrations of cadmium and zinc in dog whelps and limpets was found in the Bristol Channel after seven weeks and three weeks cleansing in clean sea water. A crab (*Carcinus* *maenas* L) lowered its zinc concentration significantly but not the cadmium concentration after seven weeks cleansing (Peden et al., 1973).

Therefore, from these few investigations one can find evidence that marine organisms can release heavy metals back to the environment, but the time of release is relatively long. There is some evidence to indicate that molluscs may not be able to regulate heavy metal concentrations in their tissues as well as crustaceans (Bryan, 1971). However, it is not known if this difference is due to separate pathways of uptake and storage, different methods of release or differences in the bonding of the metals and their complexes in the tissues.

d. Food web magnification

There is ample evidence to indicate that heavy metals accumulate in the marine food web in a variety of organisms at various trophic levels and through a variety of uptake pathways. As can be seen from the preceding discussion, heavy metals can be concentrated by absorption across gills, body surfaces and gut wells; adsorption into organisms, suspended and deposited particles; and taken up from food sources. The concentration factors listed in Table I–9 reflect tremendous abilities for marine organisms to concentrate elements from very dilute solutions in sea water. However, as mentioned previously the significance of the concentration factors is observed by the many variables and pathways involved in the uptake of heavy metals by marine organisms. Classical food web magnification, or the increasing concentrations of an element per weight of tissue in successively higher trophic levels, for heavy metals is complicated by not only the various uptake pathways but also by the ability of some organisms to release the heavy metals back to the marine environment eventually and therefore regulate concentrations in their tissues against environmental gradients. The whole process is just not well enough understood at this time.

Most of the characteristics of heavy metals in the marine environment favor their magnification in the food web. Like PCS's and synthetic chemicals, heavy metals are relatively resistant to chemical and biological degradation. Evidence has been presented that the half-life of metals in tissues is relatively long before being excreted. The half-life can range up to two years for methylmercury compounds in fish. The longevity of the metals in tissues and the high concentration factors of many marine organisms suggest that food web magnification can take place. Most of the incidents of high levels of heavy metals found in marine organisms in the ocean occur in coastal waters and point sources near pollution sources from land. A toxic effect on a consumer in the higher levels of the marine food web, including man, can result from feeding on organisms further down in the food web that have concentrated heavy metals at levels that have no apparent effect on the food organisms.

Besides the much publicized occurrence of mercury compounds in high concentrations in some tuna and swordfish, heavy metals such as arsenic, cadmium, copper, zinc, chromium, lead, nickel and silver have been reported in various organisms from the marine environment throughout the world (LeBlanc and Jackson, 1973; Stenner and Nickless, 1975; Peden et al., 1973; Stenner and Nickless, 1974; Anderlini, 1974; Windom et al., 1973a; Windom et al., 1973b; Chow et al., 1974; and Bryan, 1973). In a study of mercury in plankton in the North Atlantic, Windom et al. (1973b) reported concentrations of less than 0.2 to 0.4 ppm in open ocean plankton compared to 5.3 ppm in nearshore plankton in polluted areas. The samples included mostly copepods and arrow worms with eleven samples containing phytoplankton.

The authors hypothesized that the mercury was possibly transported from the nearshore plankton to the open ocean food web rather than through direct transport in the water since the dilution factors over the distances involved would be tremendous.

In a related study from the same area in the higher levels of the food web, Windom et al. (1973a) analyzed several heavy metals in various species of fin fish. In this investigation they found no tendency for onshore-offshore differences in concentrations for Osteichthys or Chondrichthys. There were differences in levels of accumulation and storage places for different metals in both groups as mentioned previously in this discussion. For Osteichthys arsenic concentrations ranged from less than 1.0 to 6.4 mg/g (ppm) and mercury concentrations from 0.1 to 3.0 mg/g. However, what is significant is that copper, cadmium and zinc concentrations were similar in all fish studied except for the smaller plankton-eating fish (anchovies and myctophids) which had much larger concentrations of these metals than the other fishes. This would suggest depletion of these metals up the food chain, and not magnification, since the plankton on which these fish feed have an even higher concentration of these metals (Windom et al., 1973a).

A similar instance of food chain accumulation, but not magnification, could be found in predators of the red abalone, *Haliotis rufuscens*, off the California coast. Anderlini (1973) reported a high concentration of cadmium (up to 1400 ppm) in the digestive glands of the red abalone. However, cadmium levels in the kidneys of mollusc-eating sea otters (*Enhydra lutris*) off the California coast ranged from 89 to 300 ppm. Although this was higher than cadmium in fish-eating sea lions (from 18 to 63 ppm) from a comparable level in the food web, the point is that the cadmium levels did not approach those found in the abalone. Therefore, the cadmium was probably accumulated in the food chain, but classical magnification probably does not take place. Whether or not the levels of cadmium were increased in the next trophic level, the large amounts of cadmium in the higher level predators would be cause for concern. Other marine mammals, birds, fish and man at the upper levels of the marine food web can be affected by high concentrations of certain heavy metals accumulated in the food web.

What does this mean for heavy metals introduced into the ocean from offshore petroleum operations? Evidence has been presented that heavy metal concentrations in petroleum, formation waters and drilling fluids can range from 10 to 10^5 times the natural background levels of the open ocean (see Tables I-4-8). Therefore, events such as accidental massive or chronic oil spills, accidental loss of drilling fluids and the discharge of formation waters can introduce higher loads of heavy metals into the ocean. The introduced metals are then diluted by sea water, precipitated out, adsorbed on particles or other organisms and absorbed by some marine organisms to various degrees. These discharges would be localized sources occurring around drilling platforms for the most part.

Therefore, there could be some uptake of metals especially by the sessile organisms around the platforms. It is not known to what extent this occurs and to what levels the heavy metals would concentrate in the water column, sediments or marine organisms as a result of petroleum operations. The only investigation conducted so far concerning effects of heavy metals from offshore petroleum operations indicated that the concentration ranges of heavy metals in the water column was within the ranges for the metals in open ocean water except for barium where the data was inconclusive and a zinc gradient around the platforms probably due to the decomposition of the sacrificial covering of the platform legs (GURC, 1974).

The input of heavy metals to the marine environment and accumulation in the food web due to offshore petroleum operations should be far less significant than sources of heavy metals from land in most coastal waters such as river runoff, sewage effluent and industrial wastes. Since the effects of heavy metal input from offshore petroleum operations into the marine food web are largely unknown, it is advisable to continue to observe and monitor the marine environment for possible accumulation in the food web.

BIBLIOGRAPHY

Ahearn, D. G. and S. P. Meyers, eds. 1973. The microbial degradation of oil pollutants. Workshop held at Georgia State University, Atlanta, December 1972. Publ. No. LSS-SG-73-01. Center for Wetland Resources, Louisiana State University, Baton Rouge. 322 pp.

Alyakrinskaya, I. O. 1966. Behavior and filtering ability of the Black Sea Mytilus galloprovincialis on oil polluted water. Zool. Zh. 45(7): 998-1003; also in Biol. Abstr. 48(14):6494.

Anderlini, V. C. 1974. The distribution of heavy metals in the red abalone Haliotis rufescens on the California coast. Arch. Environ. Contam. & Toxicol. 2(3):253-265.

Anderson, J. W. 1973. Uptake and depuration of specific hydrocarbons from fuel oil by the bivalves Rangia cuneata and Crassostrea virginica pp. 690-708. In: Background papers, workshop on petroleum in the marine environment. Nat. Acad. of Sci., Washington, D.C.

Anderson, J. W. and J. M. Neff. 1974. Accumulation and release of petroleum hydrocarbons by edible marine animals. Submitted to an International Symposium entitled Recent Advances in the Assessment of the Health Effects of Environmental Pollution, Paris, June, 1974.

Anderson, J. W., R. C. Clark, Jr. and J. J. Stegeman. 1974a. Contamination of marine organisms by petroleum hydrocarbons. In: Proc. of Bioassy Workshop sponsored by the Marine Technology Society, Montauk, N.Y., April 9-11, 1974.

Anderson, J. W., J. M. Neff and S. R. Petrocelli. 1974b. Sublethal effects of oil, heavy metals and PCB's on marine organisms. In: the Mechanisms of Survival of Toxic Environments, Academic Press.

Atlas, R. M. and R. Bartha. 1972a. Degradation and mineralization of petroleum in sea water. Biotech. Bioeng. 14:297-318.

Atlas, R. M. and R. Bartha. 1972b. Biodegradation of petroleum in sea water at low temperature. Can. J. Microbiol. 18:1851-1855.

Battelle Memorial Institute. 1967. Oil spillage study: literature search and critical evaluation for selection of promising techniques to control and prevent damage. U. S. Dep. Commer., Clgh. Fed. Sci. Tech. Inf., Springfield, VA 22151.

Battelle Memorial Institute. Pacific Northwest Laboratories. 1970. Review of Santa Barbara Channel oil pollution incident. Wat. Pollut. Control Res. Ser., (Dist 20).

Blumer, M. 1969. Oil pollution of the ocean. p. 5-13. In: Oil on the Sea, P. Hoult (ed.), Plenum Press, New York.

Blumer, M., J. C. Robertson, J. E. Gordon and J. Sass. 1969. Phytol-derived C di- and triolefinic hydrocarbons in marine zooplankton and fishes. Biochemistry 8:4067-4074.

Blumer, M., G. Souza and J. Sass. 1970. Hydrocarbon pollution of edible shellfish by an oil spill. Mar. Biol. 5, 195-202.

Blumer, M. and J. Sass. 1972a. The West Falmouth oil spill. Woods Hole Oceanographic Institution Tech. Rep. 72:19. Woods Hole, Mass. 125 pp.

Blumer, M. and J. Sass. 1972b. Oil pollution: persistence and degradation of spilled fuel oil. Science 176:1120-1122.

Blumer, M., P. C. Blokker, E. B. Cowell and D. F. Duckworth. 1972c. Chapter 2, Petroleum. In: A Guide to Marine Pollution. E. D. Goldberg (ed.). Gordon and Breach Science Publishers, New York.

Borneff, J., F. Selenka, H. Kunte and A. Maximos. 1968. Experimental studies on the formation of polycyclic aromatic hydrocarbons in plants. Environ. Res. 2:22-29.

Brown, R. A., T. D. Searl, J. J. Elliott, B. G. Phillips, D. E. Brandon and P. H. Monaghan. 1973. Distribution of heavy hydrocarbons in some Atlantic Ocean waters. p. 505-519.
In: Proc., Joint Conference on Prevention and Control of Oil Spills. American Petroleum Institute, Washington, D.C.

Browning, E. 1953. Toxicity of industrial organic solvents. Medical Research Council, Industrial Health Research Board Rep. No. 80, rev. ed. H. M. Stationery Office, London.

Bryan, G. W. 1964. Zinc regulation in the lobster Homarus vulgaris. I. Tissue zinc and copper concentrations. J. Mar. Biol. Ass. U.K. 44(3):549-563.

Bryan, G. W. 1971. The effects of heavy metals (other than mercury) on marine and estuarine organisms. Proc. Roy. Soc. Brist. 177:389-410.

Bryan, G. W. 1973. The occurrence and seasonal variation of trace metals in the scallops Pecten maximus (L.) and Chlamys opercularis (L.). J. Mar. Biol. Ass. U.K. 53:145-166.

Bryan, G. W. and E. Ward. 1965. The absorption and loss of radioactive and nonradioactive manganese by the lobster Homarus vulgaris. J. Mar. Biol. Ass. U.K. 45(1):65-95.

Bryant, W. J., J. R. Goldburn and S. E. Illrudey. 1974. Water pollution aspects from waste drilling mud disposal in Canada's Arctic. Offshore Technology Conference Preprints, Paper No. OTC 2044, May 6-8, 1974, Houston.

Carlson, G. P. 1972. Detoxification of foreign compounds by the quahaug, Mercenaria mercenaria. Comp. Biochem. Physiol. 43B, 295-302.

Chow, T. J., C. Patterson and D. Settle. 1974. Occurrence of lead in tuna. Nature, 251(5471):159-161.

Clark, R. C. Jr. and J. S. Finley. 1974. Uptake and loss of petroleum hydrocarbons by mussels (Mytilus edulis) in laboratory experiments (in preparation).

Conover, R. J. 1971. Some relations between zooplankton and Bunker C oil in Chedabucto Bay following the wreck of the tanker Arrow. J. Fish. Res. Board Can. 28:1327-1330.

Cox, B. A. and J. W. Anderson. 1974. Unpublished results. (In Anderson et al. 1974a). Davis, J. B. 1967. Petroleum Microbiology. Elsevier, Amsterdam. 605 pp.

Di Salvo, L. H., H. E. Guard and L. Hunter. 1975. Tissue hydrocarbon burden of mussels as potential monitor of environmental hydrocarbon insult. Environ. Sci. Technol. 9:247-251.

Ehrhardt, M. 1972. Petroleum hydrocarbons in oysters from Galveston Bay. Environ. Pollut. 3:257-271.

Eisler, R. G., E. Zaroogian and R. J. Hennekey. 1972. Cadmium uptake by marine organisms. J. Fish. Res. Bd. Can. 29:1367-1369.

Filby, R. H. and K. R. Shah. 1971. Mode of occurrence of trace elements in petroleum and relationship to oil spill identification methods. In: Proceedings Am. Nuclear Society Meeting: Nuclear Methods in Environmental Research, J. R. Vogt, T. F. Parkinson and R. L. Carter (eds.), Univ. of Missouri.

Fowler, S. W., L. F. Small and J. M. Dean. 1970. Distribution of ingested zinc-65 in the tissues of some marine crustaceans. J. Fish. Res. Bd. Can. 27:1051-1058.

Fowler, S. W., L. F. Small and J. M. Dean. 1971. Experimental studies on elimination of zinc-65, cesium-137 and cerium-144 by euphausiids. Mar. Biol. 8(3):224-231.

Friede, J., P. Guire, R. K. Gholson, E. Gaudy and A. F. Gaudy. 1972. Assessment of biodegradation potential for controlling oil spills on the high seas. Project Rep. No. 4110.1/3.1. Department of Transportation, U.S. Coast Guard, Office of Research and Development, Washington, D.C. 130 pp.

Gerarde, H. W. and D. F. Gerarde. 1961. The ubiquitous hydrocarbons. Assn. Food Drug Officials United States, p. 1-47.

Glooschenko, W. A. 1969. Accumulation of H_g by the marine diatom Chaetoceros costatum. J. Phycol. 5:224-26.

Goldacre, R. J. 1968. Effect of detergents and oil on the cell membrane. p. 131-317. In: The Biological Effects of Oil Pollution on Littoral Communities. (eds.). J. D. Carthy and D. R. Arthur. Suppl. to Vol. 2 of Field Studies, Field Studies Council, London.

Goldberg, E. D. 1965. Minor elements in sea water. p. 163-196. In: Chemical Oceanography, J. P. Riley and G. Skivrow (eds)., Academic Press, New York.

Goldberg, E. D., W. S. Broecker, M. G. Bross and K. K. Turekian. 1971. Marine Environment, National Academy of Sciences, Washington, D.C. p. 137-146.

Gunkel, W. 1967. Experimentell-okolgische untersuchungen uber die limitierenden faktoren des microbiel en olabbaues im marinin milieu. Helgolander wiss. Meeresunters. 15:210-225.

Gunkel, W. 1968. Bacteriological investigations of oil-polluted sediments from the Cornish coast following the Torrey Canyon disaster, pp. 151-158. In: E. B. Cowell, (ed.). The Biological Effects of Oil Pollution on Littoral Communities. Suppl. to Field Studies, No. 2. Inst. of Petrol., London.

GURC (Gulf Universities Research Consortium). 1974. The offshore ecology investigation: final project planning council consensus report. GURC report No. 138, Galveston, Sept. 20.

Hartung, R. 1972. Biological effects of heavy metal pollutants in water. p. 161-172. In: Metal Ions in Biological Systems, S. K. Dhar (ed.), Plenum Publishing Company, New York.

Hoss, D. E. 1964. Accumulation of zinc-65 by flounder of the genus Paralichthys. Trans. Am. Fish. Soc. 43:364-368.

IDOE. 1972. Baseline studies of pollutants in the marine environment. International Decade of Oceanographic Exploration Workshop, Brookhaven, May.

Klug, M. J. and A. J. Markovetz. 1971. Utilization of aliphatic hydrocarbons by microorganisms, pp. 1-43. In: Advances in Microbial Physiology, Vol. 6. A. H. Rose and J. F. Wilkinson, (eds). Academic Press, New York.

Lee, R. A. and A. A. Benson. 1973. Fate of petroleum in the sea—Biological aspects, pp. 541-551. In Background papers, workshops on petroleum in the marine environment. National Academy of Sciences, Washington, D.C.

Lee, R. A., R. Sauerheber and A. A. Benson. 1972a. Petroleum hydrocarbons: Uptake and discharge by the marine mussel, Mytilus edulis. Science 177:344-346.

Lee, R. A., R. Sauerheber and G. H. Dobbs. 1972b. Uptake, metabolism and discharge of polucyclic aromatic hydrocarbons by marine fish. Mar. Biol. 17:201-208.

LeBlanc, P. J. and A. L. Jackson. 1973. Arsenic in marine fish and invertebrates. Mar. Poll. Bull. 4(6):88-90.

Lowman, F. G., T. R. Rice and F. A. Richards. 1971. Accumulation and redistribution of radionuclides by marine organisms. In Radioactivity in the Marine Environment, National Academy of Sciences, Washington, D.C. 161-199 p.

Menzel, R. W. 1955. Some phases of the biology of Ostrea equestris (Say) and a comparison with Crassostrea virginica (Gmelin). Pub. Inst. Mar. Sci., Univ. Tex. 4:69-153.

Miettinen, V., E. Blankenstein, K. Rissanen, M. Tillander, J. K. Miettinen and M. Valtonan. 1970. FAO Tech. Conf. on Marine Pollution, Rome, Italy, Dec. 9-18.

Mitchell, R., S. Togel and I. Chet. 1972. Bacterial chemoreception: An important ecological phenomenon inhibited by hydrocarbons. Water Res. 6:1137-1140.

National Academy of Sciences. 1975. Petroleum in the marine environment. Washington, D.C. 107 pp.

Nash, W. W. 1975. Cellular distribution of lead in Strongylocentrotus purpuratus. In Abstracts of Program, Southern California Academy of Sciences Annual Meeting, Los Angeles, May 9-10.

NSF/IDOE (National Science Foundation/International Decade of Ocean Exploration). 1974. Pollutant Transfer to the Marine Environment. Deliberations and recommendations of the NSF/IDOE Pollutant Transfer Workshop held Port Aransas, Texas, January 11-12.

Operation Oil. 1970. Report of the task force—Operation Oil (Cleanup of the Arrow oil spill in Chedabucto Bay) to the Minister of Transport. Atlantic Oceano. Lab. Bendford Inst. Dartmouth, Nova Scotia.

Parker, C. A. 1970. The ultimate fate of crude oil at sea—uptake of oil by zooplankton. AML Rep. B. 198(M).

Parker, C. A. 1971. The effect of some chemical and biological factors on the degradation of crude oil at sea, pp. 237-244. In: P. Hepple (ed.) Water Pollution by Oil. Inst. of Petrol., London.

Pasteels, J. J. 1968. Pinocytose et athrocytos par Pepithelium branchial de Mytilus edulis. Z. Zellforsch. 92:239-259.

Pentreath, R. J. 1973. The accumulation from water of Zn, Mn, Co, and Fe by the mussel, Mytilus edulis J. Mar. Biol. Ass. U.K. 53:127-143.

Peden, J. D., J. H. Crothers, C. E. Waterfall and J. Beasley. 1973. Heavy metals in Somerset marine organisms. Mar. Poll. Bull. 4(1):7-9.

Polikarpov, G. G. 1966. Radioecdogy of aquatic organisms. Reinhold, N.Y. 314 pp.

Powell, N. A., C. S. Sayce and D. F. Tufts. 1970. Hyperplasia in enstarine bryozoan attributable to coal tar derivatives. J. Fish. Res. Board Can. 27:2095-2096.

Preston, A. and D. F. Jeffries. 1969. Aquatic aspects in chronic and acute contamination situations. p. 183-211. In: Environmental Contamination by Radioactive Materials, IAEA, Vienna.

Rice. 1975. Personal communication.

Robertson, B., S. Arhelger, P. J. Kinney and D. K. Button. 1973. Hydrocarbon biodegradation in Alaskan waters, pp. 171-184. In: Ahearn and Meyers, (ed.), op. cit.

Roubal, W. T. 1973. In vivo and in vitro spin labeling studies of pollutant-host interaction. In: F. J. Biros and R. Haque (eds.) Proc., Symposium on Mass Spectrometry and NMR of Pesticides. Plenum Press, New York.

Scarratt, D. J. 1971. Incidence of Bunker C in common benthic animals and sediments. Contrib. Oil Poll. Workshop. Nova Scotia Technical College. Halifax. p. 4-12.

SCCWRP (Southern California Coastal Water Research Project). 1974. Annual report for the year ended 30 June 1974. El Segundo.

Shipton, J., J. H. Last, K. E. Murray and G. L. Vale. 1970. Studies on a kerosene-like taint in mullet (Mugil cephalus). II. Chemical nature of the volatile constituents. J. Sci. Food Agric. 21:433-436.

Stegeman, J. J. and J. M. Teal. 1973. Accumulation, release and retention of petroleum hydrocarbons by the oyster Crassostrea virginica. Mar. Biol. 221:37-44.

Stegeman, J. J. 1974. Hydrocarbons in shellfish chronically exposed to low levels of fuel oil. In: Pollution and the Physiological Ecology of Estuarine and Coastal Water Organisms. J. F. Vernberg (ed.) Academic Press (to be published).

Stenner, R. D. and G. Nickless. 1974. Absorption of cadmium, copper and zinc by dog whelks in the Bristol Channel. Nature 247:198-199.

Stenner, R. D. and G. Nickless. 1975. Heavy metals in organisms of the Atlantic Coast of S. W. Spain and Portugal. Mar. Poll. Bull. 6(6).

Straughan, D. and D. L. Lawrence. 1975. Investigation of ova cell hyperplasia in bryzoa chronically exposed to natural oil seepage. Water Air and Soil Pollution (in press).

Suess, E. 1972. Laboratory experimentation with 3, 4 benzpyrene in aqueous systems and the environmental consequences. Aus Wissenschaft und Praxis, Zentralbl. Bakt. Hyg. I. Abt. Orig B 155:541-546.

Tissier, M. and J. L. Oudin. 1973. Characteristics of naturally occurring and pollutant hydrocarbons in marine sediments, pp. 205-214. In Proceedings, Joint Conference on Prevention and Control of Oil Spills. Amer. Petrol. Inst., Washington, D.C.

Traxler, R. W. 1973. Bacterial degradation of petroleum materials in low temperature marine environments, pp. 163-170. In: Ahearn and Meyers (eds.), op. cit.

Underwood, E. J. 1974. Factors influencing trace elements needs and tolerances in man. Mar. Oill. Bull. 5(6):86-88.

U.S. Department of Interior. 1975. Final Environmental Impact Statement for proposed 1975 Outer Continental Shelf oil and gas general lease sale offshore Southern California (OCS Sale No. 35).

Vale, G. L., G. S. Sidhu, W. A. Montgomery and A. R. Johnson. 1970. Studies on a kerosene-like taint in mullet (Mugil cephalus). I. General nature of the taint. J. Sci. Food Agric. 21:429-432.

Vaughan, B. E. 1973. Effects of oil and chemical dispersed oil on selected marine biota—A laboratory study. API Publ. No. 4191, Battelle Pacific Northwest Laboratories, Richland, WA. 105 pp.

Vernberg, W. B. and J. O'Hara. 1972. Temperature-salinity stress and mercury uptake in the fiddler crab, Uca Pugilator. J. Fish. Res. Bd. Can. 29:1491-1494.

Vernberg, W. B. and J. Vernberg. 1971. The synergistic effects of temperature, salinity, and mercury on survival and metabolism of the adult fiddler crab, Uca pugilator. Fish. Bull. 70(2):415-420.

Whittle, K. J. and M. Blumer. 1970. Interactions between organisms and dissolved organic substances in the sea: Chemical attraction of the starfish Asterias vulgaris to oysters. p. 495-507. In: Organic Matter in Natural Waters, D. W. Hood (ed.), Inst. Mar. Sci., U. Alaska, Pub. No. 1.

Windom, H., R. Stickney, R. Smith, D. White and F. Taylor. 1973a. Arsenic, cadmium, copper, mercury, and zinc in some species of North Atlantic finfish. J. Fish, Res. Bd. Can. 30:275-279.

Windom, H., F. Taylor and R. Stickney. 1973b. Mercury in North Atlantic plankton. J. Cons. Int. Explor. Mer. 35:18-21.

Yevich, P. P. and M. M. Barry. 1970. Histopathologic finding in molluscs exposed to pollutants. Abstract of papers, session III, section 4, 33rd annual meeting. Amer. Soc. Limnol. and Oceanog. URI, August 25-29.

Zitko, V. and W. V. Carson. 1970. The characterization of petroleum oils and their determination in the aquatic environment. Tech. Rep. No. 217, Fish. Res. Bd. Can. Biological Station, St. Andrews, N.B.

Zafiriou, D. C. 1972. Response of Asterias vulgaris to chemical stimuli. Mar. Biol. 17:100-107.

ZoBell, C. E. 1971. Sources and biodegradation of carcinogenic hydrocarbons, pp. 441-451. In: Proceedings, Joint Conference on Prevention and Control of Oil Spills. Amer. Petrol. Inst., Washington, D.C.

ZoBell, C. E. 1973. Microbial degradation of oil: Present status, problems, and perspectives, pp. 3-16, 153-162. In: Ahearn and Meyers (eds.) op. cit.

Appendix H

Oil Spill Risk Analysis

AN OILSPILL RISK ANALYSIS FOR THE EASTERN GULF OF MEXICO

PROPOSED SALE 65

OUTER CONTINENTAL SHELF LEASE AREA

Timothy Wyant and James R. Slack

ABSTRACT

An oilspill risk analysis was conducted to determine the relative environmental hazards of developing oil in different regions of the Eastern Gulf of Mexico Outer Continental Shelf lease area. The study analyzed the probability of spill occurrence, likely paths of the spills, and locations in space and time of such objects as recreational and biological resources likely to be vulnerable. These results combined to yield estimates of the overall oilspill risk associated with development of the proposed lease area. This risk is compared to the existing oilspill risk from existing leases in the area. The analysis implicity includes estimates of weathering rates and slick dispersion and an indication of the possible mitigating effects of cleanups.

INTRODUCTION

The Federal Government has proposed to lease 667 thousand acres of Outer Continental Shelf (OCS) lands in the Eastern Gulf of Mexico for oil and gas development. Estimated recoverable petroleum resources for the proposed 116 tracts in the sale area range from 15 million to 150 million barrels. Contingent upon actual discovery of this quantity of oil, production is expected to span a period of about 25 years. There is already existing production of petroleum in this area (largely in the western portion) which, it is estimated, has yet to yield on the order of 1.5 to 2 billion barrels of oil.

Oilspills are one of the major concerns associated with offshore oil and gas development in the Eastern Gulf of Mexico. An important fact that stands out when one attempts to evaluate the significance of accidental oil spillage for this, or any proposed lease area, is that the problem is fundamentally probabilistic. A great deal of uncertainty exists, for example, about the number and size of spills that might occur during the course of development, as well as the wind and current conditions that would exist and give direction to the oil slick at the specific times spills do occur. While some of the uncertainty reflects incomplete and imperfect data, considerable uncertainty is simply inherent in the problem.

In view of this inability to predict with certainty future oilspill effects, it is important to consider the range of possible effects that could accompany oil and gas development. It is equally important, however, in attempting to maintain perspective on the problem, to associate these potential effects with quantitative estimates of the probability of their occurrence.

This report summarizes results of an oilspill risk analysis conducted for the proposed Eastern Gulf of Mexico (Sale 65) OCS lease sale. The study had the objective of determining relative risks associated with additional oil and gas development in different regions of the proposed lease area and was undertaken to facilitate final selection of tracts to be offered for sale. The analysis was conducted in three more or less independent parts corresponding to different aspects of the overall problem. The first part dealt with the probability of spill occurrence, the second with likely spill trajectories for the times and places spills might occur, and the third part with the spatial and temporal location of specific objects, such as biological and recreation resources thought to be vulnerable to oil spills. Results of the individual parts of the analysis were then combined to give estimates of the overall oilspill risk associated with oil and gas development in the lease area. This analysis was done separately for the proposed leases and the existing leases and the results combined to determine the cumulative or incremental risk due to the proposed sale.

Much of the data and information used in the analysis were compiled by the U.S. Bureau of Land Management in the course of preparing the environmental impact statement for the proposed lease sale. These results, then, represent synthesis and analysis of existing information rather than presentation of new material.

We would like to express special appreciation to David Amstutz, John Meier, and Robert Moore of the U.S. Bureau of Land Management for their assistance in gathering the necessary data and information for the study; and to the Conservation Division of the Geological Survey for providing the estimates of petroleum.

METHODS

Spill Frequency Estimates

Statistical distributions for estimating probabilities of oilspill occurrence were taken from Devanney and Stewart (1974) and Stewart (1975, 1976). In addition to the fundamental assumption that realistic estimates of future spill frequency can be based on past OCS experience, use of these distributions requires the further specific assumptions that spills occur independently of each other (as a Poisson process), and that spill rate is dependent on volume of oil produced and handled. Each of these assumptions is open to dispute. The first assumption - that past spill rates are indicative of future spill rate owing to experience and improved standards or by assuming an increase in future spill rate owing to unknown conditions in new territory. The second assumption - that spills occur independently of each other - might be modified either by assuming a positive correlation (if a spill occurs, the time is ripe for more) or by assuming a negative correlation (if a spill occurs, extra precautions are immediately thereafter taken). The third assumption - that the spill rate is solely a function of the volume of oil handled - might be modified on the basis of size, extent, frequency, and duration of the handling. This analysis takes the middle ground through these assumptions. Any changes in the results due to variations of the assumptions apply across the board so that relative merits are not altered.

Spill frequency estimates were calculated separately for each of the 14 subdivisions of the proposed lease area (figure 1A) and the 12 subdivisions of the existing leases (figure 1B) based on estimated petroleum resources for the areas (U.S. Geological Survey, proprietary data). Use of the Devanney and Stewart distributions permitted separate estimates of platform, pipeline, and tanker spill frequencies; which could then be combined to estimate the risk from production, transport of crude to shore, and trans-shipment of some of the crude within the Gulf of Mexico. Spill frequency estimates (table 1) were made for spills less than 50 barrels, between 50 and 1,000 barrels, and greater than 1,000 barrels in size. The size grouping is somewhat arbitrary but, as discussed below, is important in considering the significance of weathering in reducing oilspill impacts.

Oilspill Trajectory Simulations

An oilspill trajectory model was constructed and used to analyze movement of hypothetical oil slicks on a digital map of the eastern Gulf of Mexico between about latitude 22 1/2° to 30 1/2° N. and about longitude 77 1/2° to 90° W. The coordinate system for this area was established a grid size of about 1 1/3 nautical miles (nmi). Surface current velocity fields were provided by National Oceanic and Atmospheric Administration. Short-term patterns in wind variability were characterized by probability matrices for successive 3-hour velocity transitions (first order Makov process). Wind transition matrices were calculated from U.S. Weather Service records from the Pensacola, Tampa, Key West, West Palm Beach, and Daytona Beach, Fla. weather stations (at least 5 years continuous record each) for each of the four seasons of the year.

Trajectories of 500 hypothetical oilspills were simulated for each of the four seasons in Monte Carlo fashion for each of 25 points (figure 2) in the lease area (representing potential starting points for spills arising from both the production and the transportation of petroleum), yielding a total of 50,000 trajectories. Surface transport of the oil slick for each spill was simulated as a series of straight-line displacement of a point under the joint influence of local and seasonal wind and current on the slick for a 3-hour period. The local wind transition probability matrix was randomly sampled each period for a new wind speed and direction, and the current velocity was updated as the spill changed location in the velocity field. The wind drift factor was taken to be 0.035 with a drift angle of 20°.

The final product of trajectory model runs consists of a large number of simulated oilspill trajectories or pathways which collectively reflect both the general trend and variability of winds and currents (see figures 4 through 7), and which can be summarized in statistical hypothetical pathways of oil slicks and do not involve any direct consideration of cleanup, dispersion, or weathering processes which would determine the quantity and quality of oil that may eventually come in contact with biological populations or other important resources. The significance of dispersion and weathering in mitigating oilspill effects is discussed in more detail below.

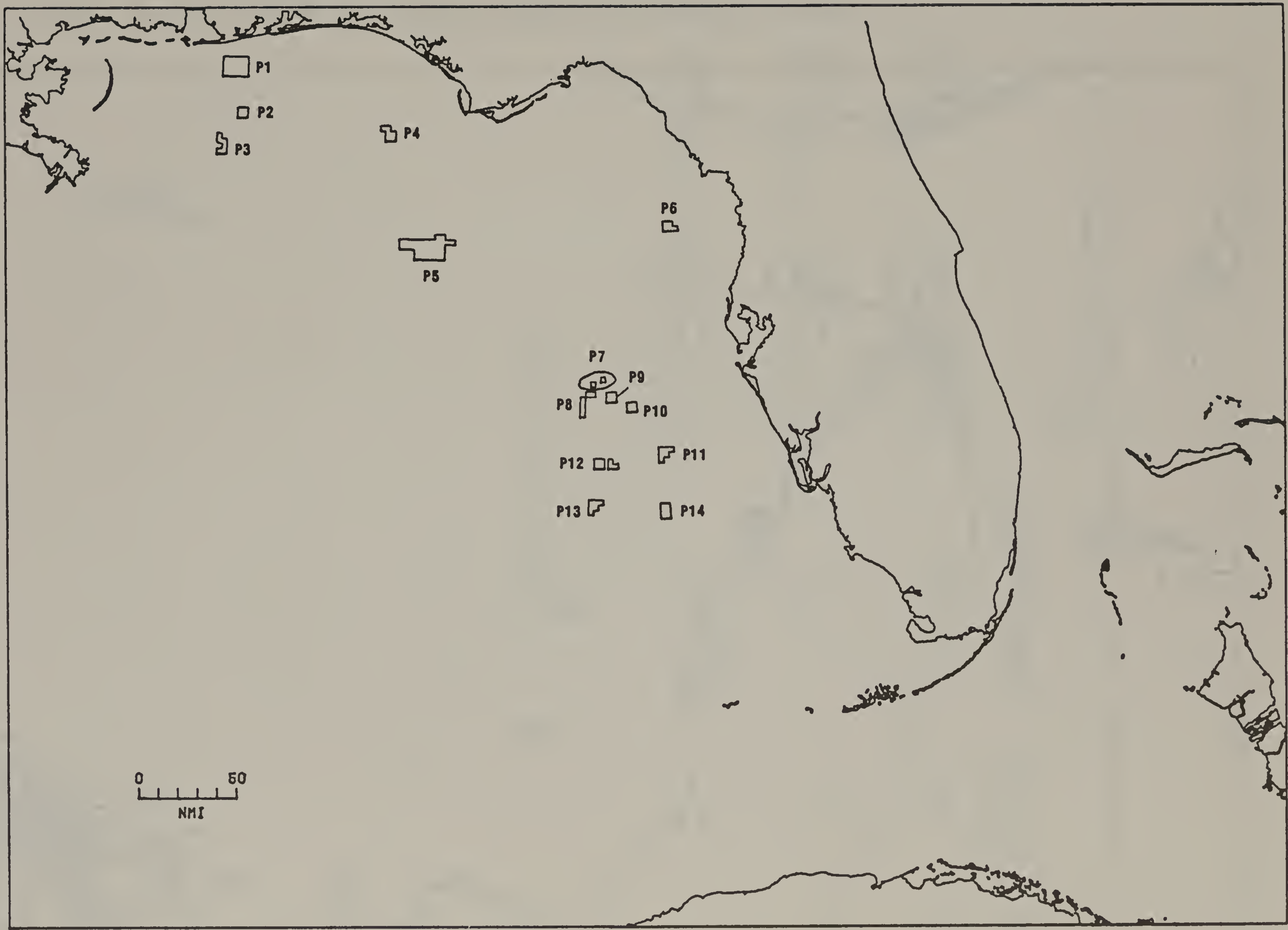


Figure 1A.--Map showing the subdivisions of the proposed leases.

Figure 1B--Map showing the subdivisions of the existing leases.

Table 1.--Oilspill probability estimates for the Eastern Gulf of Mexico lease area.

		Proposed leases	Existing leases	Both
Spills 0-50 bbl	Expected number	250	6350	6600
	Probability of at least one spill	*	*	*
Spills 50-1,000 bbl	Expected number	4.8	110	115
	Probability of at least one spill	.47	*	*
Spills > 1,000 bbl	Expected number	.4	7.4	7.8
	Probability of at least one spill	.34	*	*

* - greater than 0.995

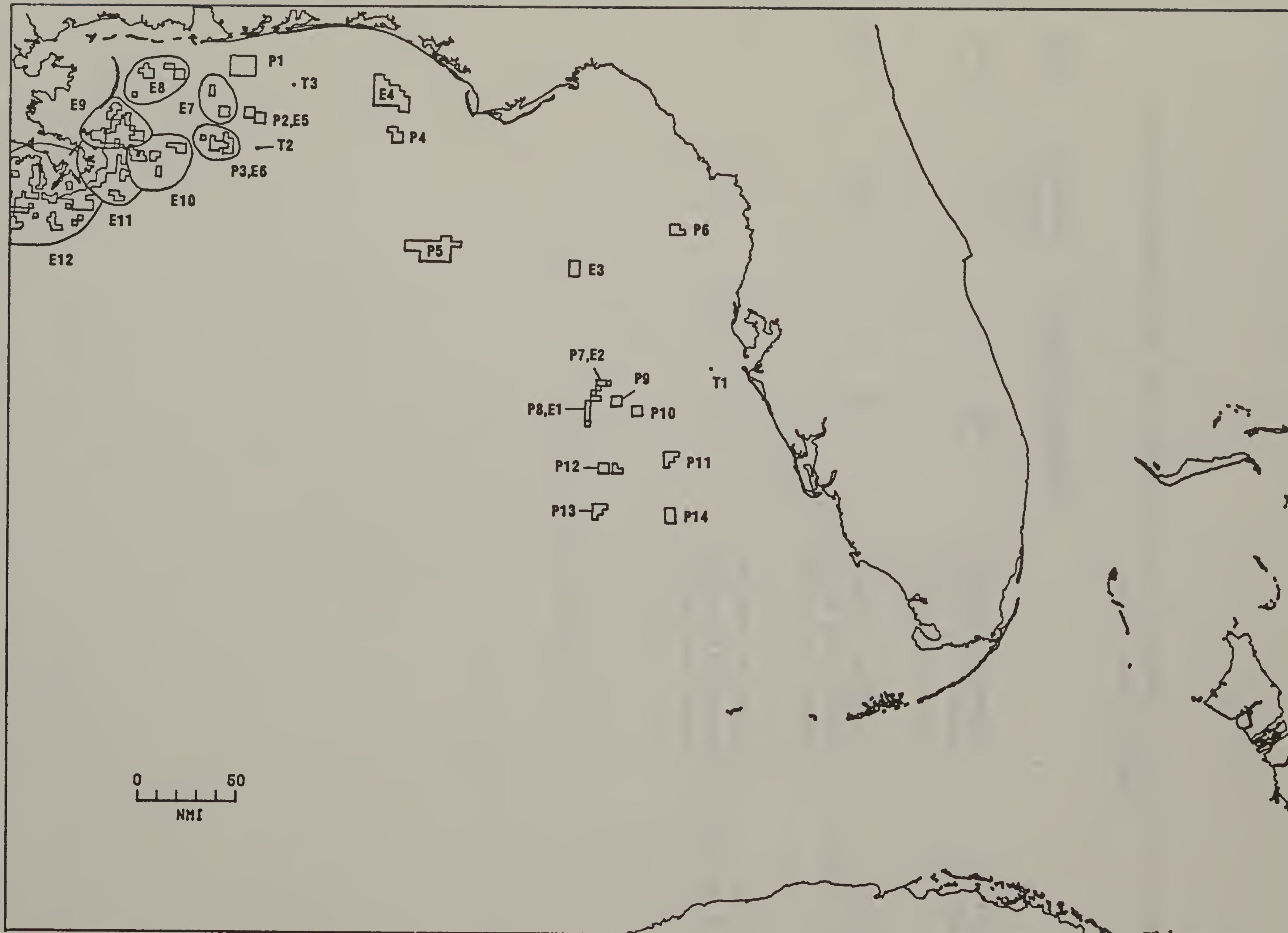


FIGURE 2 --Map showing potential starting points for spills from proposed leases (P1-P14), existing leases (E1-E12), and transportation (T1-T3).

Figure 4.--Example oilspill trajectories for a spill site (P5) near the center of the proposed lease area: winter conditions. Number on trajectory is the time to the end point in days.

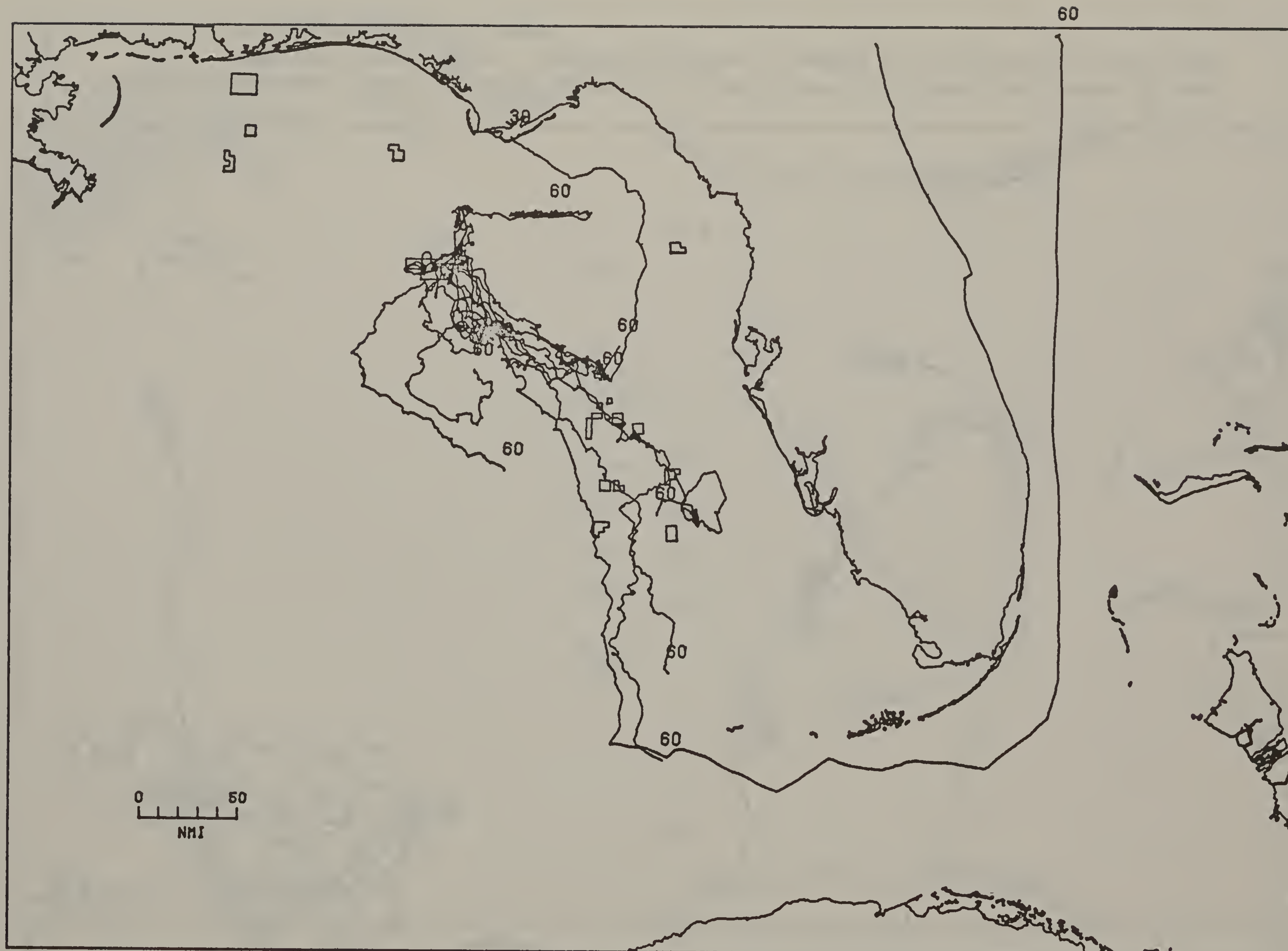


Figure 5.--Example oilspill trajectories for a spill site (P5) near the center of the proposed lease area: spring conditions. Number on trajectory is the time to the end point in days.

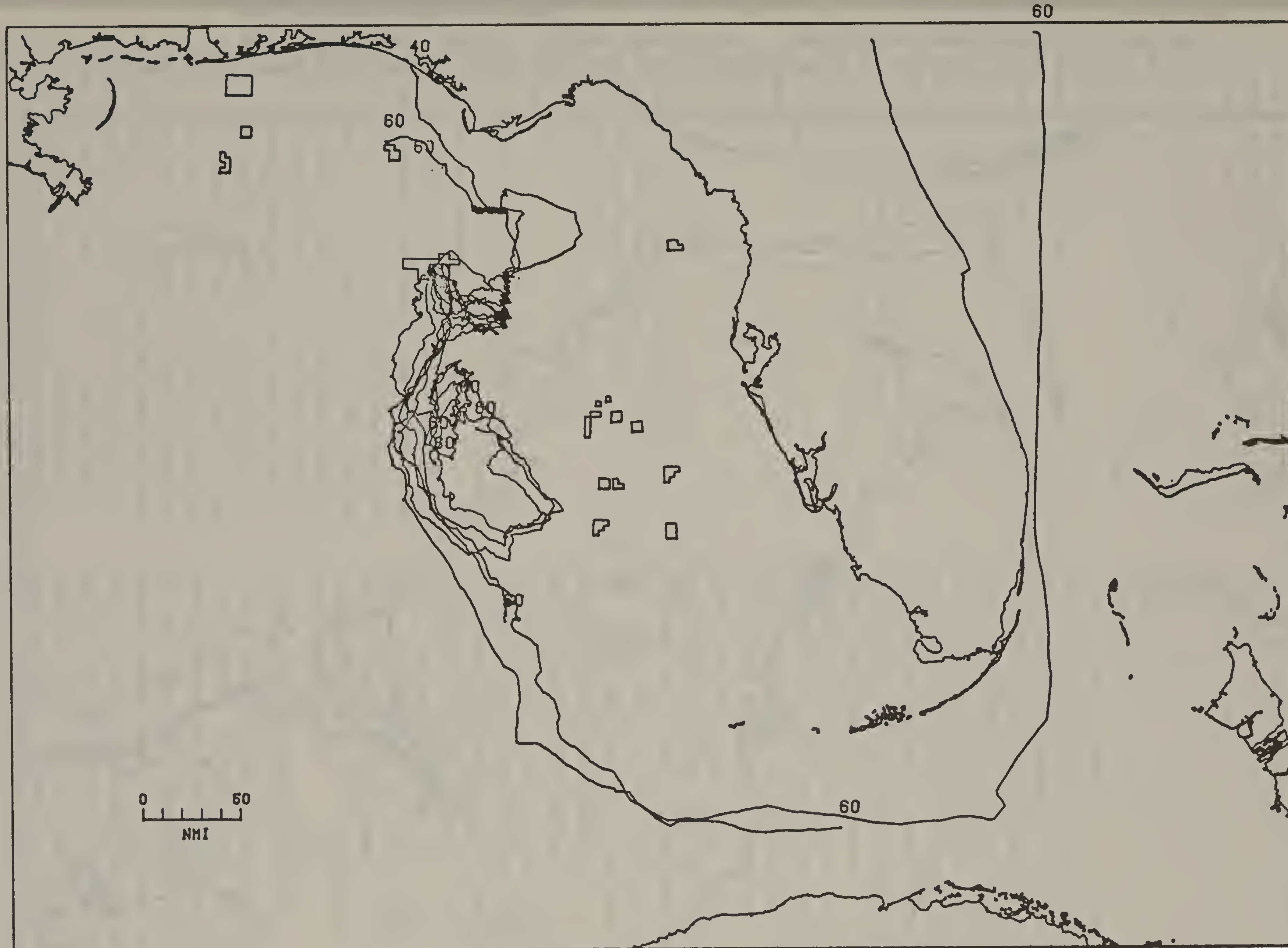


Figure 6.--Example oilspill trajectories for a spill site (P5) near the center of the proposed lease area: summer conditions. Number on trajectory is the time to the end point in days.

Figure 7.--Example oilspill trajectories for a spill site (P-5) near the center of the proposed lease area: autumn conditions. Number on trajectory is the time to the end point in days.

Locations of Biological and Recreational Resources

The locations of 30 categories of biological, recreational, and other resources were digitized in the same coordinate system as that used in trajectory simulations (Figures A-l through A-30). The monthly sensitivity of these resources (for example spawning period or migration period) was also recorded. Resource groups were as follows:

1 Coral areas
2 Manatee concentrations
3 Brown pelican rookeries
4 Wading or pelagic bird rookeries
5 Dusky seaside sparrow habitat
6 Bald eagle nesting sites
7 Mississippi sandhill crane habitat
8 Marine turtle nesting sites
9 American alligator habitat
10 Mangroves or tidal marsh
11 Estuarine nursery areas
12 West Florida adult female blue crab migration route
13 West Florida blue crab larval transport route
14 Tortugas pink shrimp nursery grounds
15 Stone crab habitat
16 Calico scallops
17 Oysters and bay scallops
18 Seagrass beds
19 Spiny lobster
20 Sandy beaches
21 Florida Straits
22 High density use shoreline
23 National register sites
24 Designated wildlife, natural, and conservation areas
25 Designated national wilderness areas
26 National marine and estuarine sanctuaries
27 Florida aquatic preserves
28 Designated shoreline, national, and state parks
29 Ports
30 Foreign islands

RESULTS AND DISCUSSION

Spill Frequency Estimates

The probability distributions on the frequency of oilspills greater than 1,000 barrels in size during the production life of the proposed lease area and the remaining production life of the existing leases are given in figure 3. Probabilities apply to the total of production platform spills and pipeline spills assuming transport of the total product to shore via pipeline plus some trans-shipment by tanker. Petroleum from the western portion of the area (proposed lease areas P1-P5 and existing lease areas E4-E12) would be piped directly to shore in that area, while petroleum from the eastern portion (P6-P14 and E1-E2) would be piped to storage facilities at the mouth of Tampa Bay. It is expected that any crude oil transported by pipeline from the lease area to storage facilities at Tampa Bay would be subsequently carried by tanker from such terminals to existing refineries either around Pensacola or the Mississippi Sound area. Although both possibilities of these two endpoints were considered, no mention of the differences between the two transport routes is made in what follows since the alternatives differ in resultant probabilities by no more than one percentage point. Estimates of the number of spills of different size for the existing and proposed leases are given in Table 1.

One of the advantages of making predictions about oil-spill frequency in the form of a probability distribution (figure 3) is that such data give not only an estimate of the most likely number of spills that would be expected to occur but some measure of the uncertainty that exists about that prediction. Table 1, for example, indicates that the expected number of spills from the proposed leases greater than 1,000 barrels is about 0.4 spills. From figure 3, however, the most likely number of spills that will occur (the mode of the distribution) is zero - with a probability of 66% of this being the case. Or more simply, the odds are 2-1 that no spill greater than 1,000 barrels will result from the proposed leasing. From table 1, the expected number of large spills from the remaining life of the existing leases is 7.4 spills. The most likely number to occur (from figure 3) is 7 with a 14% chance of that being the case. A summing of the probabilities for 5, 6, 7, 8, or 9 spills arising from the existing leases gives a total of 62%. That is, the odds are almost 2-1 that somewhere from 5 to 9 large spills are yet to result from the existing leases. Finally, while table 1 indicates that the expected number of large spills in the area will rise from 7.4 to 7.8 spills (about a 5% increase) as a result of the proposed leasing, figure 3 shows that the most likely number remains at 7 and the probability distribution hardly changes.

Recent Trends in Spill Statistics

All of the above figures are subject, of course, to the validity of earlier stated assumptions, the most important of these being that accident rates per unit production of future eastern Gulf of Mexico fields would be the same as those observed to date in this and other areas. One might question this assumption either from the point of view that safety records might be expected to improve with time, or from the standpoint that accident rates are not transferrable to new leases.

Figure A-1.--Hatched area indicates areal extent of coral areas.

Figure A-2.--Hatched area indicates areal extent of manatee concentrations.

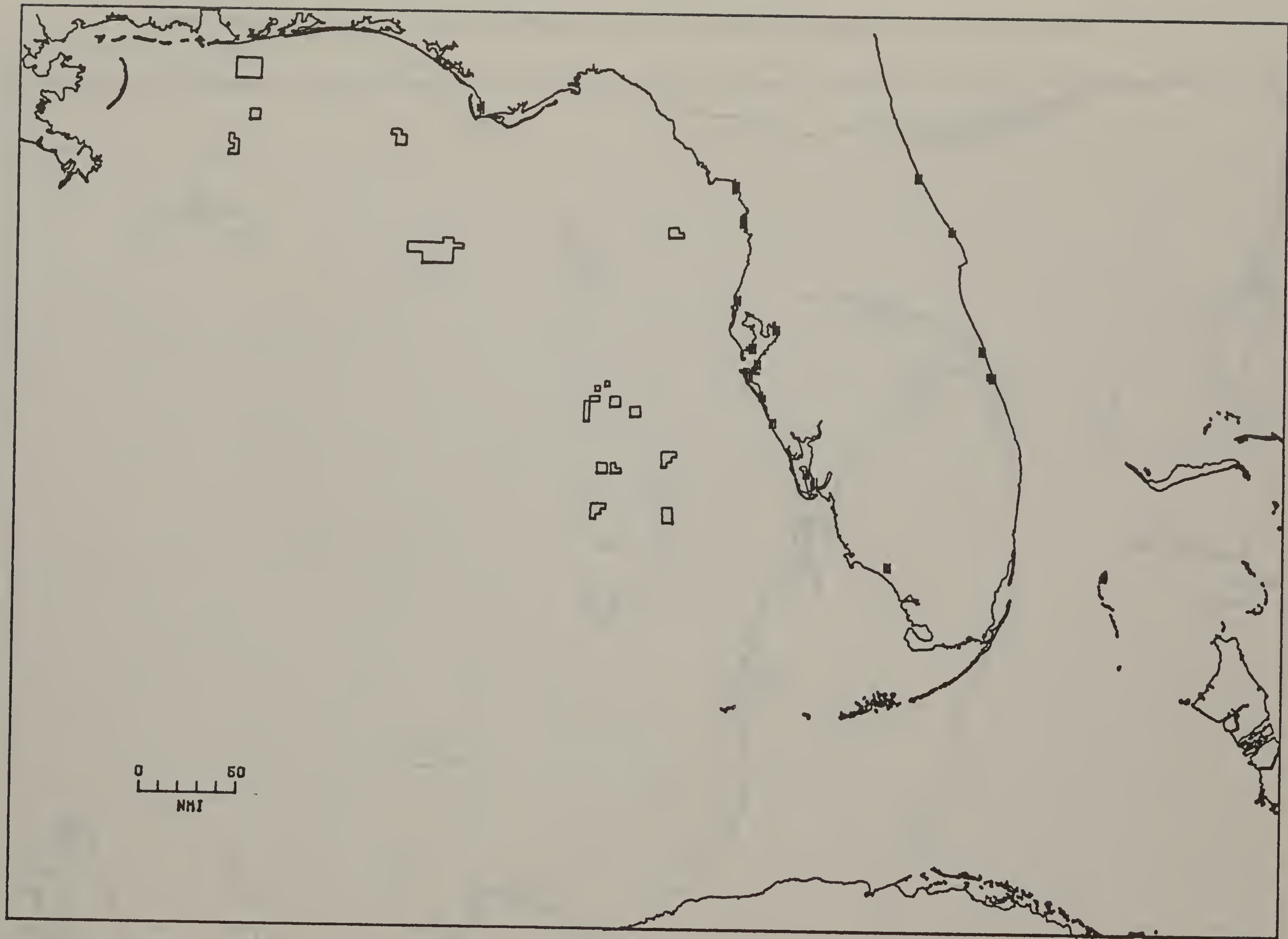


Figure A-3.--Hatched area indicates areal extent of brown pelican rookeries.

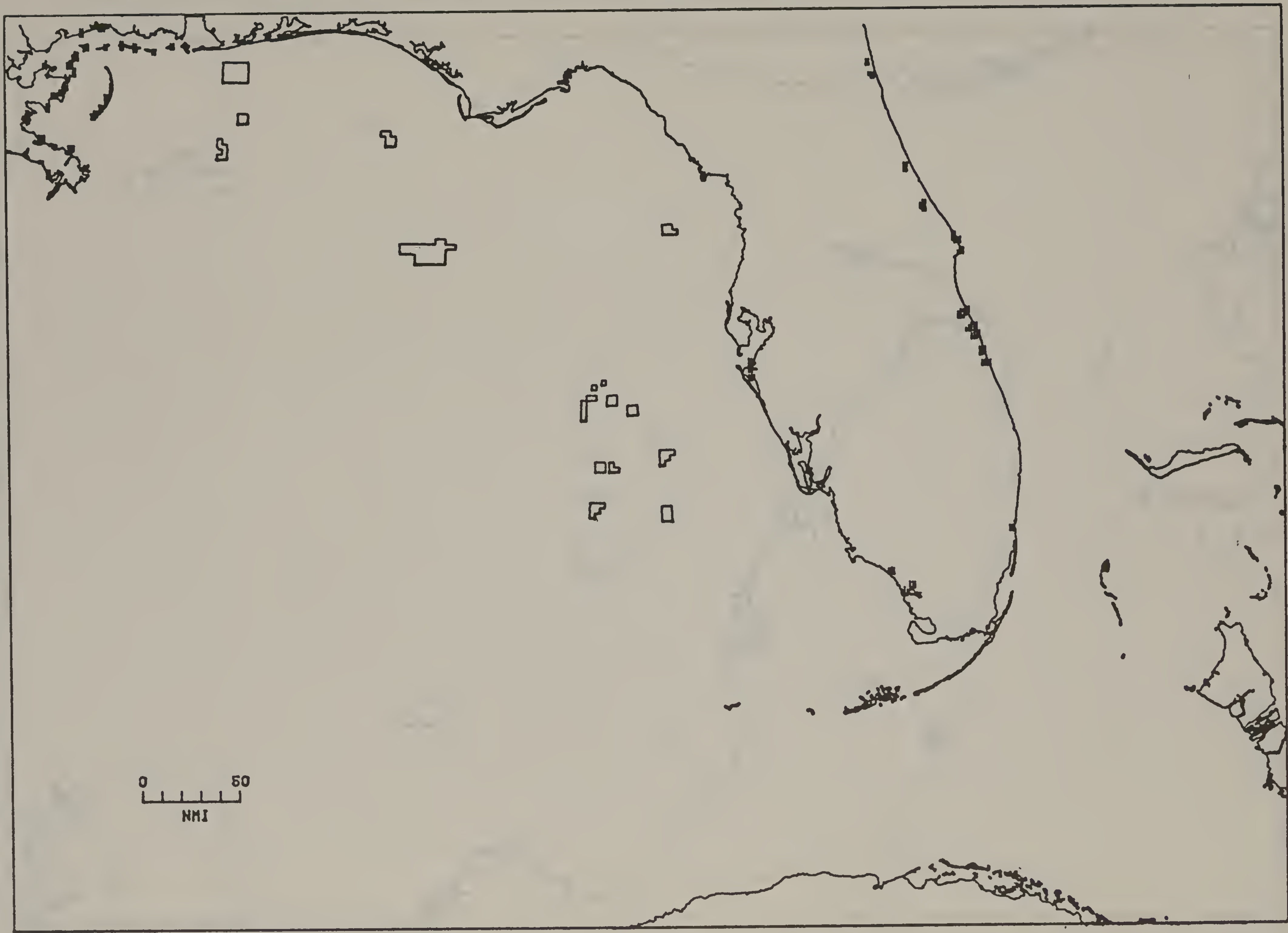


Figure A-4.--Hatched area indicates areal extent of wading or pelagic bird rookeries.

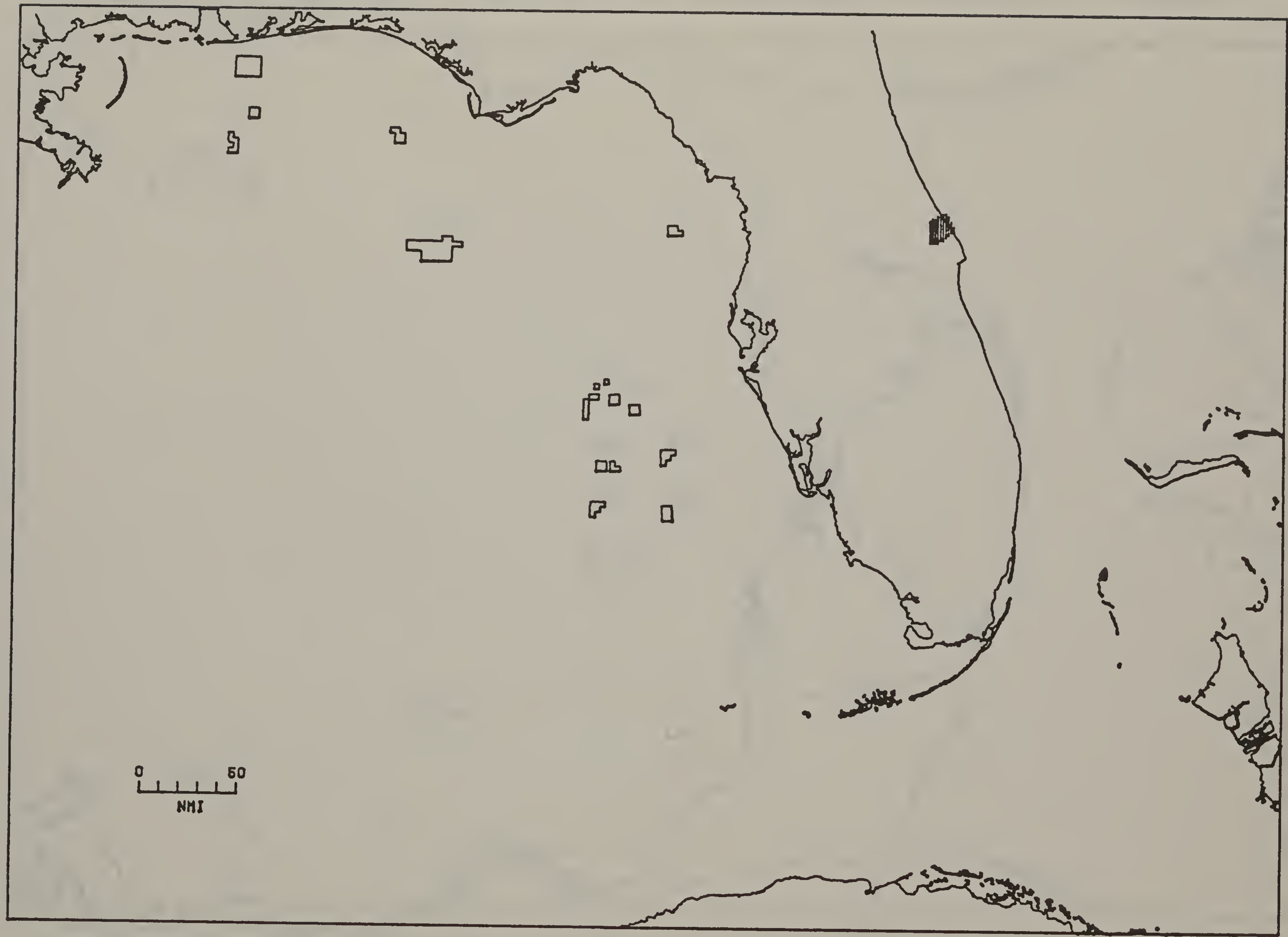


Figure A-5.--Hatched area indicates areal extent of dusky seaside sparrow habitat.

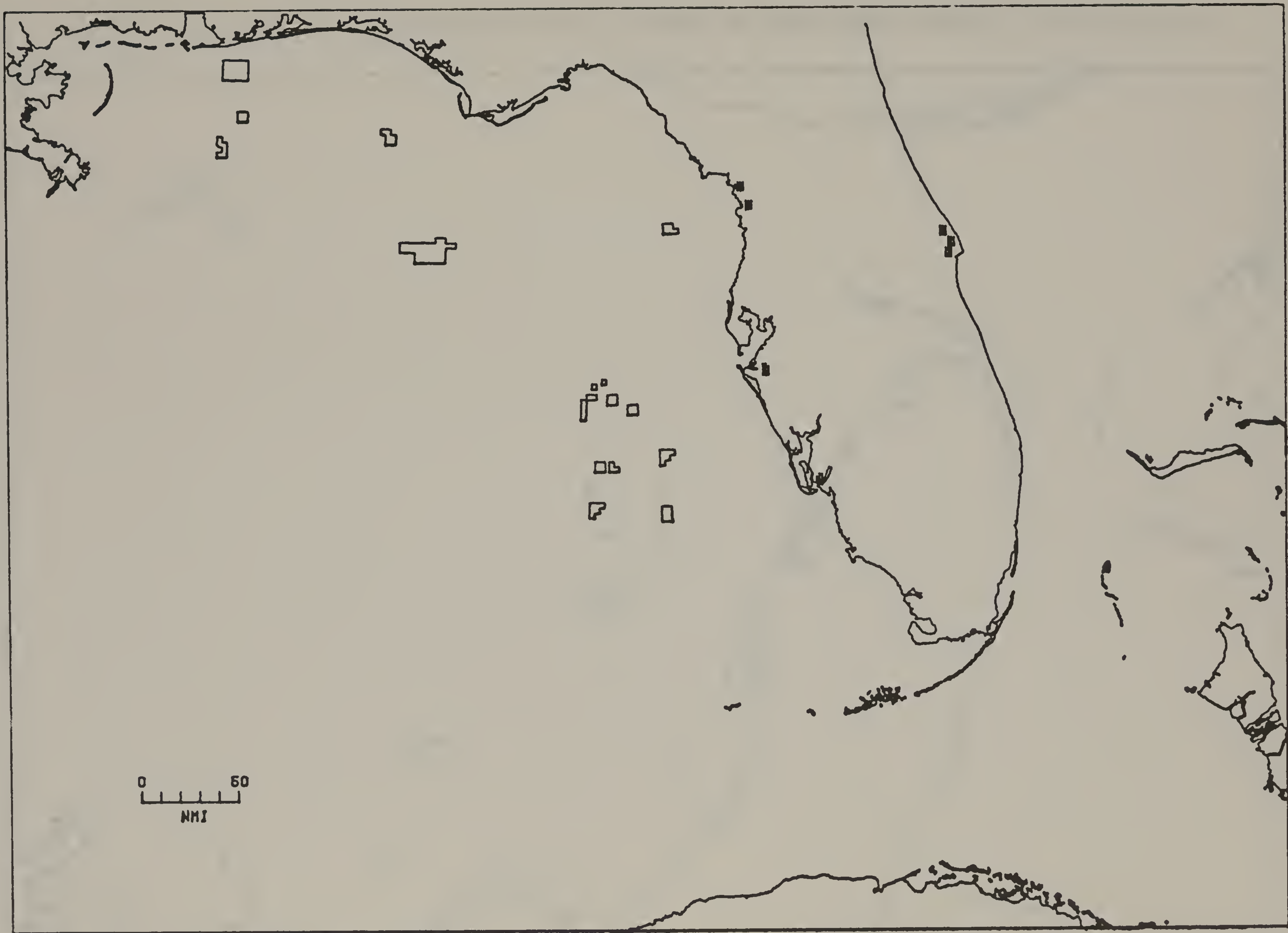


Figure A-6.--Hatched area indicates areal extent of bald eagle nesting sites.

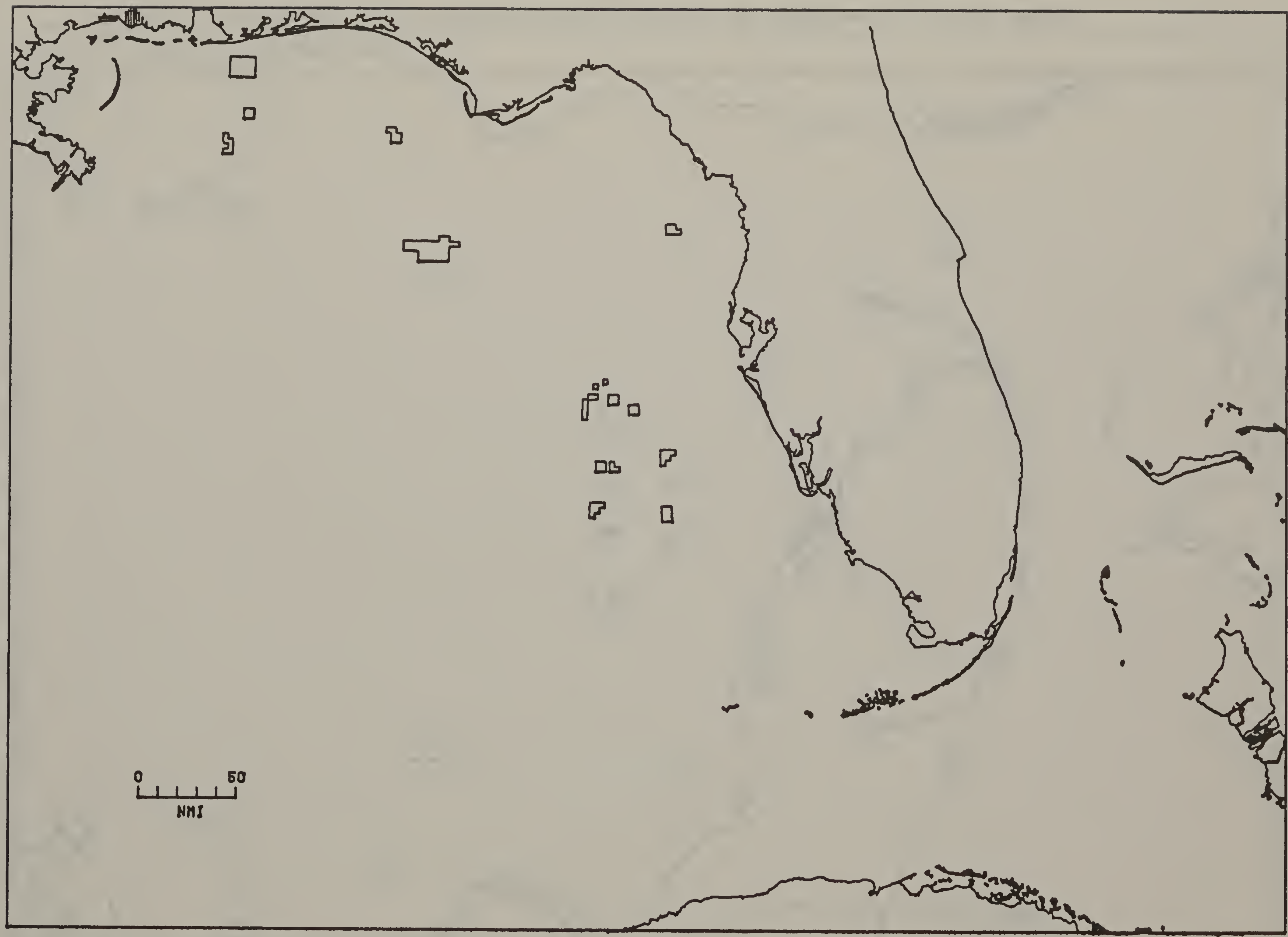


Figure A-7.--Hatched area indicates areal extent of Mississippi sandhill crane habitat.

Figure A-8.--Hatched area indicates areal extent of marine turtle nesting areas.

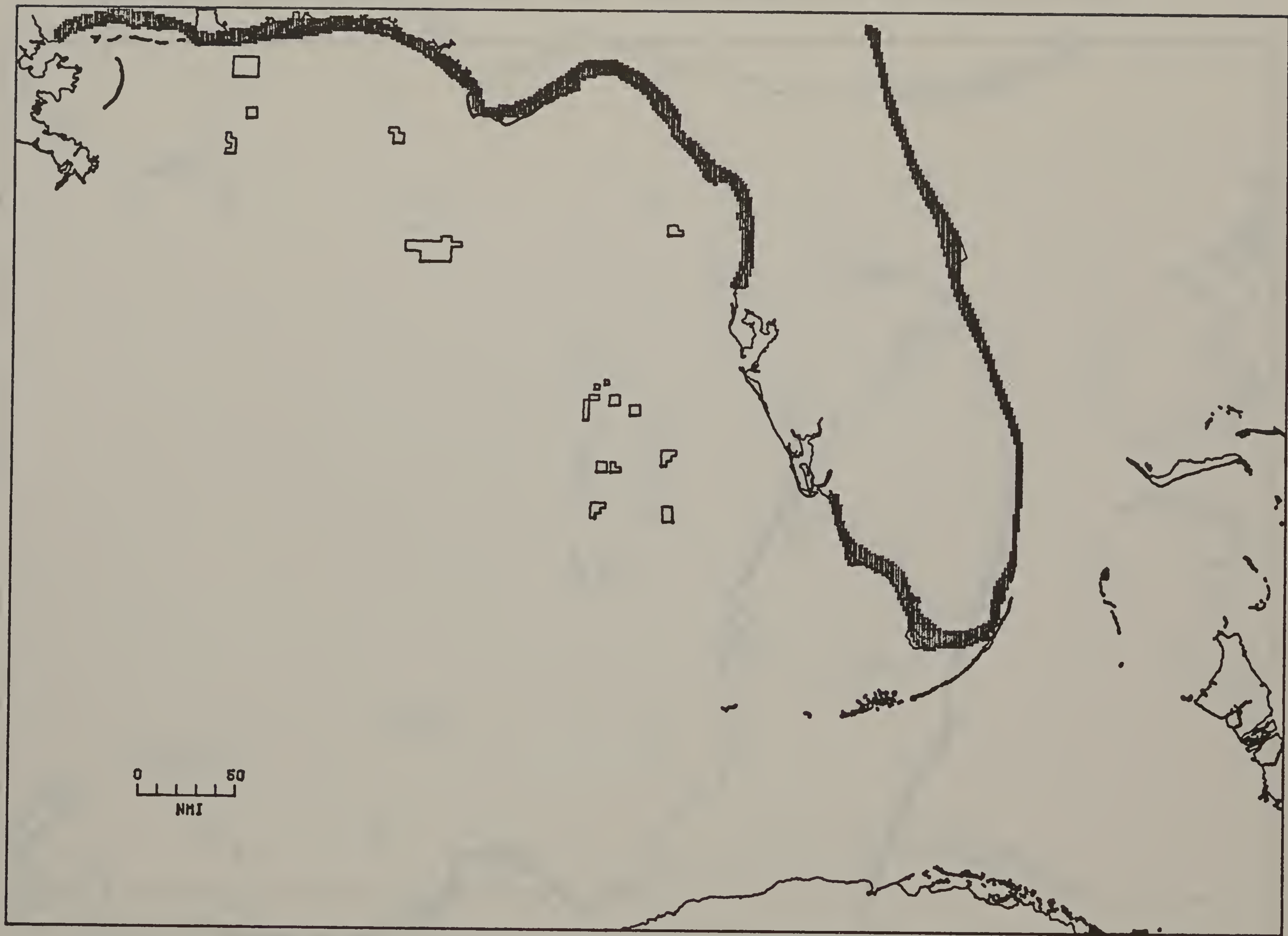


Figure A-9.--Hatched area indicates areal extent of American alligator habitat.

Figure A-10.--Hatched area indicates areal extent of mangroves or tidal marsh.

Figure A-11.--Hatched area indicates areal extent of estuarine nursery areas.

Figure A-12.--Hatched area indicates areal extent of West Florida adult female blue crab migration route.

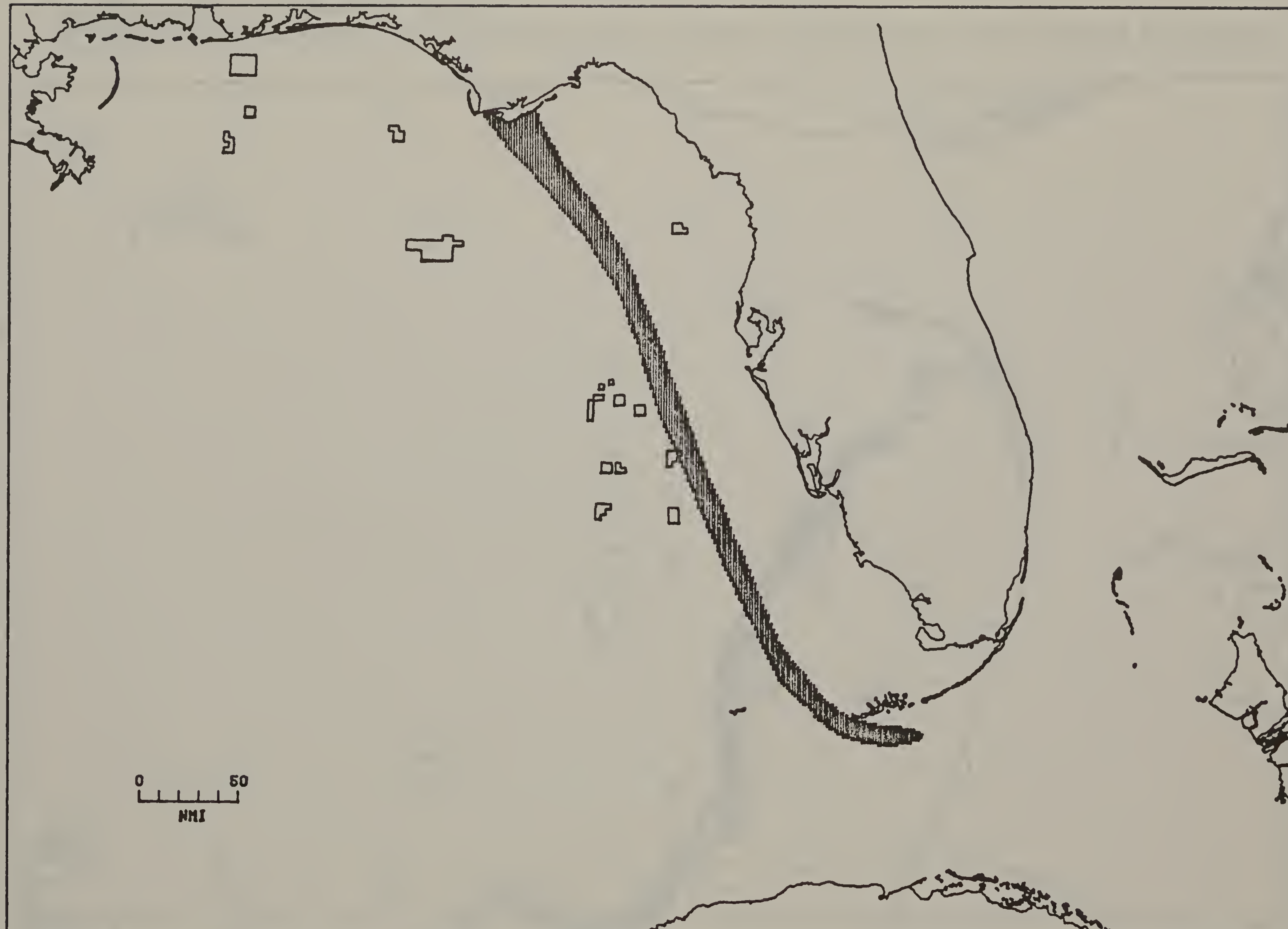


Figure A-13.--Hatched area indicates areal extent of West Florida blue crab larval transport route.

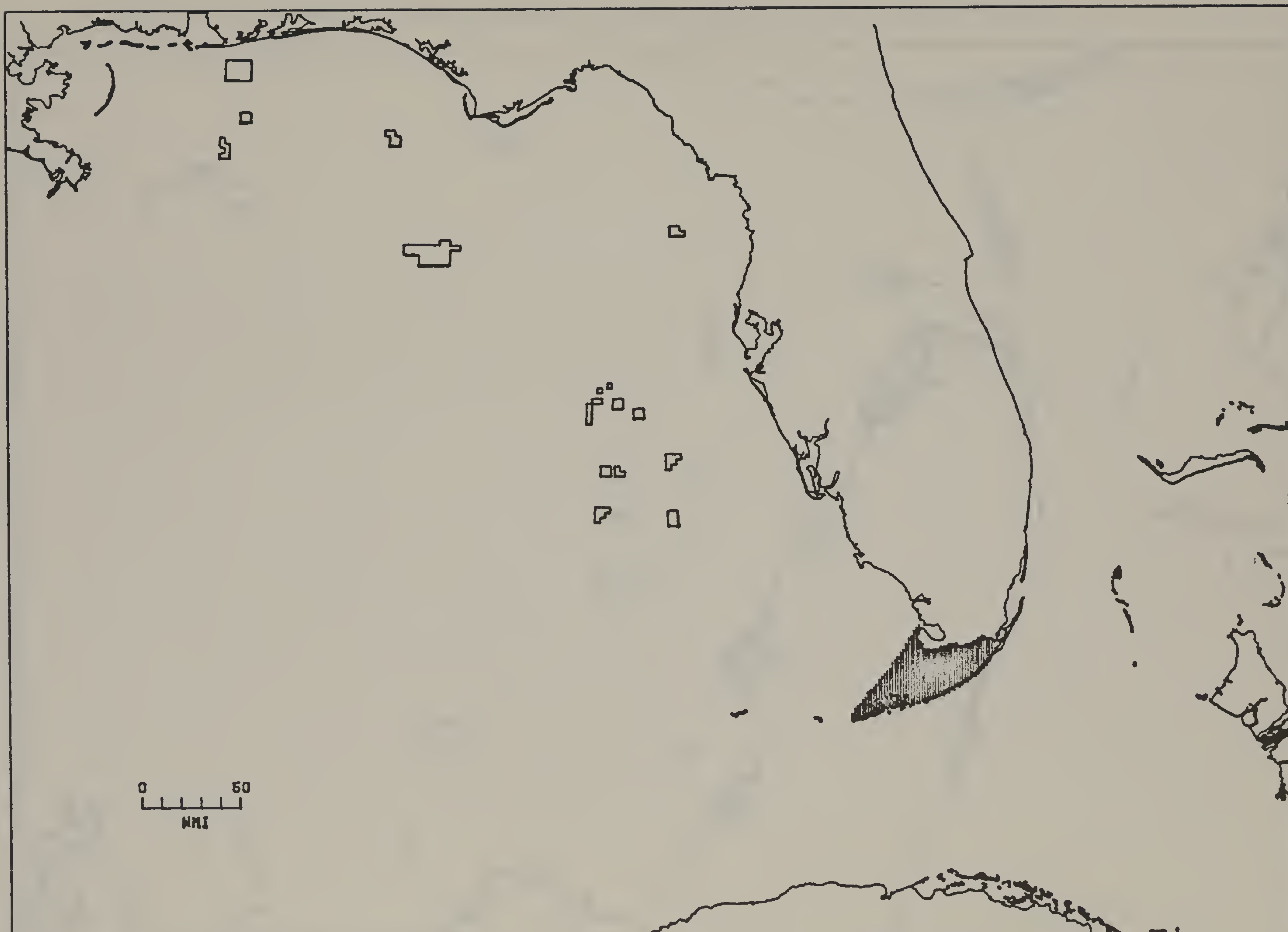


Figure A-14.--Hatched area indicates areal extent of tortugas pink shrimp nursery grounds.

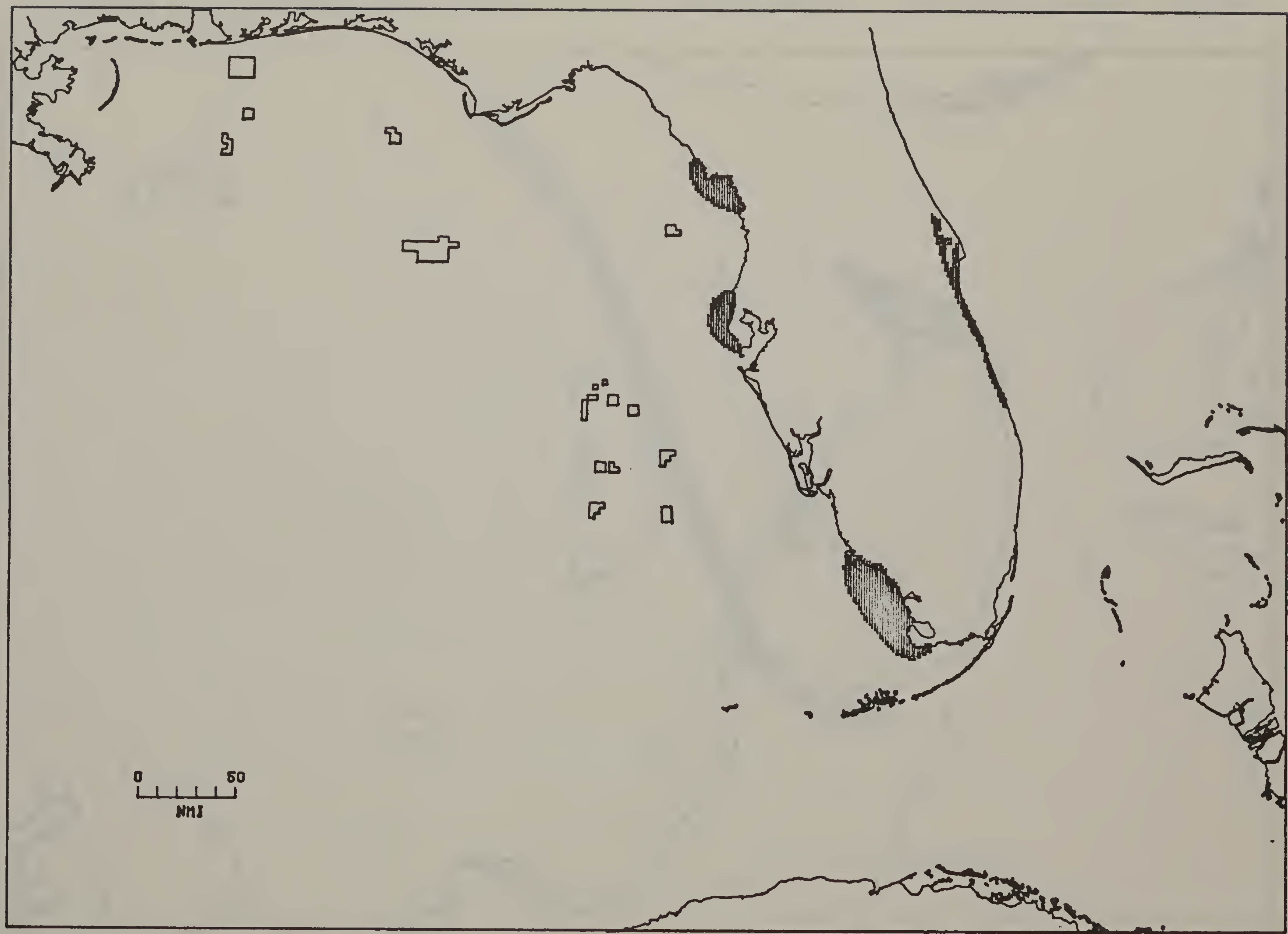


Figure A-15.--Hatched area indicates areal extent of stone crab habitat.

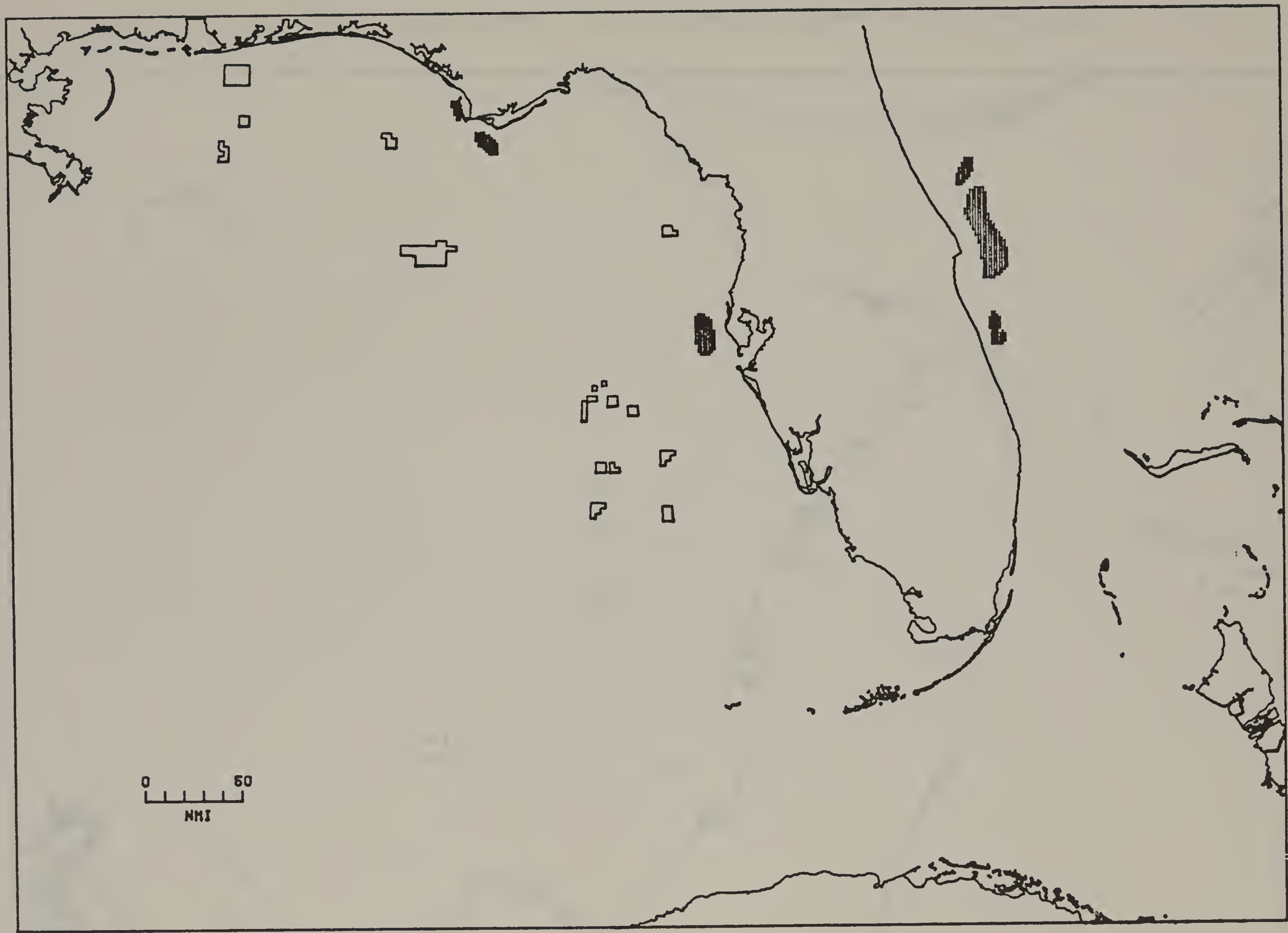


Figure A-16.--Hatched area indicates areal extent of calico scallops.

Figure A-17.--Hatched area indicates areal extent of oysters and bay scallops.

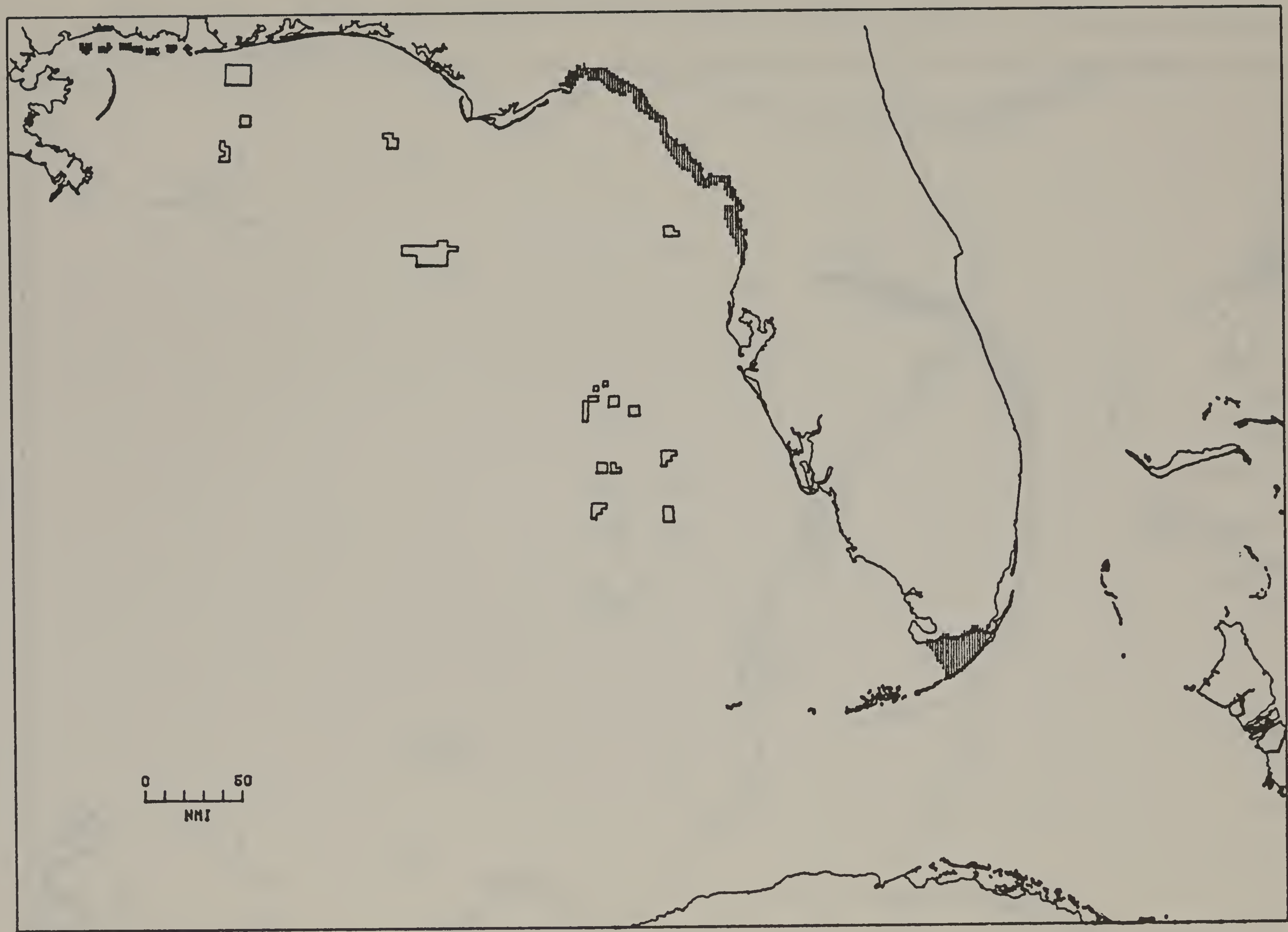


Figure A-18.--Hatched area indicates areal extent of seagrass beds.

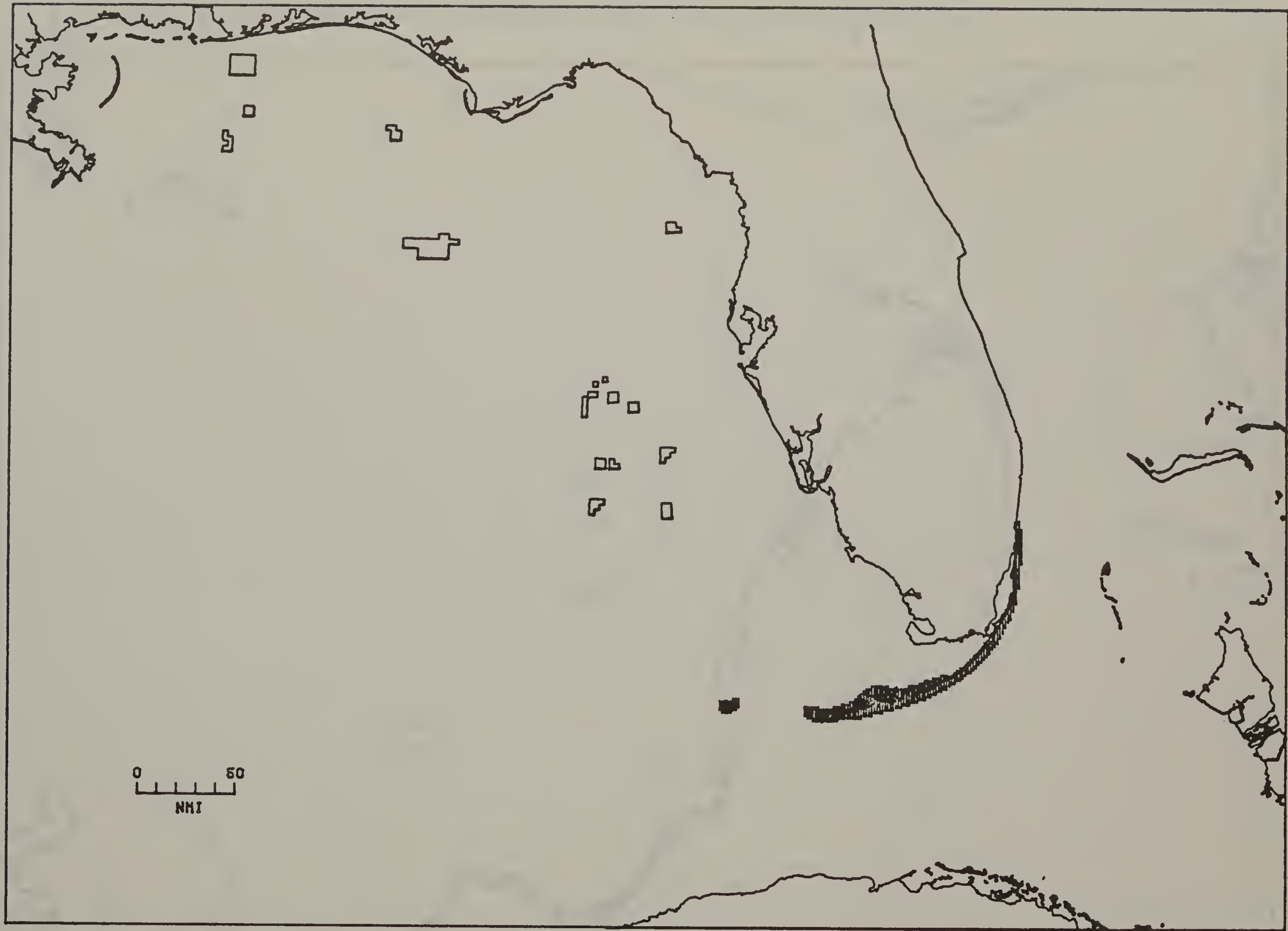


Figure A-19.--Hatched area indicates areal extent of spiny lobster.

Figure A-20.--Hatched area indicates areal extent of sandy beaches.

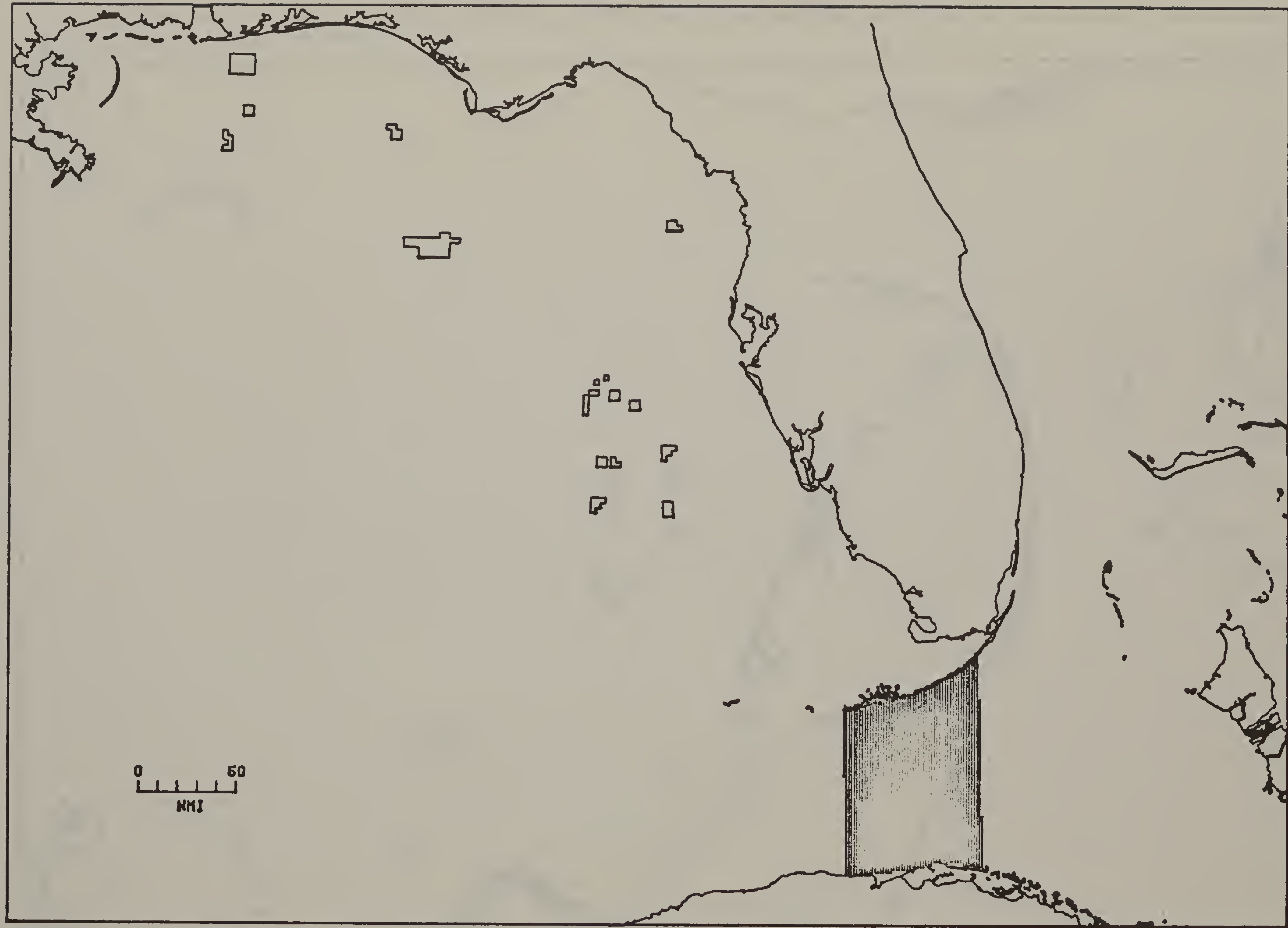


Figure A-21.--Hatched area indicates areal extent of Florida Straits.

Figure A-22.--Hatched area indicates areal extent of high density use shoreline.

Figure A-23.--Hatched area indicates areal extent of national register sites.

Figure A-24.--Hatched area indicates areal extent of designated wildlife, natural, and conservation areas.

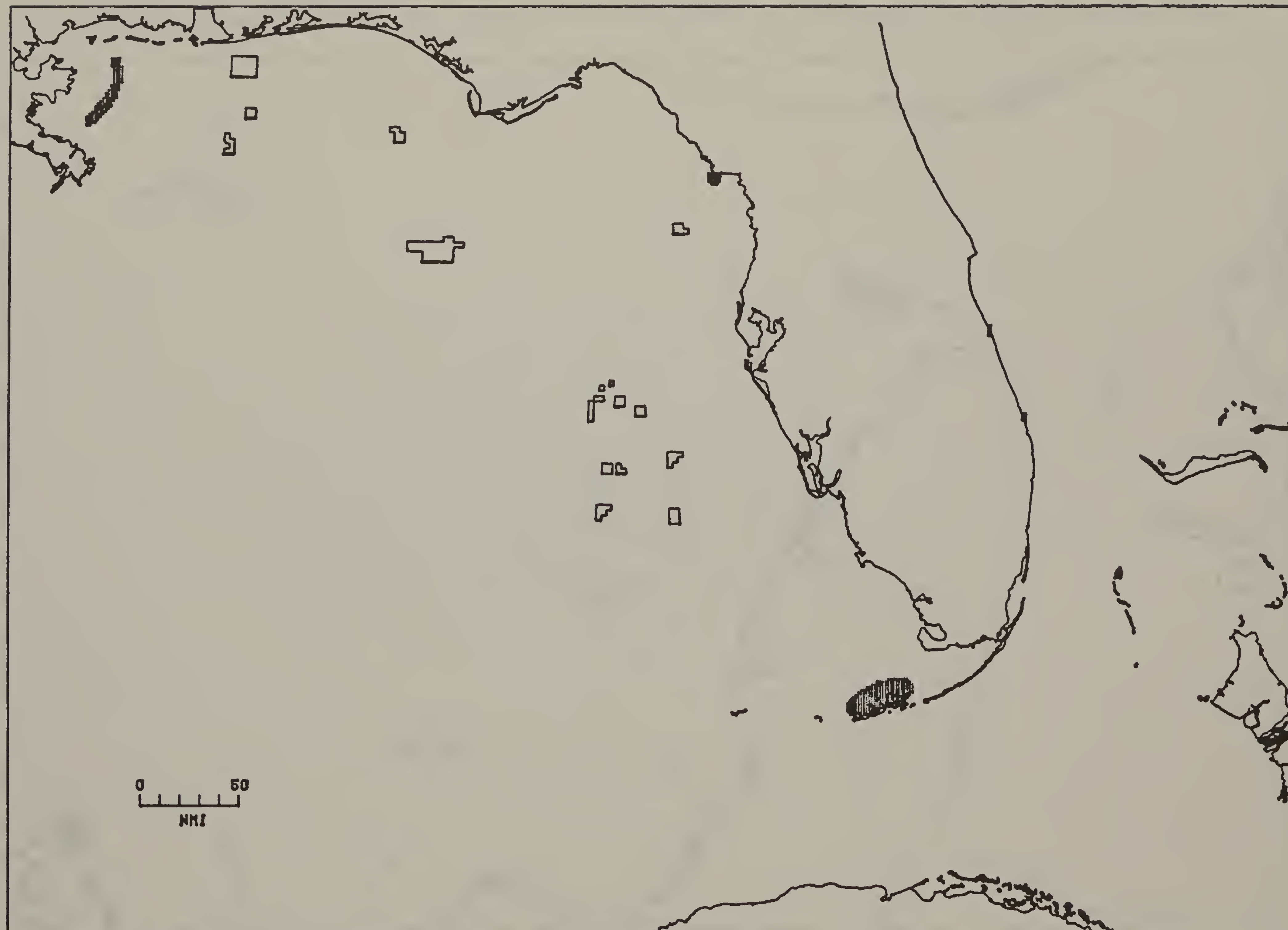


Figure A-25.--Hatched area indicates areal extent of designated national wilderness areas.

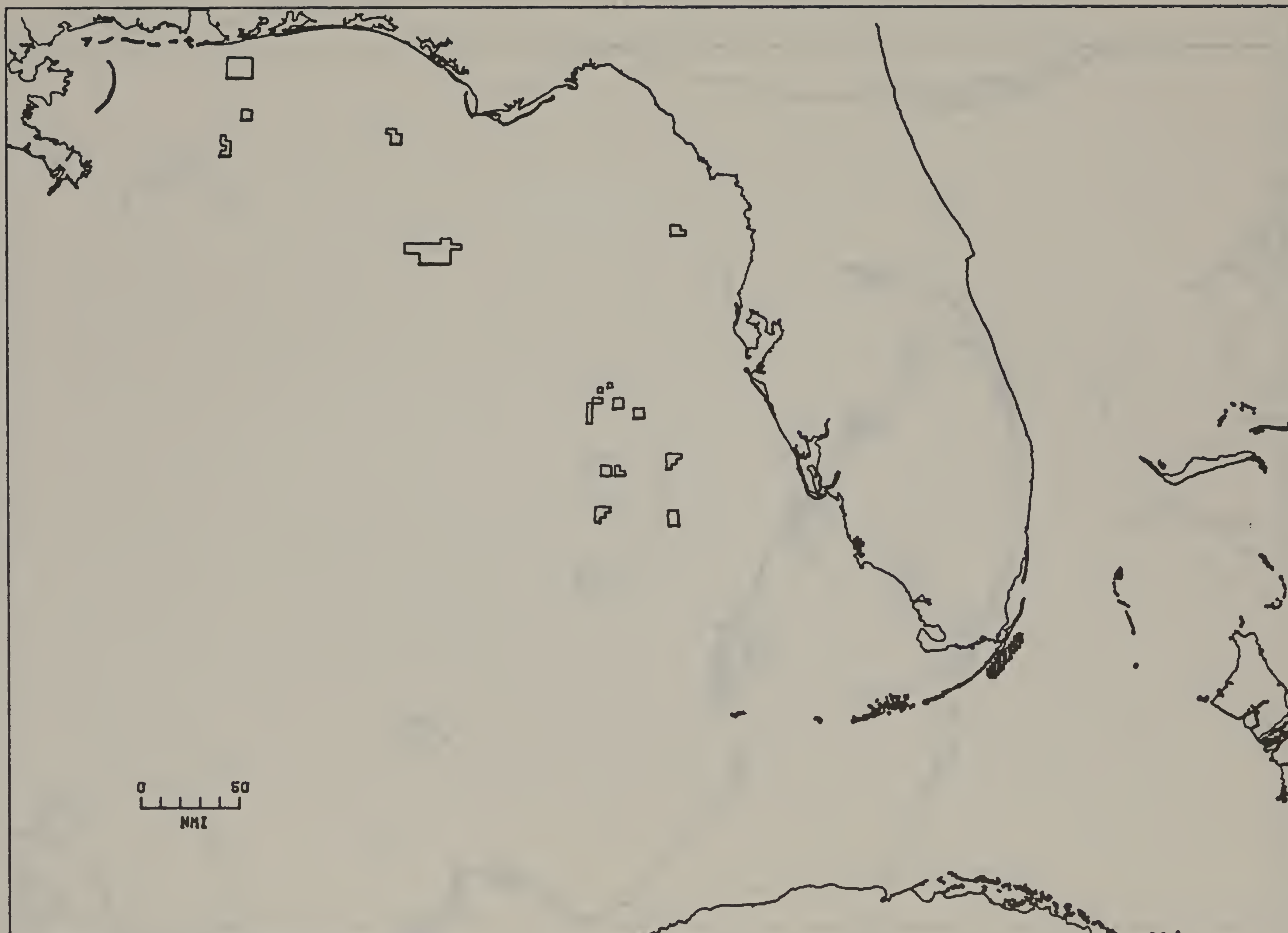


Figure A-26.--Hatched area indicates areal extent of national marine and estuarine sanctuaries.

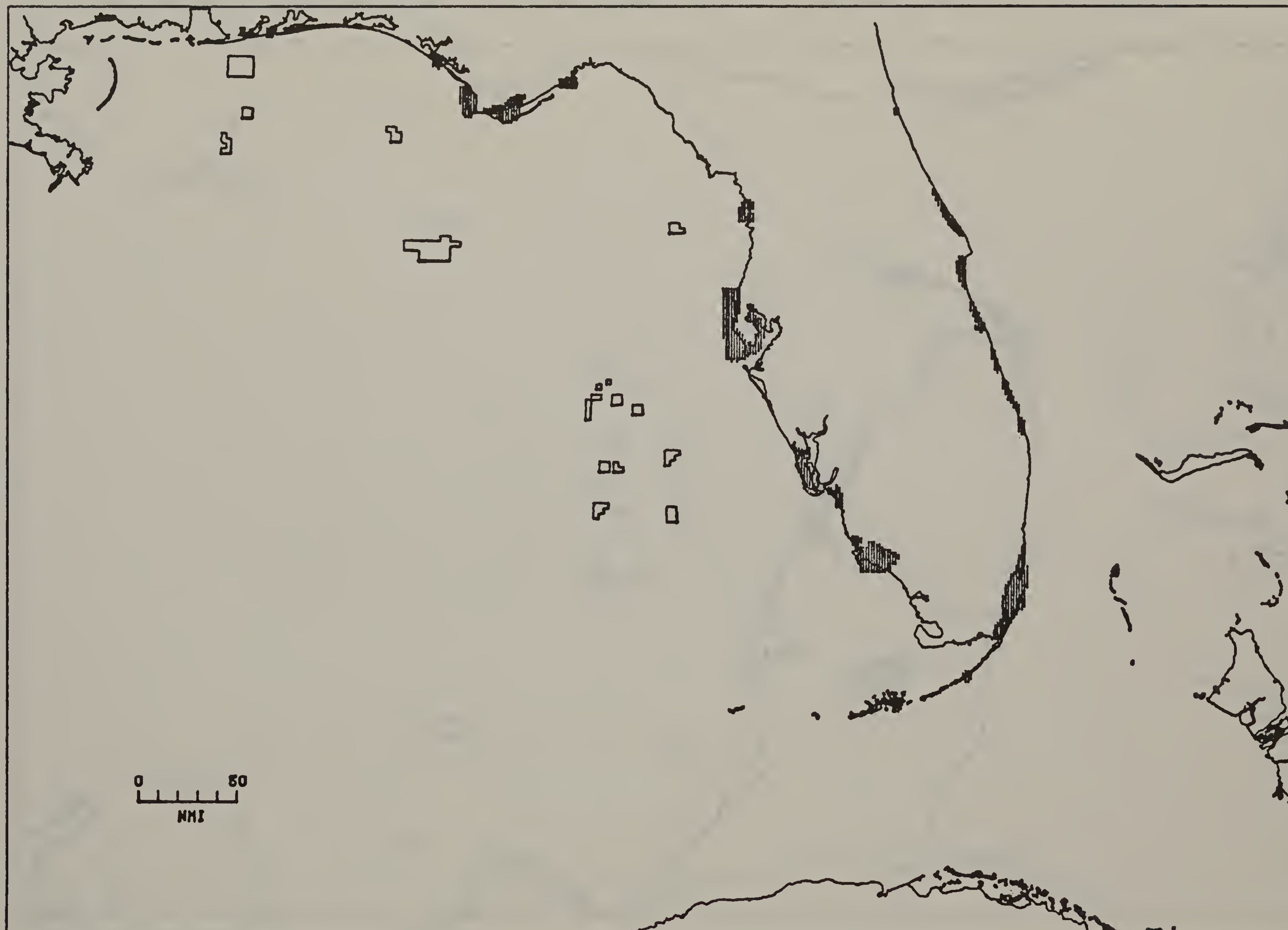


Figure A-27.--Hatched area indicates areal extent of Florida aquatic preserves.

Figure A-28.--Hatched area indicates areal extent of designated shoreline, national, and state parks.

Figure A-29.--Hatched area indicates areal extent of ports.

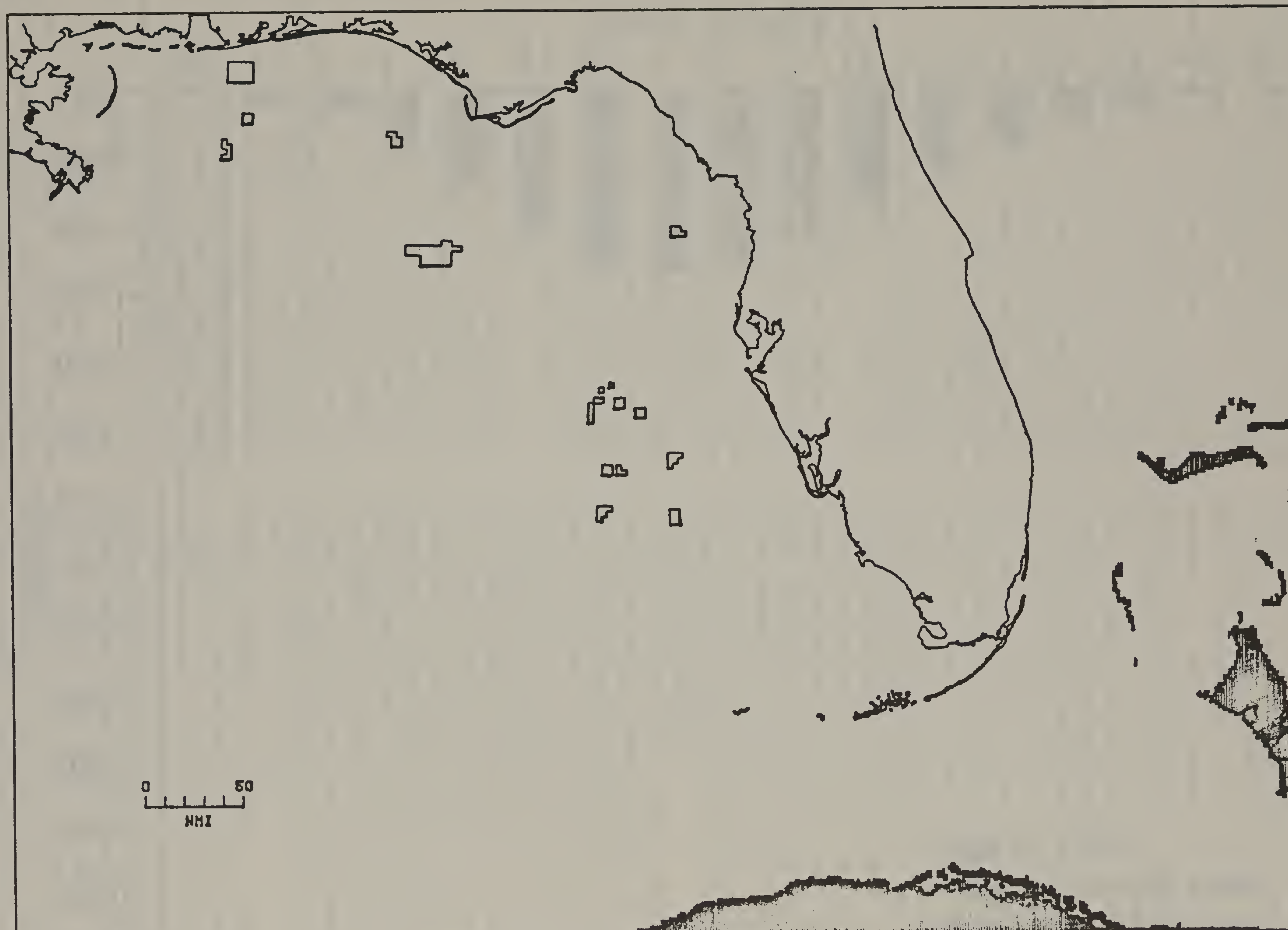


Figure A-30.--Hatched area indicates areal extent of foreign islands.

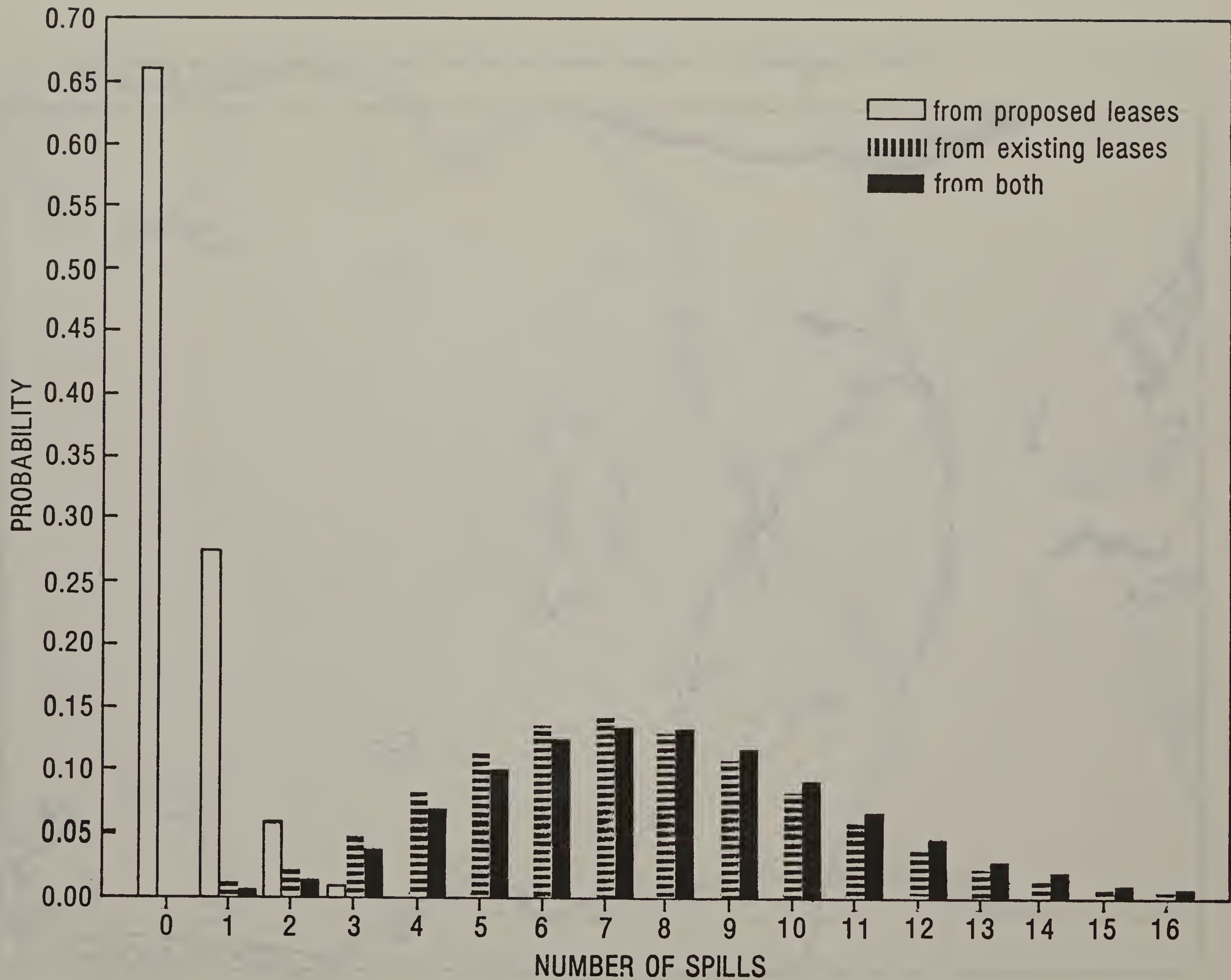


Figure 3.--Spill frequency distributions for spills greater than 1,000 barrels during the (remaining) production lives of the lease areas.

With regard to the question of improvement in accident rates, recent statistics from Coast Guard files show no clear trend in spill frequency for production platforms and pipelines during the period 1971-75. Spill frequency estimates in table 1 for platform and pipeline spills less than 1,000 barrels were based on United States spills for the years 1971 and 1972, for which the accident rate was 3.6 incidents per million barrels produced and handled (all sizes). The corresponding accident rates for the years 1973-75 were 3.9, 4.2, and 3.2 incidents per million barrels respectively. Trends in spill frequency for larger spill sizes are similarly difficult to identify. Geological Survey records for spills of 50 barrels and larger in the Gulf of Mexico OCS list 11, 2, 4, 8, and 2 incidents respectively for the years 1971 through 1975, a period during which offshore production gradually declined from 387 to 315 million barrels per year, (Danenberger, 1976).

It should also be pointed out that while the total volume of oil spilled in small OCS incidents (less than 50 barrels) declined quite steadily from about 1,500 barrels to about 700 barrels per year between 1971 and 1975, the total annual volume lost in the OCS spills of all sizes has been extremely variable and shows no decipherable trend. Total volume spilled increased from less than 3,000 barrels per year in 1971 and 1972 to more than 23,000 barrels per year in 1973 and 1974, then declined again to less than 1,000 barrels in 1975 (Danenberger, 1976).

There is evidence, however, of recent improvement in the incidence of tanker spills. Frequency estimates for tanker spills underlying table 1 were based on world statistics for the years 1969- 75 (spills over 1,000 barrels) and U.S. Coast Guard data for the years 1971-72 (spills under 1,000 barrels) for which the overall accident rate was 0.45 incidents per million barrels handled (all sizes; Devanney and Stewart, 1974). The corresponding rate for the years 1973-74 was only about 0.07 incidents per million barrels, although some of the apparent improvement is due to simply a change in the method of estimating volumes of crude handled in U.S. ports (Stewart, 1976).

Oilspill Trajectories

The trajectory simulation consists of a large number of hypothetical oilspill trajectories (50,000) which collectively reflect both the general trend and variability of winds and currents and which can be described in statistical terms. Ten trajectories based on wind and current conditions for each of the four seasons have been randomly selected as examples from a total of 2,000 trajectories released from location P5 near the center of the lease area and are shown in figures 4-7. The patterns of spill movements in figures 4-7 represent largely the effects of a looping current (gyre) holding sway over the flow in the eastern Gulf of Mexico. The gyre originates as a 1-2 knot northward current through the Straits of Yucatan. In the eastern Gulf, this current loops back to the east and then turns south until it passes through the Straits of Florida as the Gulf Stream. The body of this gyre moves north and south with the seasons. During the winter months, the gyre migrates southward and would not influence the movement patterns of spills in the northern Gulf. During the spring and summer months, the gyre extends further into the northern Gulf and would assert more influence on spill movement patterns. Spills entrapped in the gyre would be carried south, through the Straits of Florida, and north with the Gulf Stream. There is little chance that spilled oil, once enmeshed in this pattern, would escape and come ashore.

The spatial disposition of the simulated trajectories is presented in table 2 (A-D). Each entry in the table represents the probability (in percent) that if a spill starts from a certain location, it will reach a particular segment of land within the time specified. Four time limits of 3 days, 10 days, 30 days, and 60 days were selected as ‘‘milestones’’ in the life of a spill. The rationale for these time limits will be mentioned below. Briefly, they represent: 3 days-toxicity greatly diminished; 10 days-containment and clean-up, if possible, accomplished; 30 days-major spills difficult to locate or track; and 60 days-very large spills mostly dissipated. Figure 8 shows the locations of the land segments referred to in table 2.

Oilspill Trajectories in Relation to Biological Resources, Recreation Areas, and Other Objects

Oilspill trajectory simulations were conducted keeping track of the frequency in time which trajectories intersected the locations of biological, recreational, and other objects of interest. Trajectories were recorded as contacting an object only in cases where the object was listed as being vulnerable to oilspills in the month the contact took

TABLE 2A -- Probabilities (in percent) that an oilspill starting at a particular location will reach a certain land segment in 3 days.

Land Segment Number	P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	27	n	n	n
2	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	2	26	11	40	26	n	n	n
3	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	5	11	n	2	n	n	n	n
4	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	3	3	n	n	n	n	n	n
5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	2	n	n	n	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
9	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	5	34	7	4	3	n	n	n	n
10	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
11	7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	5	n	n	n	n	n	n	1
12	10	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
13	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
14	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n
15	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	2	n	n	n	n	n	n	n	n	n
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24	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n
25	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n
26	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
27	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
28	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
29	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
31	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
32	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
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35	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
36	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
37	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
38	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
39	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
40	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
41	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
42	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
43	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
44	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
45	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
46	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
47	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
48	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
49	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
50	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
51	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
52	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent.

Table 28. -- Probabilities (in percent) that an oilspill starting at a particular location will reach a certain land segment in 10 days.

Land Segment Number	P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	30	n	n	n
2	13	18	15	n	n	n	n	n	n	n	n	n	n	n	n	n	20	2	30	27	46	28	n	3	14
3	2	3	1	n	n	n	n	n	n	n	n	n	n	n	n	n	5	6	13	4	2	n	n	n	1
4	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	6	3	n	n	n	n	n	n
5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	2	n	n	n	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	5	n	n	n	n	n	n	n
9	24	13	7	n	n	n	n	n	n	n	n	n	n	n	n	n	18	43	12	9	7	n	n	1	12
10	9	3	1	n	n	n	n	n	n	n	n	n	n	n	n	n	1	3	3	n	n	n	n	n	2
11	9	2	n	1	n	n	n	n	n	n	n	n	n	n	n	5	1	14	7	3	5	n	n	n	4
12	13	1	n	2	n	n	n	n	n	n	n	n	n	n	n	8	2	3	2	2	1	n	n	n	1
13	1	1	n	3	n	n	n	n	n	n	n	n	n	n	n	9	2	n	n	n	n	n	n	n	1
14	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	2	n	n	n	n	n	n	n	n	1
15	n	n	n	3	n	n	n	n	n	n	n	n	n	n	1	7	n	n	n	n	n	n	n	n	1
16	n	n	n	n	n	2	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n
17	n	n	n	n	n	25	n	n	n	n	n	n	n	n	3	n	n	n	n	n	n	n	n	n	n
18	n	n	n	n	n	5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
19	n	n	n	n	n	2	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
20	n	n	n	n	n	3	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
21	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n
22	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	2	n	n
23	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
24	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n
25	n	n	n	n	n	n	n	n	n	1	4	n	n	n	n	n	n	n	n	n	n	n	1	n	n
26	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
27	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
28	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
29	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
31	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
32	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
33	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
34	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
35	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
36	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
37	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
38	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
39	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
40	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
41	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
42	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
43	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
44	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
45	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
46	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
47	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
48	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
49	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
50	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
51	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
52	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent.

Table 2C. -- Probabilities (in percent) that an oilspill starting at a particular location will reach a certain land segment in 30 days.

Land Segment Number	P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
1	n	1	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	30	n	n	n
2	19	28	27	4	1	n	n	n	n	n	n	n	n	n	2	12	28	3	34	32	51	28	n	6	24
3	2	4	3	1	n	n	n	n	n	n	n	n	n	n	n	1	5	6	13	4	2	n	n	1	3
4	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	6	3	n	n	n	n	n	n
5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	2	n	1	n	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	3	1	n	n	n	n	n	n	n	n	n	n	n	n	n	1	1	8	3	2	1	n	n	n	1
9	24	13	8	7	n	n	n	n	n	n	n	n	n	n	2	11	18	44	13	9	8	n	n	2	13
10	13	6	4	2	n	n	n	n	n	n	n	n	n	n	n	5	5	7	8	4	4	n	n	1	7
11	10	3	2	4	n	n	n	n	n	n	n	n	n	n	1	8	2	15	7	4	7	n	n	1	7
12	13	1	1	4	n	1	n	n	n	n	n	n	n	n	n	9	3	3	3	2	2	n	n	n	1
13	1	1	1	5	n	1	n	n	n	n	n	n	n	n	1	10	2	n	1	1	n	n	n	n	1
14	1	4	3	1	n	n	n	n	n	n	n	n	n	n	n	3	3	n	1	2	2	n	n	1	4
15	1	3	2	3	n	n	n	n	n	n	n	n	n	n	2	7	3	n	2	2	2	n	n	2	4
16	n	n	n	n	n	4	n	n	1	1	n	n	n	n	3	n	n	n	n	n	n	n	2	n	n
17	n	n	n	n	n	29	2	n	2	4	4	n	n	1	6	n	n	n	n	n	n	n	10	n	n
18	n	n	n	n	n	6	1	n	1	1	1	n	n	n	n	n	n	n	n	n	n	n	6	n	n
19	n	n	n	n	n	4	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	3	n	n
20	n	n	n	n	n	4	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n
21	n	n	n	n	n	4	n	n	n	n	2	n	n	n	1	n	n	n	n	n	n	n	4	n	n
22	n	n	n	n	n	2	n	n	n	n	1	n	n	1	n	n	n	n	n	n	n	n	3	n	n
23	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
24	n	n	n	n	n	n	1	n	1	1	1	n	n	n	n	n	n	n	n	n	n	n	2	n	n
25	n	n	n	n	n	n	1	1	1	2	5	n	n	4	n	n	n	n	n	n	n	n	1	n	n
26	n	n	n	n	n	n	n	n	n	n	n	1	n	2	n	n	n	n	n	n	n	n	n	n	n
27	n	n	n	n	n	n	n	n	n	n	n	1	n	1	n	n	n	n	n	n	n	n	n	n	n
28	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
29	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
31	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
32	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
33	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
34	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
35	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n
36	n	n	n	n	n	n	n	n	n	n	n	1	3	n	n	n	n	n	n	n	n	n	n	n	n
37	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
38	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
39	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
40	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
41	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
42	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
43	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
44	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
45	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
46	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
47	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
48	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
49	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
50	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
51	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
52	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent.

Table 20. -- Probabilities (in percent) that an oilspill starting at a particular location will reach a certain land segment in 60 days.

Land Segment Number	Hypothetical spill location: P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
1	n	1	1	n	n	n	n	n	n	n	n	n	n	n	n	1	1	n	n	1	n	30	n	n	1
2	22	32	31	8	3	2	1	1	1	n	n	n	n	n	7	17	32	3	35	34	53	28	2	10	30
3	2	5	3	1	n	n	n	n	n	n	n	n	n	n	1	2	5	6	13	4	2	n	n	2	3
4	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	6	3	n	n	n	n	n	1
5	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	3	1	2	1	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	4	1	1	1	n	n	n	n	n	n	n	n	n	n	n	1	1	9	4	3	1	n	n	1	2
9	25	14	8	9	1	2	n	1	1	n	n	n	n	n	4	12	18	44	13	10	8	n	1	2	14
10	14	9	8	4	n	2	n	n	n	1	n	n	n	n	2	5	7	8	10	5	6	n	1	2	10
11	10	4	3	5	1	1	n	n	n	n	n	n	n	n	1	9	3	15	8	5	7	n	1	3	8
12	13	1	1	4	n	1	n	n	n	n	n	n	n	n	1	9	3	3	3	2	2	n	1	1	1
13	1	1	1	6	n	2	n	n	1	n	n	n	n	n	1	10	2	n	1	1	n	n	1	n	1
14	1	4	4	2	n	n	n	n	n	n	n	n	n	n	1	3	4	n	1	3	3	n	n	2	4
15	1	3	3	3	n	n	n	n	n	n	n	n	n	n	2	8	3	n	2	4	3	n	n	2	5
16	n	n	n	n	n	5	1	n	1	1	1	n	n	1	3	n	n	n	n	n	n	n	3	n	n
17	n	n	n	n	n	30	6	2	4	5	5	n	n	3	8	n	n	n	n	n	n	n	12	n	n
18	n	n	n	n	n	6	2	1	2	3	2	n	n	1	n	n	n	n	n	n	n	n	6	n	n
19	n	n	n	n	n	4	1	1	1	1	1	n	n	1	n	n	n	n	n	n	n	n	3	n	n
20	n	n	n	n	n	4	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n
21	n	n	n	n	n	4	1	1	2	2	3	n	n	1	1	n	n	n	n	n	n	n	4	n	n
22	n	n	n	n	n	2	1	1	2	1	2	n	n	2	n	n	n	n	n	n	n	n	3	n	n
23	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
24	n	n	n	n	n	n	1	n	1	1	1	n	n	n	n	n	n	n	n	n	n	n	2	n	n
25	n	n	n	n	n	n	1	2	1	3	6	1	n	5	n	n	n	n	n	n	n	n	1	n	n
26	n	n	n	n	n	n	1	1	1	n	1	1	1	3	n	n	n	n	n	n	n	n	n	n	n
27	n	n	n	n	n	n	1	2	1	1	1	1	1	2	n	n	n	n	n	n	n	n	n	n	n
28	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n
29	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
31	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n
32	n	n	n	n	n	n	n	n	n	n	n	1	1	n	n	n	n	n	n	n	n	n	n	n	n
33	n	n	n	n	n	n	n	n	n	n	n	1	2	1	n	n	n	n	n	n	n	n	n	n	n
34	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
35	n	n	n	n	n	n	n	1	1	n	n	3	3	1	n	n	n	n	n	n	n	n	n	n	n
36	n	n	n	n	n	n	1	2	1	1	1	5	7	2	n	n	n	n	n	n	n	n	n	n	n
37	n	n	n	n	n	n	n	n	n	n	n	1	1	n	n	n	n	n	n	n	n	n	n	n	n
38	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
39	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
40	n	n	n	n	1	n	n	n	n	n	n	1	1	1	n	n	n	n	n	n	n	n	n	n	n
41	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
42	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
43	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
44	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
45	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
46	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
47	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
48	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
49	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
50	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
51	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
52	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent.

FIGURE 8 --Map of land segment numbers.

place. Table 3 (A-D) gives the probability of contact on each of the 30 categories of biological resources, recreation areas, and other objects (see Figures A-1 through A-30) for a spill originating at the twenty-five spill sites within the lease area (see figure 2). Once again, the conditional probabilities are given for the four time limits stated above.

Estimates of Weathering Rates and Slick Dispersion

It must be emphasized that up to this point the analysis has dealt only with trajectories for the transport of surface oil by winds and currents and has not involved any direct consideration of dispersion or weathering processes which would progressively reduce the quantity of oil contained in the slick as it traveled towards shore. The probabilities given in tables 2 and 3, therefore, present a worst-case picture in the sense that some fraction of the spills occurring offshore in the lease area would be expected to deteriorate to the point of insignificance before reaching either land or an object. Some attempt at quantifying weathering and dispersive effects and accounting for them in probability estimates is thus in order.

One important factor determining the significance of weathering in reducing oilspill effects is the time required for spills to reach an object. Times to land, segments, or objects for the simulated trajectories, in fact, cover a very wide range, and it is therefore particularly important to consider this factor in interpreting results of the spill trajectory analysis. The change with time of the likelihood of a spill (once it occurs) coming in contact with an object is shown in tables 2 and 3.

Also in the list of factors which would determine the potency of spills at the time of contact would be spill size and the quality or composition of the oil (since lighter weight crudes evaporate at a much more rapid rate than those with a large proportion of high molecular weight hydrocarbons). This latter factor is hard to predict in advance and the significance of weathering is therefore difficult to quantify despite its obvious importance in interpreting these results. Also, the dispersion of a spill and the likelihood that it would contact an object are potentially reduced by cleanup efforts, but this mitigating factor is not directly incorporated in the probability analysis.

The most important conclusion to be reached from the data in tables 2 and 3 is that travel time to objects for spills emanating from the proposed leases will be rather long, so that they will no longer exist as an identifiable slick but rather will have fragmented into a large number of discrete particles or ''blobs'' by the time any oil arrives at an object. Observations by Jeffrey (1973) of actual spills in the North Atlantic indicate breakup of the slick can be expected within about 4 days, and that the particles of residual oil typically consist of spongy emulsions of oil of widely varying sizes. Moreover, it is generally agreed that large fractions of the original volume of oil will evaporate in the first few days of weathering and that further loss to the atmosphere occurs at a very slow rate. Data from Nelson (1958) for crude oil of API gravity 40°, for example, indicate about 50 percent of the original spill volume would be lost to evaporation.

Thus for oilspills originating from the proposed leases it would appear that an impornt consideration is the extent to which fragments of the slick are dispersed in time. Using lateral dispersion coefficients from Csanady (1974), estimates of slick dispersion were made for various travel times and for two spill sizes, 1,000 barrels and 50 barrels, assuming 50 percent loss of the original volume by evaporation. The resulting distribution of oil along an assumed straight shoreline or object is given in figure 9 (A). It is important to note that the profiles will flatten considerably relative to a shoreline or object as the outline of the object becomes more irregular. Even for straight objects it appears that residual oil from a single spill as small as 50 barrels would not be easily detected after 30 days at sea. Figure 9 (B) shows the profile of a medium large spill after 30 days at sea.

The action of wind and waves will further disperse a spill. After 30 days it was difficult to locate the oilspill resulting from the breakup of the Argo Merchant (about 180,000 barrels of No. 6 fuel oil spilled) due to high winds. In contrast, the Torrey Canyon went ashore on 18 March 1967 in the Scilly Isles southwest of England and spilled some 700,000 barrels of crude oil. Oil from this wreck came ashore in Brittany as late as 60 days later (Wardley-Smith, 1976).

The reduction in toxicity with time of spilled oil is another factor that must be considered. Shellfish and finfish can be distinguished from other

TABLE 3A -- Probabilities (in percent) that an oilspill starting at a paticular location will reach a certain object in 3 days.

Object	Hypothetical spill location P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
Land	18	n	1	n	n	n	n	n	n	n	n	n	n	n	n	3	6	51	47	15	45	53	2	n	1
1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	50	n	n	n	n	n	n	n	n	n	n
2	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
3	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
4	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	8	9	n	1	6	n	n	n
5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	14	n	n	n	n	n	n	n	n	n	n	n	n	n	n	3	6	37	7	4	3	n	2	n	1
9	15	n	n	n	n	n	n	n	n	n	n	n	n	n	n	3	n	4	n	n	n	n	n	n	1
10	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	10	39	11	42	42	n	n	n
11	2	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
12	n	n	n	n	n	8	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	7	n	n
13	n	n	n	n	n	1	1	n	1	10	32	n	n	2	34	n	n	n	n	n	n	n	n	n	n
14	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
15	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	28	n	n
16	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	41	n	n
17	2	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	15	43	14	44	*	n	n	n
18	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
19	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
20	6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	2	n	n	n	n	1	n	1
21	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
22	22	1	n	n	n	n	n	n	n	n	1	n	n	n	n	5	1	7	n	n	n	n	6	n	2
23	3	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
24	1	n	1	n	n	n	n	n	n	n	n	n	n	n	n	n	6	45	48	17	39	n	n	n	n
25	1	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	6	40	16	5	4	n	n	n	n
26	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
27	3	n	n	n	n	n	n	n	n	n	3	n	n	n	n	n	n	n	n	n	n	n	11	n	n
28	4	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n
29	11	1	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	4	n	n	n	n	n	n	n
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent
* - greater than 99.5 percent

Table 38. -- Probabilities (in percent) that an oilspill starting at a paticular location will reach a certain object in 10 days.

Object	P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
Land	73	39	25	9	n	40	n	n	n	1	5	n	n	n	5	31	49	85	70	45	64	57	6	5	39
1	n	n	n	n	n	6	n	n	n	n	2	n	n	n	53	n	n	n	n	n	n	n	4	n	n
2	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n
3	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
4	11	4	1	n	n	1	n	n	n	n	n	n	n	n	n	n	4	13	12	3	1	7	1	1	4
5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	40	15	8	9	n	28	n	n	n	1	5	n	n	n	6	29	23	56	20	14	13	n	3	1	19
9	20	3	1	9	n	13	n	n	n	n	n	n	n	n	1	28	5	16	8	5	6	n	4	n	7
10	16	20	16	n	n	7	n	n	n	n	n	n	n	n	n	n	24	13	44	30	50	46	3	4	15
11	12	3	1	n	n	6	n	n	n	n	n	n	n	n	1	1	1	8	4	1	1	n	n	n	3
12	n	n	n	n	n	30	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	17	n	n
13	n	n	n	n	n	35	12	1	13	28	37	n	n	15	39	n	n	n	n	n	n	n	15	n	n
14	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
15	n	n	n	n	n	10	4	n	1	4	19	n	n	n	n	n	n	n	n	n	n	n	47	n	n
16	n	n	n	n	n	8	4	n	2	3	14	n	n	n	7	n	n	n	n	n	n	n	49	n	n
17	19	22	17	n	n	7	n	n	n	n	n	n	n	n	n	1	27	18	48	32	52	*	4	4	18
18	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
19	8	2	n	n	n	10	n	n	n	n	n	n	n	n	n	n	1	6	3	1	n	n	6	n	2
20	16	3	1	3	n	21	n	n	n	n	1	n	n	n	4	10	3	15	7	4	4	n	1	n	6
21	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
22	28	5	1	11	n	n	1	n	n	2	9	n	n	n	1	33	7	19	10	6	6	n	7	n	11
23	6	1	n	n	n	1	n	n	n	n	n	n	n	n	n	1	1	3	1	n	n	n	n	n	2
24	37	29	20	n	n	5	n	n	n	n	n	n	n	n	n	n	37	57	55	33	47	n	4	5	26
25	25	15	8	n	n	2	n	n	n	n	n	n	n	n	n	n	21	50	21	12	8	n	3	2	14
26	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
27	3	n	n	1	n	5	2	n	1	2	13	n	n	n	3	1	n	n	n	1	n	n	15	n	n
28	13	2	n	1	n	4	n	n	n	n	n	n	n	n	n	3	1	11	5	2	1	n	1	n	3
29	15	2	n	1	n	n	n	n	n	n	1	n	n	n	n	4	2	8	3	1	2	n	n	n	3
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent
* - greater than 99.5 percent

Table 3C. -- Probabilities (in percent) that an oilspill starting at a paticular location will reach a certain object in 30 days.

Object	Hypothetical spill location																								
	P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
Land	89	65	52	32	2	57	5	2	6	9	17	4	6	11	19	68	70	94	88	64	78	58	31	14	67
1	n	n	n	1	3	9	5	1	4	4	4	3	7	2	57	n	n	n	n	n	n	n	9	n	n
2	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n	1	n	n
3	n	n	n	n	n	n	n	n	n	n	n	n	n	1	n	n	n	n	n	n	n	n	n	n	n
4	15	7	4	2	n	2	n	n	n	n	1	n	n	1	1	5	7	17	17	8	4	7	2	1	8
5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	42	23	15	23	2	37	4	2	5	7	12	2	3	8	15	44	29	58	25	20	18	n	16	5	28
9	22	10	8	17	1	23	1	n	1	2	6	n	1	3	6	34	12	18	13	11	11	n	17	3	15
10	22	32	30	5	1	11	n	n	n	1	3	n	1	1	3	13	32	14	49	37	52	46	9	8	27
11	16	7	5	3	n	7	1	n	n	1	1	n	n	n	2	7	5	13	10	6	5	n	3	1	8
12	n	n	n	n	n	32	n	n	n	1	6	n	n	1	1	n	n	n	n	n	n	n	23	n	n
13	n	n	n	3	5	35	34	17	33	41	45	8	9	31	50	3	n	n	n	n	n	n	32	1	n
14	n	n	n	n	n	n	n	n	n	n	n	1	2	n	n	n	n	n	n	n	n	n	n	n	n
15	n	n	n	n	n	16	11	5	11	16	30	2	1	13	5	n	n	n	n	n	n	n	50	n	n
16	n	n	n	n	1	16	11	5	12	16	25	2	1	11	14	n	n	n	n	n	n	n	58	n	n
17	26	34	32	6	1	12	1	n	1	1	5	n	n	2	4	16	36	20	53	41	55	*	11	8	31
18	n	n	n	n	n	n	n	n	n	n	n	2	5	1	n	n	n	n	n	n	n	n	n	n	n
19	12	5	3	2	n	15	1	n	1	1	6	n	n	3	2	4	4	11	8	5	4	n	13	1	7
20	21	9	6	8	1	27	3	n	3	5	5	2	2	4	8	16	9	20	14	10	9	n	14	1	12
21	n	n	n	n	1	n	n	n	n	n	1	8	21	6	n	n	n	n	n	n	n	n	n	n	n
22	32	15	11	20	1	5	4	2	4	6	13	3	4	10	6	41	15	23	16	14	14	n	11	5	21
23	7	3	2	1	n	2	n	n	n	n	n	1	3	n	n	3	2	4	2	2	2	n	1	n	4
24	42	35	29	12	1	10	1	n	1	1	5	n	1	2	6	21	41	58	59	38	50	n	10	8	33
25	27	17	9	8	n	6	n	n	n	1	3	n	1	2	3	12	22	51	24	13	9	n	7	3	16
26	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
27	3	1	n	1	n	11	7	3	7	10	19	1	1	10	7	1	1	n	n	1	n	n	23	n	1
28	18	6	4	3	n	5	1	n	1	1	1	1	1	1	1	7	6	15	12	6	5	n	2	1	7
29	18	6	4	4	n	1	n	n	n	n	2	n	2	2	1	8	6	11	6	4	5	n	n	1	8
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent
* - greater than 99.5 percent

Table 3D. -- Probabilities (in percent) that an oilspill starting at a paticular location will reach a certain object in 60 days.

Object	P1	P2 -E5	P3 -E6	P4	P5	P6	P7 -E2	P8 -E1	P9	P10	P11	P12	P13	P14	E3	E4	E7	E8	E9	E10	E11	E12	T1	T3	T4
	Hypothetical spill location																								
Land	94	76	65	45	10	67	20	17	21	22	28	18	19	26	34	77	79	99	94	74	85	58	42	24	80
1	n	n	1	4	7	10	10	7	9	7	9	10	13	7	59	2	1	n	n	n	n	n	11	2	n
2	n	n	n	n	n	n	n	n	n	n	1	n	n	1	n	n	n	n	n	n	n	n	1	n	n
3	n	n	n	n	n	n	n	n	n	n	1	1	n	1	n	n	n	n	n	n	n	n	n	n	n
4	16	10	7	5	1	4	1	1	2	2	2	n	n	1	2	6	9	20	19	10	6	7	3	3	10
5	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
6	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
7	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
8	42	24	18	28	7	42	13	10	12	13	18	10	9	18	22	40	30	58	25	23	20	n	22	9	30
9	23	12	11	20	4	25	7	5	8	8	10	3	3	7	8	35	14	18	14	14	13	n	20	6	17
10	25	37	34	9	4	13	4	4	4	5	6	3	3	4	9	19	36	15	51	40	55	46	11	12	33
11	18	10	9	6	n	10	2	1	2	2	2	n	n	1	4	8	8	15	13	8	7	n	5	2	12
12	n	n	n	n	n	32	3	3	3	4	8	n	n	4	1	n	n	n	n	n	n	n	23	n	n
13	1	2	3	11	15	36	43	31	43	47	52	22	20	40	55	8	2	n	1	2	2	n	36	6	3
14	n	n	n	n	n	n	1	2	1	1	1	4	7	2	n	n	n	n	n	n	n	n	n	n	n
15	n	n	n	n	1	16	18	12	19	23	34	5	2	19	8	n	n	n	n	n	n	n	52	n	n
16	n	n	n	2	4	17	20	12	20	22	30	6	3	17	21	n	n	n	n	n	n	n	59	1	n
17	30	40	38	11	4	15	5	4	6	6	7	1	n	4	10	22	40	22	55	43	58	*	14	13	38
18	n	n	n	n	1	n	2	4	2	2	3	11	15	5	n	n	n	n	n	n	n	n	n	n	n
19	13	8	7	4	1	17	4	4	6	6	9	1	1	5	3	5	6	13	11	7	6	n	15	1	9
20	23	12	11	11	4	31	8	6	7	9	9	6	6	9	12	17	11	23	17	12	11	n	18	4	16
21	n	n	1	3	12	n	9	15	8	6	12	30	47	27	2	2	n	n	n	n	n	n	1	2	n
22	33	18	15	23	6	8	10	10	10	11	18	13	13	20	10	43	18	23	18	18	16	n	14	9	24
23	7	4	3	2	1	3	1	2	1	1	1	4	7	2	1	3	3	5	3	2	2	n	1	1	5
24	44	38	31	17	4	14	5	5	6	6	7	3	4	5	12	24	43	58	60	39	51	n	13	10	36
25	27	17	10	10	1	8	3	3	5	4	6	3	4	4	6	13	22	51	24	14	9	n	8	4	16
26	n	n	n	n	n	n	n	1	n	n	n	1	2	1	n	n	n	n	n	n	n	n	n	n	n
27	3	1	1	1	2	12	12	8	11	13	21	3	2	13	10	1	1	n	1	1	1	n	25	1	1
28	19	9	8	6	2	7	3	2	3	2	3	5	6	4	2	8	8	17	14	9	7	n	4	2	10
29	18	8	6	5	3	2	2	3	2	2	4	6	8	7	2	9	7	11	7	5	6	n	1	3	9
30	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

n - less than 0.5 percent
* - greater than 99.5 percent

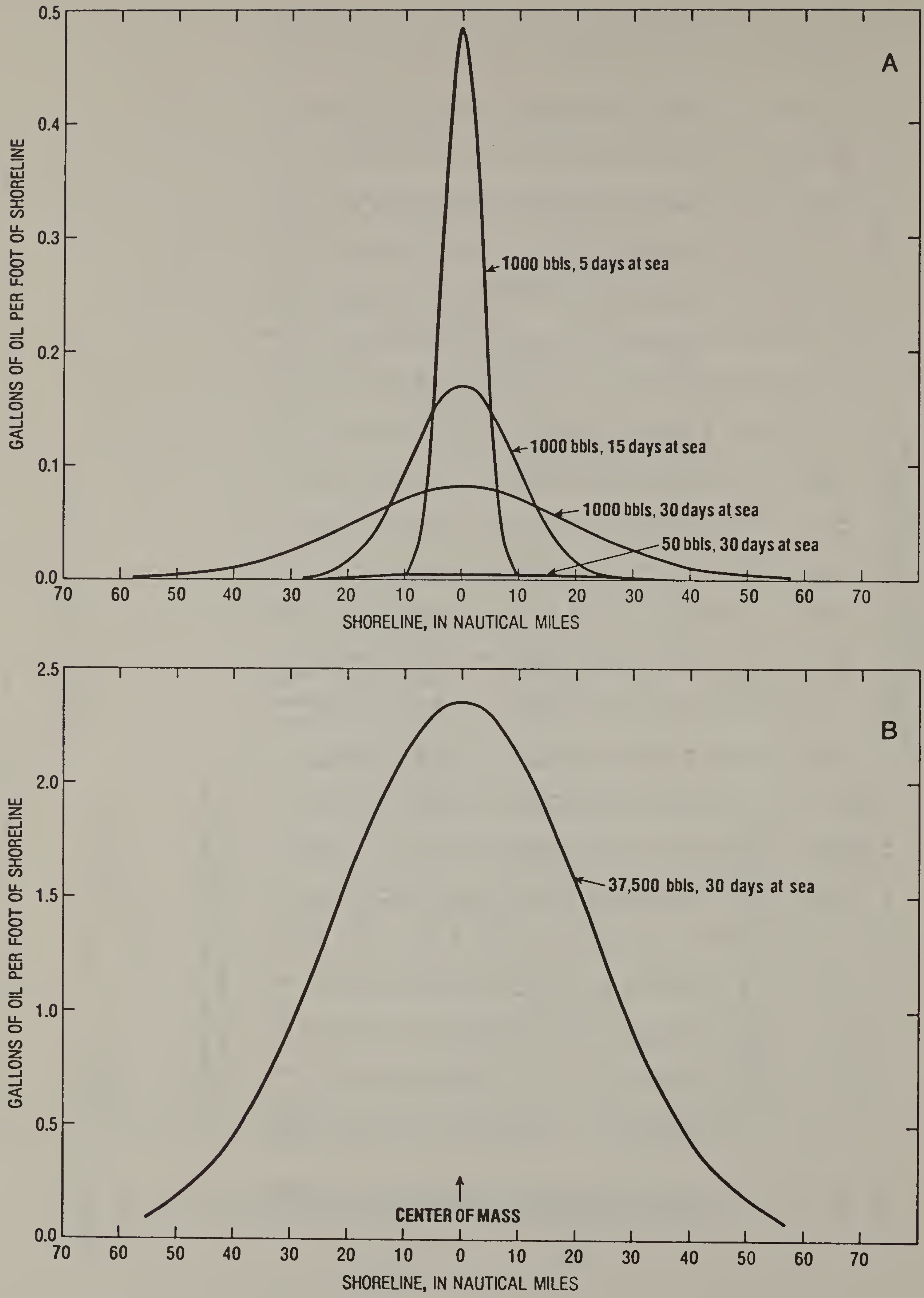

Figure 9.--Density of oil reaching an idealized shoreline (or object) as a function of travel time and initial size.

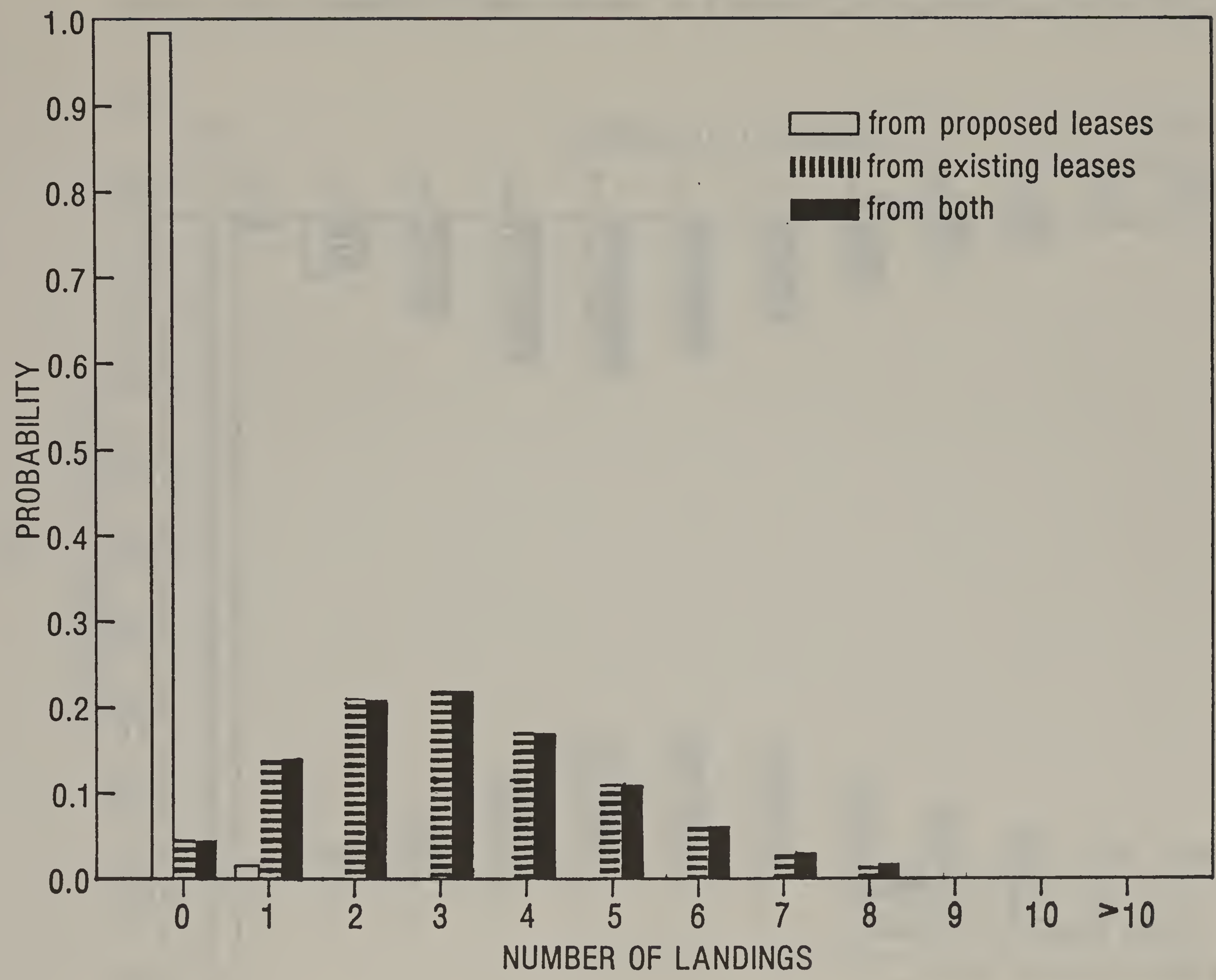

Figure 10A.--Probability distribution of frequency of landings within 3 days for oilspills greater than 1,000 barrels over the (remaining) production lives of the leases.

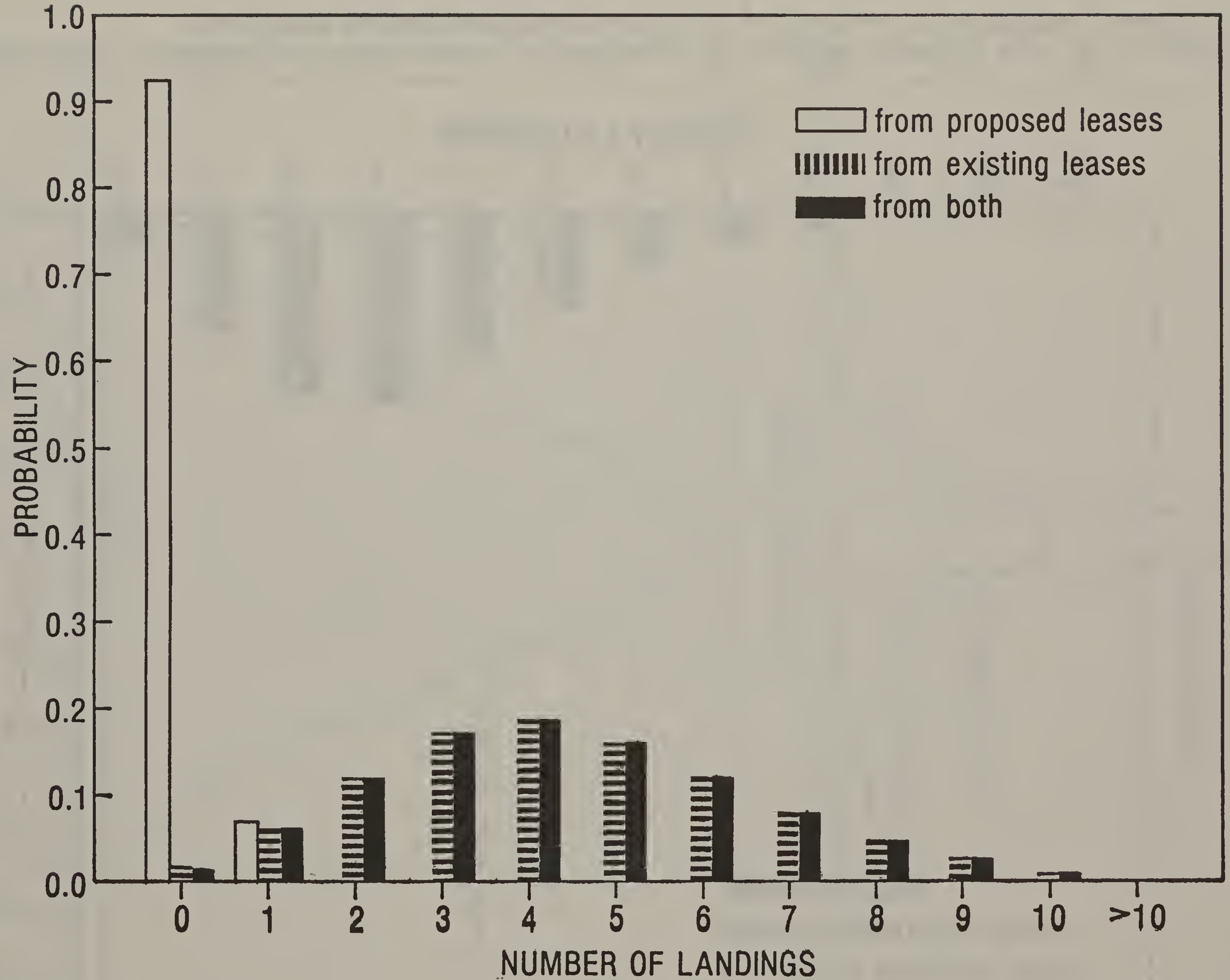

Figure 10B.--Probability distribution of frequency of landings within 10 days for oilspills greater than 1,000 barrels over the (remaining) production lives of the leases.

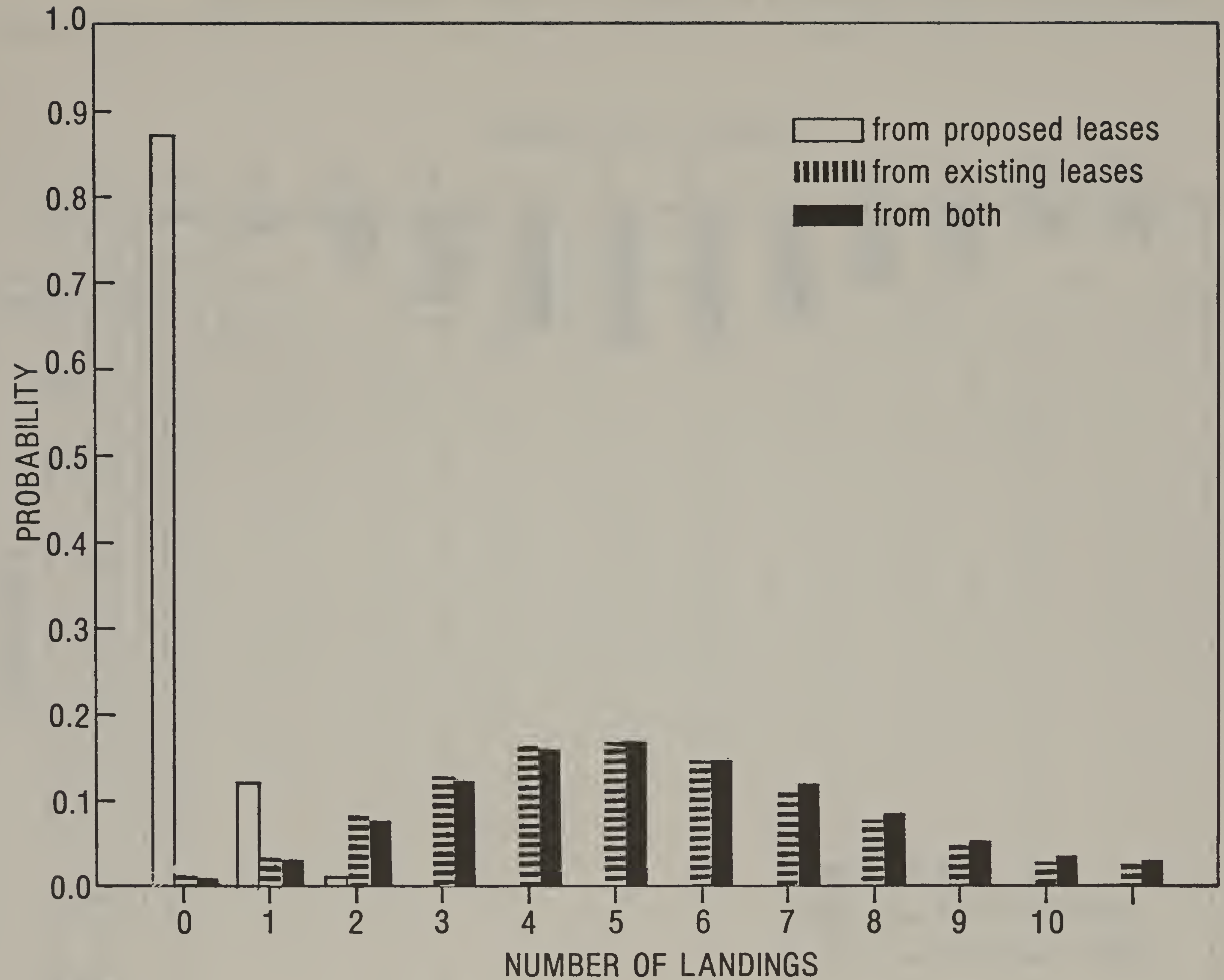

Figure 10C.--Probability distribution of frequency of landings within 30 days for oilspills greater than 1,000 barrels over the (remaining) production lives of the leases.

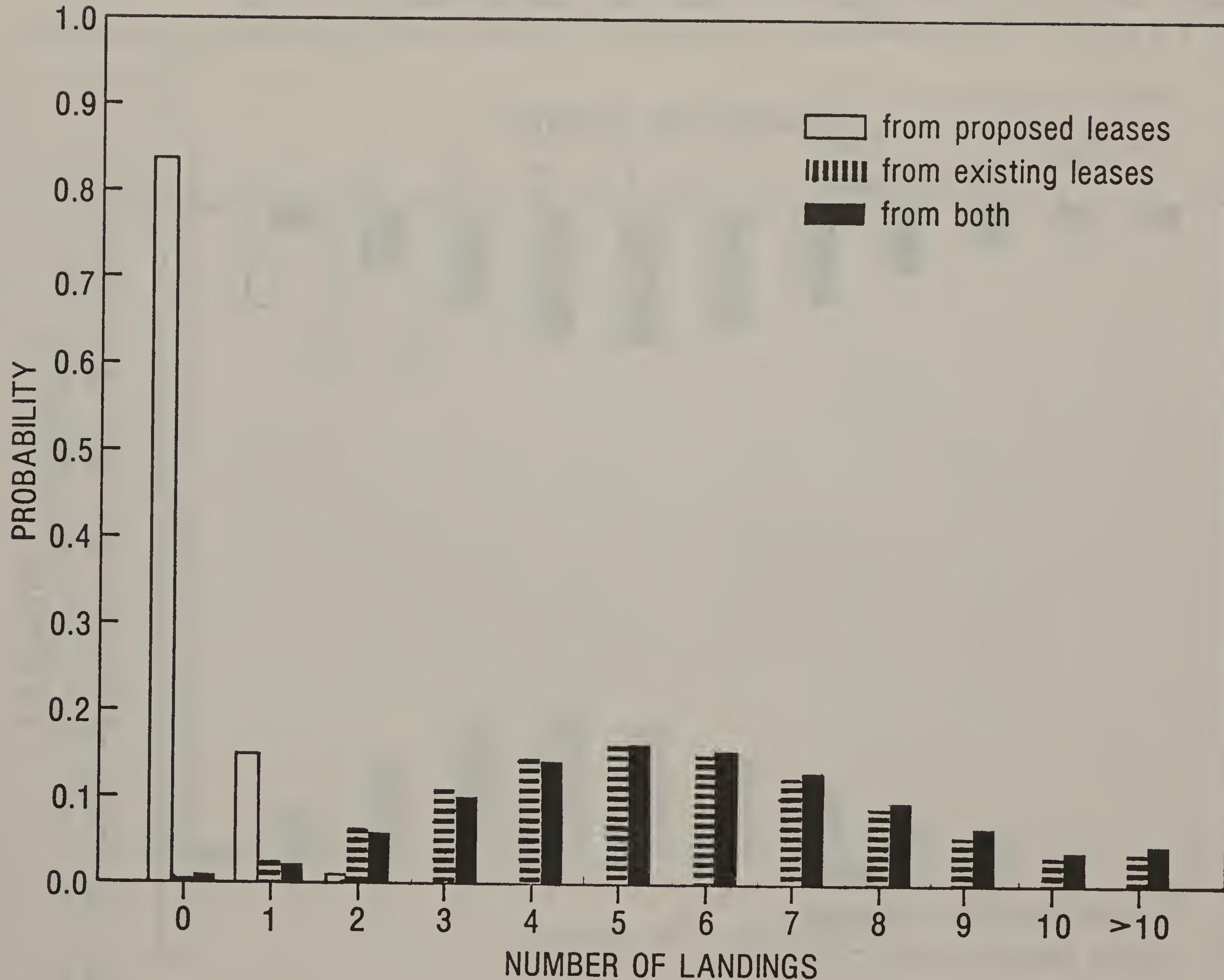

Figure 10D.--Probability distribution of frequency of landings within 60 days for oilspills greater than 1,000 barrels over the (remaining production lives of the leases.

TABLE 4 -- Probabilities (in percent) of one or more spills and most likely number of spills greater than 1,000 barrels occurring and contacting objects over the (remaining) production life of the lease area.

Object	Within 3 days						Within 10 days						Within 30 days						Within 60 days					
	Proposed Leases		Existing Leases		Both		Proposed Leases		Existing Leases		Both		Proposed Leases		Existing Leases		Both		Proposed Leases		Existing Leases		Both	
	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode	Prob	Mode
Land	2	0	95	3	95	3	7	0	99	4	99	4	13	0	99	5	99	5	16	0	*	5	*	5
1	n	0	n	0	n	0	n	0	n	0	1	0	1	0	n	0	2	0	2	0	2	0	5	0
2	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
3	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
4	n	0	17	0	17	0	1	0	24	0	25	0	2	0	37	0	38	0	2	0	43	0	44	0
5	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
6	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
7	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
8	1	0	18	0	19	0	4	0	52	0	54	0	6	0	65	1	67	1	8	0	68	1	71	1
9	1	0	n	0	1	0	2	0	27	0	29	0	4	0	45	0	47	0	5	0	51	0	54	0
10	n	0	93	2	93	2	2	0	96	3	96	3	4	0	97	3	97	3	5	0	97	3	97	3
11	n	0	n	0	n	0	1	0	4	0	5	0	2	0	26	0	27	0	2	0	35	0	37	0
12	1	0	n	0	1	0	1	0	n	0	2	0	2	0	n	0	2	0	2	0	n	0	2	0
13	n	0	n	0	n	0	2	0	n	0	3	0	5	0	1	0	6	0	8	0	10	0	17	0
14	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
15	2	0	n	0	3	0	4	0	n	0	5	0	5	0	n	0	6	0	6	0	n	0	6	0
16	3	0	n	0	4	0	4	0	n	0	5	0	6	0	1	0	6	0	7	0	1	0	7	0
17	n	0	98	3	98	3	3	0	99	4	99	4	5	0	99	4	99	4	6	0	99	4	99	4
18	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	1	0	n	0	1	0
19	n	0	n	0	n	0	1	0	3	0	5	0	2	0	21	0	23	0	3	0	29	0	31	0
20	1	0	n	0	1	0	1	0	19	0	21	0	3	0	41	0	43	0	5	0	48	0	51	0
21	n	0	n	0	n	0	n	0	n	0	n	0	1	0	n	0	1	0	3	0	1	0	4	0
22	2	0	n	0	2	0	3	0	30	0	32	0	5	0	54	0	56	0	6	0	60	0	62	0
23	n	0	n	0	n	0	n	0	2	0	3	0	1	0	11	0	11	0	1	0	12	0	13	0
24	n	0	85	1	85	1	4	0	91	2	91	2	6	0	92	2	93	2	7	0	93	2	93	2
25	n	0	25	0	25	0	3	0	42	0	43	0	3	0	45	0	46	0	4	0	45	0	47	0
26	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
27	1	0	n	0	1	0	2	0	1	0	3	0	3	0	3	0	5	0	3	0	4	0	7	0
28	n	0	n	0	n	0	1	0	7	0	8	0	2	0	27	0	29	0	3	0	36	0	37	0
29	1	0	n	0	1	0	1	0	8	0	9	0	2	0	23	0	25	0	3	0	28	0	29	0
30	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0

Notes: Prob is the probability (in percent) of one or more spills contacting the object.
Mode is the most likely number of contacts.
n - less than 0.5 percent.
* - greater than 99.5 percent.

Table 5. -- Probabilities (in percent) of one or more spills and most likely number of spills greater than 1,000 barrels occurring and contacting land segments over the (remaining) production life of the lease area.

Land Segment Number	Within 3 days: Proposed Leases Prob	Mode	Existing Leases Prob	Mode	Both Prob	Mode	Within 10 days: Proposed Leases Prob	Mode	Existing Leases Prob	Mode	Both Prob	Mode	Within 30 days: Proposed Leases Prob	Mode	Existing Leases Prob	Mode	Both Prob	Mode	Within 60 days: Proposed Leases Prob	Mode	Existing Leases Prob	Mode	Both Prob	Mode
1	n	0	40	0	40	0	n	0	43	0	43	0	n	0	43	0	43	0	n	0	44	0	44	0
2	n	0	89	2	89	2	2	0	94	2	94	2	3	0	95	2	95	3	4	0	95	3	95	3
3	n	0	10	0	10	0	n	0	14	0	15	0	n	0	15	0	16	0	n	0	15	0	16	0
4	n	0	1	0	1	0	n	0	3	0	3	0	n	0	3	0	3	0	n	0	3	0	3	0
5	n	0	n	0	n	0	n	0	1	0	1	0	n	0	1	0	1	0	n	0	4	0	4	0
6	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
7	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
8	n	0	n	0	n	0	n	0	1	0	1	0	n	0	6	0	6	0	n	0	10	0	11	0
9	n	0	18	0	18	0	2	0	35	0	37	0	2	0	38	0	39	0	3	0	38	0	40	0
10	n	0	n	0	n	0	1	0	3	0	4	0	1	0	21	0	22	0	2	0	29	0	30	0
11	1	0	n	0	1	0	1	0	23	0	24	0	1	0	29	0	29	0	1	0	30	0	31	0
12	1	0	n	0	1	0	1	0	6	0	7	0	1	0	9	0	10	0	1	0	9	0	11	0
13	n	0	n	0	n	0	n	0	n	0	n	0	n	0	2	0	2	0	n	0	2	0	2	0
14	n	0	n	0	n	0	n	0	n	0	n	0	n	0	10	0	10	0	n	0	13	0	13	0
15	n	0	n	0	n	0	n	0	n	0	n	0	n	0	9	0	9	0	n	0	14	0	14	0
16	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
17	n	0	n	0	n	0	n	0	n	0	n	0	1	0	n	0	1	0	1	0	n	0	2	0
18	n	0	n	0	n	0	n	0	n	0	n	0	1	0	n	0	1	0	1	0	n	0	1	0
19	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
20	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
21	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
22	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
23	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
24	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
25	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
26	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
27	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
28	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
29	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
30	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
31	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
32	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
33	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
34	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
35	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
36	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
37	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
38	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
39	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
40	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
41	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
42	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
43	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
44	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
45	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
46	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
47	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
48	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
49	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
50	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
51	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0
52	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0	n	0

Notes: Prob is the probability (in percent) of one or more spills contacting the object.
Mode is the most likely number of contacts.
n - less than 0.5 percent.

biological resources on the basis that their sensitivity to spilled crude is dependent on contact with soluable toxic components of the oil fractions which tend to evaporate relatively rapidly from a spreading slick. Past experience with oilspills in shellfish areas has ranged from reportedly severe and lasting effects in the case of the West Falmouth spill, when toxic components of the oil were quickly churned into near-shore sediments (Blummer, 1970), to much more modest effects following the Torrey Canyon spill when more time was available for weathering before contact (Smith, 19698). These differences in effects occurred despite the fact that the Torrey Canyon spilled more than 150 times the volume lost in the West Falmouth spill. Three days is reported to be sufficient time for evaporation and dissolution of most of the toxic aromatic fractions of crude oil, with less time required under high wind conditions (Offshore Oil Task Group, 1973).

Combined Analysis: Spill Frequency Estimates and Oilspill Trajectories

It is worth briefly summarizing some of the important points to be drawn from the results presented thus far. Data in table 1 indicate that the proposed leasing will add about 260 spills to the already existing expected number of spills of about 6470 (a ratio of about 25 to 1) and none are likely to exceed 1,000 barrels. Furthermore, consideration of travel time to contact (tables 2 and 3), evaporation rates, and rates of slick dispersion (figure 9) leads to the conclusion that an individual spill would need to be as large as 1,000 barrels in size in order to have significant ecological contact. The probabilities in tables 2 and 3 give the chances that if a spill occurs in the lease area it would contact an object within the allotted time.

With respect to the hazard of major spills (that is, greater than 1,000 barrels), the data presented in tables 2 and 3 represent only a partial solution to the problem of assessing oilspill risks to important resources. The overall oilspill risk posed by oil and gas development in the proposed sale must be assessed as a joint function of the probability that spills will occur in the course of development as well as the likelihood that spills will follow certain trajectories. Thus, the data in tables 2 and 3 must be combined with the spill frequency estimates presented in figures 2 and 3 to obtain a total probability distribution for contacts with individual objects.

Despite the intuitive logic of simply multiplying the probabilities in figure 3 by those in tables 2 and 3, the correct computation of the overall or "total" probability is in fact somewhat more complicated. This results from the fact that the probabilities presented in tables 2 and 3 are actually conditional probabilities and refer to the probabilities of contact on objects "conditioned" on the chance of spills occurring in the first place. The overall probability that oilspills will contact a particular object exactly k times during the production life of the area, P(k), is given by

$$P(k) = \sum_{n=k}^{\infty} P(k|n)\ P(n)$$

where P(k n) is the probability of k contacts with the resource given the occurrence of n spills, and P(n) is the probability P(k n) can be assumed to be distributed binomially and is given by

$$P(k|n) = \binom{n}{k} p^{k} (1-p)^{n-k}$$

where p is the probability of contac with the object given the occurrence of a spill (tablers 2 and 3). The combined probability distributions calculated in the above manner for spills coming ashore is presented in figure 10 for the four "milestones" time periods. The distributions are based on spill frequency estimates from figure 3 and therefore refers to contacts from all spills originating as 1,000 barrels or greater during the production life of the total lease area. Figure 10 (A-D) indicates that there is a 98.5 percent probability that no oilspill greater than 1,000 barrels will occur and come ashore within 3 days in the course of oil production in the proposed leases and that there is an 84% chance that no oilspill greater than 1,000 barrels will occur and come ashore within 60 days from the proposed leases. In contrast, the comparable numbers for the existing leases are 5% and 0.5% respectively, and almost the same, respectively, for the combination of both the proposed and existing leases.

Probability distributions similar to those in figure 10 can be developed and likewise interpreted for each of the 30 categories of biological resources, recreation areas, and other objects. Statistics for spills greater than 1,000 barrels occurring during the production life of the area and contacting the various resource groups are given in table 4. Similar statistics for land segments are given in table 5.

It is emphasized that probability estimates refer only to the chances that oil in some form or another, from a spill originating larger than 1,000 barrels, will come in contact with some portion of an object. The mitigating effects of weathering processes and clean-up efforts are only indirectly reflected in the probabilities in tables 4 and 5 by virtue of the fact that estimates apply only to large spills. Figure 9 provides a rough description of the likely effects of evaporation and dispersion on spills of various sizes as a function of time. To this must be added the likelihood of at least some, and perhaps considerable, success in containing oil in the course of the days or weeks separating the occurrence of a spill on the OCS and its arrival on shore.

It is important that the distinction between the probabilities is given in tables 2 and 3 and those in tables 4 and 5 be very clear. The data given in tables 2 and 3 refer only to the likelihood that spills would follow certain trajectories and have nothing to do with the chances that spills would occur in the first place. The probabilities in tables 4 and 5, by contrast, reflect both the expected frequency of spill occurrence as well as the likelihood of certain trajectories.

Relative Risks of Leasing

The risk due to the proposed leasing appears to be quite small. Table 4 shows that the highest probability of an object, other than land, being contacted by one or more large spills from the proposed leases is only 8 percent if a travel time of 60 days is allowed. With few exceptions, the increase in the probability, due to the proposed leasing, that any object, including land, will be contacted by a large spill is no more than 3 percentage points over the already existing risk.

REFERENCES

Blummer, M., Sonza, S., and Sass, j., 1970, Hydrocarbon polluting of edible shellfish by an oil spill: Marine Biology, v. 5, p. 195-202.

Csanady, G. T., 1973, Turbulent diffusion in the environment: D. Reidel Publishing Co., Geophysics and Astrophysics Monographs, v. 3, Boston.

Danenberger, E. P., 1976, Oil spills, 1971-75, Gulf of Mexico Outer Continental Shelf: Geological Survey Circular 741, 47 p.

Devanney, J. W., III, and Stewart, R. J., 1974, Analysis of oil-spill statistics: Report to Council of Environment Quality, Wash., D.C., 126 p.

Jeffery, P. G., 1973, Large-scale experiment on the spreading of oil at sea and its disappearance by natural forces, In Proceedings of Conference on Prevention and Control of Oil Spills (1973): p. 469-474.

Nelson, W. L., 1958, Petroleum refinery engineering, New York, McGraw-Hill.

Offshore Oil Task Group, 1973, The Georges Bank petroleum study, v. II: MIT Sea Grant Report, 311 p.

Ralph M. Parsons Library, 1976, A review and evaluation of basic techniques for predicting the behavior of surface oil slicks, In Report to Deep water Ports Office: Natl. Oceanog. Aeronaut. Admin., 171 p.

Smith, J. E., ed., 1968, Torrey Canyon pollution and marine life, Cambridge University Press, Cambridge.

Stewart, R. J., 1975, Oil spillage associated with the development of offshore petroleum resources, In Report to Organization for Economic Co-operation and Development: 49 p.

Stewart, R. J., 1976, A survey and critical review of U.S. oil spill data resources with application to the tanker/pipeline controversy, Report to U.S. Department of the Interior, Wash., D.C., 69 p.

U.S. Department of the Interior, Bureau of Land Management, 1977, Proposed 1977 outer continental shelf oil and gas lease sale in the Western Gulf of Alaska (OCS Draft Environmental Statement), 4 volumes.

Wardley-Smith, J., ed., 1976, The control of oil pollution on the sea and inland waters, Graham and Trotman, Ltd., United Kingdom, 251 p.

Appendix I

Call for Nominations and Comments for Proposed Sale 65

UNITED STATES DEPARTMENT OF THE INTERIOR

Bureau of Land Management

EASTERN GULF OF MEXICO OUTER CONTINENTAL SHELF

(TENTATIVE SALE NO. 65)

CALL FOR NOMINATIONS OF AND COMMENTS ON AREAS FOR OIL AND GAS LEASING

The Department of the Interior on May 17, 1977, identified a new proposed sale in the Eastern Gulf of Mexico Outer Continental Shelf (OCS Sale No. 65). Therefore, the Department is issuing this supplemental Call for Nominations for the area. This Call area constituted a part of a Call for Nominations and Comments for proposed OCS Sale No. 51 (42 FR 9452, February 16, 1977). The areas identified in this call will not be considered for proposed OCS Sale No. 51.

Pursuant to the authority prescribed in 43 CFR 3301.3 (1976), nominations are hereby requested for areas on the Eastern Gulf of Mexico Outer Continental Shelf for possible oil and gas leasing under the Outer Continental Shelf Lands Act (43 U.S.C. 1331-1343 (1970)). Nominations will be considered for any or all of that part of the following mapped areas, on OCS Official Protraction Diagrams, seaward of the submerged lands of the adjacent States.

1. **NH 16-5 Pensacola except that area between the west boundary of the E95 range of blocks and the west boundary of the E118 range of blocks)**
2. **NH 16-8 Destin Dome (except that area between the west boundary of the E95 range of blocks and the west boundary of the E118 range of blocks); (formerly Pensacola South No. 1)**
3. **NH 16-11 De Soto Canyon (except that area between the west boundary of the E95 range of blocks and the west boundary of the E118 range of blocks); (formerly Pensacola South No. 2)**
4. **NH 16-9 Apalachicola**
5. **NH 16-12 Florida Middle Ground (formerly Apalachicola South)**
6. **NG 16-3 The Elbow (formerly Tampa West No. 1)**
7. **NG 16-6 Note: Unnamed (formerly Fort Myers West No. 2)**
8. **NH 17-7 Gainesville**
9. **NH 17-10 Tarpon Springs**
10. **NG 17-1 Saint Petersburg (formerly Tampa)**
11. **NG 17-4 Charlotte Harbor (formerly Fort Myers West No. 11)**

All these maps may be purchased for $2 each from the Manager, New Orleans Outer Continental Shelf Office, Bureau of Land Management, Suite 841, Hale Boggs Federal Building, 500 Camp Street, New Orleans, Louisiana 70130.

All nominations must be described in accordance with the Outer Continental Shelf Official Protraction Diagrams prepared by the Bureau of Land Management, Department of the Interior and referred to above. Only whole blocks or properly described subdivisions thereof, not less than one quarter of a block, may be nominated.

In addition to requesting nominations of tracts for possible oil and gas leasing within the specified areas, this notice also requests comments identifying particular tracts recommended to be either specifically excluded from oil and gas leasing or leased only under special conditions because of conflicting values or environmental concerns. Particular geological, environmental, biological, archaeological, socioeconomic or other information which might bear upon potential leasing and development of particular tracts is requested where available. Information on these subjects will be used in the tentative selection of tracts which precedes any final selection by the Director pursuant to 43 CFR 3301.4. This information is requested from Federal, State and local governments, industry, universities, research institutes, environmental organizations, and members of the general public. Comments may be submitted on blocks or subdivisions thereof, as required for nominations, or on all areas or portions thereof as described above. They should be directed to specific factual matters which bear upon the Department's decision whether to make a preliminary selection of particular tracts within these areas for further environmental analysis pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321-4347 (1970)) and possible leasing. Comments relating to general matters which would be applicable to oil and gas operations in any part of the OCS are not sought at this time.

Nominations and comments must be submitted not later than June 30, 1977, in envelopes labeled "Nominations of Tracts for Leasing in the Outer Continental Shelf Eastern Gulf of Mexico," or "Comments on Leasing in the Outer Continental Shelf Eastern Gulf of Mexico," as appropriate. They must be submitted to the Director, Attention 720, Bureau of Land Management, Department of the Interior, Washington, D.C. 20240. Copies must be sent to the Conservation Manager, Gulf of Mexico OCS Operations, Geological Survey, Suite 336, Imperial Office Building, 3301 North Causeway Boulevard, Metairie, Louisiana 70011 and to the Manager, New Orleans Outer Continental Shelf Office, Bureau of Land Management at his address cited above.

This call for nominations and comments does not in any way commit tbe Department to leasing in the Eastern Gulf of Mexico. It is an information-gathering component of the Department's leasing procedure.

Final selection of tracts for competitive bidding will be made only after compliance with established Departmental procedures and all requirements of the National Environmental Policy Act of 1969. Notice of any tracts finally selected for competitive bidding will be published in the FEDERAL REGISTER stating the conditions and terms for leasing and the place, date, and hour at which bids will be received and opened.

/s/ Curt Berklund
Director, Bureau of Land Management

Approved:

/s/ Guy R. Martin
Assistant Secretary of the Interior