FINAL
NVIRONMENTAL STATEMENT

For a Proposed
1973 OUTER CONTINENTAL SHELF
OIL AND GAS GENERAL LEASE SALE
SHORE MISSISSIPPI, ALABAMA, AND FLORIDA

OCS SALE NO. 32
FES 73–60

Volume 1 of 5

Description of the Proposal

and

Environmental Setting

Prepared by the
BUREAU OF LAND MANAGEMENT
U.S. DEPARTMENT OF THE INTERIOR

Director

Summary

( ) Draft (X) Final Environmental Statement
Department of the Interior, Bureau of Land Management, Division of Marine Minerals

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

2. One hundred and forty-seven tracts (817,338 acres) of OCS lands are proposed for leasing action. The tracts are located offshore Mississippi, Alabama, and Florida. If implemented, this sale is tentatively scheduled to be held in late fall, 1973.

3. All tracts offered pose some degree of pollution risk to the environment and adjacent shoreline. The risk potential is related to adverse effects on the environment and other resource uses which may result principally from accidental or chronic oil spillage. Each tract offered is subjected to a matrix analytical technique in order to evaluate significant environmental impacts should leasing and subsequent oil and gas exploration and production ensue.

4. Alternatives considered:
   - A. Hold the Sale in Modified Form
     1. Delete Tracts
     2. Substitute Tracts
   - B. Withdraw the Sale
     1. Energy Conservation
     2. Conventional Oil and Gas Supplies
     3. Coal
     4. Synthetic Sources of Oil and Gas
     5. Hydroelectric Power
     6. Nuclear Power
     7. Energy Imports
     8. Other Energy Sources
     9. Combination of Alternatives
   - C. Delay Sale
     1. Pending New Technology
     2. Pending Completion of Studies
     3. Pending Development of Onshore Land Use Plans
     4. Pending Completed Implementation of Recommendations Made in Reports on OCS Operating Orders and Regulations

5. Comments have been requested from the following:

Environmental Protection Agency*

Department of Commerce*
National Oceanic and Atmosphereic Administration

Department of Defense*

Department of Transportation*
U. S. Coast Guard

Department of Treasury

Atomic Energy Commission*

Federal Power Commission*

State of Florida*
Department of Administration

State of Louisiana*
Commission on Intergovernmental Relations

State of Alabama*
Alabama Development Office

State of Mississippi*
Coordinator for Federal-State Programs

State of Texas
Office of the Governor

Department of the Interior
Bureau of Sport Fisheries and Wildlife*
Bureau of Outdoor Recreation*
Bureau of Mines*
Geological Survey*
National Park Service*
Office of Oil and Gas*

6. Final statement made available to the Council on Environmental Quality and the public on October 17, 1973.

Draft statement was made available to Council on Environmental Quality and the public on July 16, 1973.

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* Comments or acknowledgement received.

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Note:

This final environmental statement has been prepared pursuant to section 102(2)(C) of the National Environmental Policy Act of 1969.

The regulations to which reference is made throughout this environmental statement are 30 CFR Part 250 and 43 CFR 3300, and Geological Survey OCS Orders Nos. 1 through 12 - Gulf of Mexico. The OCS Orders for the Gulf of Mexico have been appended to this statement (see Attachment A). Although too bulky to append here, the CFR's cited may be obtained from the United States Department of the Interior.

I. DESCRIPTION OF PROPOSAL

A. Background of Proposal

"As America has become more prosperous and more heavily industrialized, our demands for energy have soared. Today, with 6% of the world's population, we consume almost a third of all energy used in the world. Our energy demands have grown so rapidly that they now outstrip our available supplies, and at our present rate of growth, our energy needs a dozen years from now will be nearly double what they were in 1970."

President's Energy Message
April 18, 1973

As the President indicated, the U.S. is the single largest energy-consuming nation in the world, accounting for one-third of the world's total consumption. The growth in domestic demand for electric power and industrial demand for energy has caused a sustained high level of energy demand; from 1960 to 1970 demand increased at an average rate of 4.3% per year. Domestic production of the two primary energy sources, petroleum and natural gas, has not been able to keep pace with demand. As indicated in the following table (Tab. 1), this gap is expected to widen.

Table 1 Supply and Demand of Petroleum and Natural Gas 1/

	1971 2/	1980	1985
Petroleum (million barrels/day)			
Projected Demand	15.1	20.8	25.0
% of total U.S. Energy Demand	44.1	43.9	43.5
Projected Domestic Supply	11.3	11.7	11.7
% of Domestic Petroleum Demand that will be fulfilled by domestic supply	74.0	56.3	46.6
Natural Gas (trillion cubic feet)			
Projected Demand	22.0	26.2	27.5
% of total U.S. Energy Demand	33.0	28.1	24.3
Projected Domestic Supply	21.1	23.0	23.8
% of Domestic Gas Demand that will be fulfilled by domestic supply	96.0	85.5	80.7

1/ Dupree, W. G. and J. A. West. 1972. United States energy through the year 2000. U.S. Department of the Interior, Washington, D.C. (Dec., 1972).

2/ Actual

B. Proposed Five-Year Schedule - Provisional OCS Leasing

The proposed schedule is continually being updated and revised within the Department.[1/] Improved resource information has been acquired and the overall supporting analysis is being refined in line with the current energy situation. In the development of the schedule, the Department considered its three leasing objectives; orderly resource development, protection of the environment, and receipt of fair market value. These objectives constitute overall policy parameters for the OCS program and consideration accorded to each may vary from one component to another. An analysis was made in broad terms of when, where, and how much oil and gas acreage to offer for lease. This was done through a review of the national energy situation and the identification of future supply-demand imbalances. Deficits were identified by matching projections of future non-OCS supplies of oil and gas and future OCS production from existing leases with future projected demand. Demand forecasts were made on a regional basis, using the regions of the Future Requirements Committee for gas and the Petroleum for Administration of Defense districts for oil. New OCS sales were proposed in line with helping to meet the deficits. Different alternative schedules were tested with respect to their impact on demand.

These different options were also reviewed from the perspective of receipt of fair market value. The size and frequency of sales can in-

1/ See Attachment B.

induce or inhibit a competive market which in turn affects the Government's recepit of fair market value. In FY 1973, three general lease sales were held resulting in the lease of 290,321 acres, 535,874 acres, and 547,173 acres each. Bidding in these sales was highly competitive with more than $3.8 billion in bonus bids accepted.

In view of the projected need for energy supplies together with the realization that our traditional sources of fossil fuel supplies are finite and exhaustible, it is becoming increasingly evident that new OCS areas must be made available as part of the short-term supplement to our energy supplies.

It is within this context that the MAFLA sale is proposed. This area is the most logical "new" area for a proposed sale since it would be a northeastern extension of over twenty-five years leasing experience off the Texas and Louisiana Gulf of Mexico. In addition, new areas such as MAFLA, must be proposed early in the schedule because they require a longer lead time between leasing and production for exploration and justification of pipeline construction, among other things.

Under the proposed five-year schedule, an environmental impact statement based upon detailed analysis of all appropriate data will be prepared for each proposed OCS oil and gas lease sale included in the five-year schedule. In addition, an environmental analysis of the overall impact of OCS oil and gas operations resulting from the proposed schedule is being initiated.

No sales are scheduled on the Atlantic OCS or in the Gulf of Alaska. However, studies of the environmental, natural resources, mineral, economic, and other regional factors of these areas are being and will be carefully analyzed. An in-house data reconnaissance study on the Mid-Atlantic areas has been completed. 1/

The Bureau of Land Management has awarded contracts to independent research groups for environmental and socio-economic analysis of Alaska, Atlantic and Gulf of Mexico areas. BLM is also currently working closely with the Council on Environ-

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1/ Library Research Project Mid-Atlantic Outer Continental Shelf (Reconnaissance), Dept. of Interior, Bureau of Land Management, December, 1972.

mental Quality and other Federal agencies to provide as a result of these contract studies, the information necessary for the implementation of the President's directive in his April 18, 1973 Energy Message, to assess the environmental impact of oil and gas production on the Atlantic OCS and in the Gulf of Alaska. The proposed schedule has indicated that if CEQ's study of the environmental impact determines that development in these areas can proceed in an environmentally satisfactory manner, lease sales in one or both areas will be added to the proposed schedule at the earliest practicable time.

C. Activity, Environment, and Impact from the Five-Year Schedule in the Gulf of Mexico

1. Proposed Sale

Sales tentatively included in the proposed five-year schedule are shown on Attachment A.

2. Development

The following table (Tab. 2) indicates the intensity of activity that will be required in order to develop the hydrocarbon reserves believed to underlie areas included in the Gulf of Mexico.

3. Environment

The coastal zone of the Gulf of Mexico is richly endowed with estuaries and coastal marshes. Over 200 estuarine systems extend from Florida Bay and the famous Ten Thousand Islands of the Everglades to the

Table 2 Activity Required to Develop Hydrocarbon Reserves in the Proposed Area

	This Proposed Sale	Status June 30, 1973	Increment: 1/ Five-Year Schedule	1978 Status
a. Acres under lease (million)	0.654 2/	4.3	8.0 - 10.0	12 - 14 3/
b. Reserves to be developed:				
- oil (bil. bbl.)	1.5 - 2.4		7.0 - 15.0	
- gas (tcf)	1.8 - 2.9		50 - 100	
c. Remaining reserves:				
- oil (bil. bbl.)		4.0		4.0 - 8.0
- gas (tcf)		32		32 - 60
d. Wells	700-1,120	11,162 5/	6,000-15,000	17,000-26,000
e. Platforms	75 - 125	1,956	800-1,900	2,800-3,900
f. Miles of Pipelines	480 - 800	7,000 4/	2,000-4,000	9,000-11,000
g. Terminal/Storage Facilities	5 - 8	74 - 82	14 - 32	90 - 120
h. Support/Supply Facilities	12 - 15			

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

2/ Estimated that 80% 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/ 4,256 wells plugged and abandoned.

hypersaline Laguna Madre of the Southwest Texas coast. It is estimated that there are about 12.7 million acres of estuary and coastal marsh habitat in the five states bordering the Gulf of Mexico. This is about 45% of the total estuary and coastal marsh area in the contiguous 48 states, about two-thirds of the coastal marshes and one-third of the estuarine water area. It is this area of shallow estuaries and marshes that makes the Gulf of Mexico so productive of fish and wildlife resources. 1/

From the shoreline of the barrier islands of the Gulf, waters deepen gradually at a rate of about six feet per mile out to depths of about 300 feet, where the gradient increases more rapidly out to the shelf break or continental slope. In some areas the shelf is more than 100 miles wide. The Gulf coast area lies, generally, in a zone of transition between tropical and temperate weather patterns. The climate is mild (mean temperature 69° F.) and the area receives considerable precipitation (55 inches annually). Wind flows are complicated, particularly in the cold months, when the normal track of disturbance traveling west to east lies near the coast.

The Gulf of Mexico is defined ecologically as a high energy system in which the naturally generated energy supply is sufficient to maintain

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1/ U.S. Congress, Senate, Report of the Secretary of the Interior to the U.S. Congress, the National Estuarine Pollution Study, 91 st Congress, Second session, March 1970.

a large and diverse population of plant and animal life. The extensive shallow water area of the Continental shelf provides a broad expanse of nutrient laden substrate that tends to concentrate commercial species of fish where they can be caught readily.

a. Wildlife

The coastal area in and adjacent to the Gulf of Mexico offers wintering and nesting areas for a large proportion of the waterfowl population of the United States. It is the southern terminal for much of the Central Flyway and both the Mississippi and Atlantic Flyways. Twenty-five national wildlife refuges, including 486,780 acres are located in the area. These are distributed as follows:

	National Wildlife Refuges	Acres
Texas	5	131,333
Louisiana	5	232,476
Florida	15	122,971

In addition, 66,250 acres of wildlife habitat adjacent to the refuges have been closed to hunting by Presidential Proclamation.

Each State, including Louisiana, Alabama and Mississippi, Florida, and Texas, also operates several wildlife refuges or management areas adjacent to the Gulf of Mexico.

b. Fishery Resources

The rich nutrient laden estuarine zone and its adjacent oceanic waters produces an abundance of sport, commercial and nongame or noncommercial fishery resources. The major species harvested includes, mullet, grouper, mackerel, snapper, menhaden, flounder, seatrout, bluefish, blue runner, croaker, drum, grunt, pompano, spot, ladyfish, thread herring, shrimp, crab, oysters, lobster, clam, and scallops.

c. Recreation

The Gulf of Mexico offers a wide variety of outdoor recreation opportunities. 2/ Included are swimming, boating, sailing, fishing, diving, wildlife study, and shelling.

Florida

Florida's total recreation shoreline on the Gulf of Mexico is 1,755 miles including 111 miles of public recreation areas and 771 miles of

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1/ The National Estuarine Pollution Study, op. cit., p. 116.

2/ All statistics pertaining to outdoor recreation were taken from, Shoreline Recreation Resources of the United States, Outdoor Recreation Resources Review Commission, Report No. 4, 1962.

beach. Approximately half of the entire shoreline (840 miles) consists of mangrove swamps or marsh.

Alabama

Total recreation shoreline in Alabama is 204 miles including 115 miles of beach and 89 miles of marsh shore and only 3 miles of public recreation areas.

Mississippi

Mississippi's total recreation shoreline is 203 miles including 69 miles of marsh shore and 134 miles of beach. The Mississippi mainland shoreline lies some miles behind a widely broken chain of offshore islands (Petit Bois, Horn, Ship and Cat Islands), which protect the shore from the open Gulf.

Louisiana

Louisiana's total recreation shoreline (including Lake Pontchartrain) is 1,076 miles including 819 miles of marsh shore and 257 miles of beach.

Texas

Area available for recreation in the Texas coastal zone is 23.3 square miles, or 0.2% of the total land area in the coastal zone. 1/ This recreation area includes 343 linear miles of beach and 359 miles of marsh shore. The shorelines are probably as little developed as any beach areas in the United States.

Table 3 National Park Service Units, Potential New Areas, and National Landmarks in the Gulf of Mexico 2/

National Park Service units in the Gulf of Mexico area are:

Padre Island National Seashore
Gulf Islands National Seashore
DeSoto National Monument
Everglades National Park
Fort Jefferson National Monument

Potential new areas:

Suwanee Wild and Scenic River
Jean Lafitte National Cultural Park
Wakulla River National Monument or Wild and Scenic River

National Landmarks:

Fort Morgan National Historic Landmark
Fort San Marcos De Apalche National Historic Landmark
Safety Harbor Site National Historic Landmark
Lignumvitae Key Natural Landmark

1/ Flawn, P. T. and B. Fisher, 1970. Land-use Pattern in the Texas Coastal Zone. In. The coastal resources management programs of Texas, appendices. Ed. by J. T. Goodwin and J. C. Mosely, Coastal Resources Management Program, Office of the Governor, Austin.

2/ Current data, National Park Service.

4. <u>Resource Use and Commercial Activity Related to the OCS in the Gulf of Mexico</u>

The following major activities and resource uses occur on the OCS or are related to the OCS of the Gulf of Mexico.

a. <u>Mineral Industry</u>

The petroleum refining industry and the related extraction industries of Louisiana and Texas have a growth rate several times greater than the national rate for industries of this type. In 1972, Gulf of Mexico OCS operations produced more than 412 million barrels of oil and condensate valued at $1.46 billion ($3.55/bbl.), and about 3.0 trillion cubic feet of gas and over 1.7 billion gallons of gas liquids valued at over $752 million. Total sulphur production on the Outer Continental Shelf was about 1.2 million tons valued at $22.3 million. In addition, 358,782 tons of salt were produced in 1972 with a value of $64,581.

b. <u>Commercial Fishing</u>

The Gulf of Mexico is one of the most productive fishing areas in the United States. In 1972, the commercial fish landings was 1.585 billion pounds valued at $223.4 million ($0.141/lb. paid to fishermen). This catch was 33.6% of the volume and 31.8% of the value of the total United States commercial fisheries catch in 1972. In addition to the value of fish landings, the Gulf commercial fishery represents a significant component of the economy in terms of onshore employment. The following table (Tab. 4) contains the numbers of processing and wholesale plants and corresponding levels of employment.

Table 4 FISH PROCESSING AND WHOLESALE ESTABLISHMENTS AND EMPLOYMENT, 1971 1/

Area & State	1971								
	Processing			Wholesale			Total		
	Plants	Employment average		Plants	Employment average		Plants	Employment average	
		Season	Year		Season	Year		Season	Year
Gulf:									
Florida, West Coast	127	4,321	3,562	172	574	489	299	4,895	4,051
Alabama	48	1,590	1,018	14	592	229	62	2,182	1,247
Mississippi	44	1,604	1,025	18	141	75	62	1,745	1,100
Louisiana	128	4,699	3,112	51	607	468	179	5,306	3,580
Texas	81	3,698	2,771	78	1,146	707	159	4,844	3,478
Total	428	15,912	11,448	333	3,060	1,968	761	18,972	13,456

1/ Fisheries of the United States, 1972. U.S. Dept. of Commerce.

c. Sport Fishing

In 1970, an estimated 2.4 million fishermen, 12 years and older, spent 25.7 million man-days of fishing in the Gulf of Mexico. Approximately 53% of this sport fishing was in the ocean or from beaches and 47% was in estuaries. 1/ No projections are available for 1976, but the 1970 level is expected to increase.

d. Recreation

In 1970, recreationists participated in 215 million recreation activity occasions 2/ in the Gulf of Mexico area; by 1975 it is expected that recreationists will participate in approximately 250 million recreation activity occasions in this area. 3/ Recreation activities in the Gulf area are, of course, largely water-oriented. Water-oriented recreation is the most popular form of outdoor recreation in the United States. The warm climate of the Gulf of Mexico makes this area very attractive to recreationists both in, and beyond, the region.

The number of visits to National Park Service units in the Gulf of Mexico for 1971, and estimates for 1976, (Tab. 5) are as follows:

1/ Projected from 1965 National Survey of Fishing and Hunting and 1965 Salt Water Angling Survey; U.S. Fish and Wildlife Service, and preliminary 1970 Salt Water Angling Survey, National Marine Fisheries Service.

2/ A recreation activity occasion is the participating in a single activity by a single individual.

3/ The above estimates for recreation use are based on data and procedures contained in A New Perspective on Recreational Use of the Ocean, National Planning Association, Winslaw and Bigler. The above estimates are included for the purpose of presenting order of magnitude data and could be subject to considerable adjustment.

Table 5 Number of Visits to National Park Service Units

	Visits in 1972 1/	Estimated Visits 1976
Padre Island	883,800	1,165,900
Gulf Islands	606,900 2/	2,052,600
De Soto N. Mon.	139,200	161,600
Everglades	1,773,300	1,428,200
Ft. Jefferson	15,700	20,900
Chalmette	364,000	3/

e. Shipping

The Gulf of Mexico is subject to heavy shipping traffic. The following table (Tab. 6) is an analysis of shipping traffic.

Table 6 Daily Shipping Distribution in the Gulf of Mexico 4/

All Vessels Over 100 GRT*

Location	1969	1972	1980
Straits of Florida	19	27	21
Eastern Gulf of Mexico	17	19	17
Wastern Gulf of Mexico	9	6	10
Mobile Area	62	77	73
Ent. to Miss. R.	18	16	19

* Gross Tons

f. Military Use

Some areas of the Gulf of Mexico are designated Defense Warning Areas by branches of the U. S. Armed Forces and are to be used for military purposes. A possible constraint on the extent of future offshore oil and gas leasing invloves conflicts in some areas between mineral development and high priority uses of the Department of Defense. Some adjustments in Defense Warining Areas on the OCS and/or development

1/ Public Use of the National Parks, Dec. 1972, National Park Service, Department of the Interior.
2/ From its opening through 7/73.
3/ No Projections available at this time.
4/ A study of Maritime Mobile Satellites, Vol. I, - Merchant Vessel Population/Distributors Present and Forecast, Automated Marine International, Newport Beach California.

of adequate special oil and gas lease stipulations, where appropriate, will need to be made before mineral leasing in such areas can proceed.

g. Research and Education

Besides applied research in petroleum geology, ocean engineering, commercial fishing, fish farming, and other fields, a number of Gulf states colleges and universities are involved in basic research in the marine sciences. The shoreline and open waters of the Gulf of Mexico serve as an important outdoor laboratory.

Examples of this emphasis on field research in the Gulf include the: (1) Plans of the University of Texas Medical Center to establish Flower Garden Ocean Research Center; (2) Gulf Universities Research Corporation, Gulf of Mexico Ecological Studies; (3) State University System of Florida Institute of Oceanography, Ecological Studies of the Eastern Gulf of Mexico; (4) Eastern Gulf of Mexico programming sport and commercial fisheries of the eastern Gulf.

The following table is a partial list of colleges and universities, and degrees offered, that carry out part or all of their field education and research in the Gulf. (Tab. 7).

TABLE 7 A PARTIAL LIST OF COLLEGES, UNIVERSITIES AND RESEARCH INSTITUTES UTILIZING THE GULF OF MEXICO FOR RESEARCH AND EDUCATION

Institution	Location	Degree Offered/Research Activity
Univ. of Alabama	Bayou La Batre	Undergrad courses; research
Fla. Institute of Technology	Melbourne	B.S., M.S. in Oceanography
Fla. State University	Tallahassee	M.S., Ph.D. in Marine Biology, Oceanography Ph.D. in Geophysical Fluid Dynamics
Univ. of Florida	Gainseville	M.A., M.S., Ph.D. in main departments with emphasis in Marine Science
Rosenstiel School of Marine and Atmospheric Science--Univ. of Miami	Miami	M.S., Ph.D. in Marine Biology Science, Marine Geology and Geophysics, Physical Oceanography, Chemical Oceanography, and Atmospheric Sciences
Nova University Oceanographic Laboratory	Fort Lauderdale	Ph.D. in Physical, Chemical Oceanography, Marine Biology, Physics (marine emphasis)
Univ. of South Florida Marine Science Institute	St. Petersburg	M.S. in Marine Science
Univ. of West Florida	Pensacola	M.S. Biology--Estuarine, Marine Studies
Louisiana State University	Baton Rouge	M.S., Ph.D. in Marine Sciences
Gulf Coast Research Laboratory	Ocean Springs, Miss.	Affiliated with 29 Gulf States Colleges and Universities; M.S., Ph.D. in Biological Sciences (marine emphasis)
Institute of Engineering Tech. Miss. State University	State College	Bach. of Engineering Tech. (marine emphasis)
University of Southern Miss.	Hattiesburg	M.A., M.S. in Biology, Geology
Gulf Univ. Research Corp.	College Station, Tex.	Consortium of 21 universities and research institutes of Gulf States; basic and applied research in all areas of marine science.
Univ. of Houston	Houston, Tex.	M.S. in Biology, Geology, Ph.D. in Biology (marine emphasis) J.D. with emphasis in marine law
Lamar State College of Tech.	Beaumont	B.S. in Oceanographic Technology
Marine Biomedical Institute	Galveston	Doctoral and Postdoctoral training in marine biomedical sciences
Rice University	Houston	M.A., Ph.D. in Geology, Geophysics, Geochemistry
Texas A & M University	College Station	M.S., Ph.D. in Oceanography, Zoology, Botany, Microbiology, Biology (marine emphasis) M.S. in Marine Resource Management
Texas A & M University Marine Biology Laboratory	Galveston	Basic and applied research in all phases of marine biology
Texas Christian Univ.	Fort Worth	M.S. in Biology, Environmental Science, Geology (marine emphasis)
Texas Maritime Academy Texas A & M University	Galveston	B.S. in Marine Engineering, Marine Transportation
Univ. of Texas at Arlington	Arlington	M.A. in Biology, Chemistry, Physics, M.S. in Geology (all with marine emphasis)
Univ. of Texas	Austin	M.A., Ph.D. in Botany, Chemistry, Geology, Microbiology, Physics, Zoology, Engineering, (marine emphasis)
Univ. of Texas Medical Branch at Galveston	Galveston	Teaching and research in marine biomedical Sciences
Univ. of Texas Marine Institute	Port Aransas	Research in marine science; Seaside facility to augment curricula at Arlington, Austin campuses
University of Puerto Rico	Mayaguez	M.S. in Marine Science
Univ. of West Florida	Pensacola	Ph. D. in Marine Biology

h. Land and Water Conservation Fund

The Land and Water Conservation Fund was formed to develop and preserve outdoor recreational resources for the benefit and enjoyment of all American people of present and future generations.

Oil and gas, sulphur, and salt royalties credited to the U.S. Treasury from Outer Continental Shelf operations together with lease rentals and bonuses from OCS lease sales are in turn credited to the Land and Water Conservation Fund in amounts necessary to bring that fund to $300 million for 1971 and 1972, as follows:

Table 8 OCS Contributions to the Fund

Fiscal Year	Fund Requirement	Funds From OCS	Percent From OCS
1969	$200 million	$126.9 million	63
1970	$200 million	$107.9 million	54
1971	$300 million	$210.1 million	70
1972	$300 million	$223.7 million	75

Revenue funding also comes from entrance and user fees charged at designated Federal recreation areas, motorboat fuel taxes, and the sale of surplus Federal real estate.

The Contingency Reserve portion of the Land and Water Conservation Fund is a small percentage of the State's share of annual appropriations, set aside to assist the States in financing half the cost of special situations where a unique and valuable area is endangered by helping State and local governments acquire lands which may otherwise be lost to recreation and conservation purposes.

Grants-in-aid under the Fund program can be made only to the States, their cities and counties, and legal political subdivisions. The Federal money pays half the cost of statewide planning projects, land acquisition and development of facilities for public outdoor recreation. Appropriations to the Fund also pay land acquisition costs for authorized areas being added to the national system of parks, forests, wildlife refuges, wild and scenic rivers, and scenic and recreation trails.

5. <u>Possible Environmental Impacts from OCS Oil and Gas Development Resulting from Implementation of the Five-Year Lease Schedule</u>

The environmental impact which would result from implementation of the five-year lease schedule can be estimated with fair accuracy only after specific factors related to each sale are known. For example, at least the following information is needed but is not immediately available for sales beyond the offshore MAFLA area: (a) location of tracts in relation to resources, shipping lanes, recreation areas, refuges, etc., (b) type of expected production, e.g., oil or gas, (c) geologic formations, (d) water depths, (e) expected terminal points for pipelines, and (f) expected size and location of required new storage facilities.

In general, it can be assumed that future impacts of OCS oil and gas lease sales, both favorable and unfavorable, will be greater on the environment, on other industries, and on communities in areas where no previous OCS oil and gas leasing has been undertaken. This is so because new pipelines and storage facilities must be built, relationships must be developed between existing industries, (i.e., fishing and the oil and gas industry), and new labor forces and new payrolls will be introduced to the areas. In short, incremental impacts, both positive and negative, will be greater than for similar lease sales offshore Louisiana and Texas where offshore and nearby onshore production has been in existence for many years.

The general impacts expected to result from the implementation of the five-year schedule are expected to be similar to those described in this statement for the proposed MAFLA OCS lease sale.

D. Location and Reserves

The sale under consideration includes 147 tracts offshore 1/ Mississippi, Alabama, and Florida. These tracts if leased, would add 817,297 acres, an increase of about 18.8% of the current total of 4,336,862.50 acres (as of June 30, 1973), under Federal lease in the Gulf of Mexico. Twelve tracts or 43,423 acres are drainage and development tracts, the remaining 135 tracts are wildcat. Presently there are no Federal leases on the Mississippi, Alabama, and Florida OCS. The proposed lease sale would be made under Section 8 of the Outer Continental Shelf Lands Act (76 Stat. 462; 43 U.S.C. Sec. 1337) and regulations issued under that statute.

The estimated reserves to be developed on this sale are 1.5-2.4 billion barrels of oil and 1.8-2.9 trillion cubic feet of gas. This would require 700-1,120 wells from 75-125 platforms and require 480-800 miles of pipeline. As this is a relatively new area in the Gulf of Mexico and is geologically so different from the majority of OCS leases in the Gulf, little information is available to use in projecting production rates. However, as a rough estimate, the proposed leases may produce 270,000 443,000 barrels of oil per day and .34-.52 billion cubic feet of gas per day after development and production stabilizes. The hydrocarbon potential of the MAFLA area is predominantly oil and is divided into

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1/ The tracts are summarized by water depth, distance from shore, and expected type of production in Attachment C. Also see attached map.

two categories; Jurassic production to be found generally below 15,000' depth, and Cretaceous potential, generally above 15,000' depth.

E. Tract Selection

Having determined through development of the tentative five-year schedule, the timing, size, and location of a specific lease sale, it must be determined which tracts should be offered in the sale. The first step leading toward the selection of tracts is that reports (43 CFR 3301.2) are requested and received from the U. S. Geological Survey - on the general geology and potential mineral resources of the proposed area - and from other interested Federal and state agencies regarding other resources, environmental conditions and the effect of mineral operations on the resources and the total environment. A call for nominations of tracts is then issued by the Department. Industry responds by nominating tracts in which they are interested. With improved seismic, geologic and economic data on the specific sale under consideration, the Department analyzes the past leasing history of tracts under consideration and the nominations themselves and makes an initial identification of tracts to be included in the sale.

1. Responsibilities and Procedures

Responsibility for the initial selection of tracts lies with the field offices of the Bureau of Land Management (BLM) and the U. S. Geological Survey (GS) under guidance as to Departmental policy and objectives furnished by the respective Washington offices.

BLM and GS also consider recommendations by the Bureau of Sport Fisheries and Wildlife regarding limitations on permits for exploration and mineral development.

a. BLM-New Orleans Office (NO) is responsible for furnishing the historical and current leasing status of all tracts nominated and their location with respect to fairways, anchorage, and warning areas, and pipelines. BLM-NO makes preliminary selection of tracts based on the following general considerations:

(1) The extent of industry interest as indicated by the number and pattern of nominations.

(2) Past leasing history of the area.

(3) General geological and geophysical data from GS and other sources.

(4) Environmental considerations based on research results presented by the New Orleans Office Environmental Assessment Team.

(5) Analysis of estimated potential for oil and gas production.

(6) Economic considerations.

(7) A thorough analysis of the resources of the area and an initial evaluation of the potential impact on each individual resource from oil and gas exploration, drilling and producing operations.

(8) Special considerations such as mix of tracts by water depths and distance from shore.

b. GS-NO is responsible for furnishing technical information including geological, geophysical, engineering, and paleontological information in determination of tracts to be recommended for selection. GS-NO identifies tracts based on the following criteria: need to initiate leasing in rank wildcat areas from a geologic standpoint; drainage tracts or those in imminent danger of drainage; tracts from which companies have presented data for GS inspection and evaluation demonstrating their necessity and desirability for further development; tracts which are most prospective for production; other tracts susceptible to prompt drilling and development.

c. The Regional office of BSF&W reviews all the tracts under consideration for the potential effect on fish and wildlife resources and advises BLM-NO accordingly.

d. The Washington Office of BLM and GS furnish guidelines which flow from the Departmental objectives: orderly and timely resource development, protection of the marine environment and receipt of fair market value for leased marine resources. These guidelines include but are not limited to: recommended size of sale; tracts or areas for special consideration; and information relative to Administrative or Department policy. The Washington Office also reviews the joint recommendation of tracts submitted by the BLM and GS field offices for conformity with these objectives and guidelines.

2. Purpose of the Tract Selection Process

It is intended that by this initial tract selection process, tracts which have the highest geological potential normally will be selected. In response to the Department's call for nominations for the Mississippi, Alabama, Florida general sale, 30 oil companies nominated approximately 8 3/4 million acres. From this total, a list of 195 tracts comprising 1,093,818 acres were initially selected in accordance with the process described above for further detailed environmental analysis. As a result of on-going negotiations with the Department of Defense, 36 of the 195 tracts originally selected for inclusion in this sale were withdrawn and deleted from consideration prior to release of the draft environmental statement. Negotiations were concluded with the Department of Defense during the review period for the draft environmental statement (DES) concerning this proposed sale. As a result of the conclusion of negotiations, 12 more tracts which were included in the DES have been deleted from this sale proposal. (See Vol. 2, Sec. III.F.). Additional information concerning the initial tract selection process for the proposed MAFLA sale is contained in Vol. 3, Sec. VIII. A.

BLM is charged with responsibility for assessment of the impacts on the environment which may occur as a result of leasing operations. The collection of environmental data begins with analysis of preliminary resource reports which are prepared for the overall sale area. The next major stage is the preparation of an environmental report to the OCS Manager prior to tract selection. This report is prepared by the Environmental Assessment Team specifically to insure that tracts tentatively selected have been reviewed for potential environmental hazards in the event of their later development.

After completion of tract selection procedures, BLM prepares a draft environmental impact statement, soliciting a wide spectrum of views from Federal, state, and local agencies, and the public. This environmental statement evaluates the potential effect of the proposed lease sale on all components of the environment of the entire area during exploration, development and operational phases. Pertinent published and unpublished resource reports and evaluations are reviewed and portions are included in this statement. In the case of a general sale a public hearing is held. Through these processes, further modification of the list of tracts may result, or special stipulations may be required for the leasing of certain tracts as will be reflected in the final environmental statement.

F. A Description of Oil and Gas Operations Including a Timetable for this Proposal

1. Geophysical Exploration

a. Industry

In order to locate hydrocarbon deposits, the oil industry must analyze the substructure of the continental shelf. The prime objective of the structural analysis is to locate geologic structures which are favorable for the accumulation of petroleum. A knowledge of the subsurface geologic environment is also necessary to detect near surface conditions, such as recent faulting or high pressure zones, which are potential hazards to exploration and production operations. Once hazardous conditions are identified, drilling programs are modified to assure safety of operations.

Prior to a call for nomination of lease sale tracts, industry normally conducts regional geophysical surveys of an area of interest. These surveys provide a network of modern state-of-the-art common depth point (CDP) seismic lines on approximately a 4 mile-by-4 mile grid spacing to provide data for reconnaissance mapping. In some cases an ever closer 2 mile-by-2 mile line spacing may be used. After the Department issues a call for nominations, industry initiates the collection and interpretation of even more detailed seismic data in order that potentially productive tracts may be identified for nomination and reasonable bid offers formulated.

In seismic exploration, a ship travels along a predetermined path, towing signal generating and recording equipment. The signal generated by the energy source is a series of small-amplitude seismic pulses that travel at thousands of feet per second through the water and sediments below, where they are reflected and refracted by the underlying strata. An array of sensitive hydrophones towed by the vessel detect incoming seismic waves which are recorded on magnetic tape. After extensive processing, these recordings are displayed in the form of vertical cross sections. These seismic profiles are interpreted to identify those areas where the sediments are arched, faulted or pierced by salt domes, and where they thicken or thin, and where reef structures occur. By assembling cross sections run in various directions, a three-dimensional picture can be constructed, indicating location, size, and form of geologic structures favorable for oil and gas accumulation. This information is normally displayed in the form of a series of subsurface seismic structure maps.

In the early years of offshore exploration the energy source for the seismic wave was explosive charges detonated in the water layer. Because of the hazards associated with the use of dynamite to the seismic vessel, crew, and natural marine life, new equipment and methods have evolved within the last five years and now account for well over 95% of marine seismic activity. 1/ In particular, the use of a vibrator system, sparkers, air guns, and gas guns now provide excellent seismic data, with no harmful effect on the marine environment.

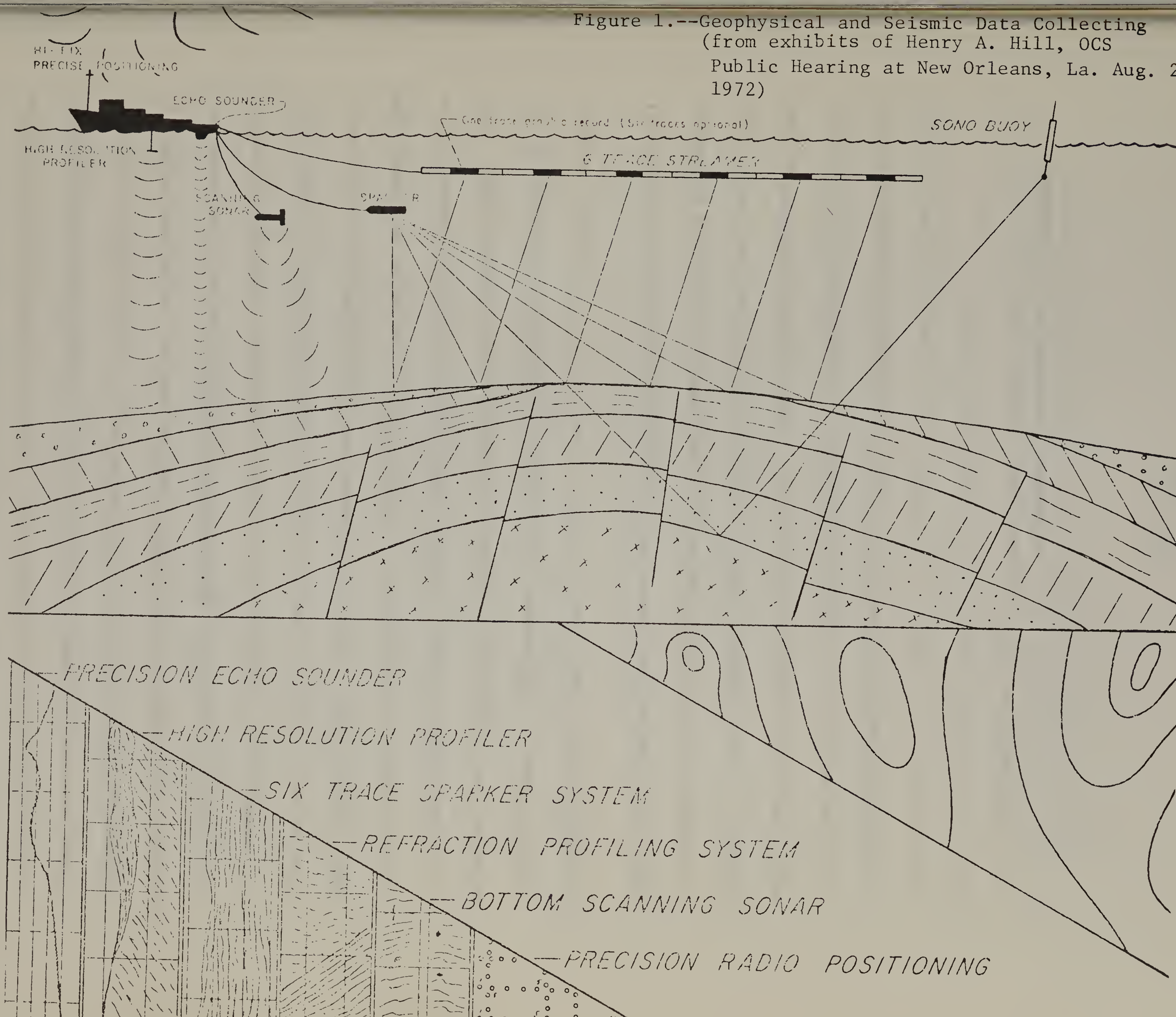
1/ Taken from Testimony of E. O. Bell, past President, Offshore Operators Committee, presented at OCS Public Hearing, Houston, Texas, February 22, 1973.

In January 1969 and October 1970, due to concern about the effect of acoustic energy sources on the ecology of the marine environment, a comprehensive investigation of the effects of compressed air charges on the water column, water bottom and marine life (oysters) was conducted by marine biologists of the Louisiana Wild Life and Fisheries Commission. The experiments were conducted in Sister Lake, Terrebonne Parish, Louisiana, in water depths from three to five feet at two separate locations: (1) hard shell bottom; (2) soft mud bottom. Normal seismic survey operating procedures were used in the tests. The evidence from the tests, as reported by the Commission, indicates no damage to the water, water bottom, or oysters from the air blasts. (The oysters were examined daily for approximately three months after the completion of the tests for evidence of mortality or abnormality.) General observations indicated that no fish or other marine animals were affected. 1/

In addition to the deep penetration CDP seismic reflection data, some companies purchase and interpret shallow penetration high resolution geophysical data to locate potential geologic hazards such as unstable bottom sediment conditions and fault zones. A typical high resolution data acquisition system is illustrated in Fig. 1. A discussion of geologic hazards present in the proposed sale area is presented in Vol. 1, Sec. II. A. 4.

1/ Field Notes, 1969, 1970. Louisiana Wild Life and Fisheries Commission; New Orleans, Louisiana.

Figure 1.--Geophysical and Seismic Data Collecting (from exhibits of Henry A. Hill, OCS Public Hearing at New Orleans, La. Aug. 23 1972)



b. U.S. Geological Survey

In order to provide needed geotechnical information for the Federal offshore leasing program, the U.S. Geological Survey, Conservation Division, has purchased approximately 12,000 miles of modern seismic reflection data on the continental shelf offshore Mississippi, Alabama, and Florida. These data provide definitive information for Government use on the size, shape, and depth of structural features located in and adjacent to blocks to be offered at the proposed sale. Seismic information was also used to locate structural features prior to making the selection of blocks to be offered in the proposed leasing. In addition to the 12,000 miles mentioned above, which form grids varying from 2 x 2 miles to 9 x 16 miles, other data are being acquired as fill-in to provide additional control over the proposed lease tracts. This additional seismic information is needed for detailed mapping, particularly in the northeastern Gulf of Mexico where reefing and other complex geologic features are found in carbonate deposits.

The USGS also acquires shallow, high resolution data for detection of shallow geologic hazards which is used in guidance and regulation of platform and well locations and drilling procedures. This will be discussed in more detail in Vol. 2, Sec. IV. D. 5.,"Mitigating Measures".

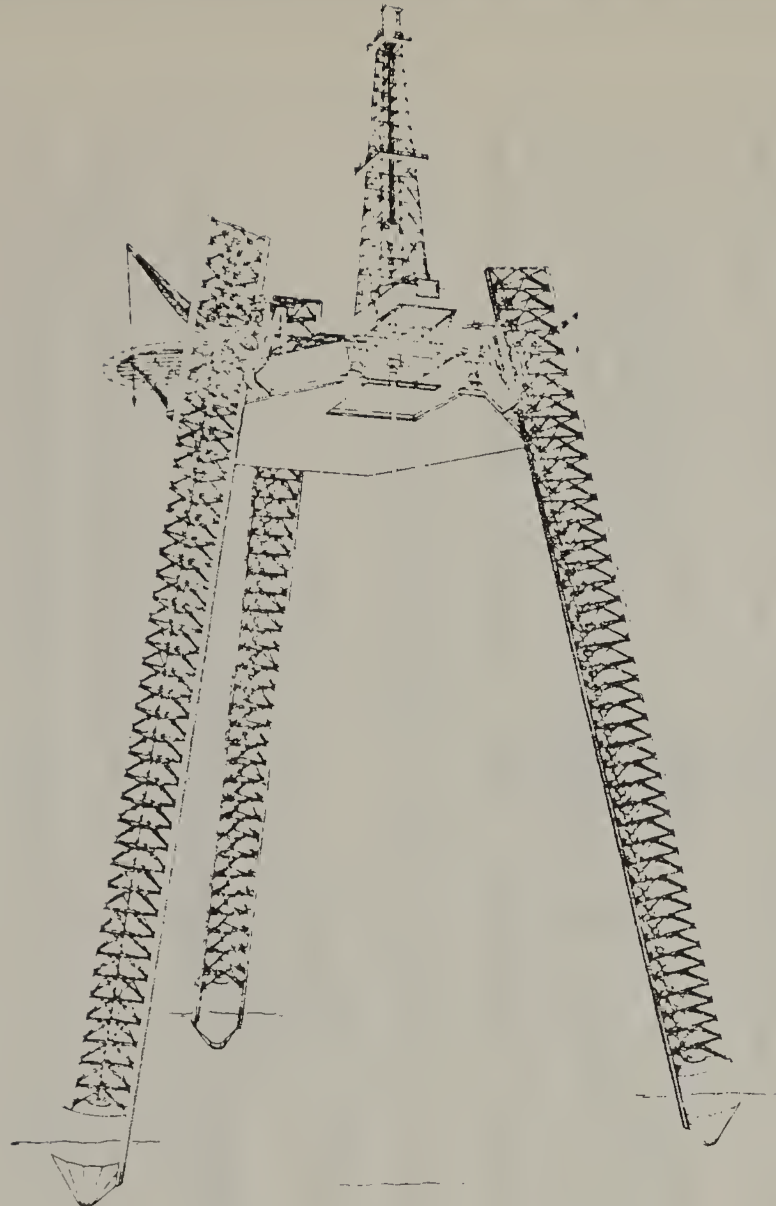
2. Exploratory Drilling

a. Drilling Phase

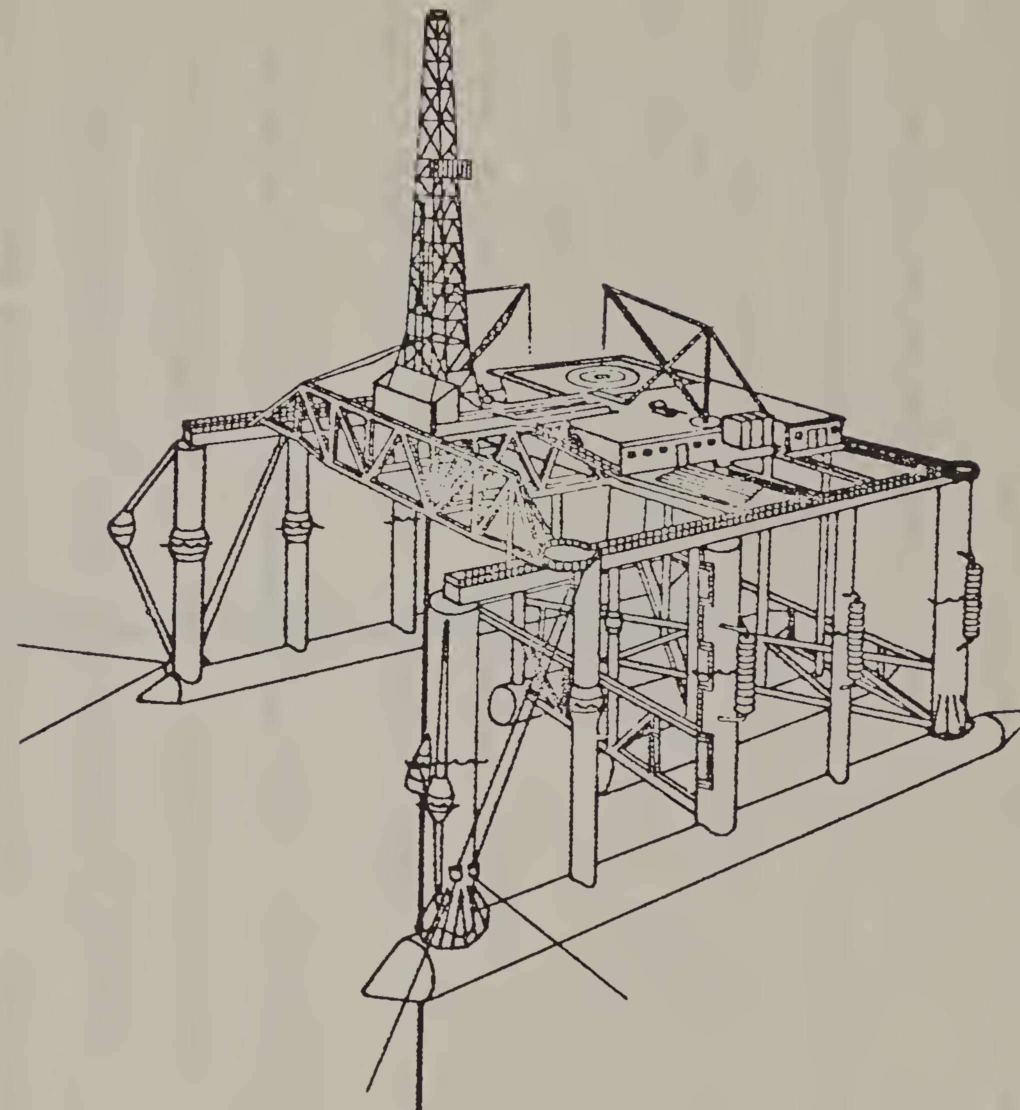
Most offshore exploratory drilling is accomplished with the use of mobile drilling rigs that can be moved from one location to another with relative ease. These mobile rigs include those that are bottom-supported while drilling and those floating rigs that are held in position over the site by anchors.

Shallow (less than 200 feet) water exploratory drilling is commonly conducted using bottom-supported rigs of the "jack-up" (Fig. 2) and submersible (not pictured) types. The submersible drilling rigs normally operate in water depths to approximately 70 feet. Most "jack-up", bottom-supported drilling rigs are towed by tugboats from one location to another while in a floating position, whereas some are self-propelled and do not require tug assistance.

The semi-submersibles (Fig. 2) are large, advanced-design floating rigs that can work in water depths up to 1,000 feet and beyond, and have better motion characteristics in rough seas than do ships or barges. These rigs are floated to the site, partially submerged, and held in place by anchors. The major problem encountered during the use of floating and semi-submersible drilling vessels is keeping them properly aligned with the drill hole on the sea floor. Winds, waves, and ocean currents tend to push them off location regardless of how good the mooring system. One solution has been to connect the wellhead (on the sea floor) with the drilling rig by a drilling riser pipe which is tensioned at the top to maintain its structural integrity. The tension requirements can be reduced by attaching bouyant material to the riser. High seas, strong currents, and heavy weather, however, can still cause the rig to drift off location, putting excessive stresses on the riser. One company's solution to this problem is the use of an acoustic posi-



With elevating legs, the jack-up rig can be floated to location and then raised or jacked up on the legs to appropriate height above water. This rig is normally limited to about 300-foot water depths.



Once anchored in place, the semi-submersible is used to drill wildcat or exploratory wells in depths up to 1,000 feet and beyond.

Figure 2.--Exploratory Drilling Rigs

(from "The Offshore Search for Oil and Gas," Exxon Background Series No. 2R, Nov., 1972, Public Affairs Department, Exxon Corporation).

tion reference system (Fig. 3) whereby acoustic signals from a beacon located near the wellhead on the sea floor are received by three shipboard hydrophones. In use, the vessel's position is determined by comparing, at each of the three shipboard hydrophones, the signals emitted by the sea floor beacon. The correct position, with reference to the wellbore, is shown on the drilling rig's console viewing screen and the rig is kept in position by adjusting mooring lines or using the rig's thrusters. If, for some reason the rig should have to move off location, the sea floor beacon is used to reposition it upon return.

In drilling, two distinct, important pressures must be considered. One is the pressure within the geologic formation penetrated, and the other is the pressure required to fracture or allow the drilling fluid to enter the formation just below the last casing string and above the drill bit. These pressures are naturally occurring phenomena. A drilling plan calls for maintaining a sufficient hydrostatic gradient to prevent formation fluids from flowing into the wellbore. This is done by adjusting the density of the drilling fluid or "mud" that is continuously circulated through the drill string to provide pressure control, lubrication of the drill bit, and circulation of wellbore cuttings out of the hole (Fig. 4).

In spite of considerable research, it is still not always possible to predetermine, for wildcat wells, the formation pressure and fracture pressure that the wellbore will encounter. During drilling there are

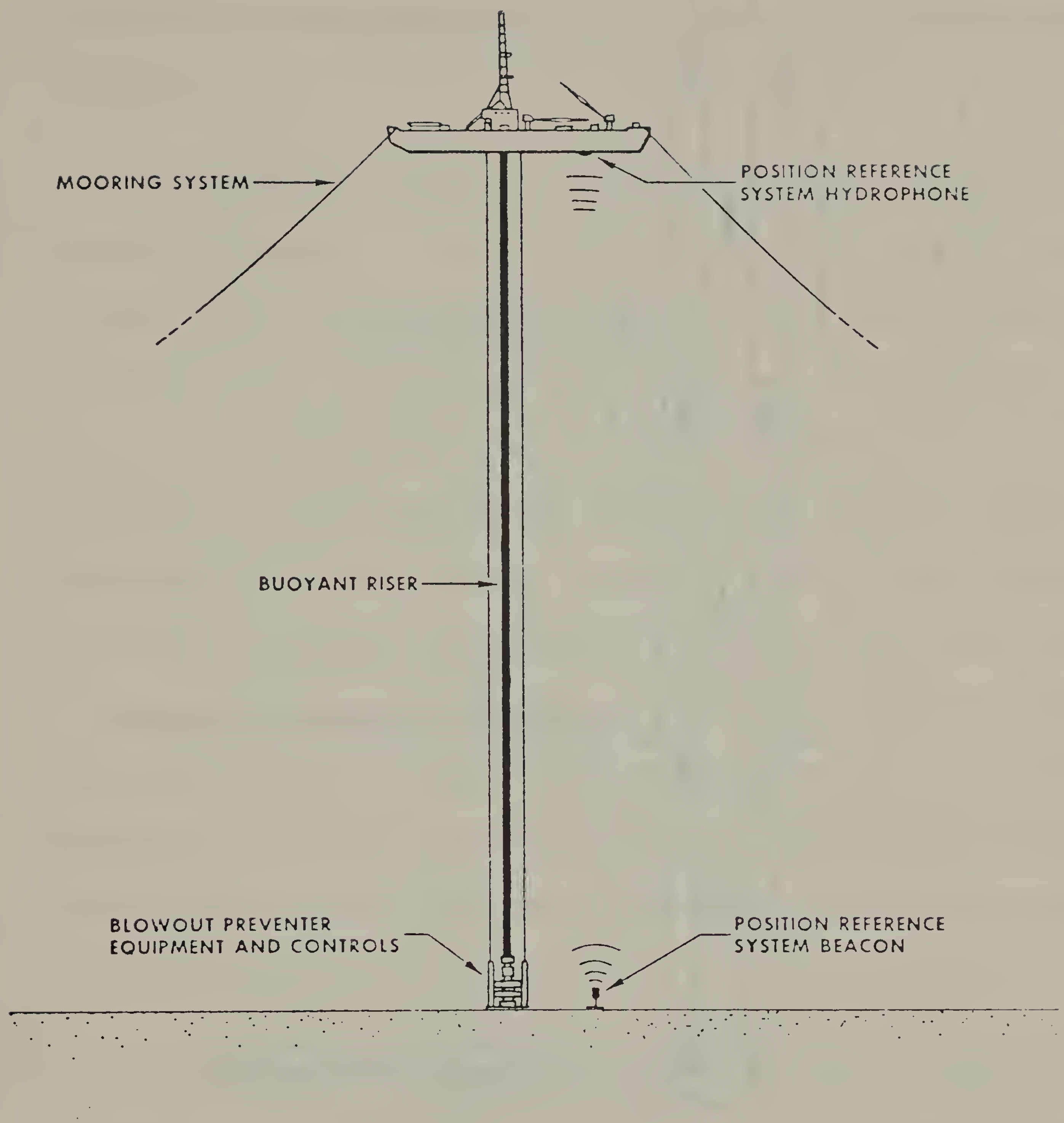


Figure 3. Components of a Deepwater Exploratory Drilling System
(From Deepwater Capabilities ESSO Production Research Company.)

Example of Well Bore and Casing

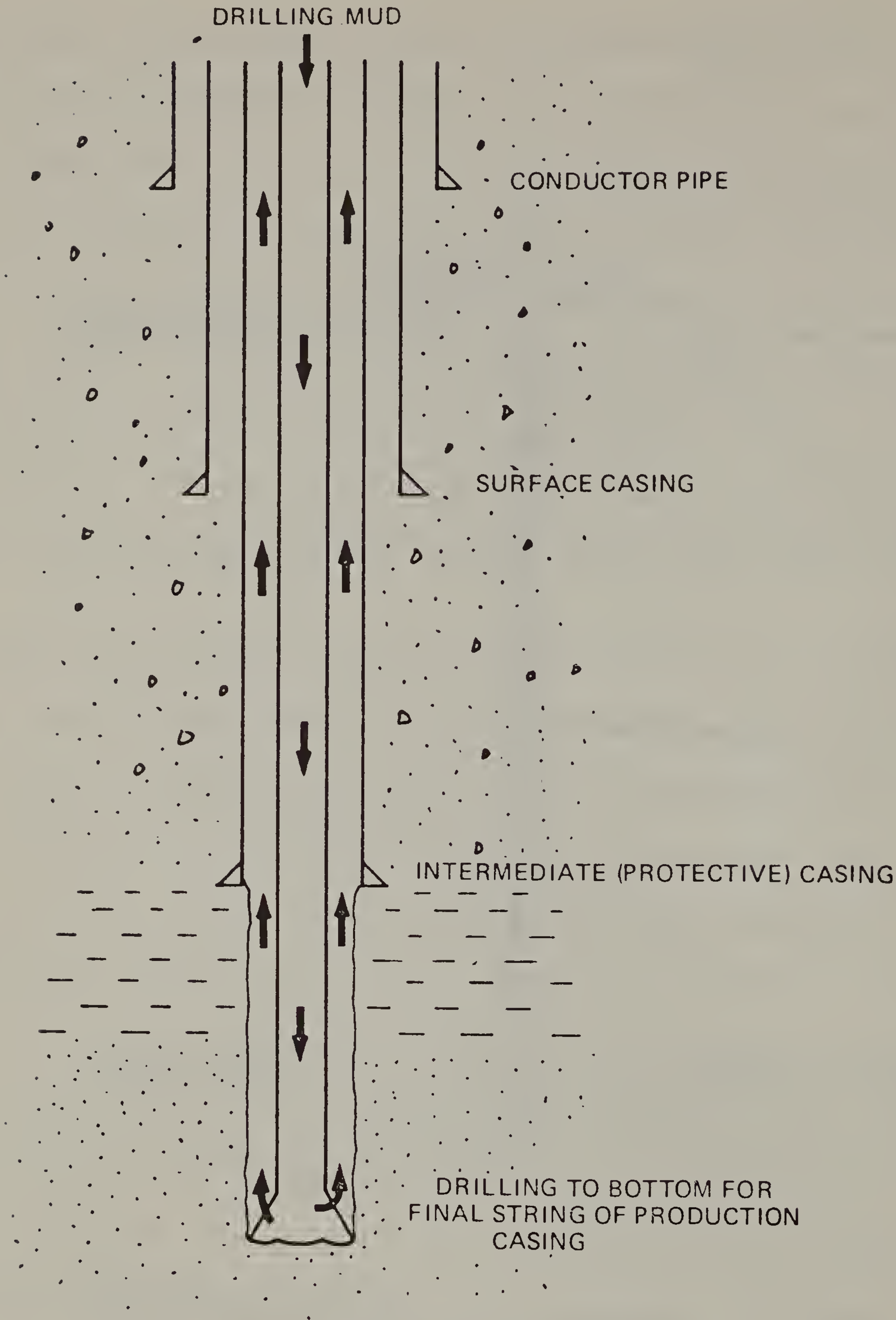


Figure 4.-- The drilling mud circulates down through the drill pipe and up the annulus. The relation between the mud pressure gradient and the formation fracture gradient is critical.

(Adapted from Panel on Operational Safety in Offshore Resource Development, "Outer Continental Shelf Resource Development Safety," Marine Board of National Academy of Engineering, Dec., 1972.)

several means of determining the trend in pressure. They include measurements such as formation temperature (as reflected by the temperature of the returning mud), shale density and changes in the penetration rate of the drill bit.

If the hydrostatic gradient of the drilling fluid becomes less than formation pressure, a "kick" of gas or other fluid may flow into the wellbore from the formation being drilled. The influx displaces the drilling fluid, thereby causing an additional reduction in the hydrostatic head in the annular space between the drillpipe and the borehole (Fig. 5). If the volume of the influx is not excessive, and surface indication (increased mud tank volume) is observed, the unwanted influx of fluid or gas can be circulated out of the well by careful observation of well conditions and adherence to preplanned emergency procedures. From the record of a kick, the bottom-hole pressure can be determined accurately, and with this pressure known, the mud weight can be increased to provide a sufficient hydrostatic head for the safe continuation of drilling.

An uncontrolled kick is called a "blowout". Blowouts seldom occur but usually can be controlled by implementation of preplanned emergency procedures and actuation of devices known as "blowout preventers" which are mounted on every offshore well during drilling. A simplified diagram of a blowout preventer is shown in Fig. 6. Actual blowout preventers used offshore contain at least three types of rams. A

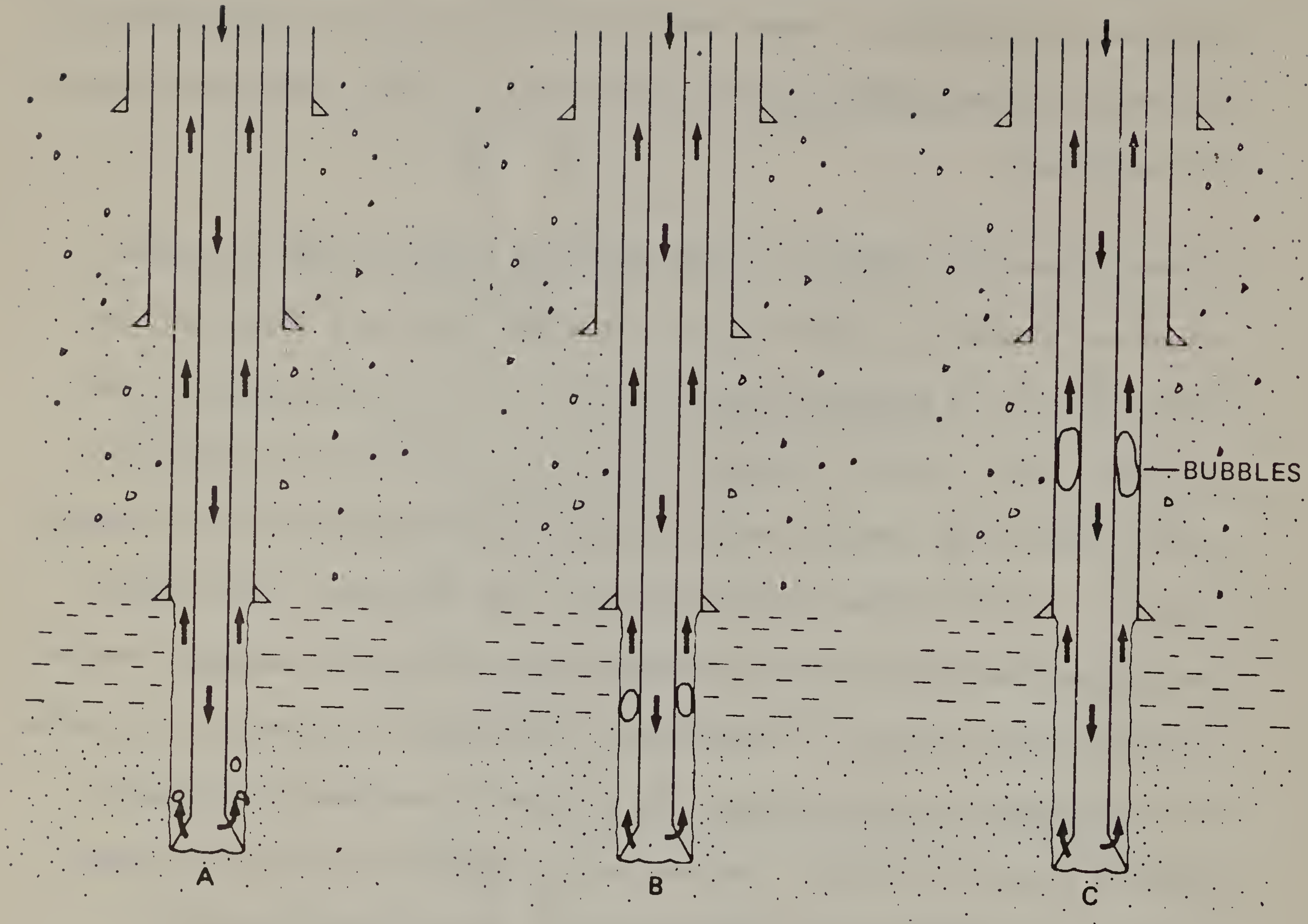
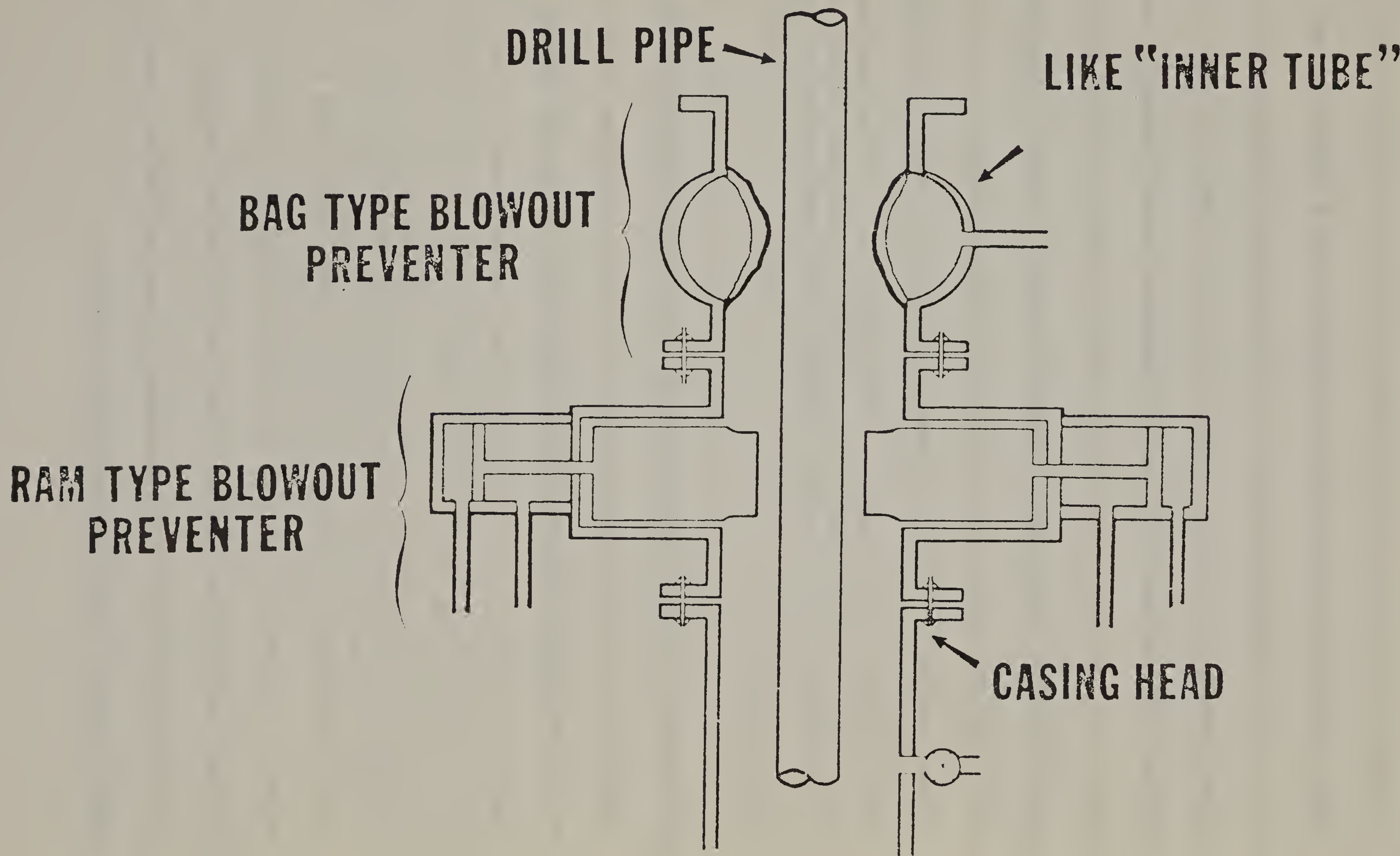


Figure 5.--A "kick" is a gas or liquid influx that reduces the hydrostatic head in the annulus. Here, the kick is a gas bubble (A). As it rises (B and C), it expands--causing a sudden increase in the upflow of the mud. When the bubble reaches the top, if it has not been allowed to expand, the bottom-hole pressure reaches a maximum -- the sum of mud pressure and gas pressure. This pressure maximum, if excessive, can exceed the formation fracture pressure, and lead to a loss of drilling mud to the formation, thus further decreasing the hydrostatic pressure. This could cause an influx of formation fluids into other formations, or the fractured formation taking fluid from another formation, commonly referred to as an underground blow out.

(Adopted from Panel on Operational Safety in Offshore Resource Development, "Outer Continental Shelf Resource Development Safety", Marine Board of National Academy of Engineering, December, 1972).

Figure 6.-- BAG TYPE AND RAM TYPE BLOWOUT PREVENTERS



(From testimony of Bob G. Murphy on behalf of the Offshore Operators Committee at a public hearing in Houston, Texas, on February 22, 1973.)

typical blowout preventer system would include the following (1) one bag-type; (2) one with blind-rams; and (3) one or two with pipe rams, depending on how many strings of casing have been set in the bore hole. Blowout preventers are essentially large valves that can close around the drill string or across an open hole and seal off the well at the surface. Blowouts can occur downhole when a low-pressure formation fractures, and fluids from a higher-pressure zone flow into the fractured formation. Such underground blowouts, like surface blowouts, require the careful use of preplanned emergency techniques to regain control. Blowout preventers and other well-control equipment must meet the requirements of OCS Order No. 2. This equipment is tested on a schedule set by prudent practice, but not less often than regulations specify.

To ensure that adequate provisions have been made for safety and well control, the casing program and drilling mud program must be approved by the Geological Survey before a drilling permit is issued. Along with adequate casing, it is important that enough cement be spotted between the casing and the wall of the hole to seal off and isolate all sensitive geological formations such as hydrocarbon zones and fresh water sands, and to separate abnormally pressured zones from those with normal pressures. A prime function of the drilling mud is to maintain hydrostatic pressure control in the well, and mud is tested frequently during drilling operations to ensure that it has sufficient density and meets other physical and chemical specifications.

b. Well Completion Phase

Should the initial test well be dry, it is plugged with cement. One objective is to confine formation fluids in their parent subsurface formations to prevent them from intermingling and to prevent flow to the surface. If a well is to be abandoned, the casing is cut-off at least 15 feet below the mud line, all obstructions are removed, and the bottom is dragged to be sure that no obstructions were overlooked. During plugging, well-control equipment remains in use. In some cases, it may be necessary to drill several exploratory wells on the 5,760 acre block before the lease is totally condemned.

Formation fluids penetrated by wells are often brought to the surface in drill-stem tests to evaluate the possibility of oil and natural gas production. These fluids may be collected in tanks at the surface; drilling mud is separated from the produced fluid, and if the formation fluid is oil it may be stored for later disposition, or the oil and natural gas are flared in specialized, high volume burners.

If well tests show that commercial quantities of natural gas or oil have been found, it may be necessary to evaluate several additional confirmation tests before the company is satisfied that the reserves will support installation of a drilling-production platform.

It is also important to delineate precisely the extent of the petroleum reservoir because of the extreme expense of deeper water platforms and the economic necessity of drilling as many production wells as possible (sometimes over 30) from a single platform. Platform location in relation to hydrocarbon deposits must be extremely accurate to minimize the number of platforms installed.

If petroleum deposits prove to be of commercial size, one of two courses of action may be followed:

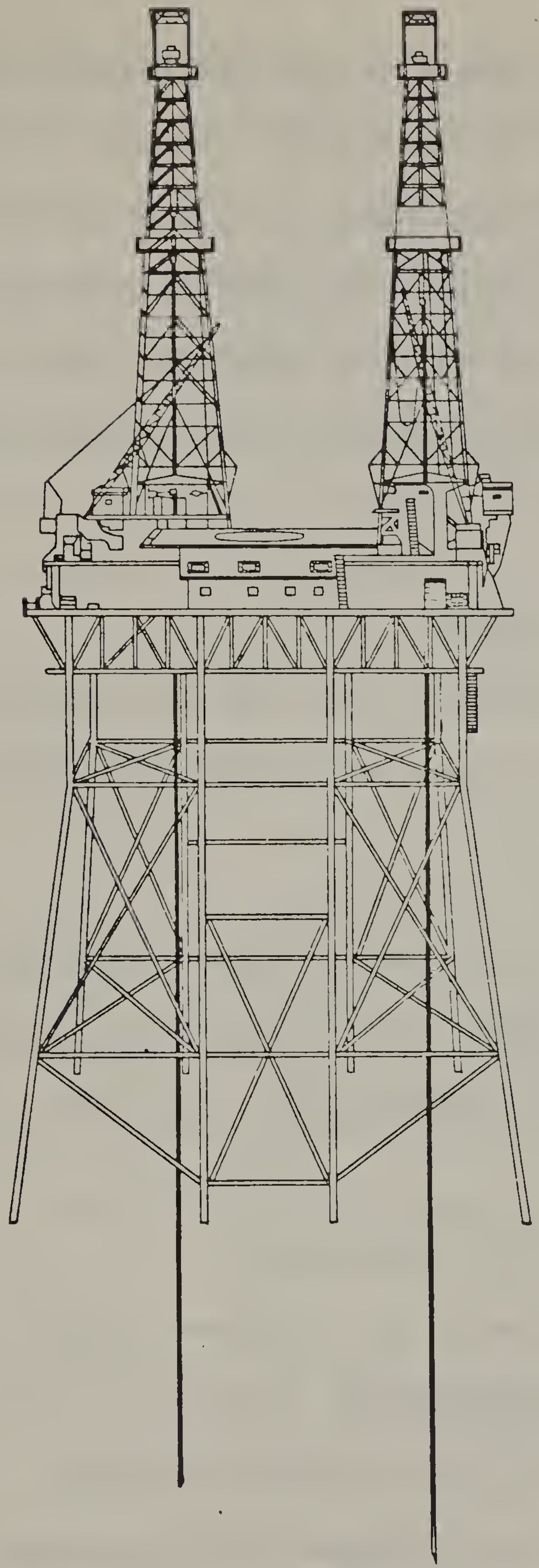
(i) The exploratory well may be deemed expendable and be permanently abandoned. Procedures followed would be the same as in dry hole abandonment.

(ii) The well may be deemed satisfactory for future use as a production well and temporarily abandoned. In this case, a mechanical bridge plug is emplaced in the smallest string of casing and the well head capped and left for future entrance when production activity commenced. This results in the temporary existence of an underwater "stub". The Coast Guard District Commander requires that such stubs be marked by a buoy at the surface if located in 200 feet of water or less, and that the buoy be lighted if located in 85 feet of water or less.

3. Development Drilling and Production Activities

a. Platform Installation

Offshore production operations are usually conducted on fixed, bottom-founded, water surface-piercing platforms (Fig. 7). The platform is generally fabricated in two pieces at a shore-based facility according to design specifications of the petroleum producers. The two component pieces, the supporting structure and the upper, horizontal



Rigs mounted on fixed platforms, used for development drilling after an oil or gas discovery, permit drilling up to thirty wells from a single platform and location. After drilling, the rigs are removed, and the platform is used for production.

Figure 7.--Fixed Production Platform

(from "The Offshore Search for Oil and Gas," Exxon Background Series No. 2R, Nov., 1972, Public Affairs Dept., Exxon Corp.)

platform, are then towed or barged to the installation site. The structure is emplaced by controlled flooding and sinking of the lower end of the tubular legs. The horizontal platform is then lifted into place on top of the tower and welded to it. The drilling derrick rig, power plants, generators, living quarters, storage sheds and other components, constructed in modular form, are added to the platform, and production well drilling commences.

b. Drilling Programs

As with exploratory drilling, the casing program and mud program for each well must be approved by the Geological Survey before a drilling permit is issued.

The following information was furnished by the Geological Survey and petroleum industry and describes the mud and casing programs and cuttings generated by a representative offshore well. This well is assumed to be:

1) a development well (not exploratory)
2) drilled from a multi-well slot platform using a standard platform mounted rig
3) a "normal" well, i.e., one in which no special drilling problems or mud problems are experienced which would cause an abnormal volume of cuttings or usage of mud (special cases are discussed later)
4) drilled to a total depth of 10,000 feet.

This representative 10,000-foot offshore well generates approximately 1,674 bbl. of cuttings weighing about 695 tons. To drill this well approximately 7,000 bbl. of seawater drilling mud containing 237 tons of mud components are used. Of the combined total weight of drill cuttings and used mud solids generated per well (a little more than 932 tons), 695 tons of cuttings and 80 tons of commercial mud components are discharged overboard and 159.5 tons of barium sulfate ($BaSO_4$) are separated and saved for future use.

Average drilling time is 10 to 14 days. The casing program for this well consists of four strings:

1) the structural casing, about 20 inches in diameter. It is set to a minimum depth of 100 feet to provide stability in unconsolidated sediments
2) the 16-inch conductor pipe, set at 900 feet
3) the 10 3/4-inch surface casing, set at 3,500 feet
4) the 7-inch production string, set at 10,000 feet.

Drill Cuttings

Table 9 shows the volume of cuttings generated by the representative 10,000-foot well and the types of drilling muds that are used to drill the well.

As the drilling fluid-drill cuttings mixture is circulated to the surface, drill cuttings are separated from the drilling fluid by shale shakers, desilters, and desanders and discharged overboard.

Table 9. VOLUME OF DRILL CUTTINGS GENERATED AND DRILLING MUDS USED IN REPRESENTATIVE 10,000-FOOT OFFSHORE WELL

Interval (Feet)	Hole Size (Inches)	Volume of Cuttings (Barrels)	Approxi. Weight of Cuttings (Pounds)	Drilling Mud Type	Mud System Volume (Barrels)
0-900	24	514	453,000	seawater & natural mud	as required
900-3500	15	545	440,000	gelled sea-water	700
3500-10,000	9 7/8	615	497,000	ferrochrome lignosulfonate	950
Total		1674	1,390,000		

Drilling Mud

There are two types of mud systems used in most OCS drilling operations. The most common is a water base mud where the liquid phase is water. The other is an inverted emulsion mud where the liquid phase consists of finely dispersed water droplets in oil. Oil muds are covered in OCS Order No. 7 which prohibits the discharge of oil-containing muds into Gulf waters. Both systems require the addition of weight material to produce a desired density. The most widely used weight material is Barium Sulfate ($BaSO_4$) obtained from barite which is mined in Arkansas. The addition of weight material can be from 50-900 lbs./bbl. depending on the desired density.

Many mud additives are used in OCS drilling operations to overcome negative conditions. The following table (Table 10) lists the most common additives and their primary function.

Table 10

MUD ADDITIVES

Function	Name	Amount (lbs./bbl.)
Alkalinity & pH control	1. Sodium hydroxide NaOH	0.1-0.3
	2. Sodium bicarbonate $NaHCO_3$	0.1-1.5
	3. Calcium chloride $CaCl_2$	0.1-3.0
	4. Calcium hydroxide $Ca(OH)_2$	0.5-8.0
Bacteriocides		
	1. Paraformaldehyde $(CH_2O)_x$	0.5-1.0
	2. Sodium chloride NaCl	5.0-10.0
	3. Sodium chromate Na_2CrO_4	0.1-4.0
Calcium Removers		
	1. Sodium bicarbonate $NaHCO_3$	0.1-1.5
	2. Sodium carbonate Na_2CO_3	0.5-2.0
	3. Sodium hydroxide NaOH	0.1-3.0
	4. Organic phosphate	0.1-0.5
Corrosion Inhibitors		
	1. Calcium hydroxide $Ca(OH)_2$	0.5-8.0
	2. Sodium chromate Na_2CrO_4	0.1-4.0
	3. Film forming amine	2.0
Defoamers		
	1. Aluminum stearate $[CH_3(CH_2)_{16}COO]_3Al$	1.0-10.0
	2. Alkyl aryl sulfonate	0.2-0.3
	3. Silicones	0.1-3.0
Emulsifiers		
	1. Calcium lignosulfonate	1.0-4.0
	2. Oxyethylated alkyl phenol	0.5-3.0
	3. Ferrochrome lignosulfonate	0.1-2.0
	4. Quebracho	0.2-5.0
Filtrate Reducers		
	1. Bentonite	5.0-10.0
	2. Sodium carboxynethlyl	0.1-1.5
	3. Sodium polyacrylate	1.0-3.0
	4. Starch	2.0-8.0

Table 10(cont')

Function	Name	Amount (lbs./bbl.)
Flocculants	1. Acrylamide polymeric hydrolite	.005- .01
	2. Bentonite	1.0 -5.0
	3. Lignosulfonate	1.0 -5.0
Foaming Agents		
	1. Alkyl polyoxyethylene	8.0-16.0
Lost Circulation		
	1. Cottenseed hulls	3.0-25.0
	2. Cane fibers	2.0- 6.0
	3. Asbestos	2.0- 6.0
	4. Cellophane	5.0-10.0
	5. Mica	2.0-10.0
Lubricants		
	1. Oxidized asphalt	3.0-6.0
	2. Carbon powder	1.0-2.0
Shale Control Inhibitors		
	1. Oxidized asphalt	3.0-6.0
	2. Calcium hydroxide	0.5-8.0
	3. Sodium silicate	0.1-3.0
	4. Calcium lignosulfonates	0.1-3.0
Surface Active Agents		
	1. Oxyethylated alkyl phenol	0.5-3.0
	2. Alkyl aryl sulfonate	0.2-0.3
Thinners & Dispersants		
	1. Sodium tetraphosphate $Na_6P_4O_{13}$	0.1-0.2
	2. Calcium lignosulfonate	1.0-4.0
	3. Sodium chromate Na_2CrO_4	0.5-3.0
	4. Quebracho	1.0-10.0
Viscosifiers		
	1. Bentonite	1.0-5.0
	2. Asbestos	2.0-6.0
	3. Sodium carboxymethly cellulose	0.1-1.5

In the representative 10,000-foot well being considered here, approximately 7,000 bbl. of seawater drilling muds are used during drilling. About 1,050 bbl. of commercial mud components and 7,000 bbl. of seawater are used to make up and maintain the gelled seawater and ferrochrome lignosulfonate muds used for the well. Conditioning of the mud system in order to maintain the desired mud characteristics requires some overboard discharge of mud and an addition of commercial mud and seawater to the system daily.

The top 900 foot section of the well is drilled with a mixture of seawater, attapulgite clays, and natural mud and clays from the surface formations that are drilled. Shale particles and sand are discharged overboard as this section of the hole is drilled.

Prior to installation of the 16 inch conductor pipe in the hole, a gelled seawater mud is mixed and circulated into the well bore, and the natural mud system is discharged overboard. This gelled seawater mud is used to drill the next 3,500 feet of hole. Table 11 shows the weight and various components used to make up and maintain the required characteristics of the mud while this interval is drilled. A total volume of 700 bbl. is made up and maintained in the system.

When drilling is resumed after setting 10 3/4" casing, the mud system is altered to a lignosulfonate type (Table 12) and the volume is expanded to 950 bbl. in order to allow drilling of the final 5,600 feet of hole. After the 7 inch production string of casing is set, about

Table 11

GELLED SEAWATER MUD - TYPICAL COMPOSITION

Mud Component Used	Weight, lb.
Attapulgite Clay	56,300
Caustic (Sodium hydroxide)	5,500
Barium Sulfate (weighting agent)	12,200
Organic Polymer	3,700
Ferrochrome Lignosulfonate (Iron-2.6%, Chromium-3.0%, Sulfur-5.5%)	3,300
Pregelatinized Starch	500
Seawater	As required
Total Mud Components	81,500

Table 12

LIGNOSULFONATE MUD - TYPICAL COMPOSITION (Modification of mud described in Table 11)

Mud Component Used	Weight, lb.
Barium Sulfate (weighting agent)	319,000
Caustic (Sodium hydroxide)	22,500
Ferrochrome Lignosulfonate (Fe-2.6%, Cr-3.0%, S-5.5%)	29,600
Organic Polymer	4,100
Bentonite Clay in freshwater, or Attapulgite Clay in seawater	17,100
Proprietary Defoamer	325
Water	As required
Total Mud Components	392,632
Total Mud Components, less barium sulfate	73,632

550 bbl. of mud in the tanks is saved for use in drilling the next well. The remaining 400 bbl. in the well are discharged overboard after the barite has been removed by centrifugation. After the final well is drilled, all barite is barged ashore to be used at other locations.

Special Cases

Occasionally, abnormal formation pressures, exceptionally tight formations, or other problems require the use of oil-based or highly treated drilling muds. Drill cuttings are then separated and cleared of entrained oil before being discharged overboard, and the drilling muds are retained and shipped to shore and stored in tanks for future use.

c. Production Operations

(1) Downhole Safety Devices

Wells usually are produced through tubing placed inside the final or production string of casing. During tubing installation, the blowout preventers remain in use to ensure control of the well. A system of in-tubing safety valves, plus other casing and tubing valves at the surface or seafloor, is installed to control well flow. Actuation is usually at the producing platform. A wellhead, consisting of several redundant control valves, is installed at the platform cellar deck level and subsurface safety valves are installed at depths varying from a few hundred to several thousand feet in the tubing string.

Of major concern in the operation and control of every production platform are the downhole control devices. Production tubing is fitted with one or more safety valves that are installed and located at least 100 feet below the mud line or seafloor. In the past, velocity choke valves designed to shut off production when the flow rate exceed predetermined limits have been used. Such valves should close if surface equipment failure results in an excessive flow through the tubing. These chokes are particularly susceptible to failure from internal erosion in areas where sand is produced along with the oil and gas.

Newer types of valves do not depend on the velocity of well fluids for actuation, but are held open by hydraulic or other fluid pressure applied from the surface. Release of this pressure by a control signal, or by an accident, causes them to close immediately. Their use increases costs significantly, but the need for more reliable valves has been shown by recent incidents in the Gulf of Mexico and elsewhere. The Environmental Protection Agency has noted, and we agree that reliability of velocity actuated subsurface safety devices has been very low in recent disasters (11 out of 22 wells failed in the Bay Marchand Fire). It is hoped that the newer pressure-release-closure valves will offer an increased degree of safety but they have not been in OCS service long enough to allow a confident prediction of reliability.

(2) Produced Formation Water

The waters associated with oil and gas pools which are frequently produced along with the oil and gas are called formation waters. The lower edge or boundary of most oil and gas pools is marked by an oil-water or gas-water contact. In some pools, water is produced with the oil in early stages of production, whereas in others, appreciable water never comes up with the oil.

Most formation waters produced in the Gulf of Mexico are brines, characterized by an abundance of chlorides, mostly as sodium chloride, and have concentrations of dissolved solids several times greater than that of seawater. The total amount of mineral matter commonly found dissolved in oil-field waters ranges from a few parts per million (ppm), nearly fresh water, to approximately 300,000 ppm, a heavy brine. One of the highest brine concentrations recorded was 624,798 ppm; or 64.3%, from a field in Michigan (Case, 1945, as cited by Levorsen, 1958). 1/

It is highly unlikely that any of the produced formation water resulting from this sale would ever be piped ashore. Both economic and environmental considerations weigh heavily towards choosing to treat and release the formation water into the ocean at the platform site or reinject it into subsurface formations. In nearly all cases, reinjection is utilized as a secondary recovery technique by pumping the formation water, under pressure, back into the lower reaches of the petroleum-producing zone and thus maintaining good reservoir pressure.

Formation water which is to be discharged into the ocean is first passed through a water-polishing facility that removes all but traces (less

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1/ Case, L. C., 1945; Exceptional silurian brine near Bay City, Michigan. Bull. Amer. Assoc. Petrol. Geol. 29:567-570.

than 50 ppm) of entrained oil. However, the water is still void of dissolved oxygen and contains large quantities of dissolved minerals.1/

d. Workover Operations

Since petroleum production involves the handling of flammable fluids under pressure, the safety systems control is of utmost importance to preclude hazardous conditions. Nowhere is this hazard greater than during workover, or remedial operations on a well in order to improve its production rate or to replace faulty downhole equipment. Since workover operations are potentially hazardous, they must be planned carefully, both to keep wells from getting out of control and to prevent or minimize the release of oil to the environment. In response to the hazard of multiple well involvement during workover accidents, the Geological Survey is currently revising OCS Order No. 8; this revision will limit the conditions under which multiple operations may be conducted on an offshore structure. The restrictions will apply to workover operations as well as to drilling and production operations.

To reduce pollution, specially treated salt water that can be weighted with various materials is used for hydrostatic control when re-entering the wells in wire-line or swabbing operations.

To increase production, acid or other fluid and suspended particulate matter may be pumped through the well bore into producing formations. The function of this treatment is to enlarge flow channels leading to

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1/ Composition of formation water is discussed in detailed in Vol. 2, Sec. III. A. 1. b.

the well. The spend acid returns up the well when production is resumed, and is handled as are other fluids from the well. Oil and water contaminated with acid are disposed of ashore.

Sand produced along with the well fluids can cause the wells periodically to plug, or "sand up", and must be removed. Other procedures to increase productivity and oil recovery include the injection of high-pressure steam, water and/or gas into specially prepared injection wells. The water used for this purpose may be taken from the ocean or from formation water. Water too contaminated to be treated, polished, and discharged is reinjected into formations, taking suitable precautions to ensure that fresh water aquifers will not be contaminated by oil or salt water. Gas produced from the well may be reinjected for pressure maintenance where feasible or piped to shore for sale.

From the safety standpoint, completion and workover operations must be carefully conducted, and it is their critical nature that, in all likelihood, makes these operations safer than they otherwise might be. Operators of swabbing and wire-line units are well aware of the hazardous nature of their work and are extremely cautious. Despite the potential hazard, safety records during wire-line and swabbing unit work are excellent.

e. Solid Waste and Sewage Disposal

Solid waste accumulating on offshore rigs consists largely of common kitchen waste and shipping containers. Solvents, additives, lubricants, and treatment chemicals are shipped in returnable drums.

All solid waste is collected in large containers constructed of heavy grating. To reduce the bulk before being transferred to shore, wastes are sometimes compacted in mechanical compactors but are generally incinerated in burn baskets suspended from the platform. Ashes are allowed to fall into the water. Non-combustible solids are then loaded into service boats for transfer to shore. Solid wastes, transferred to shore, are emptied into municipal or private sanitary landfills which are subject to the sanitary landfill laws of the state.

Sewage treatment and disposal on offshore rigs and platforms is very similar to the common septic tank, but with the addition of a chlorination system. In this case the septic tank is normally a fiberglass container somewhere on the platform into which all toilet, kitchen, and laundry drains discharge. The usual settling and bacterial digestion takes place in this tank and the final effluent is chlorinated. OCS Order No. 8 requires that the effluent shall contain 50 ppm or less of biochemical oxygen demand (BOD), 150 ppm or less of biochemical solids, and shall have a minimum chlorine residual of 1.0 mg/liter after a minimum retention time of fifteen minutes.

4. Transportation of Produced Oil and Gas

a. Pipelines

Construction and Burial

Nearly all hydrocarbons produced on the OCS are transported by pipeline (as of 1971, only $3\frac{1}{2}\%$ of OCS crude oil was transported by barge). All natural gas, of course, must be moved by pipeline. A substantial amount of natural gas is necessary to justify economically the construction of a natural gas pipeline. In the early stages of the development of an oil field, small amounts of gas may be vented or flared or reinjected into the petroleum reservoir to maintain good pressure. However, wasteful venting or flaring is prohibited by OCS Order No. 11.

(1) Offshore

Pipelines laid offshore are constructed and emplaced by several different methods, depending mainly on the size, location, intended use, and cost. One method, pipepulling, involves the use of barges and tugs to pull sections of welded pipe from an onshore launchway over the preselected right-of-way. These sections may either be dragged along the bottom or suspended by floats. There are at least three limitations to this system. First, an extensive section of shoreline, roughly perpendicular to the shore, must be available for the fabrication and launchway site. (Alternatively, it is possible although more costly to use a launching jetty constructed from the beach out over the water.) Second, the total length of pipeline that can be laid is limited. One company estimates the limit to be 100,000 feet for smaller diameter pipe. Third, the pipeline right-of-way must be essentially a straight line. The pipe pulling method is not used often for the emplacement of pipelines to OCS locations.

The second method, used in nearly all cases for large-diameter pipelines, involves the welding together of short sections of pipe on a barge while simultaneously moving the barge forward, and allowing the completed expanse of pipeline to sag downward and lay on the seafloor. This operation begins at the offshore location and proceeds toward the intended onshore terminus. The advantage of this system is that the pipeline right-of-way need not be straight, and that any diameter of pipeline can be laid in this way. The main disadvantage is slow rate at which the laying proceeds; average rates are about 300-800 feet per hour.

The third method has become increasingly popular in the last decade for laying smaller-diameter pipelines and involves the use of a lay-barge equipped with a large reel or spool of coiled pipe. With the reel-pipelaying technique, miles of pipe are welded together onshore and the appropriate coatings are applied. Then the pipe is wound onto a large-diameter reel which is mounted on a barge or other floating vessel. The vessel is then transported to the construction site. As the barge is towed along the right-of-way, the pipe is pulled off the reel through straightening equipment and continuous lengths of pipeline are laid on the seafloor. The reel method has several advantages 1/. With no welding and little crane work being done on the barge, the operation is much less susceptible to interruption by bad weather and high seas. A thicker-walled pipe can be used, eliminating the necessity of a concrete coating for negative buoyancy, increasing the pressure rating, and adding significant corrosion allowance. This method allows pipelaying to proceed at a much faster rate that other methods - up to 5000-10000 feet per hour.

The reel method has two principal disadvantages. First, economic considerations limit the diameter of the pipe that can be laid to 12 inches. Second, during pipe-handling operations, pipe coatings are subject to occasional damage, necessitating repairs and thus, slowing the rate of pipelaying.

In depths under 200 feet present OCS administrative procedures requires burial of the pipeline. Burial is effected by jetting sediment away from underneath the pipeline and allowing it to sink into the resulting trench. The equipment used in this operation consists of a work barge equiped with high volume/high pressure water pumps and air compressors. From the barge, a multiple membered towline consisting of a strength member, water line, and air line extends downward to a U-shaped structure which saddles the pipeline and

1/ Johnson, P. K. 1971. A reel-type pipelaying barge. Civ. Eng.-ASCE. Oct. 1971: 45-47.

glides along it on rollers. Affixed to the U-shaped jetting device are several nozzles which direct water and air, under high pressure, ahead and below the pipeline. Sediments are blasted out of a narrow trench by the water jets, partially lifted by the air and deflected to the sides by various types of fins. The suspended sediments falls diffusely along either side of the trench. As the jetting device is pulled forward, the pipeline settles into the trench and is partially buried quite soon by the reworked sediment as it slips and settles back into the depression. Complete burial and restoration of original bottom contours may require additional time. In shallow waters, experience has shown that contour restoration to be quite rapid, whereas in deeper waters, more than a year may be required.

Even though a buried line is protected from fluid forces it is not necessarily stable. 1/ If it is too light, it will gradually work its way up through the soil and become exposed to the water forces. If it it too heavy, it will gradually sink in the soil and impose additional tensile stress in the line. Design procedures for determining the vertical stability of the line in sands and clays have been developed and are available in the industry.

Difficulties have been experienced in burying pipe in cohesionless sands. 2/ In this case the sand will often refill the jetted trench before the pipe can settle into it. Another method, fluidization of

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1/ Milz, E. A. and D. E. Broussard, 1972. Technical capabilities in offshore pipeline operations to maximize safety. Paper presented at 1972 Offshore Technology Conference, Dallas, Texas, May 1-3, 1972.

2/ Ibid.

the sand, enables successful burial in this type of substrate. It is likely that this would be the method of choice on the sandy Florida shelf. West of Cape San Blas either the trench-jetting or fluidizing method could probably be used.

In waters beyond the 200-foot contour, pipelines are not buried. Industry spokemen maintain that at this time burial in waters substantially deeper than 200 feet is technologically possible but would not be economically feasible.

To prevent corrosion, pipelines are carefully coated with such materials as epoxy compounds or thick asphaltic mastic. If extra weight or mechanical protection is needed, these, in turn, are covered with a layer of dense concrete. The lines are protected from electrolysis by both impressed-current systems and by sacrificial anodes (zinc is commonly used). Corrosion prevention measures are now required by 49 CFR Part 195. Although offshore pipelines are relatively inaccessible as compared to onshore pipeline, they nonetheless can be repaired by divers. Experimental dives have been made to 1,000 feet, but work at this depth is difficult and expensive. Methods of using submersibles to latch on to a subsea line and repair it with mechanical arms and special tools are under study and nearing the point of practical demonstration.

As in the case of workover operations, the expense of the pipeline installations, coupled with the catastrophic implications for the local marine environment should a major break occur, have combined to dictate a highly conservative design, emplacement, and operating philosophy.

As the pipeline construction approaches and traverses the shoreline, it is buried deeply enough to avoid its being exposed by storm-associated beach erosion. From this point the pipeline construction will be extended toward a storage facility, wharf facility, or a major existing pipeline system, in turn leading to a processing facility, refinery, or interstate gas line.

(2) Onshore Pipelines

From the beach to their inland terminals, pipelines may cross barrier islands and spits, wetlands, and uplands. A soils study by industry in areas of tentative pipeline routes has led them to the opinion that all lines can be located so as to come ashore at either elevated terrain or firm wetlands. They believe the subsoil of these wetlands is firm enough to support construction equipment and provide adequate backfill for the pipeline ditch. Over elevated terrain, burial consists of the familiar trench-and-backfill method. Where wetlands and perhaps low spits such as Saint Joseph Spit might be crossed, the push-ditch method is employed. In this technique 1/ a narrow, relatively shallow ditch is excavated by a dragline or clamshell digger. By using a "marsh buggy" base or by

1/ McGinnis, J. T., R. A. Ewing, C. A. Willingham, S. E. Rogers, D. H. Douglass, and D. L. Morrison. 1972. Environmental aspects of gas pipeline operations in the Louisiana coastal marshes. Final Report to Offshore Pipeline Committee. Battelle Columbus Laboratories, Columbus, Ohio.

using runners or pads to spread the weight, damage to the terrain is minimized. The ditch dimensions may be 4 to 6 feet deep by 8 to 10 feet wide. Pipe sections are joined together at the point of origin of the ditch, the line given temporary buoyance by attached floats, and pushed down the ditch. After being floated into place, the floats are cut loose and the line allowed to sink to the bottom of the ditch. The ditch is then normally backfilled.

Pipelines-Operation and Maintenance

The safe operation and maintenance of a pipeline system requires several redundant monitoring systems to ensure the integrity of the line and detect leaks. The primary leak detection system in use (required on all lines built after March 31, 1970 by 49 CFR Part 195.404 and 195.408) is a set of automatic pressure sensing recorders on both ends of each pipeline system. These recorders are equipped with a built in alarm system which either shuts down the flow automatically or sounds an alarm to alert personnel of an abnormal pressure level. In this way, a leak of substantial rate is detected immediately. This system is insensitive to very small leaks which do not produce a decrease in line pressure.

The second system of leak detection is the routine patrolling of the offshore and wetlands routes by boat or aircraft, and onshore by wheeled vehicle or aircraft. A minimum patrolling frequency of intervals between inspections not exceeding 2 weeks is required by

49 CFR Part 195.412, but in actual practice is performed more often. This type of monitoring would result in the detection of all sizes of leaks of course, but would be of little consequence in preventing the loss of a large amount of petroleum in the event a large line were severed. The appeal of a system of regular pipeline patrolling is that it allows detection of small leaks and therefore compliments the pressure-sensing system described above.

The third system for leak detection consists of a series of volume-recording flow meters on either end of a pipeline system. Because nearly all crude oil moves from OCS areas to shore by common carrier lines, it must be metered in the offshore pipline gathering system and again at the onshore pipeline terminal in order that each producer be properly credited for his share of the common stream. This flow monitoring system has been designed so that the flow sensors continually indicate net input and output in real time so that attendant personnel are able to discover a decrease in output and alert appropriate stations of the possibility of a leak.

One more safety feature which would be built into all pipelines resulting from this proposal, according to industry spokemen, is that remotely operated mainline block valves will be provided remotely controlled pipeline facilities in order to allow isolation of segments of the pipeline 1/.

1/ American National Standard Liquid Petroleum Transportation Piping Systems ANSI B34.4-197 434.15, In press.

b. Barges and Barge Operations

Tank barges are flat-bottomed vessels that may be self-propelled, towed, or pushed. If they are towed or pushed, a sea-going tug is used as the power source. Tugs used for this purpose vary in size from 65 to more than 150 feet in length, and are powered by 350 hp to 4500 hp diesel engines. Although non-self propelled tank barges come in all sizes, three are most popular:

- 1000 ton capacity (7200 bbl), 175 ft. long, 26 ft. beam, 9 ft. draft.
- 1500 ton capacity (10,800 bbl), 195 ft. long, 35 ft. beam, 9 ft. draft.
- 3000 ton capacity (21,600 bbl), 290 ft. long, 50 ft. beam, 9 ft. draft.

One tugboat of 4500 hp is easily capable of pushing ten of the 3000 ton barges that are lashed together. Some barges are provided with a notch in the stern into which the tug may be fitted and secured; others are towed by being lashed to the port and starboard sides of the tug.

Self propelled barges that may be used offshore have capacities ranging from 20,000 to 25,000 bbl. A 20,000 bbl barge averages 200 ft. in length, 50 ft. in width and draws 9 feet of water; 25,000 bbl barges are all relatively new, are only slightly longer (236 ft.) than their predecessors, but are the same width and draft. Larger 30,000 bbl barges are under construction, but not yet in use in the Gulf of Mexico. All self-propelled barges and tankers must be inspected and certified by the United States Coast Guard. Power is provided by two 1000-1500 hp diesel inboard engines, each connected to a powerful screw which moves the barge at an average open water speed of 10 knots.

There are three basic barge designs: 1. single skin (hull), 2. double skin, and 3. barges having independent cylindrical tanks. Single skin tank barges have both bow and stern compartments that are separated from the midship by collision bulkheads. The entire midship shell of the vessel constitutes the cargo tank with structural framing inside. Double skin barge have an inner and an outer shell with the inner shell forming the cargo tank. This double skin structure provides added protection in case of collision, grounding, or some other mishap. Barges with independent cylindrical tanks are used for transporting liquids under pressure or where pressure is to be used to off-load the cargo; these will not be used for transportation of crude oil. In any case, barges usually do not have compartmentalized storage tanks.

The transfer of petroleum either into, or out of, a barge is a relatively simple operation. The vessel is docked either at an offshore platform or shore-based offloading facility usually with the aid of either an active rudder or a bow-thruster. Docking can be accomplished with relative ease in seas up to five feet. Once secured, hoses are connected to a manifold located on either side of the barge. These hoses must be equipped with a "quick-disconnect" apparatus in order to prevent a back flow from the hose from discharging into the sea. The coupler, because it may contain up to one-half gallon of oil, must have drip pans placed beneath it in order to catch any oil before it could spill into the water. The U.S. Coast Guard requires that a certified tankerman be present and on duty at the manifold during any oil transfer operations. After loading, or offloading, is completed, the transfer hose is drained dry by back flowing or draining the crude to the platform. The couple is then broken, and either a receptacle is placed over the end to catch the drippings or the hose is plugged directly.

Loading of crude oil is usually done by means of a gravity feed system either from platform storage tanks or directly from the well. Offloading of crude to shoreside facilities is accomplished by pumps located on the barge or shoreside. The average rate of loading or discharge is approximately 4000 bbl/hr.

More than 2600 tank barges are presently in service with a total cargo capacity of more than 6 million tons. The majority of this tank barge capacity is used in the transport of crude petroleum and petroleum products amounting to more than 150 million tons annually.*

*All data from the American Waterways Operators, Inc. publication entitled "Big Load Afloat."

c. Tankers and Tanker Operations

At some later date tankers may be used to transport crude oil from Tampa Bay facilities to existing Gulf Coast refineries (see section d). In this regard, the following is a brief description of the types of tankers than can be used and their operations. The restriction on the size of the tanker will be dependent upon the depth of the harbor at Tampa/St. Petersburg which, at the present time is 35 feet. The largest fully-loaded ship that can be accomodated under these circumstances is approximately 40,000 dwt"* which will draw 35-36 feet. Ships of this size average 700 ft. in length and have a 100 ft. beam. Most are capable of making 14-17 knots in the open ocean. Smaller tank ships in the 28,000-32,000 dwt size class are quite common for short hauls, and may be used in this operation. It is, however, to the operators economic advantage to use as large ships as possible.

Loading and offloading of crude is accomplished in much the same way as explained for barges. There are, however, some additional points that deserve mention.

- All vessel transfer pumps have check valves in the discharge line to prevent back flow during unloading.

- The Scuppers 1/ are all securely plugged during transfer operations and any spillage is cleaned up prior to unplugging.

*dead weight tons-this is the cargo-carrying capacity.

1/ Scuppers: Openings in the bulwark at deck level which provide for overboard drainage of seawater taken on the decks, for example during transit through heavy seas.

- Valves are turned on and off in a planned sequence in order to prevent excessive pressure on hoses.

- When loading is nearly complete, the rate of flow is cut back to preclude overflowing the tanks.

- Most loading pumps are equipped with dockside control systems that can remotely shut-down the operation.

- Tankers, unlike barges, are compartmentalized to reduce the possibility of capsizing as a result of cargo surging.

d. Anticipated Modes of Transportation for Oil and Gas Recovered as a Result of This Sale

Assuming that development follows the timetable set forth in the following section (I.F.6), production can be started approximately $2\frac{1}{2}$ years after the first discovery provided that a separate offshore facility platform is utilized or that pipelines are installed with the first platform. Otherwise, production will not be started until the fifth year.

As the result of a recent reassessment of potential production, tract locations, and existing facilities, industry spokesmen have proposed the following plan for handling production resulting from this proposed lease sale. It should be noted that this is a tentative plan which industry has proposed and is subject to change by pipeline corridor selection (see Vol. 2, Section IV. D.1) and barging restrictions (see Vol. 2, Section IV. C.).

(1) Barging

Barging is not considered by industry to be the primary means of crude oil transportation from offshore platforms. Barging large volumes of oil requires large offshore tankage. Therefore, unless additional storage or large self-contained platforms are installed during the initial development of this region, this type of barging is not considered likely.

Barging, if it occurs, would begin near the end of the fourth year after exploration had started and would be due, according to the industry, to economics not justifying a pipeline. It is felt that low reserves and production of less than 10,000 bbl. of oil per day (BOPD) per area would prove uneconomical for pipeline construction and would necessitate barging. Some early barging might occur from Areas II and III as depicted in Figure 8.

It is estimated then that, if required, not over 20,000 BOPD would need barging from these two areas before economical pipelines could be run to shore.

Maximum barging would require

1 Barge (21-22,000 bbl capacity)
1 Trip/day - 20,000 bbl
365 Trips/year - 7,300,000 bbl
3-4 Barges/day in Gulf due to round trip time to existing refineries.

Another type of barging that may be needed concerns oil produced while testing an exploratory well. Many wells may not be tested due to satisfactory interpretation of logging information. Assuming maximum testing, no more than one two-zone well per productive tract will be tested at a 500 BOPD rate for 6 hours per zone. A maximum barging schedule based on yearly averages can be set up as follows (to existing refinery or storage facilities):

1st year - 9 wells

Barge (6-12,000 bbl capacity)
1 Trip/40 days - 500 bbl
9 Trips/year - 4,500 bbl

2nd year - 19 wells

Barge (6-12,000 bbl capacity)
1 Trip/20 days - 500 bbl
19 Trips/year - 9,500 bbl

3rd year - 19 wells

Barge (6-12,000 bbl capacity)
1 Trip/20 days - 500 bbl
19 Trips/year - 9,500 bbl

4th year - 9 wells

Barge (6-12,000 bbl capacity)
1 Trip/40 days - 500 bbl
9 Trips/year - 4,500 bbl

If more than one test occurred at the same time then the number of trips would be reduced. Barging small quantities of oil over long distances over the open Gulf is seldom economical. An alternative would be to limit the amount of testing and burn the test production with an approved smokeless complete burner.

(2) Pipelines

If profitable quantities of oil are found in any of the tracts, it is expected that pipelines will be developed as common carriers on an area basis. Gas pipelines, unlike oil pipelines, are not developed as common carriers, and any resulting pipeline system, both offshore and onshore, could be highly variable, depending on the purchaser. The most probable routes and alternatives are identified below as working examples for each area. It could be expected that 3 to 9 oil pipelines 1/ would be required to transport the oil to shore. The Area numbers cited below refer to those depicted in Figure 8.

(i) Area IV

These six drainage tracts would be developed as an extension to existing fields. No additional shore facilities or extensive additional pipeline systems will be required.

(ii) Area I

Oil

All production from this area could be brought to shore in the Pascagoula area. From the shore terminal it could be delivered to refineries in Pascagoula, transshipped from existing tanker terminals, or it could go cross country to existing interstate pipelines north of Pascagoula.

1/ Estimate was made prior to removal of 12 tracts from northeastern Pensacola South No. 1 Areas by U.S. Dept. Interior.

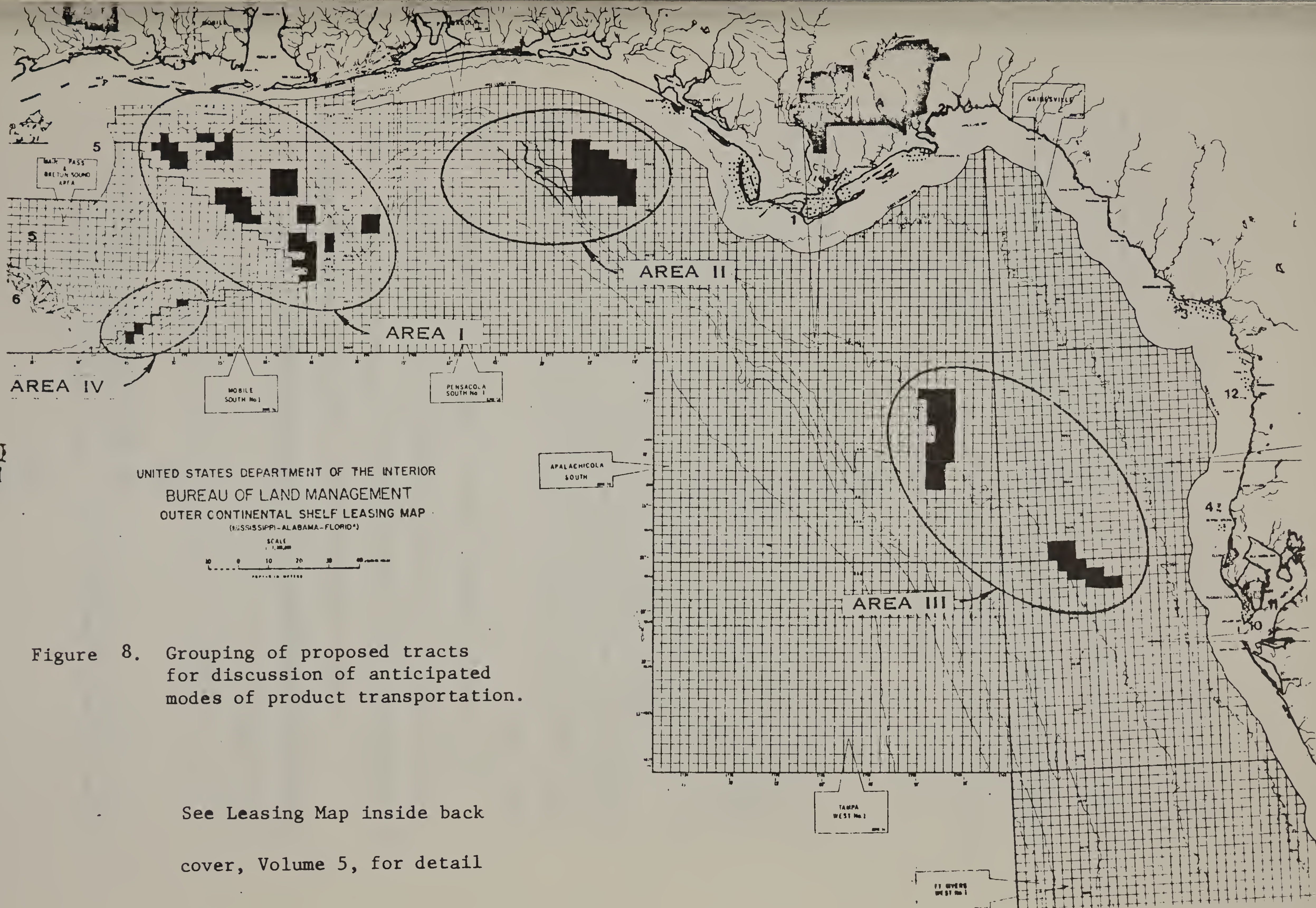


Figure 8. Grouping of proposed tracts for discussion of anticipated modes of product transportation.

See Leasing Map inside back cover, Volume 5, for detail

Gas

Production from this area could be brought to shore in the Pascagoula area, and brought to United Gas Pipe Line Company's existing line at a point north of Pascagoula in Jackson Co., Mississippi.

(iii) Area II

Oil

It is likely that this oil field will be quite productive and it is anticipated that a pipeline would be constructed soon after development was underway. There are three alternative routes for this pipeline:

a) From the offshore field, it could be laid to cross the shoreline just west of Pensacola and then cross-country to the head of Mobile Bay where it could be connected with existing Jay Field lines.

b) From the offshore field it could be laid eastward to come ashore at Port St. Joe where it would be loaded onto tankers for reshipment to existing Gulf Coast or Mississippi River refineries.

c) From the offshore field it could be brought ashore to an area east of Pensacola Bay and then cross-country to the head of Mobile Bay.

Gas

The two alternative gas pipeline routes to handle production from this area are as follows:

(a) From the offshore field a line could be brought ashore east of Choctawhatchee Bay, and overland to connect with Florida Gas Transmission Company's existing line at a point east of DeFuniak Springs in or near Walton Co., Florida.

(b) From the offshore field a line could be brought across Perdido Bay to connect with United Gas Pipe Line Company's existing line at a point northwest of Pensacola in Escambia Co., Florida.

(iv) Area III

If profitable quantities of oil are found here, it would probably be combined in a pipeline to shore in the Tarpon Springs/Tampa vicinity. It is probable that a new or enlarged existing terminal for tanker transshipment would have to be constructed here. Oil from this terminal would probably be transported by tanker directly to existing Gulf Coast refineries in Mississippi, Louisiana and Texas or an alternate, to the East Coast.

Gas

The two alternate gas pipeline routes to handle production from this area are as follows:

(a) From the offshore field a line could be brought ashore north of Clearwater, to connect with Florida Gas Transmission Company's existing line at a point north of Oldsmar in Pinellas Co., Florida.

(b) From the offshore field a line could be brought ashore in central Taylor County, to connect with Florida Gas Transmission Company's existing line at a point northwest of Perry in Taylor Co., Florida.

(3) Pipeline/Tanker Transshipment

The possibility exists that a portion of the production may need to be handled by Pipeline/Tanker Transshipment as mentioned in the above section. Any required tanker terminals would need to be operational at the time pipelines to shore are completed, and existing terminals would be used or expanded if available. Depending on the alternate selected for the development, as many as two tanker terminals could be needed as early as $2\frac{1}{2}$ years from initiation of drilling. Pipelines are considered the most satisfactory means of transporting production and would be used where justified.

Based on a uniform timetable of development a tanker terminal, if required, would have a throughput of up to about 140,000 BOD peaking at about $8\frac{1}{2}$ years after initiation of drilling. Based on this rate of production and a small tanker in the range of 30,000 DWT loading would have to be accomplished at average intervals of 1.4 days. This would require approximately 22 trips per month or 246 trips per year at each required terminal. It is assumed that all the oil would be transshipped to existing Gulf Coast refineries using existing sea lanes.

5. Termination of Offshore Oil and Gas Operations

According to industry estimates, with proper placement of wells and sufficient pipeline capacity, a gas reservoir could be profitably drained in as little as ten years. In contrast, some oil reservoirs have been producing for over twenty years in offshore areas. When the reservoir has been depleted to a level where it cannot be profitably produced, operations are terminated. During abandonment, the wells are plugged with cement, the casing severed at least 15 feet below the mudline, the platform is removed, and all obstructions are cleared from the area. All that remains is the pipeline system. Frequently, major trunklines can be used for future oil and gas production from adjacent areas, but smaller spur lines are abandoned in place. Pipeline abandonment consists of first purging the lines of entrained hydrocarbons by water flushing, and then severing the ends below the mudline.

6. Timetable for Development of Tracts Leased at Sale

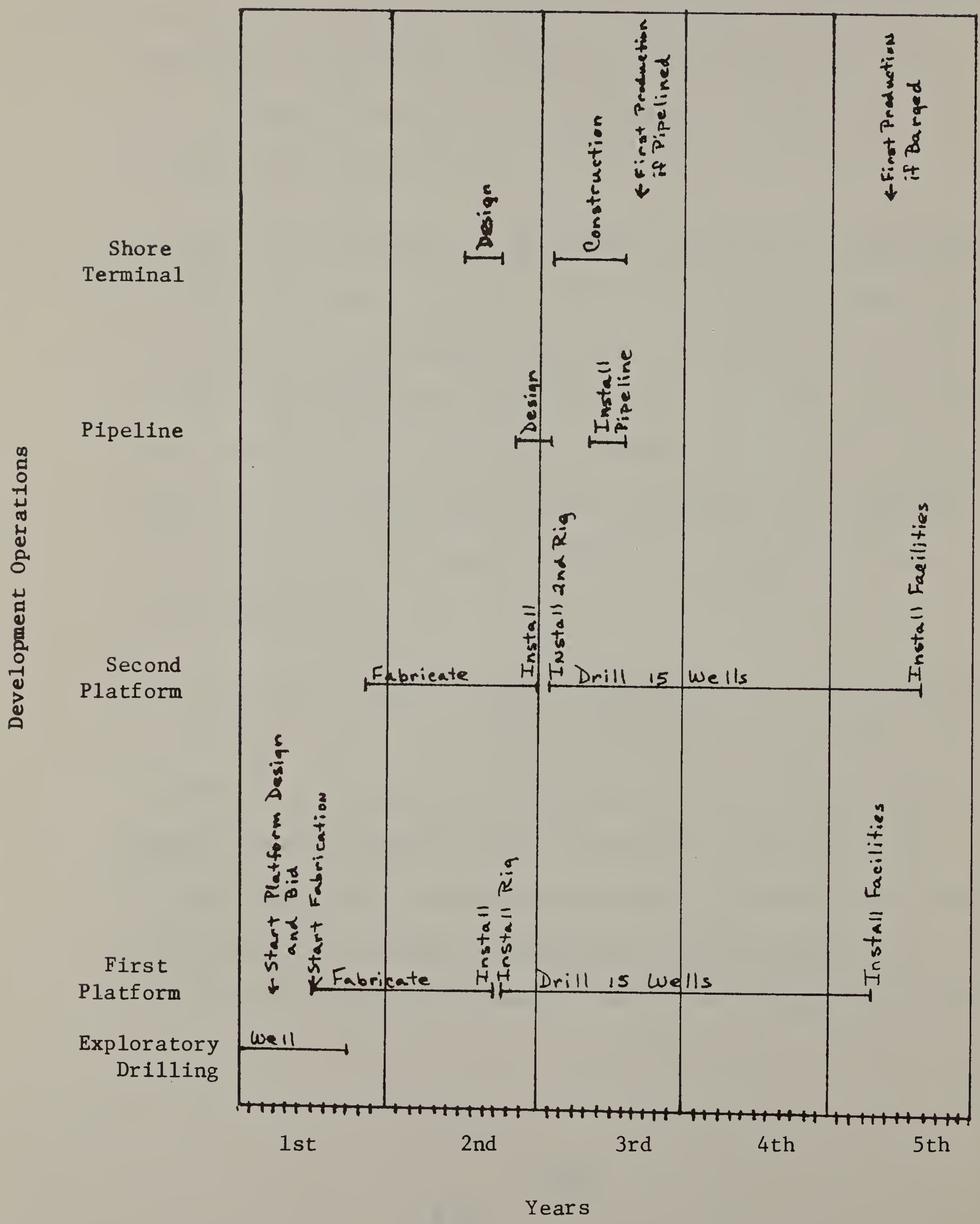
Figure 9 shows the expected timetable and development sequence for a typical tract which would be leased at the proposed sale. This timetable, developed from a survey of industry representatives, is based on the information about the tracts under consideration and industry experience in the Louisiana offshore area.

For this timetable and development sequence it was estimated that twenty-six rigs would be available for exploration in the eastern Gulf, and that the exploration phase would require seventy-nine rig years. The number of rigs in operation would increase to a maximum of twenty-six at the end of the first year. This level would be maintained for two years and then be reduced to zero at the end of the fourth year.

The final platform design is completed and fabrication begins after a discovery is made, with installation during the second year of the operations on the lease. After the installation of the first platform, development drilling on the tract will begin. Development drilling in the area will begin, therefore, at the end of the second year after the sale and continue into the seventh year. Platform oil, gas and water treating facilities are installed after the wells are completed.

Production can be started approximately two and one-half years after the first discovery if a separate offshore facility platform is utilized or if pipelines are installed with the first platform. Otherwise, production will not be started until the fifth year. For this development scheme, it was assumed pipelines would be used with production initially separated and treated onshore until facilities are installed offshore. Under these assumptions production would begin during the third year after the sale and, after the completion of development drilling, level off at the maximum production rate during the eighth year.

Figure 9. Typical Time Table for Lease Development



G. Relationship of This Proposed Action to Existing and Prospective Offshore Oil and Gas Development in the Gulf of Mexico

This proposed action must be viewed as one part of a continuing activity that has been underway since the 1940's and that will continue indefinitely, with or without this proposed lease sale, on into the future. Although primary emphasis concerning the description of the proposal and its potential environmental effects has been placed on this particular sale in isolation from all previous activities of the same nature, it should also be put into a perspective of an on-going offshore oil and gas development process. As of January 1, 1973 there have been 22 OCS oil and gas lease sales on submerged lands in Federal areas of the Gulf of Mexico and 4 offshore the Pacific Coast.1/

Table 13. Total Acreage Leased From the Inception of OCS Leasing Activities Through December, 1972

Area	Acreage
Louisiana	6,558,468
Texas	1,152,583
Florida	132,480
Pacific (Cali., Wash., Ore.)	1,258,974
Total	9,102,505

Table 14. Acreage Currently Under Lease as Of May 25, 1973.

Area	Acreage
Louisiana	4,155,129
Texas	301,454
Pacific Coast	351,877
Total	4,808,460

1/ There also have been five OCS sulphur and salt sales in the Gulf of Mexico.

The total acreage expected to be made available for leasing under the five-year lease schedule of OCS sales is approximately 15 million.

The relationship of this proposed sale to other offshore oil and gas development activities in the Gulf of Mexico indicates that additional increments of transportation and storage facilities, platform and pipeline construction activities required if this sale proceeds, for example, will be added to a whole network of existing facilities and activities. As of this writing there are a total of 1,939 offshore platforms on the OCS in the Gulf of Mexico and 5 offshore California. There are a total of 67 mobile drilling rigs available in the Gulf of Mexico of which 62 are working and there is one mobile rig working offshore California. The Bureau of Land Management as of June 4, 1973 had issued 319 pipeline right-of-way permits resulting in 3,739 miles of pipelines on the OCS. The Geological Survey has issued a total of 830 pipeline permits on the OCS resulting in 2,361 miles of offshore pipelines.

As production declines in existing areas, much of the equipment, transportation facilities, pipelines, platforms, etc., not to mention the personnel and technological expertise presently available, can be used for new areas of activity. As existing areas of production decline the pipelines in place for that system can be used for new production areas, adjacent, or further from shore, reducing the quantity of pipelines necessary to transport production from new areas to shore. This latter event has already been exercised in some areas of the Gulf of Mexico. 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. Nevertheless, in this proposed sale some new pipelines, drill rigs, platforms and expansion of existing onshore facilities and perhaps construction of new ones where necessary, will be required although the quantities involved will be less than they would be without utilization wherever possible of existing facilities.

Cumulative effects on the environment from OCS leasing will result as more and more areas are made available for an expanded offshore mineral development program. An increased level of potential conflict with navigational hazard will result from the cumulation of additional offshore structures associated with OCS leasing. This will have its greatest effect on commercial shipping and fishing activities. The effect of increasing the numbers and lengths of pipelines to shore will also have a cumulative impact on the onshore and offshore environment. The effect is expected to have its greatest impact in those nearshore and onshore areas which feature estuaries, marsh, and wetlands environments. The biota in the path of a pipeline will undergo disruption, loss of habitat, and will suffer physiological stress, injury or death. The overall, relative significance of this effect in most areas is considered low because of the small areas involved and the short duration of the activity. In eastern and central portions of coastal Louisiana, the cumulative effect of pipelines has been more severe, due to the necessity of using large, permanent flotation canals through the unconsolidated marsh substrate for pipeline laying operations. In addition to pipelines, additional increments of transportation, storage, refinery, treatment and other facilities and activities associated with oil and gas production on the OCS will have an overall, cumulative effect on the coastal environment and local and regional economics. The initial effect on biota will be one of disruption and destruction in the construction areas. The effect on air and water quality is unknown, at this time. The overall significance of these effects on a cumulative basis are unknown, but are considered adverse.

There will be a cumulative effect resulting from solid and liquid waste disposal associated with OCS development and any oil polluting events should they occur. The effect will be physiological stress and death for oiled plants and animals and possible contamination of marine food sources for man. The scope, duration, location and overall significant effects of an oil spill on a cumulative basis are unknown. However, the area of greatest potential for receiving lethal and sub-lethal adverse effects on a cumulative basis are embayments and semi-enclosed waters where many species undergo early development and are more vulnerable to toxic compounds. The probability of a massive oil spill resulting from operations on the Outer Continental Shelf impacting upon areas such as these is considered to be low because of the distances involved and the fact that in the history of OCS leasing, no oil spill resulting from an OCS lease area has ever penetrated semi-enclosed embayments, estuaries, or wetlands. By far the most likely single source of a massive spill in these sensitive areas is from tankers. In the past, tankering of OCS production has not been necessary principally due to its proximity to refineries. In this proposed sale, however, tankering of some production is probable. If tankering results from this sale them a potential hazard will exist to St. Joseph Bay and the Tampa Bay system. Oil on a beach, should it occur, would be aesthetically unpleasant and if it occurred repreatedly, it would disrupt recreational events and render affected beach areas unsuitable for human enjoyment.

H. Contract, Research and Study Programs

1. Introduction

The purpose of this section is to describe studies recently completed, contract studies and research in progress, studies planned for this fiscal year, and a proposed program study plan and monitoring system. All of these study and research efforts are directly related to improvement of OCS management practices, operating procedures and data bases. These studies and research efforts, by identifying problem areas, gaps, weaknesses and proscribing preventive or corrective measures, fulfill an invaluable role for achieving our goal of reducing or eliminating, wherever possible, potential hazards to human life and to the environment.

2. Studies on OCS Practices and Technology

There have been several studies recently completed which identify weaknesses in OCS operating regulations and procedures and recommend remedial measures. The Geological Survey had undertaken on their behalf studies conducted by NASA 1/, the Marine Board of the National Academy of Engineering 2/, and an internal System Laboratory Group of the Water Resources Division of the Geological Survey 3/. An analysis of the results of these studies was completed by a special

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1/ NASA, "Applicability of NASA Contract Quality Management and Failure Mode Effect Analysis Procedures to the USGS Outer Continental Shelf Oil and Gas Lease Management Program", November, 1971.

2/ Marine Board, National Academy of Engineering, "Outer Continental Shelf Resource Development Safety: A Review of Technology and Regulation for the Systematic Minimization of Environmental Intrusion from Petroleum Products", December, 1972.

3/ USGS, "Outer Continental Shelf Lease Management Study", May, 1972.

Work Group of the GS in May, 1973, and a report titled the "Work Group on OCS Safety and Pollution Control" was issued. This report has been appended to Vol. 5 of this environmental statement as Attachment D. Implementation has commenced on all 15 recommendations made by the Work Group in its report.

Specifically, the Geological Survey has initiated actions to implement all of the 15 recommendations as follows:

Recommendation No. 1. Failure Reporting and Corrective Action

Action Taken: OCS Order No. 5 has been revised and now requires operators to submit quarterly failure-analysis reports on subsurface safety devices. The Offshore Operators' Committee is developing procedures for a closed loop failure reporting and corrective action system which will include all critical platform safety components. The output from these systems is computerized and will be analyzed by the safety review committee.

Recommendation No. 2. Accident Investigation and Reporting

Action Taken: The legality of publishing investigation reports of major accidents has been affirmed by the Solicitor's Office of the Department of the Interior. The Regional offices of the Geological Survey are developing accident investigation reporting procedures which are more responsive to cause and effect relationships.

Recommendation No. 3. Information Exchange

Action Taken: A "Safety Alert" system has been initiated. With this system operators are advised of accidents occurring during OCS drilling and producing operations to let the industry know immediately of its own mistakes and malfunctions so that improvements can be made where applicable. It is anticipated that an information dissemination system will be designed during the next fiscal year to provide industry with the results of the failure reporting and corrective action systems, accident investigations, inspections, and other elements of the lease management program.

Recommendation No. 4. Research and Development

Action Taken: A cooperative committee on offshore safety and anti-pollution research has been formed in conjunction with the American Petroleum Institute (API). The purpose of the committee is to determine the research and development efforts being undertaken by industry and Government in this area; determine specific needs for additional efforts; and to contract for research and development in areas where industry response is lacking or unsatisfactory.

Recommendation No. 5. Standards and Specifications

Action Taken: A cooperative committee on offshore safety and anti-pollution standards has been formed in conjunction with the API. This committee's function is to establish standards and specifications for safety and anti-pollution equipment. The first project undertaken by the committee was recommended practice for design, installation and operation of subsurface safety valve systems and specifications for subsurface safety valves. Draft copies of these standards have been made available for review and comment. The final copies of these standards will be published later this year. In connection with this, a facility for the testing of subsurface safety valves will be constructed and operated by an independent research institute.

Recommendation No. 6. System Analysis

Action Taken: System analyses were performed on 13 installations in the Gulf of Mexico under two Geological Survey contracts. These studies are currently being evaluated with the objective of possible adoption into the lease management program in connection with the work being done in this area by the committee on standards and specifications.

Recommendation No. 7. Engineering Documentation

Action Taken: The current proposed revision of OCS Order No. 8 includes requirements on documentation as recommended by the studies.

Recommendation No. 8. Wearout Prevention

Action Taken: The proposed revision of OCS Order No. 8 includes an erosion control program. This is also the subject of one of the research and development committee's projects.

Recommendation No. 9. Training

Action Taken: A committee has been formed in conjunction with the API on offshore safety and anti-pollution training and motivation. This committee is outlining the training needed for personnel working offshore, setting up training programs, and establishing a time-framework for accomplishing this. The Geological Survey is establishing a more formalized training program for their own personnel and have plans for developing a training course in OCS Orders and regulations for presentation to the industry.

Recommendation No. 10. Motivation Program

Action Taken: The API and oil industry are taking the lead in developing a motivation program.

Recommendation No. 11. Lease Management Program

Action Taken: Additional personnel have been hired for the Gulf of Mexico OCS office. The areas of responsibilities and goals of the individual organizational units are being developed. Also under development, is a system for incorporating reports from other program areas into an annual review.

Recommendation No. 12. Inspection Procedures

Action Taken: Data processing equipment has been installed in the Gulf of Mexico area office. Inspection checklists are being updated to keep current with OCS Orders. Special inspections are conducted bi-monthly as data gathering exercises. Consistent enforcement policy is being applied in each OCS area. Computerized data files regarding inspections, platforms, and accidents have been established and are used as input for the safety review committee.

Recommendation No. 13. OCS Order Development Procedures

Action Taken: The Geological Survey is currently developing formalized procedures for the evaluation and revision of existing OCS Orders and the development of new OCS Orders. Proposed new and revised orders are now being published in the Federal Register for public comment prior to their adoption.

Recommendation No. 14. Standardization of Pollution Report Form

Action Taken: This form is currently being revised by the area offices.

Recommendation No. 15. Safety and Advisory Committees

Action Taken: The industry has established a committee on OCS Safety in both the Gulf of Mexico and Pacific Areas. The area offices have designated personnel to form systems analysis review committees to meet on a regular basis. These committees have had their initial meetings. The Director of the Geological Survey has formed a review committee on safety of OCS petroleum operations. This committee is composed of experts not regularly employed by industry or the Government and is sponsored by the Marine Board of the National Academy of Engineering. The initial meeting of this committee was held in Washington, D. C. during August 1973, and the next meeting will be in New Orleans, Louisiana during the later part of November 1973.

In addition to the above studies and reports, the General Accounting Office issued a report at the request of the Conservation and Natural Resources Subcommittee of the Committee on Government Operations, House of Representatives 1/. This study, like those mentioned above, presents

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1/ General Accounting Office, "Improved Inspection and Regulation Could Reduce the Possibility of Oil Spills on the Outer Continental Shelf", Report No. B-146333, June 29, 1973.

a critical review of OCS regulatory and inspection procedures and includes recommendations designed to achieve more effective capability and procedures. In a letter dated August 3, 1973, from Secretary Morton to Mr. Henry S. Reuss, Chairman of the Conservation and Natural Resources Subcommittee, it is pointed out that the recommendations contained in the GAO report which have not already been implemented are being implemented as part of the Work Group's recommendations (see Vol. 5, Attachment D for the Work Group's recommendations).

Many of the recommendations contained in the GAO report were also made in the studies discussed above. Nevertheless, the following statements specifically apply to the GAO report:

1. Inspectors are instructed to apply prescribed enforcement actions for violations of OCS Orders unless deviations have been authorized and properly documented for each case by the Chief, Conservation Division, Geological Survey.

2. The inspection staff is to be increased and the number of inspections, both scheduled and unannounced, have been increased.

3. Inspections include workover and remedial operations as well as drilling, producing and abandonment operations.

4. Work groups have been formed to study the feasibility of:
    a. Requiring operators to submit a preventive maintenance schedule.

    b. Requiring operators to perform scheduled inspections and report results in a specified format.

5. GS is working with industry and with the API in an attempt to set standards and requirements for training personnel. GS personnel would participate in this training. In the meantime, Conservation Managers have been instructed to initiate formalized training in inspection procedures.

6. Plans are being adopted to limit the conditions under which multiple operations may be conducted for a single platform.

A few weeks ago a comprehensive report of a technology assessment of oil and gas operations on the U.S. Outer Continental Shelf was published by an interdisciplinary research team from the Science and Public Policy Program at the University of Oklahoma 1/. The independent analysis, funded by the National Science Foundation, was conducted over a 20 month period beginning in September, 1971.

The principle conclusions of the study are: (1) That existing OCS technologies are adequate for continued oil and gas operations; (2) that more sharply defined concerns for safety and environmental protection continue to pose a challenge to OCS management even though technologies responsive to these new concerns are gradually evolving; (3) that in the past, participation in the management of OCS oil and gas operations was limited to the Department of the Interior and the petroleum industry and that this relatively closed management system was initially unable to sense and respond quickly to a changing social climate. Interested groups and Federal agencies representing concerns such as environmental conservation are now participating in the management system primarily through the impact statement process required by NEPA. These new participants are demanding changes from past patterns of operations; and (4) but most of the new demands being made on OCS technologies are well within state-of-the-art. The necessary information modifications in the physical

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1/ The Technology Assessment Group, Science and Public Policy Program, University of Oklahoma, Energy Under the Oceans: A Technology Assessment of Outer Continental Shelf Oil and Gas Operations, University of Oklahoma Press, September, 1973.

technologies required by a changing social climate can be met. Although the application of stringent environmental and safety criteria pose problems, the industry either has or can develop the required physical technologies and procedures.

3. Ongoing Contracts and Inhouse Efforts

As an integral part of its OCS leasing program the Bureau of Land Management has undertaken a broad-based inhouse and outside contract study effort to aid in the implementation of the OCS leasing program.

The Bureau has awarded four contract studies for the purpose of gathering and consolidating available environmental and socio-economic data in the Atlantic, Gulf of Alaska, and the Gulf of Mexico. The areas of primary interest in the environmental studies are coastal zone climate, ecology, physical properties, man-made features, hydrography and continental shelf physical oceanography, meterology, geology, and marine ecology. The socio-economic studies will review industrial and commercial activity, petroleum industrial development, demography, land and water use, sources of pollution, and existing transportation systems. The studies are scheduled for completion in June, 1974.

The specific areas being studied and indentification of the contractors are as follows:

1) The North Atlantic - from the Bay of Fundy to Sandy Hook, New Jersey - awarded to the Research Institute of the Gulf of Maine (TRIGOM) of Portland, Maine, in conjunction with the Public Affairs Research Center, Bowdoin College and the University of Rhode Island.

This study will include the environmental and socio-economic aspects of mineral leasing in this area. TRIGOM will also supply environmental data for an oil spill computer model being used in the Council on Environmental Quality's study on the environmental impact of oil and gas production on the Atlantic OCS.

2) The Mid-Atlantic - from Sandy Hook, New Jersey to Cape Hatteras, North Carolina - awarded to the College of Marine Studies, University of Delaware of Newark, Delaware. This contract includes the gathering of socio-economic data pertaining to mineral leasing on the Outer Continental Shelf in this area. Environmental data pertaining to this area were gathered in a previous draft study. 1/

3) A study of the Gulf of Mexico was awarded to Environmental Consultants of Dallas, Texas. The contract calls for an updating and broadening of the Cooperative Investigation of the Caribbean and Adjacent Regions (CICAR) Bibliography that was published in 1972 by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration. The contract also provides for identification of research in progress relating to CICAR categories and a socio-economic study of the Gulf of Mexico.

4) The Gulf of Alaska and adjoining OCS areas of the Pacific Ocean, Cook Inlet to Unimak Island - was awarded to The Arctic Environmental

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1/ Dept. of the Interior, Bureau of Land Management, December, 1972. Library Research Project Mid-Atlantic Outer Continental Shelf (Reconnaissance), Draft Study.

and Data Center of the University of Alaska at Anchorage, Alaska. The study will include environmental and socio-economic data.

In addition, a contract for the development of an oil transportation computer model was awarded to Stanford Research Institute of Menlo Park, California. This model will aid in the analysis of Outer Continental Shelf oil resources and alternative sources of petroleum supply to help meet future regional demands and to assess the effects of prices and transportation costs relating to regional supplies and flow patterns.

Inhouse study efforts are being directed at specific areas where additional information is needed especially in the Gulf of Mexico. The Bureau's Environmental Assessment Team in New Orleans is undertaking a study of Stetson Bank, offshore Texas. Tracts located on this bank, which contains coral communities, were leased in the Texas sale this past June. A stipulation was placed on the tracts requiring a report from the Bureau of Land Management prior to the approval of any drilling permits of environmental impact of proposed operations on the unique biotic community. The team will conduct semi-annual inspections of production operations on the bank to determine the effects of oil and gas operations on the biotic community of the area.

A study concerning pipelines in Texas was recently completed by the team and is entitled: "Preliminary Environmental Assessment and Impact Analysis of Potential Oil and Gas Pipeline Construction in the Galveston-Sabine Area, Texas".

In addition, an inhouse library research study is presently in progress and is designed to consolidate environmental and socio-economic information in the Gulf of Alaska from Cape Spencer to Resurrection Bay.

As a part of the study program and in order to keep current with ongoing research efforts, close liaison is maintained with state and local officials, and university and industry personnel. The Environmental Assessment Team in the Gulf has maintained close liaison with the Gulf Universities Research Consortium (GURC) program in the Gulf of Mexico, especially the results of their Offshore Ecology Investigations Program, their Shelf Dynamics Program and their Environment-Dependent Management Process Automation and Simulation (EDMPAS) data management system.

Close coordination is maintained so that the Bureau can receive the results of ongoing studies as quickly as possible and can be aware of planned research efforts to minimize any duplication.

4. Planned Study Efforts - FY '74

During the 1974 fiscal year the Bureau will continue its base line environmental and socio-economic studies on the OCS. Specifically, proposals are presently being reviewed for a contract study to gather and consolidate environmental and socio-economic data in the Southern California Offshore Continental Borderland Area. This study is scheduled to be completed in the summer of 1974. Additional FY '74 funds have been transferred to the Council on Environmental Quality for a contract study on a data inventory of the southeast Atlantic coast. A study is planned to conduct a data inventory of the Western Alaskan Coastline.

In addition to the base line data inventory-type studies, the Bureau will conduct a series of contract studies related to the gathering of specific information needed on the Gulf of Mexico OCS. The studies are to be completed in the fall of 1974. Study proposals are being designed to include an archeological inventory of the Gulf of Mexico, an ocean currents study of the Gulf, a pipeline corridor analysis of the northeast Gulf (see Vol. 2, Sec. IV. C.) an environmental study (biological) of the continental slope in the Gulf, a heavy metal survey along pipelines in the Gulf, an oil spill matrix analysis, and contingency plans involving both inhouse and contract efforts to analyze effects of a major oil spill.

Inhouse environmental assessment teams are presently being established in Los Angeles, Anchorage, and New York City. The preliminary feasibility studies underway by the CEQ concerning possible oil and gas leasing on the OCS in the Gulf of Alaska and the Atlantic Ocean has underscored the importance protection of the environmental will play in any determination concerning whether or not to open these frontier areas to OCS leasing. The environmental assessment teams will analyze the studies in their respective areas undertaken by BLM and the CEQ and will plan and initiate studies on their own concerning potential environmental impacts of specific types of mineral exploration, leasing, development and production in these areas. They will establish liaison with state and local agencies, the scientific community, and industry to benefit from data and research in their respective areas of expertise.

They will prepare detailed descriptions of physical oceanographic and biological base line data of the open ocean, nearshore and estuarine areas in their respective study areas. Major wildlife and fisheries resources, conservation areas including parks, refuges, sanctuaries, aquatic preserves and areas of recreational activity and cultural or historical value will be identified and included in environmental profiles. In short, their environmental profiles, analyses and data presentations will provide the basis for preparing environmental statements which will assess the impacts OCS activities potentially pose to the environment.

5. Additional Study and Research Program

Pending the allocation of sufficient funding and as a continuation of our ongoing study efforts, we are planning to conduct a three stage study program to gather, and analyze environmental data and monitor environmental impacts in the area of the proposed Mississippi, Alabama, and Florida lease sale. The program is designed to be conducted simultaneously with the exploration and development of the oil and gas resources in order to obtain first hand data to examine possible environmental effects. This effort will be coordinated with the Interagency Committee for Marine Environmental Prediction to assure that this effort is coordinated with the overall Federal Plan for Marine Environmental Prediction.

Phase I

Immediately following the lease sale we will commence a quantitative biological, chemical, geological and physical investigation to characterize and establish base line data within the potentially high oil and gas production areas in the Mobile, Pensacola South, Appalachicola South, and the Tarpon Springs-Tampa lease zones. This particular phase would extend over a two year period in order to account for the normal variations in the natural systems in the area. The benchmark data to be collected and analyzed will be available prior to any production activities and emplacement of permanent structures. In some instances, it would be available prior to exploratory drilling operations, however, in others, the information would be gathered concommitant with drilling.

A study will be initiated to determine the effects oil produced in the offshore MAFLA area will have on shoreline habitat and organisms. This study will require identification and selection of representative flora and fauna and performance of toxicity and sublethal evaluations using crude oil produced in the MAFLA area. The first part of this study involving selection of representative shoreline species can begin anytime following the sale, but toxicity evaluations will have to be made after production begins, which is estimated to occur within three to five year of the sale date.

Phase II

Simultaneously with the base line study a quantitative biological, chemical, geological and physical monitoring program on exploration and production sites within selected typical habitat types will be conducted. This particular phase will extend beyond phase one in that it will be conducted during production activities. Its purpose is to reflect and measure the biological effect of oil development and production on leased sites. During the initial period monitoring will be conducted monthly, and after a good data base has been developed, monitoring will be decreased to quarterly intervals.

Phase III

Phase III of the study program will commence following completion of the pipeline corridor contract study mentioned previously in this section and described in Vol. 2, Sec. IV. C. This initial contract study will be completed within one year from the sale date and will tentatively identify corridor routes using existing data pertaining to the environmental setting of the area. This initial study effort is not contingent upon allocation of additional funds. However, after tentative identification of corridor routes is made, an additional study phase will be needed to obtain quantitative biological, chemical, geological and physical base line data within the corridor routes. This data will be assessed and then corridor routes will be finalized. Monitoring of the effects of specific pipeline installations within corridors will then be possible.

Results of these studies will aid in making any necessary revisions in OCS operating orders, in the review of development plans, and in the granting of pipeline rights-of-way on the OCS.

Table 15. ENVIRONMENTAL BASE LINE + MONITORING PROGRAM

Year	Phase I	Phase II	Phase III
1	Phase I Base Line Data Collection + Analysis (years 1–3)	Phase II Monitoring of Specific Lease Sites (years 1–5)	
2			Phase III (years 2–5): Pipeline Corridor Base Line Data Collection and Analysis; Toxicity and Sub-lethal Evaluations
3			
4			
5			
		Until Production Ends	Until Production Ends

II. DESCRIPTION OF THE ENVIRONMENT

A. Geologic Framework 1/

1. Geologic History and Structural Geology of the Gulf of Mexico 2/

a. Geologic History

In early Jurassic time the Gulf region was flooded with shallow seas in which extensive salt and anhydrite (e.g., the Louann salt and the Buckner anhydrite) were deposited over the basement which consists of Triassic to pre-Cambrian igneous, metamorphic, and sedimentary rocks. Late Jurassic seas were widespread in the area and the deposition of considerable amounts of limestone occurred (e.g., the Smackover and Cotton Valley formations). During early Cretaceous time the southeastern part of the area underwent subsidence (Wilhelm and Ewing, 1972). Information from wells drilled in southern Florida indicates a minimum subsidence of 10,000 feet. This subsidence was slow and both the Florida Platform (Fig. 10) and the Yucatan Platform were formed from shallow water carbonate and anhydrite rocks deposited behind growing barrier reefs. No sizeable deepwater Cretaceous deposition took place beyond the barrier reefs; thus areas seaward of the barrier reefs became increasingly deeper (with respect to the platforms) as the subsidence continued. The late Cretaceous-Paleocene Laramide mountain building episode has a major impact on the Gulf of Mexico area. It provided vast quantities of sediments from northern and western continental interiors. These sediments were carried by the Mississippi River, the Rio Grande, and smaller rivers to the Gulf Coast Geosyncline

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1/ A geologic time chart is included as Attachment G.

2/ References used were Antoine (1972), Bornhouser (1958), Moore (1971), Puri and Vernon (1964), and Wilhelm and Ewing (1972).

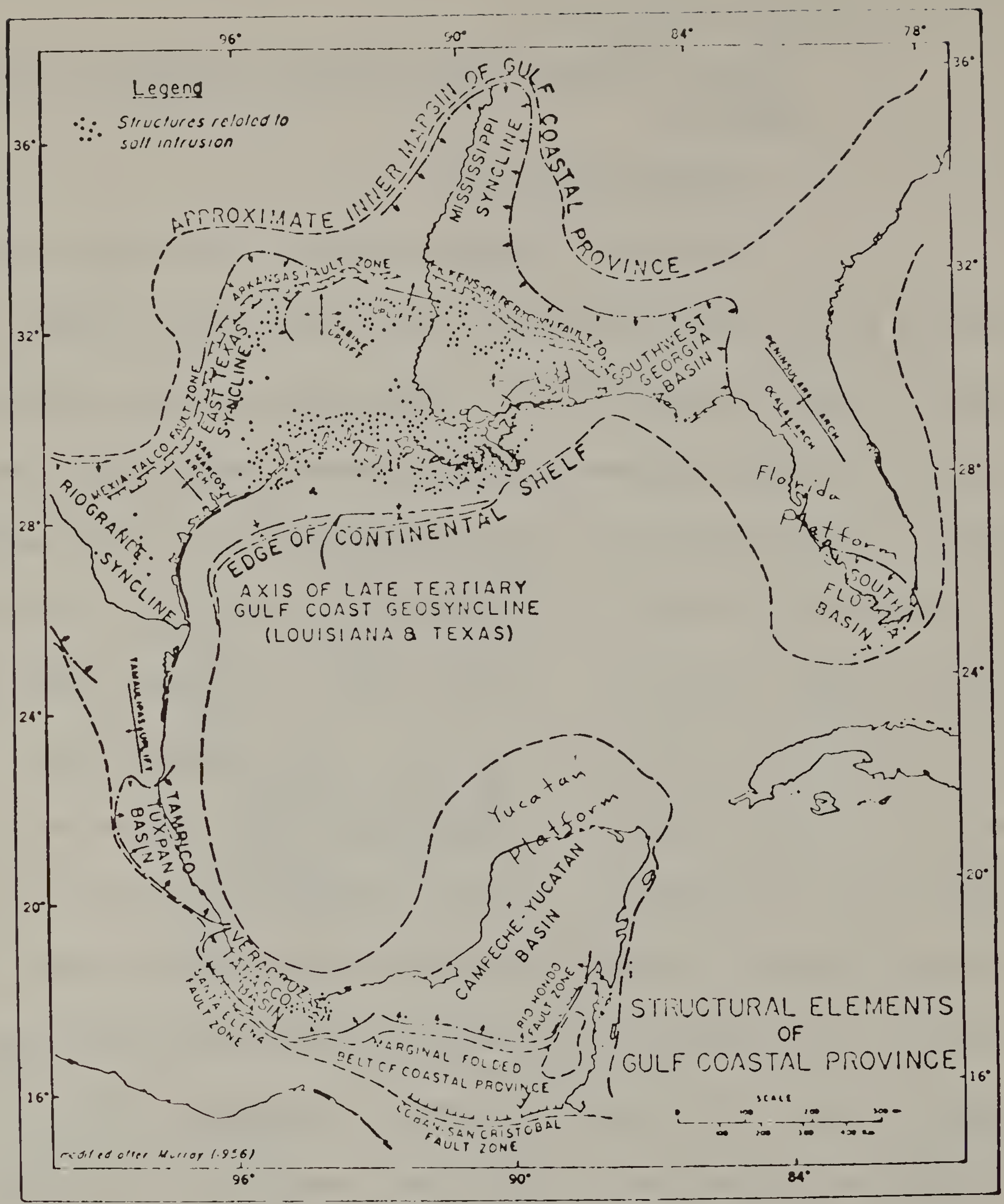

Figure 10. Structural features in the Gulf of Mexico area (from Cardley, 1962).

(Fig.10). This invasion from the north and northwest of the hugh mass of deposits throughout Cenozoic times has reduced the Gulf of Mexico to its present size. The last major volume of clastic sediments were deposited on the Mississippi Fan in early Holocene times, and since then, river borne deposits have been laid down on the shelves with a minimum of terrigenous material reaching the abyssal Gulf. The age and composition of surface geologic formations are shown in Fig. 11.

The structural history of the northern Gulf of Mexico has led to two distinct provinces on the continental shelf. To the east of DeSoto Canyon (Fig. 12), the shelf is composed largely of a thick sequence of carbonate deposits. West of DeSoto Canyon the shelf is composed of a thick sequence of predominantly clastic sediments which were deposited in the area of the Gulf Coast Geosyncline during the Tertiary period. Widespread salt deposits underlie this part of the shelf and are responsible for the salt dome structures typical of this area (Fig. 12). These salt dome structures are formed after salt beds are covered by 2,000 to 3,000 feet of sediment (Bornhauser, 1958), at which time the density of salt is less than the overburden and upward flow causes a dome structure (Fig. 13).

b. Structural Geology

The oldest sediment penetrated by well bores overlying the basement to the south and the Louann salt to the north are Upper Jurassic in age, and they, in turn, are overlain by Lower Cretaceous, Upper Cretaceous, and Cenozoic rocks. The gradation of continental

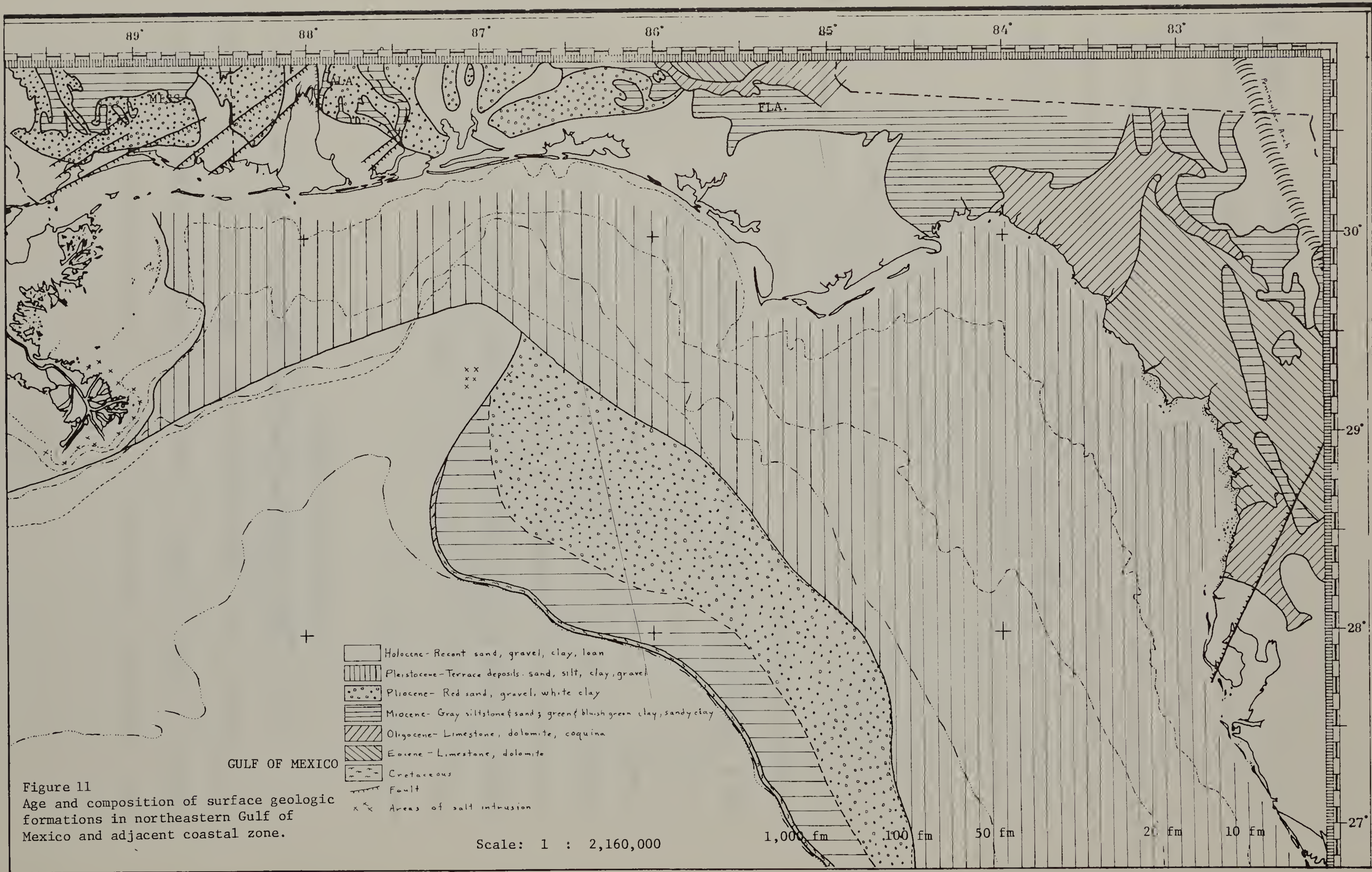

Figure 11
Age and composition of surface geologic formations in northeastern Gulf of Mexico and adjacent coastal zone.

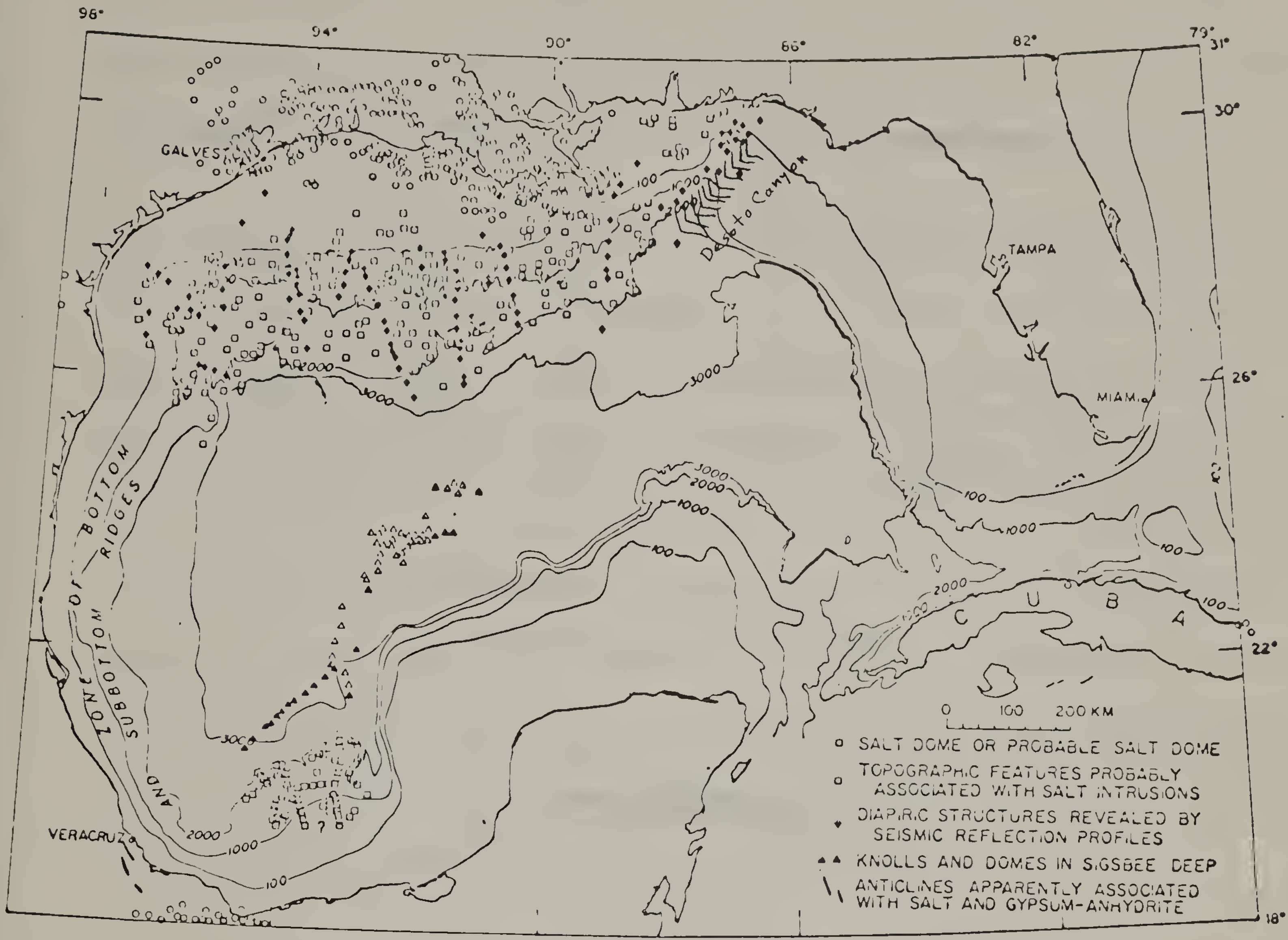

Figure 12. Distribution of salt domes in the Gulf of Mexico (from Uchupi and Emery, 1968).

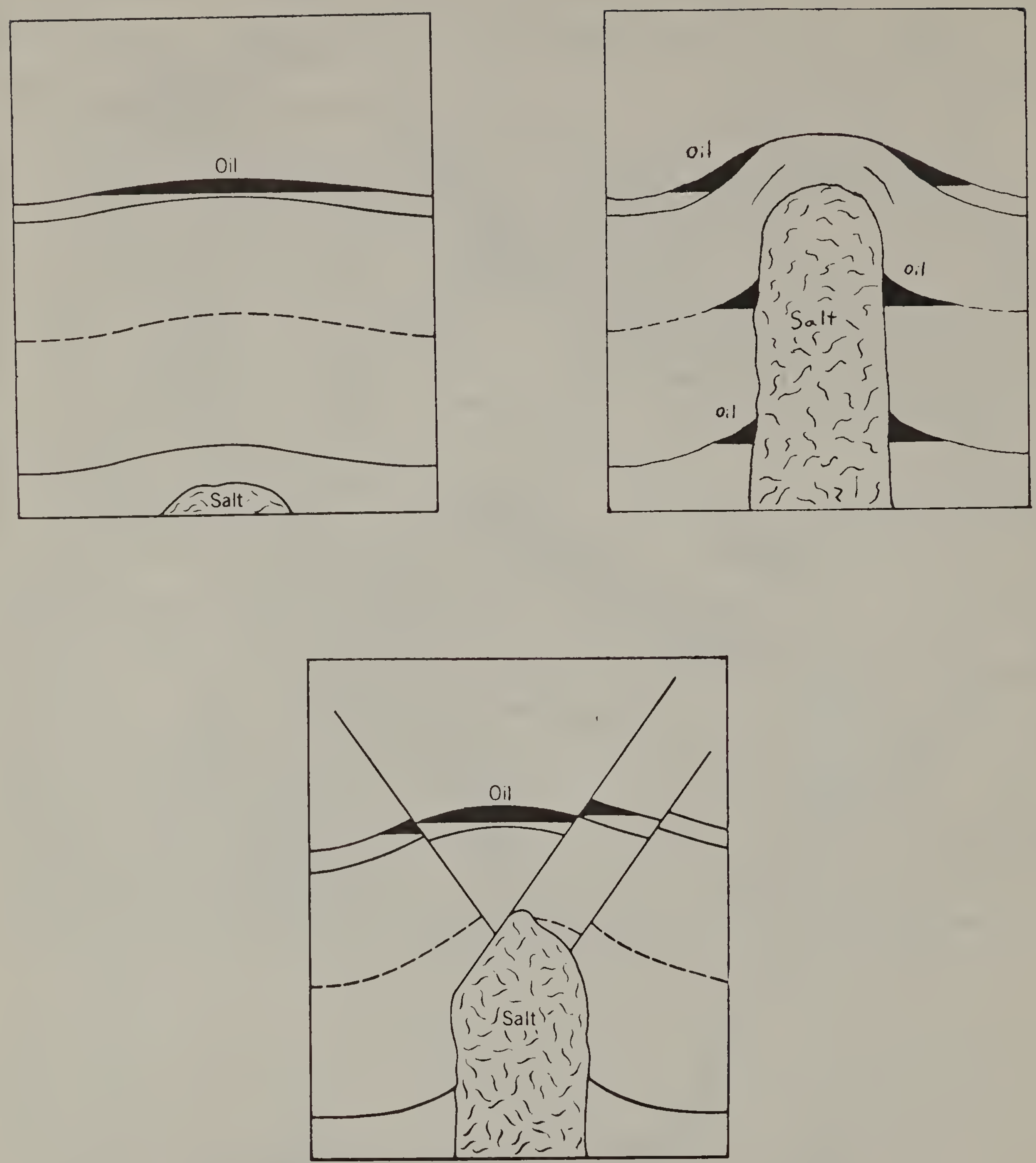

Figure 13. Cross-section of salt dome structures (from Landes, 1953).

deposits in the north, through nearshore, marine, detrital sandstones, and into deeper-water, offshore shales, or shallow water carbonate-shelf deposits southward, indicates a northern source for all detrital sediments.

The Upper Jurassic section trends in a southeast direction, and appears to parallel the Florida peninsula as it approaches the shelf. From its updip positions (lower origin) to the northeast it thickens to over 5,000 feet in the south across the Florida panhandle, and consists of continental, deltaic, and marine sandstones, shales, and some evaporites, together with some carbonates, including the prolific oil-producing Smackover limestones. The Smackover attains a maximum known thickness of 1,200 feet in a basinward (southwest) direction. The character of the Jurassic rocks south of the Florida panhandle is not known, but it is on trend with the known onshore section.

The Lower Cretaceous thickens to over 7,000 feet beneath the Florida panhandle, and the rocks grade southward from sandstones into carbonate. Presumably there is a barrier-reef fringe located basinward of the shelf, and this reef trend extends from Mexico through Texas, central Louisiana, then southeast to Rancock County, Mississippi. Seismic evidence strongly suggests its presence south of the DeSoto Canyon along the Florida escarpment at about the 1,000-fathom bathymetric contour. The trend extends as far south as 27°N, and the occurrence of evaporating in the Lower Cretaceous of southern Florida indicates restricted water circulation which could be due to the barrier.

Upper Cretaceous rocks grade from sandstone and shale southward into shallow water carbonates and reach a maximum thickness of 3,000 feet. On the Florida peninsula this section, dominantly chalk, was deposited on a slowly subsiding, shallow carbonate shelf.

Tertiary rocks just west of the subject area thicken to 20,000 feet, and consist of a sequence of sand and shale. The section offshore from Mississippi, Alabama, and Florida is mostly carbonate, ranging in thickness to a maximum of 8,000 feet with most areas less than 6,000 feet.

2. Bottom Sediments 1/

The continental shelf 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.

The bottom sediments in the northeastern Gulf can be assigned to two broad categories: one, relict sediments and the other, modern sand and silt. The relict sediments consist of detrital sediments deposited

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1/ References used were Bouma (1972), Emery (1968), Grady (1970), and Upshaw, Creath, and Brooks (1966).

on the continental shelf during the Pleistocene (Ice Age) when sea level was much lower than at present. The relict sediments have been covered in some areas by modern sands and silts consisting largely of detrital material transported by rivers, wind, and bottom currents (Fig. 14).

Particularly striking is the large area on the west Florida shelf composed of relict sediments. (This area has been designated as "sand" in Fig. 15) In general these areas provide good foundation for man-made structures. Further westward on the shelf, areas of finer sediments are encountered that were derived from the Mississippi River system and other lesser rivers. These recent finer sediments provide less substantial foundations and, in areas of slope, are subject to slumping and flowage. Surface sediment distribution has been depicted in Fig. 15.

3. Potential Oil and Gas Provinces

a. Onshore Producing Zones in Coastal Plain Sediments

Since few wells have been drilled in this part of the Gulf of Mexico, little is known of the actual hydrocarbon potential of the strata. However, comparison with onshore geology, relationship with producing fields, seismic records and geologic inference, yields estimates, though they are highly speculative.

There has been significant production from the onshore Mississippi-Alabama-Florida area. Numerous fields have been in operation since

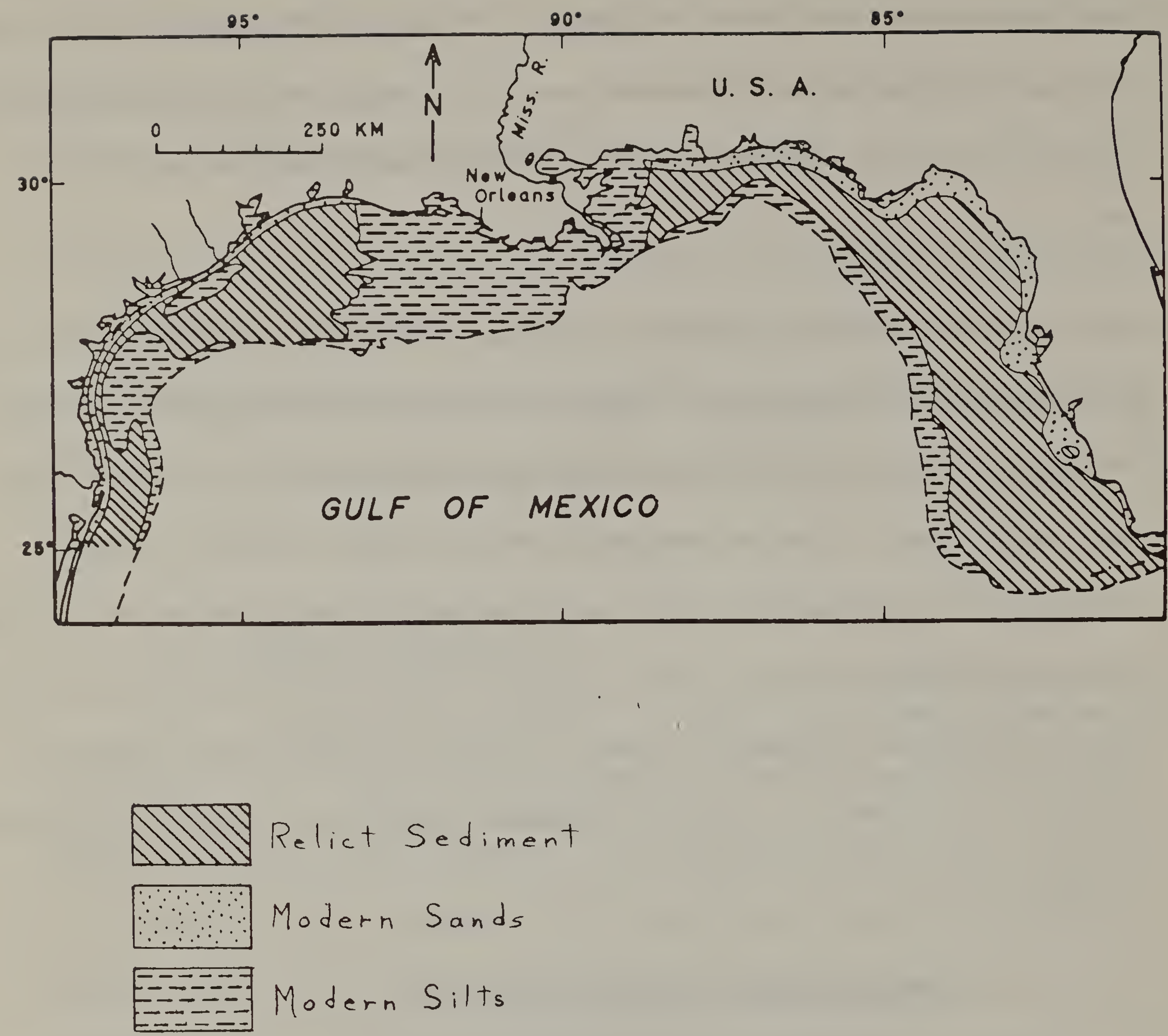

Figure 14. Sediments of the continental shelves in the northern Gulf of Mexico (from Emery, 1968).

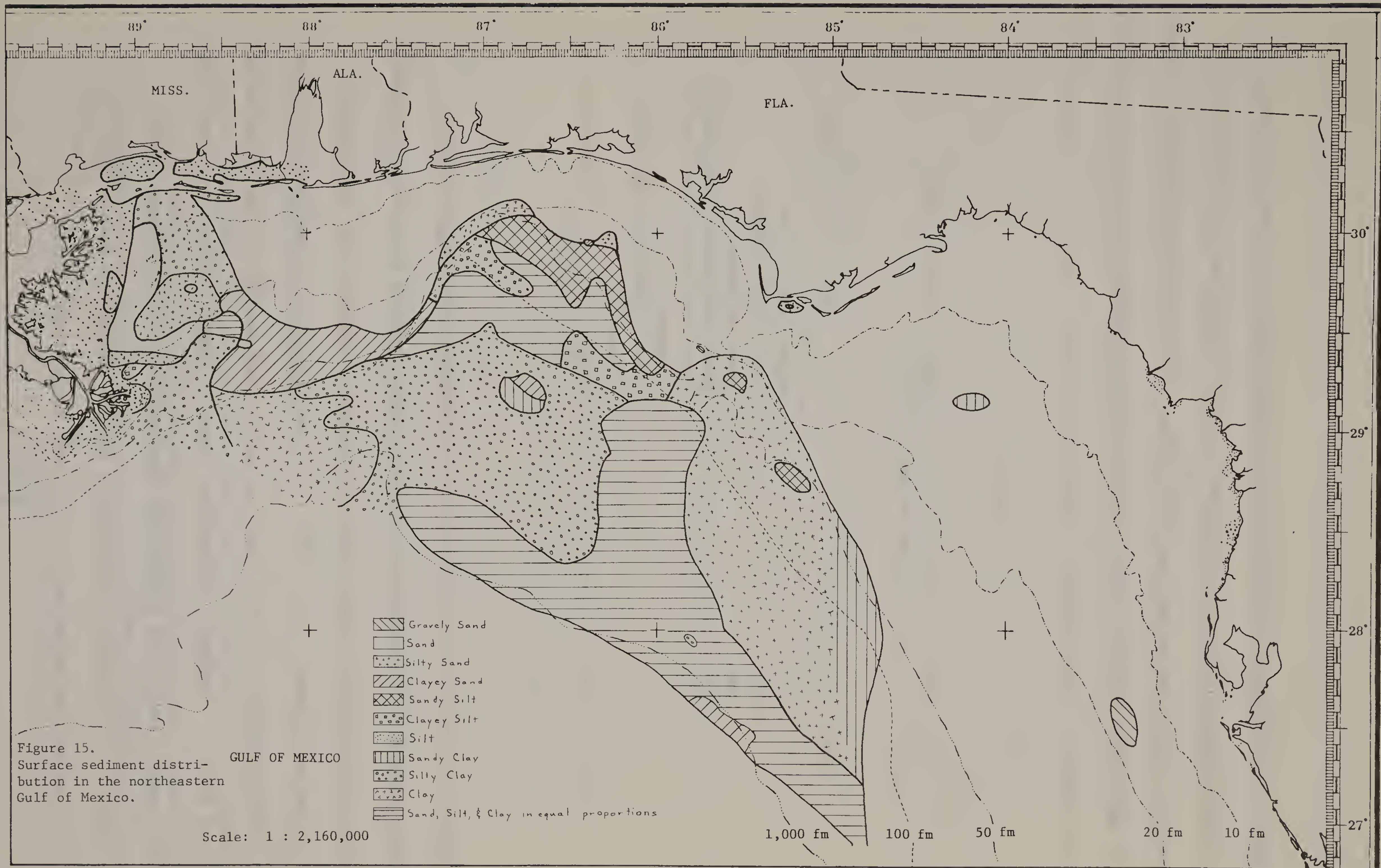

Figure 15.
Surface sediment distribution in the northeastern Gulf of Mexico.

1939. At least 133 fields have been discovered with Mesozoic production. In addition, there are 23 Mesozoic fields in Alabama and three in the northern Florida panhandle. This does not include the Paleozoic fields to the north in a different trend. The following table (Tab. 16) contains a breakdown of the fields by age of production:

Table 16.

OIL AND GAS FIELDS WITHIN THE STATES OF MISSISSIPPI, ALABAMA AND FLORIDA

Number of Fields	Age of Production
51	Upper Cretaceous
22	Lower Cretaceous
58	Upper Jurassic
11	Upper and Lower Cretaceous
3	Upper Cretaceous and Upper Jurassic
8	Lower Cretaceous and Upper Jurassic
2	Upper and Lower Cretaceous, Upper Jurassic
155	

Production is mostly centered in the eastward extension of the Mississippi Salt Basin, a structure that contains shallow salt domes (as shallow as 410 feet) and has a large potential for hydrocarbon production (Braunstein, 1958). Alabama fields are smaller than those in Mississippi, but are also located on the margin of the Mississippi Salt Basin. The most productive zones in these states are the lower and upper Cretaceous formations including the Tuscaloosa, Eutaw, Paluxy, and Glen Rose formations, all of which are sands (Rainwater, 1970; Paine and Meyerhoff, 1970; and Braunstein, 1958).

Production in Florida is limited to two areas although several hundred wells have been drilled. The Jay field, located in Santa Rose County in the panhandle, was discovered in 1970, and is producing from the Jurassic Smackover formation which is a very prolific limestone at onshore locations.

Four fields are active in South Florida, the largest of which is the Sunniland Field. All of these fields are in the lower Cretaceous Sunniland limestone. This is a part of the large thickness of carbonates and shales known as the South Florida Embayment. There is some promise for large fields in this trend which is continuous onto the continental shelf of West Florida. Stratigraphic and reef traps are the most likely types of oil reservoirs, although some structural traps may be present and are potential producers.

b. Potential Offshore Petroleum Producing Zones

The upper Jurassic and lower Cretaceous rocks are most prospective for oil and gas. Production is anticipated from the Smackover limestones and possibly from sandstone reservoirs in the Jurassic. It is also anticipated from carbonate rocks in the lower Cretaceous, although some sandstone interbeds are anticipated just south of the Florida panhandle.

Upper Cretaceous and Tertiary rocks are not considered as prospective with the possible exception of the lower Tuscaloosa sandstone in the northernmost part of the area, and perhaps some Paleocene reefs elsewhere.

One structure is of particular interest in this area. South of Choctawhatchee Bay is the large Destin Anticline, a 20 by 50 mile structure in the upper Jurassic-lower Cretaceous strata. The long axis of the anticline is oriented east-west and is located approximately 40 miles south of the beach. It has nearly 3,000 feet of closure (more or less the "height" of the structure) and is comparable in size to some of the great producing structures of the Middle East (U.S. Geological Survey Seismic Reflection Data).

Farther south on the West Florida shelf, there is abundant evidence of reefs of probable lower Cretaceous age. There is a strong possibility that production could occur from these reef structures and from the seaward continuations of the thick sequence of strata in the South Florida Embayment.

4. Geologic Hazards

a. Seismic Hazards

Seismic risk areas were originally designated for all parts of the United States in 1947 by the 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

Figure 16 shows that most of central and all of southern Florida lie in an area where the occurrence of seismic hazards is extremely unlikely Zone 0 (Algermissen, 1969). Northern Florida and Western Mississippi lie in Zone 1 risk areas which means that there is some danger of earthquakes of low intensity (ones which would not do damage to buildings). The stars on Fig. 16 indicate earthquake epicenters. Small quakes have been reported in Central Florida, Gulfport, Miss. (1955) and three were reported in an area approximately 250 miles south of Pensacola, Florida. Because of the geological similarity of the land areas surrounding the Gulf and the adjacent continental shelf, one can reasonably extend the seismic risk zone boundaries some distance offshore.

b. Shallow Hazards, Unstable Bottom

High resolution seismic reflection and side-scan sonar data give adequate detail of surface and subsurface (down to approximately 2,000 feet) features useful in detecting shallow geologic hazards such as potentially unstable bottoms (mud waves, etc.), shallow faults, and in some cases, near-surface gas pockets. These features are identified prior to drilling operations, or platform construction, and the operator is notified so he can take the necessary action to assure that his operation is conducted with maximum safety. There have been no geologic hazard areas reported in those tracts included in this proposed lease sale. To the west of this area the Mississippi delta front region is considered unstable and requires that special precautions be taken (horizontally lined area on Fig. 13).

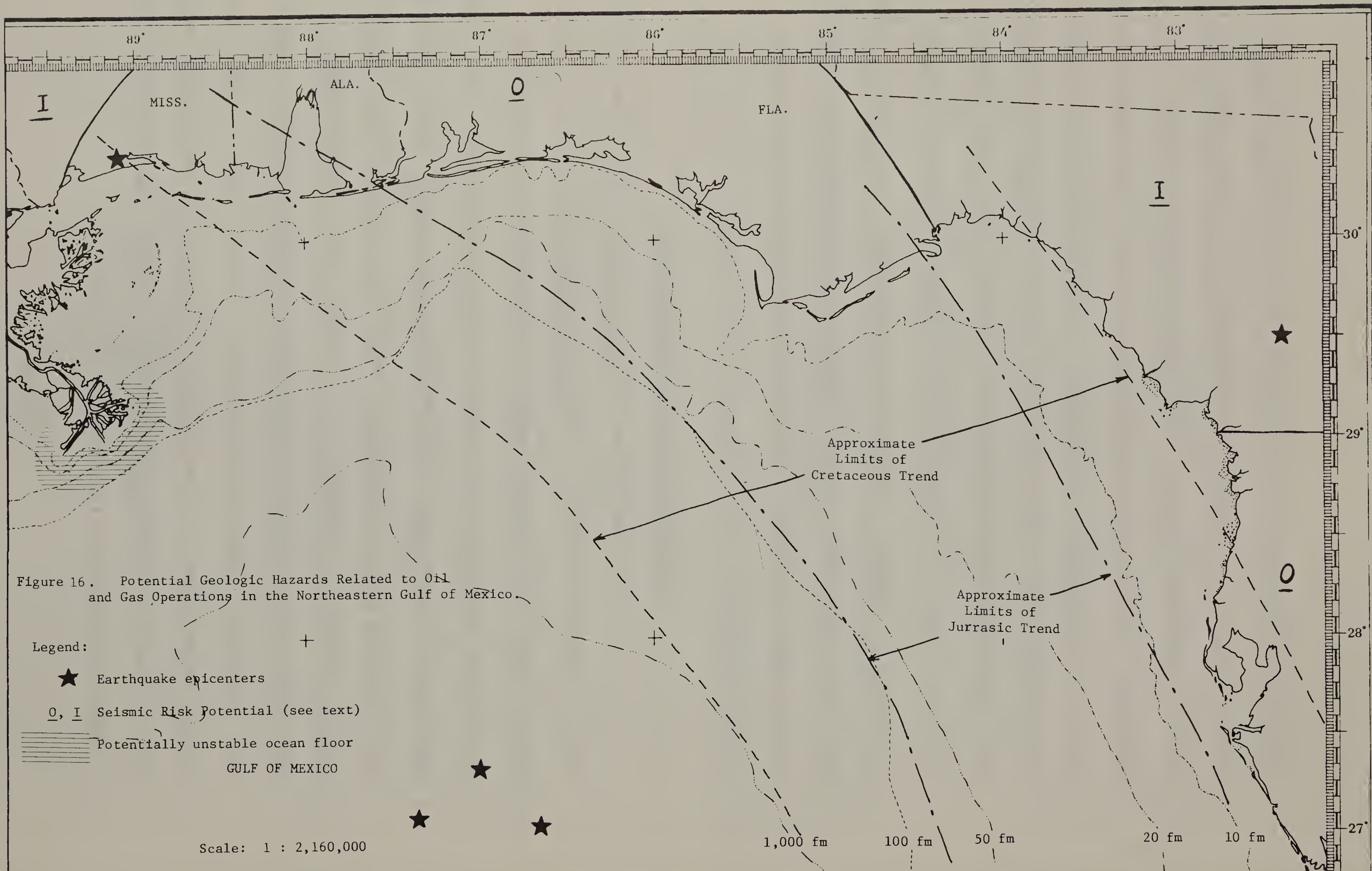

Figure 16. Potential Geologic Hazards Related to Oil and Gas Operations in the Northeastern Gulf of Mexico.

Additional geologic hazards to be mentioned are the submerged karst topography extending offshore from the Big Bend area, 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 lost circulation zones associated with limestone terraines prior to actual drilling, adequate drilling technology is available to identify such conditions during drilling operations and suitable accomodations necessary to preclude any hazardous conditions can be implemented.

All aquifers extending to offshore areas from the onshore subsurface strata will require protection, even if they contain salt water.

Tracts located south of the panhandle between Mobile Bay and Cape San Blas, in water depths from 50 to 100 fathoms are in an area of high bathymetric relief with reef pinnacles averaging 20 to 30 feet in height and 0.4 to 1.7 miles in width.

c. <u>High Gas Pressures, Hydrogen Sulfide</u>

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 up-dip 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), a highly corrosive and noxious gas, is produced from many Jurassic wells. Production of H_2S, which does extend into Alabama and Florida, is hazardous to those people working on the rig and to nearby communities.

It is speculative at this time to state that these geologic hazards will be encountered on the OCS of the eastern Gulf of Mexico. However, they should be initially anticipated in those areas where Jurassic and Cretaceous rocks will be penetrated (see Fig. 13).

It is standard U.S. Geological Survey procedure in application-to-drill discussions to inform the applicant of all available data concerning bottom conditions, faulting, potential lost circulation zones, high pressures or other potential geologically-related hazards. At this time, and prior to approval of a drilling permit, the Geological Survey requires the submittal of an operation plan that includes suitable procedures necessary to accomodate any of the above-mentioned hazards that could be anticipated.

B. Climate of the Northeastern Gulf of Mexico and Adjacent Coastal Zone 1/

The climate of the coastal zone varies from humid and subtropical over southern Florida to a more variable but warm marine climate along the coasts of Mississippi, Alabama, and the Florida Panhandle. In general, the weather patterns are essentially those which prevail in a transition zone between a tropical and a temperate area. Extended periods of stable humidity and temperature frequently occur.

The Gulf of Mexico is the source of warm moist air which generally flows northward during the warmer months conditioning the coastal climate. Over the Florida Peninsula, the warm Gulf Stream brings a rather even climate throughout most of the year, with mild winters and without summer extremes.

Strong air masses of continental origin periodically reach the area, particularly in winter.

1. Atmospheric Pressure

The general circulation of air near the surface of the Gulf and along the Gulf Coast follows the sweep of the western extension of the Bermuda high pressure cell during the spring and summer months. The July mean pressure chart shows broad parallel isobars running generally from southeast to northwest over the entire Gulf. By autumn

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1/ References: U. S. Coast and Geodetic Survey (1967), U.S. Naval Weather Service Command (1970 a, b). Jordan, (1973).

higher pressures over the North American continent modify the pattern and the isobars tend to lie more along an east-west axis over the Gulf.

Average pressures continue to be higher over North America through the winter, but by spring the western extension of the Bermuda High again emerges as the dominant control of the pressure pattern over the Gulf. This high has greater constancy than the continental high pressure so that in late spring and summer it maintains a rather steady flow of warm moist air which, to a large degree, controls the climate over the Gulf during these seasons of the year. Accordingly, spells of good weather tend to be longer during these seasons than during the late fall, winter and early spring.

2. Winds

Near the Gulf Coast winds are more variable than over the open waters of the Gulf because the coastal winds fall more directly under the influence of the moving cyclonic storms that are characteristic of the continent. Average wind conditions for four localities along the northeastern Gulf Coast, New Orleans, Pensacola, Apalachicola, and Fort Myers, are shown in Fig. 17. Monthly wind conditions in the same locality are presented in Attachment F. The predominant wind direction observed in the northeastern Gulf is from the east. Of particular importance to oil slick movement and impact on the shoreline is the frequency and intensity of onshore winds. The table following the wind roses in Fig.17 depicts these components.

Figure 17. Annual wind patterns from four localities along the northeastern coast of the Gulf of Mexico. (Data source: U.S. Naval Weather Service Command, 1970 a, b)

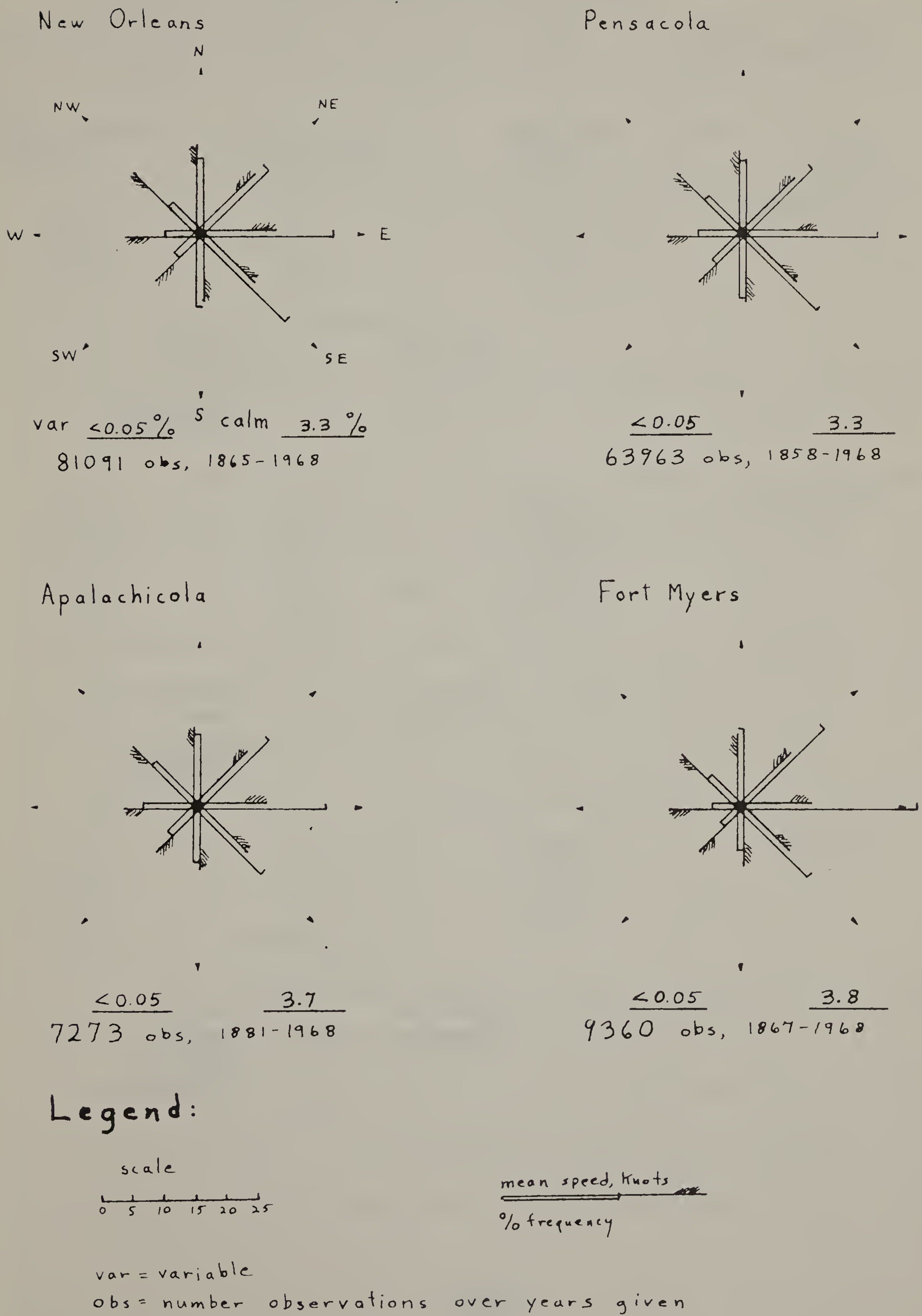


Table 17

SHOREWARD COMPONENTS OF WINDS, FREQUENCY AND INTENSITY, IN THREE AREAS OF THE EASTERN GULF OF MEXICO

(Courtesy of EPA, in review of draft environmental impact statement.)

Area	Direction of Wind	Percent of Observations		Mean Speed (Knots)
Fort Myers	To N	7.1		9.7
	To NE	4.0		10.0
	To E	4.4		11.4
	To SE	6.8		12.4
	Total % Shoreward	22.3	Average Speed Shoreward (Weighted)	10.9
Apalachicola	To SE	9.7		13.3
	To E	8.5		11.5
	To NE	6.4		10.0
	To N	9.0		10.2
	To NW	14.9		11.0
	Total % Shoreward	48.5	Average Speed Shoreward (Weighted)	11.3
Pensacola	To NW	17.0		11.6
	To N	10.3		10.9
	To NE	6.1		10.7
	To E	7.0		12.0
	Total % Shoreward	40.4	Average Speed Shoreward (Weighted)	11.4

3. Northers

Some 30 to 40 polar air masses penetrate from the north American continent to the Gulf of Mexico each winter. Some 15 to 20 of these bring strong northerly winds to the Gulf, and are called northers. Northers ordinarily occur from November to March and from 1 to 6 per year are likely to be severe. Northers generally last about a day and a half, but severe storms may endure for 3 to 4 days.

4. Precipitation

Along the Gulf coast precipitation tends to fall periodically during the late autumn, winter, and spring months, and is generally associated with extratropical cyclones. In summer and early autumn, scattered shower and thunderstorm activity is high. The gentle coastal slopes do not, however, give rise to persistent areas of concentrated thunderstorm activity day after day. In general, the greatest rainfall occurs in summer and early autumn with some of the heaviest falls associated with tropical cyclones during the months of August, September, and October. Monthly precipitation totals for several coastal localities are shown in Table 18.

5. Temperature

Average temperatures at coastal locations vary with latitude and exposure, and in winter depend, in addition, on the frequency and intensity of northers. The mean annual temperatures range from 68.2° F. at Mobile, which is the northermost coastal point included in the area to 73.7° F. at Fort Myers, which is the southernmost point. Monthly

Table 18. Monthly totals of precipitation recorded at several coastal localities. (From U.S. Coast and Geodetic Survey, 1967)

Month	New Orleans	Mobile	Pensacola	Apalachicola	Tampa	Fort Myers
	RECORDING STATION (inches)					
Jan	3.84	4.64	4.22	3.14	2.13	1.52
Feb	3.99	4.59	4.25	3.91	2.84	2.21
Mar	5.34	7.23	6.04	4.52	3.75	2.62
Apr	4.55	6.36	5.25	4.30	2.84	2.64
May	4.38	4.88	4.56	2.88	2.85	3.85
Jun	4.43	6.23	5.43	5.30	7.28	8.96
Jul	6.72	9.67	8.02	7.93	8.62	9.08
Aug	5.34	6.49	6.97	7.74	8.24	7.38
Sep	5.03	6.25	7.69	8.53	6.87	8.50
Oct	2.84	3.03	2.98	2.44	2.78	4.09
Nov	3.34	3.35	3.24	2.58	1.46	1.20
Dec	4.10	5.46	4.22	2.96	1.89	1.29
Total	53.90	68.13	62.87	56.23	51.57	53.34

temperature averages, ranges, minima, and maxima for several coastal localities are shown in Table 19.

6. Cloudiness

Along the Gulf coast cloudiness averages between five- and six-tenths sky cover with relatively small seasonal variation. October is generally the clearest month and December through March the cloudiest. The nature of the cloudiness varies with the season. In winter the Gulf coast has occasional gray, overcast days but in summer these are rare. Much of the summer cloudiness consists of convective cumulus clouds or high, relatively transparent clouds.

7. Storms 1/

Storms in the eastern Gulf of Mexico are relatively rare as compared to many marine locations in the Gulf. The area is occasionally affected in winter by extratropical cyclones, which form along slow-moving cold fronts, and by hurricanes and tropical storms in summer and early fall. In addition, there are weak storms, especially in summer, which are difficult to classify. Some of these are of tropical origin but do not reach tropical storm intensity; others develop in response to upper-level cyclonic circulations. For the purpose of this discussion, all storms not qualifying as hurricanes and tropical storms will be considered together under the extratropical cyclone category.

1/ Taken from Jordan (1973).

Table 19. Air temperature means and extremes from several coastal localities. (From U.S. Coast and Geodetic Survey, 1967)

NEW ORLEANS, LOUISIANA

Month	Air temperature (°F.)				
	Normal			Extreme	
	Daily maximum	Daily minimum	Monthly	Record highest	Record lowest
(a)	(b)	(b)	(b)	20	20
Jan.	64.4	44.8	54.6	83	14
Feb.	66.7	47.5	57.1	84	19
Mar.	71.2	51.6	61.4	87	29
Apr.	77.7	58.1	67.9	91	38
May	84.4	64.4	74.4	96	41
June	89.6	70.5	80.1	100	55
July	90.6	72.6	81.6	99	65
Aug.	90.7	73.0	81.9	100	62
Sept.	87.2	69.3	78.3	97	54
Oct.	80.3	60.5	70.4	92	36
Nov.	70.3	49.6	60.0	86	28
Dec.	65.3	45.5	55.4	83	17
Year	78.2	59.0	68.6	100	14

MOBILE, ALABAMA

Month	Air temperature (°F.)				
	Normal			Extreme	
	Daily maximum	Daily minimum	Monthly	Record highest	Record lowest
(a)	(b)	(b)	(b)	5	5
Jan.	62.3	43.7	53.0	76	8
Feb.	64.7	45.7	55.2	79	11
Mar.	70.3	50.3	60.3	87	11
Apr.	77.5	57.6	67.6	90	38
May	85.9	65.3	75.6	99	52
June	91.4	71.5	81.5	100	56
July	92.0	73.1	82.6	99	69
Aug.	91.2	73.0	82.1	98	66
Sept.	87.4	68.3	77.9	98	54
Oct.	80.3	59.5	69.9	93	39
Nov.	69.6	48.2	58.9	81	26
Dec.	63.9	44.3	54.1	78	10
Year	78.0	58.4	68.2	100	8

PENSACOLA, FLORIDA

Month	Air temperature (°F.)				
	Normal			Extreme	
	Daily maximum	Daily minimum	Monthly	Record highest	Record lowest
(a)	(b)	(b)	(b)	3	3
Jan.	62.3	44.6	53.5	77	11
Feb.	65.2	46.9	56.1	75	26
Mar.	70.2	51.8	61.0	80	32
Apr.	76.5	59.3	67.9	87	42
May	84.0	66.9	75.5	96	52
June	89.3	72.8	81.1	96	57
July	89.2	74.1	81.7	97	69
Aug.	89.2	73.8	81.5	96	66
Sept.	85.9	70.5	78.2	97	58
Oct.	79.6	61.1	70.4	90	38
Nov.	69.3	49.7	59.5	81	29
Dec.	63.2	45.3	54.3	78	24
Year	77.0	59.7	68.4	97	11

APALACHICOLA, FLORIDA

Month	Air temperature (°F.)				
	Normal			Extreme	
	Daily maximum	Daily minimum	Monthly	Record highest	Record lowest
(a)	(b)	(b)	(b)	37	37
Jan.	62.3	47.9	55.1	79	14
Feb.	64.0	49.5	56.8	80	21
Mar.	68.0	54.0	61.0	82	26
Apr.	74.3	60.7	67.5	90	37
May	81.7	67.9	74.8	96	50
June	86.7	73.7	80.2	101	58
July	87.6	75.4	81.5	102	66
Aug.	87.7	75.3	81.5	99	66
Sept.	84.8	73.0	78.9	96	52
Oct.	78.5	63.8	71.2	93	39
Nov	69.1	53.4	61.3	87	24
Dec	63.2	48.4	55.8	82	13
Year	75.7	61.9	68.8	102	13

TAMPA, FLORIDA

Month	Air temperature (°F.)				
	Normal			Extreme	
	Daily maximum	Daily minimum	Monthly	Record highest	Record lowest
(a)	(b)	(b)	(b)	3	3
Jan.	71.3	51.0	61.2	81	24
Feb.	72.8	52.6	62.7	84	27
Mar.	76.0	56.0	66.0	87	38
Apr.	81.4	61.3	71.4	92	45
May	87.0	66.6	76.8	95	52
June	89.4	71.7	80.6	97	61
July	89.7	73.4	81.6	97	69
Aug.	90.3	73.7	82.0	95	69
Sept.	88.7	72.3	80.5	95	65
Oct.	83.8	65.6	74.7	93	40
Nov.	76.8	56.8	66.8	86	35
Dec.	72.5	52.1	62.3	81	31
Year	81.6	62.8	72.2	97	24

FORT MYERS, FLORIDA

Month	Air temperature (°F.)				
	Normal			Extreme	
	Daily maximum	Daily minimum	Monthly	Record highest	Record lowest
(a)	(b)	(b)	(b)	7	7
Jan.	74.8	52.2	63.5	88	28
Feb.	76.3	54.0	65.2	92	35
Mar.	79.6	56.8	68.2	90	39
Apr.	84.1	61.4	72.8	92	45
May	88.6	66.1	77.4	98	56
June	90.5	71.0	80.8	97	64
July	91.0	73.3	82.2	97	70
Aug.	91.6	73.8	82.7	95	71
Sept.	89.7	72.9	81.3	95	70
Oct.	85.2	67.0	76.1	93	52
Nov.	79.7	58.7	69.2	89	42
Dec.	76.0	54.0	65.0	86	26
Year	83.9	63.4	73.7	98	26

These tables were compiled from Weather Bureau data.

(a) means length of record in years.
(b) means climatological standard normals, 1931-1960.

a. Hurricanes

Hurricanes pose a definite threat to the northern Gulf of Mexico from June until late October. The season is longer in the southeastern Gulf with occasional occurrences in November and very rare cases in winter and spring. Statistics for hurricanes (wind speeds greater than 64 knots) and tropical storms (wind speeds between 34 and 63 knots) are often lumped together since it is often difficult, especially in the older records, to determine the storm intensity while at sea. The probability of a tropical storm or hurricane influencing the eastern Gulf coast during any given year is about 50 percent and the probability of two hurricanes or tropical storms during a given season is about 15 percent.

Frequency statistics for hurricanes and tropical storms for the 1901-1971 period which passed through the areas shown in Fig. 18 are presented in Table 20. Frequencies are similar in all areas especially if some adjustment is made for the smaller size of areas A and E. The seasonal distribution shows a decrease from June to July in all areas and September is the month of maximum frequency in all areas except E. The off-season storms (November through May) are much more frequent in areas D and E.

Most hurricanes and tropical cyclones influencing the eastern Gulf form in other areas and there is normally some advance warning - often as long as several days - of the possibility of a storm. Hurricanes influencing the eastern Gulf arrive from many directions, as shown by

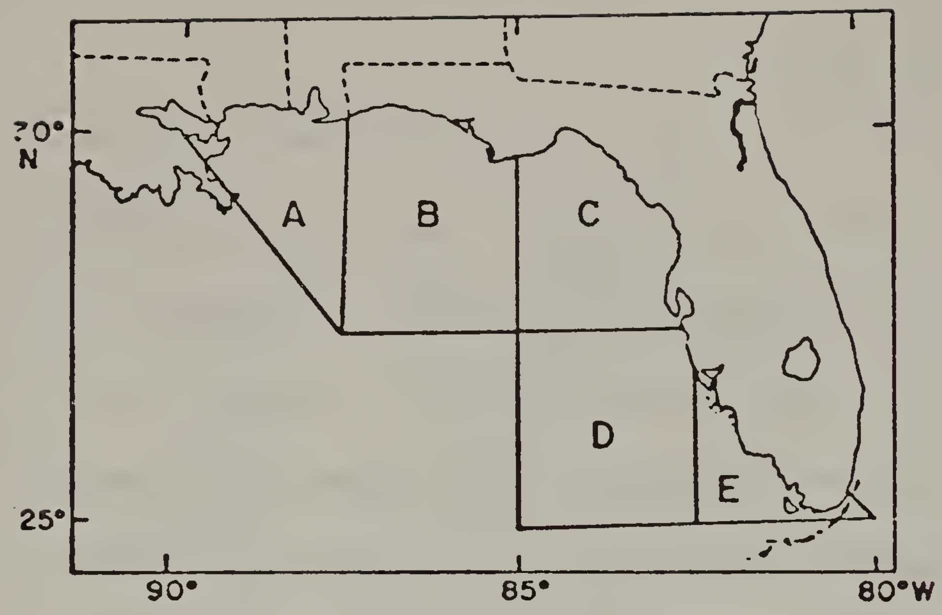


Figure 18. Location of Areas for which Combined Hurricane and Tropical Storms Statistics are Presented in Table 20. Some of the individual storms moved through more than one of the areas. (From Jordan, 1973)

Table 20

Total number of hurricanes during the 1901-1971 period which passed through the individual areas (A-E) shown in Figure 18.

Area	Jun	Jul	Aug	Sep	Oct	Nov-May	Total
A	5	4	6	17	7	0	39
B	7	5	7	20	6	1	46
C	5	3	11	15	12	1	47
D	8	3	9	12	11	3	46
E	3	1	7	9	14	4	38

the hurricane tracks included in Fig. 19. In general, June hurricanes are most likely to arrive from the south while the August and September cases are more likely to arrive from the southeast. Some hurricanes and tropical cyclones form in the eastern Gulf and, of course, with such cases the period of prior warning may be very short. During the period 1901-1971, seven hurricanes and seven tropical storms formed in the Gulf north of 25°N. and east of 85°W. The direction a hurricane moves is somewhat immaterial, however, as the cyclonic nature of the winds would tend to push spilled oil in all directions.

Much of the damage at coastal locations due to hurricane results from the marked rise in water level, which is referred to as the hurricane surge or tide. Some of the most pronounced surges in the northern and eastern Gulf area are given in Table 21. The maximum surge height at any given location depends on many factors including bottom topography and coastline configuration. There is little doubt, however, that a hurricane as intense as Camille of 1969, and moving in the most favorable direction and speed, would be capable of producing a very damaging surge at any location along the Gulf coast.

Hurricanes and tropical cyclones are capable of producing effects which may persist for days or weeks. The heavy rains associated with these storms may lead to abnormally large river discharges which may affect coastal areas for a period of days or longer. For example, a storm in October 1941 which never reached hurricane intensity, resulted in a

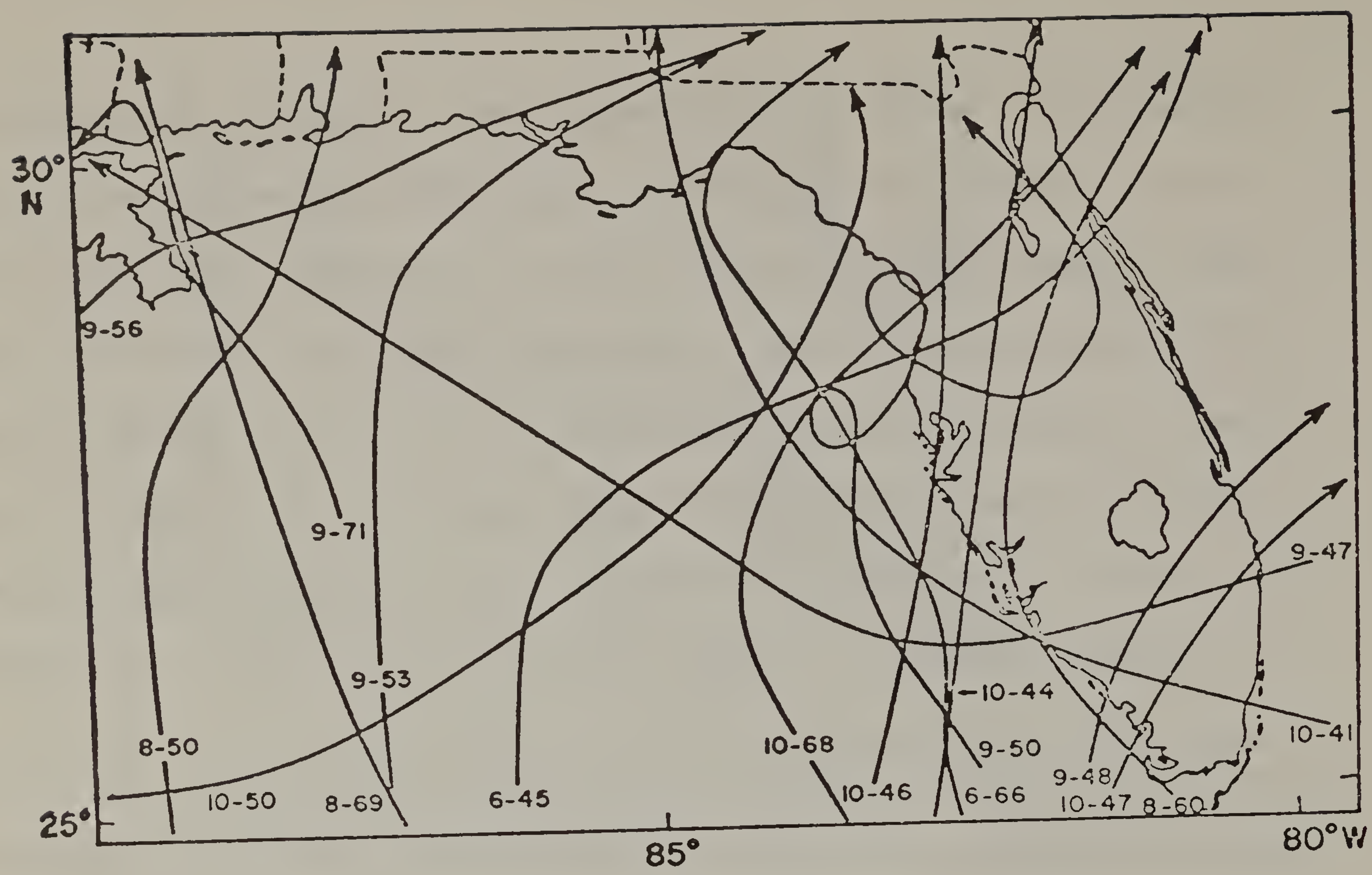


Figure 19 . Hurricane tracks for the eastern Gulf during the period 1941-1971. Tracks of storms not attaining hurricane intensity have not been included. Also hurricanes which moved northward over the peninsula of Florida, and which may have influenced the eastern Gulf to some extent, have been omitted (From Jordan, 1973).

Table 21

A listing of some of the major hurricane surges on the northern and eastern gulf coast between Pass Christian, Mississippi, and Everglades, Florida. (From Jordan, 1973)

Location	Surge Height (feet)	Month of occurrence
Pass Christian	25	Aug 1969
Ocean Springs	15	Aug 1969
Mobile	12	July 1916
Pensacola (Fort Barrancas)	11	Sept 1906
Panama City	6	July 1936
St. Marks	12	Oct 1877
Cedar Key	10	Sept 1896
St. Petersburg	8	Oct 1921
Tampa	15	Sept 1848
Fort Myers	9	Oct 1921

maximum three-day rainfall of 35 inches some miles inland from Cedar Key. Intense hurricanes are capable of bringing cold water to the ocean surface with the result that cold pools may persist over the open ocean for periods of weeks. A marked case of this type in the Gulf of Mexico resulted from Hurricane Hilda of 1964, in which there was a cooling of the surface water as much as 9°F.

b. Extratropical Cyclones

Preferred storm tracks over the Gulf of Mexico for a 20-year period are shown in Fig. 20. No tracks were shown except for storms of tropical origin in the months June through September. Storm tracks over land near the Gulf coast have not been included and such storms, can, on some occasions, lead to strong winds in the northern Gulf, especially in winter and spring.

The curves in Fig. 20 simply give the preferred areas of the formation and the direction of motion of extratropical cyclones in winter. Obviously, such storms form in other areas and during other months and follow tracks quite different than those shown in this figure. More general information on the seasonal frequency and intensity of these storms is presented in Tables 22 and 23

The frequency statistics (Table 22) show that low pressure centers are much more frequent in the northern Gulf than south of 28.5°N. latitude and are, in general, most frequent in winter. However, a fairly large percentage of the cases occur in spring and fall.

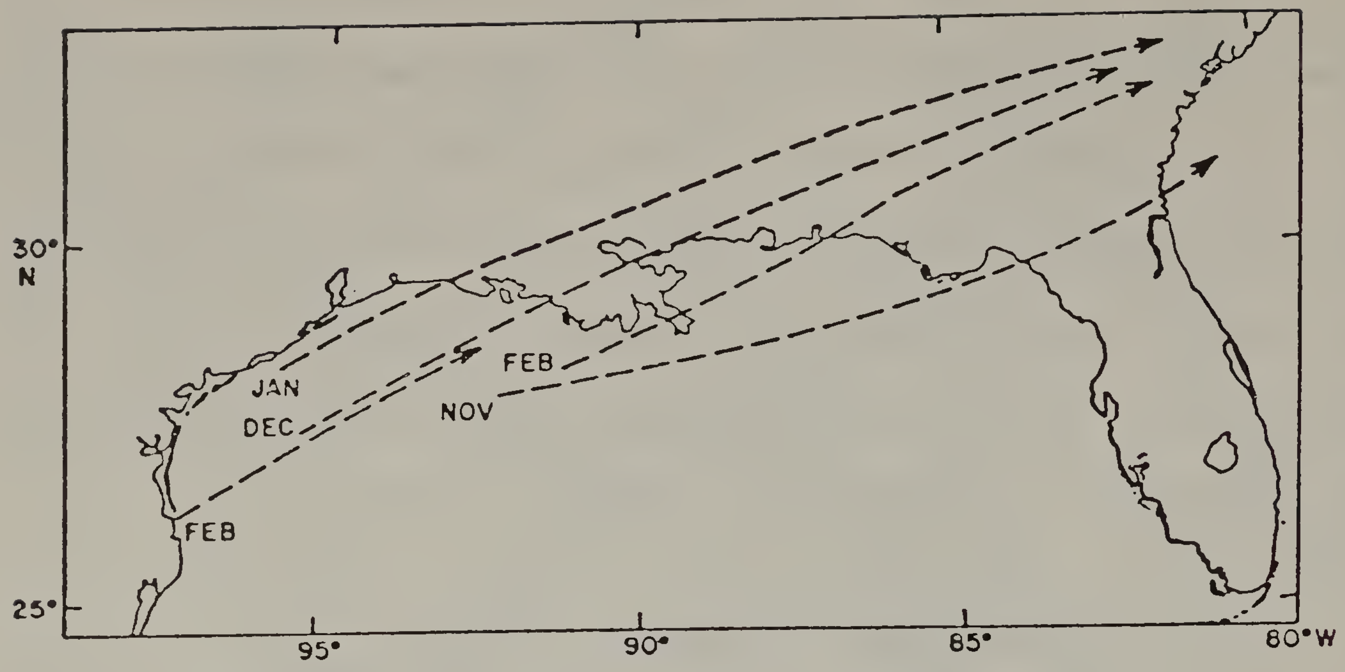


Figure 20. Preferred extratropical cyclone tracks over the Gulf of Mexico. (From Jordan, 1973)

Table 22

Mean seasonal frequency (in occurrences per year) of low pressure centers which moved inland in the indicated coastal sectors. Hurricanes and tropical cyclones have been excluded. (From Jordan, 1973).

	90 W to Apalachicola	Apalachicola to 28.5 N	28.5 N to Fort Myers	Fort Myers to 25 N	All Sectors
Winter	1.6	2.2	0.2	0.4	4.4
Spring	0.7	1.0	0.3	0.2	2.2
Summer	0.7	0.6	0.2	0.1	1.6
Fall	1.6	1.0	0.2	0.1	2.9
Total	4.6	4.8	0.9	0.8	11.1

The intensity statistics (Table 23) show that a very small percentage of the extratropical cyclones over the Gulf have central pressures as low as 1000 mb, with the greatest number of intense cases in fall and winter. Most of the summer cases had relatively high central pressures.

Table 23

Seasonal distribution (total number of cases) of intensity of low pressure centers (measured by minimum sea level pressure in millibars) over Gulf of Mexico during the 1954-1969 period. (From Jordan, 1973)

	1000 mb	1000-1004 mb	1005-1009 mb	1010 mb	Total
Winter	4	11	20	35	70
Spring	1	8	16	11	36
Summer	1	4	3	19	27
Fall	3	7	13	23	46
Total	9	30	52	88	179

C. Physical Oceanography

1. Surface Circulation in the Gulf of Mexico

Water movements in the Gulf of Mexico are controlled by a variety of interacting forces including fresh water inflow from land, currents set up by winds, currents and water transport induced by surface gravity waves, tidal currents, currents associated with internal waves, and movement of water masses due to density differences.

The general circulation pattern for the eastern Gulf consists of a clockwise Loop Current flowing in through the Yucatan Strait and out through the Florida Strait; (Fig. 21). This is essentially an extension of the Yucatan Current which flows into the Gulf, circles to the right and flows out through the Florida Strait to join the Gulf Stream Current. A counterclockwise gyre off the west coast of Florida is a persistent feature, more defined during the winter months, however. The western half of the Gulf has no strong, semi-permanent currents but is characterized by a well-defined pattern of winter flow and a highly variable summer pattern (Nowlin, 1971). There is a general westward sweep of currents along the northern shelf west of the Mississippi Delta. Another mass of water moves northward along the Mexican coast to a zone of convergence off Texas. All the currents in the western Gulf seem to flow toward this general zone.

Figure 21. Generalized surface circulation in the Gulf of Mexico inferred from logs of ships at sea. The numbers refer to current speeds in knots, as estimated from ships' drift. (From Nowlin, 1971)

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 circulation. 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. There are places and times where this gyre is weak or non-existent. Thus, some bays and inlets, as well as some open beaches, are isolated from tidal and current exchanges.

2. Surface Sea Temperatures

Leipper (1954) presents figures for average February and August surface sea temperatures for the Gulf of Mexico; they are reproduced on the following pages as Figs. 22 and 23. According to Leipper, the main feature of the average winter pattern is a gradual drop from approximately 75°F. in the south to 65°F. in the north in all parts of the Gulf. In the summertime, average temperatures are very nearly uniform at 84°F. throughout the Gulf. 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 approximately follow air temperatures without reaching the extreme limits exhibited by air temperatures during brief periods.

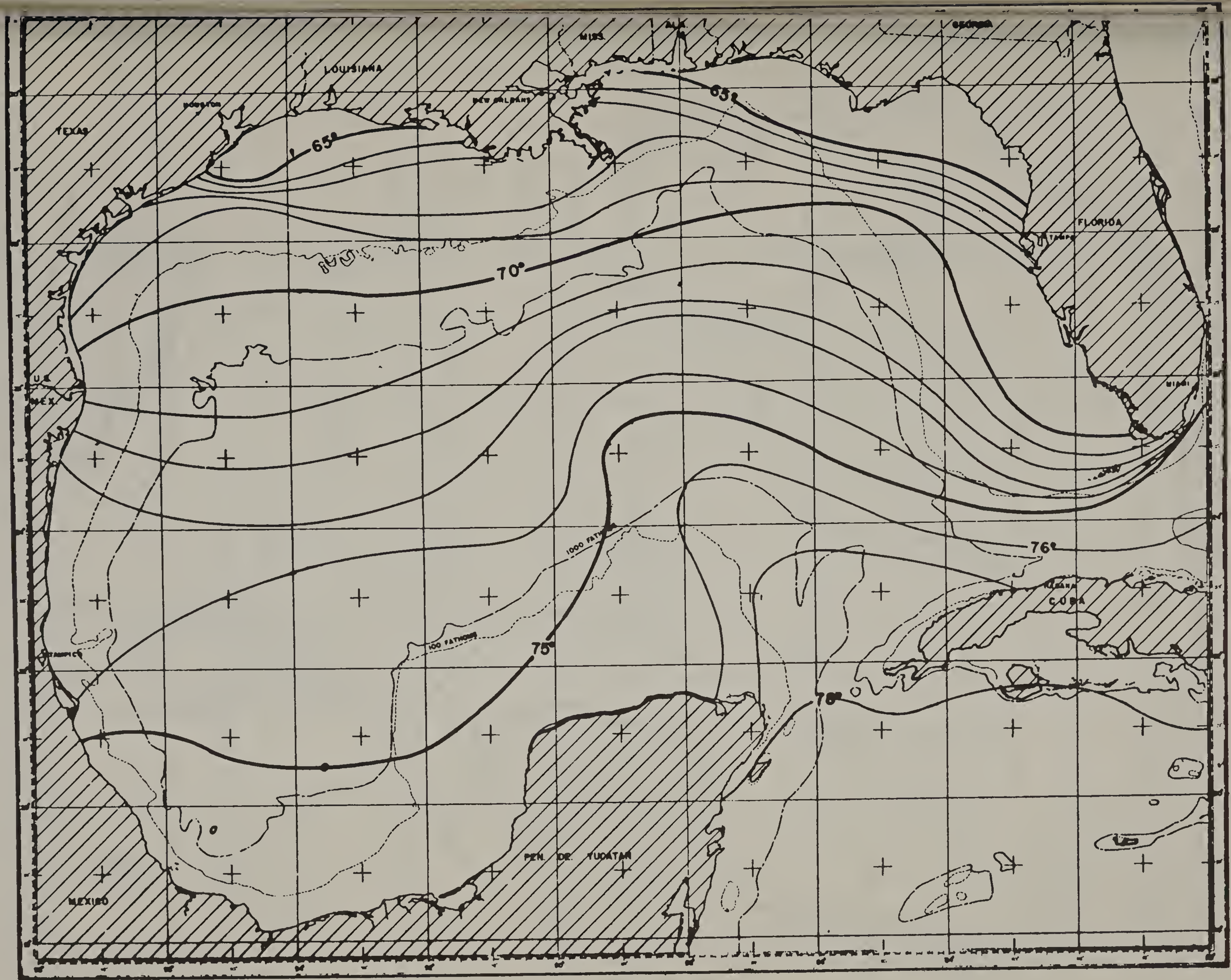


Figure 22. Average sea surface temperatures for February (after Fuglister). (From Leipper, 1954)

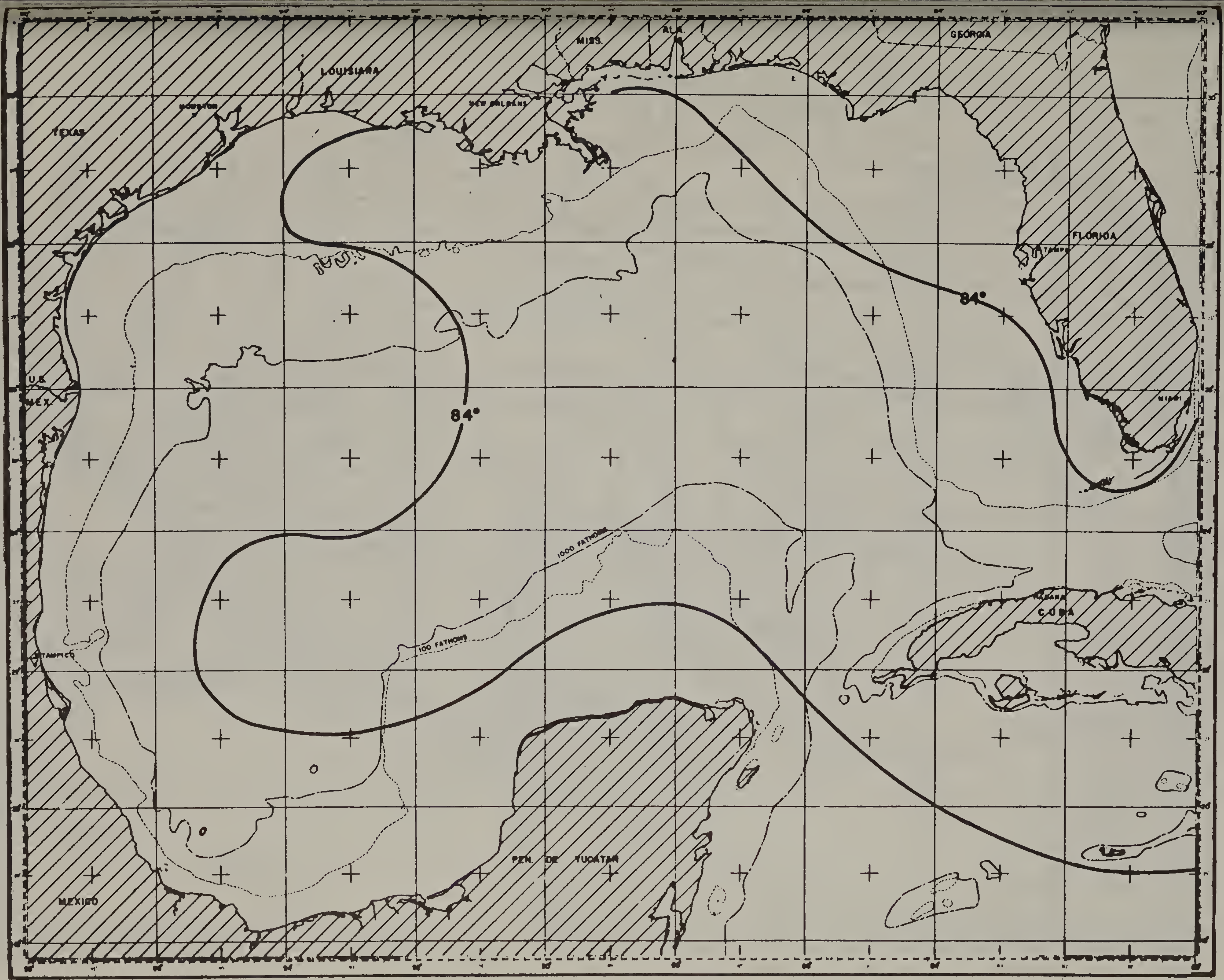


Figure 23. Average surface sea temperatures for August (after Fuglister).
(From Leipper, 1954)

3. Salinity

In the upper 50 meters (168 ft.), water in the central Gulf of Mexico typically has a salinity of very near 36.0 parts per thousand (ppt) (Leipper, 1954).

The distribution of surface salinities in the winter of 1962 is given in Fig. 24. 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).

4. Tides

Periodic tides in the Gulf of Mexico usually are small and may, therefore, be greatly modified and sometimes obliterated by fluctuations in the water surface due to winds or other meteorologic conditions.

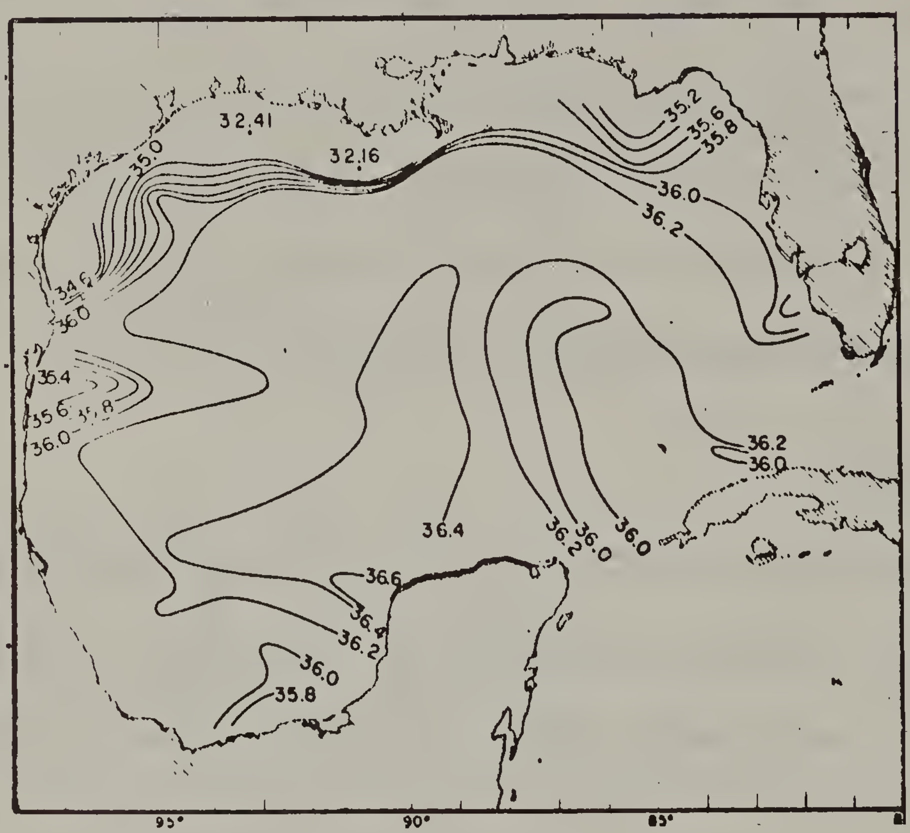
At Key West the mean range of tide is less than 1.5 feet. Extreme variation in the level from 1.5 feet below the plane of reference to 4 feet above may occur in this locality.

Along the west coast of the peninsula of Florida from Cape Sable to Apalachee Bay, the mean range varies from 1 to 4 feet. Extreme tides from 3 feet below to 6 feet above the plane of reference have been observed on this coast.

Along the northern shore of the Gulf of Mexico from St. George Sound to the Rio Grande the tide is diurnal and the mean range is less than

2 feet, but fluctuations due to the wind from 3.5 feet below to 4 feet above the plane of reference are not uncommon.

Figure 24. Surface Salinities (parts per thousand) in the winter of 1962.



5. Sea and Swell

An examination of wind conditions would suggest that moderate seas should exist over the eastern Gulf for most of the year. Wave data summarized in a Navy Oceanographic Atlas (U.S. Naval Oceanographic Office, 1963) for the Gulf north of 25°N. and east of 85°W. show that this is the case. Monthly differences are small between October and April with about 60 to 65 percent of the observations showing wave heights less than three feet, 10 to 15 percent of the heights greater than 5 feet, and about one percent with heights greater than 12 feet. During May through August, the observations show 80-90 percent of the wave height less than 3 feet, 2-6 percent show heights greater than 5 feet and much less than one percent show heights greater than 12 feet. Values intermediate to those presented above are reported in September. Predominant wave directions tend to be from east and northeast from September through February and from east and southeast from March through August. Waves from the north and northwest, especially in the fall and winter, tend to have greater heights than those from other directions, a fact that is significant because in this case, the seas are running toward the shore.

Wave periods greater than nine seconds were indicated in only 5-6 percent of the observations during all seasons and periods greater than five seconds were noted in 61-74 percent of the seasonal observations. The greatest frequency of these short period waves was in summer and the lowest frequency was in the fall.

Swell observations given in the Navy Oceanographic Atlas show about the same seasonal changes as the wave observations. From September through April, 72-80 percent of the observations show swell heights less than 6 feet and 3-6 percent show heights greater than 12 feet. From May through October, 86-93 percent of the observations gave swell heights less than 6 feet and less than two percent gave heights greater than 12 feet, with nearly zero frequency of swell of this height in June and July (Jordan, 1973).

D. The Biological Environment and Communities of the Coastal Zone

The area under consideration here is the band of coastal lands and waters from the tidal zone to roughly thirty miles inland, extending from the Mississippi Delta to Tampa Bay, and including offshore islands and enclosed bays.

Terrestrial biological community units, the biomes, are usually identified by the dominant or climax vegetation. Broadly speaking, this area has been described as a long-leafed pine subclimax within the deciduous forest biome maintained in the pine subclimax by periodic fires (Odum, 1959). Within the pine subclimax formation and along its periphery are a number of areas supporting other types of vegetation and biological communities due to such localized conditions as:

standing waters, saturated soils (freshwater marsh, swamp, aquatic grasses)

presence of brackish tidewaters or marine waters (mangrove swamp, tidal marsh, sea grasses), excessively drained sandy soil (scrub forest) and others.

The following series of maps (Figs. 24-25 a-h) illustrates the distribution of vegetational types and other features of the coastal zone.

1. Tidal Marsh 1/

Included here are the salt and brackish marshes that extend

1/ Largely from Humm (1973a) and McNulty, Lyndall, and Sykes (1972).

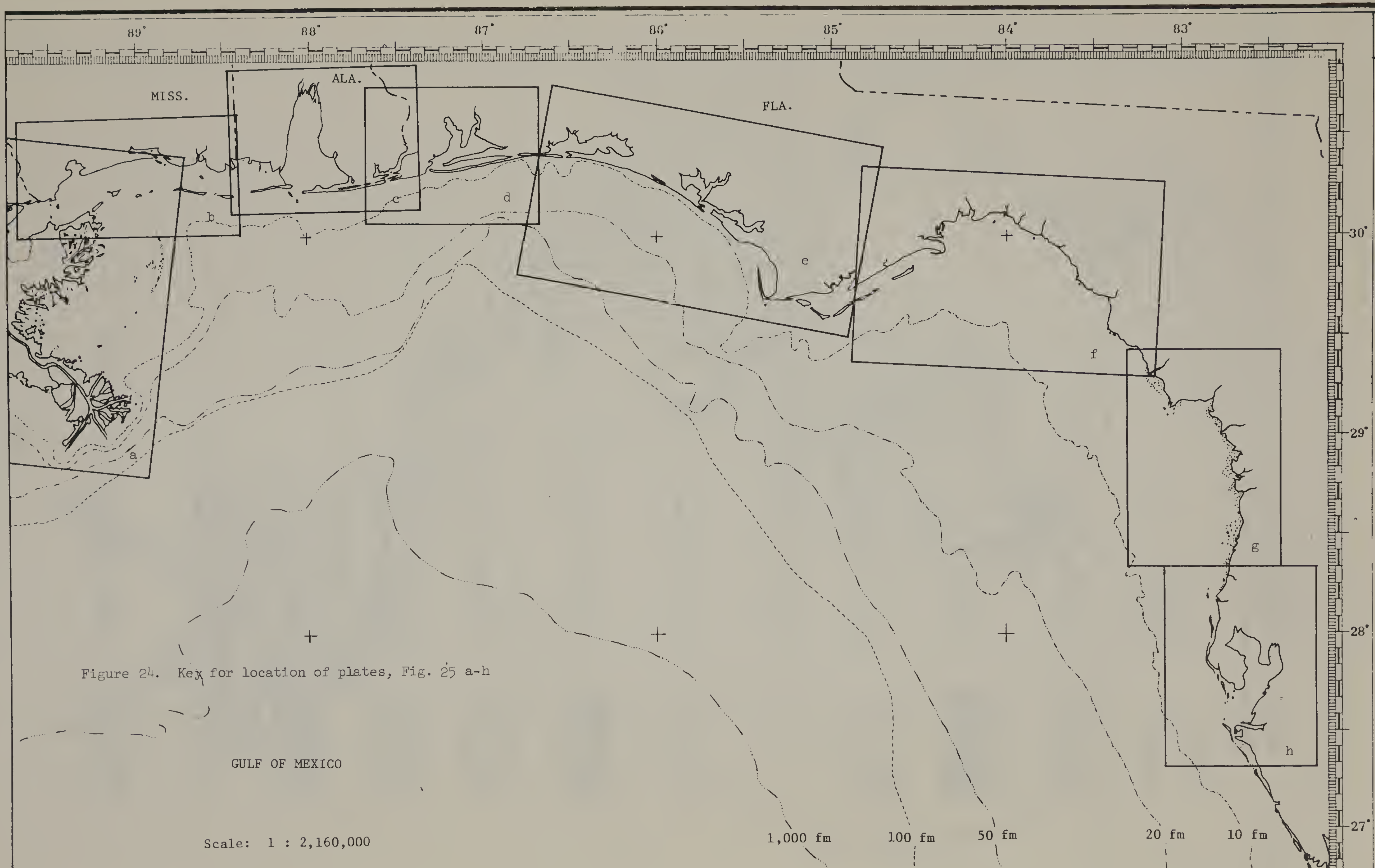


Figure 24. Key for location of plates, Fig. 25 a-h

Figure 25. Natural Vegetation of the Coastal Zone, Louisiana, Mississippi, Alabama, and Florida

Key :

Submerged Vegetation

Mangrove

Tidal Marsh

Freshwater Marsh

Pine Flatwoods

Hardwood Forest

Longleaf Pine Forest

Swamp Forest

Sand Pines

Prairie Grassland

Mixed Hardwood-Pine Forest


MISSISSIPPI SOUND
Miss.
La.
LAKE BORGNE
CHANDELEUR SOUND
CHANDELEUR ISLANDS
BRETON SOUND
BRETON ISLAND
GULF OF MEXICO

Figure 25 a

Figure 25b

Figure 25c

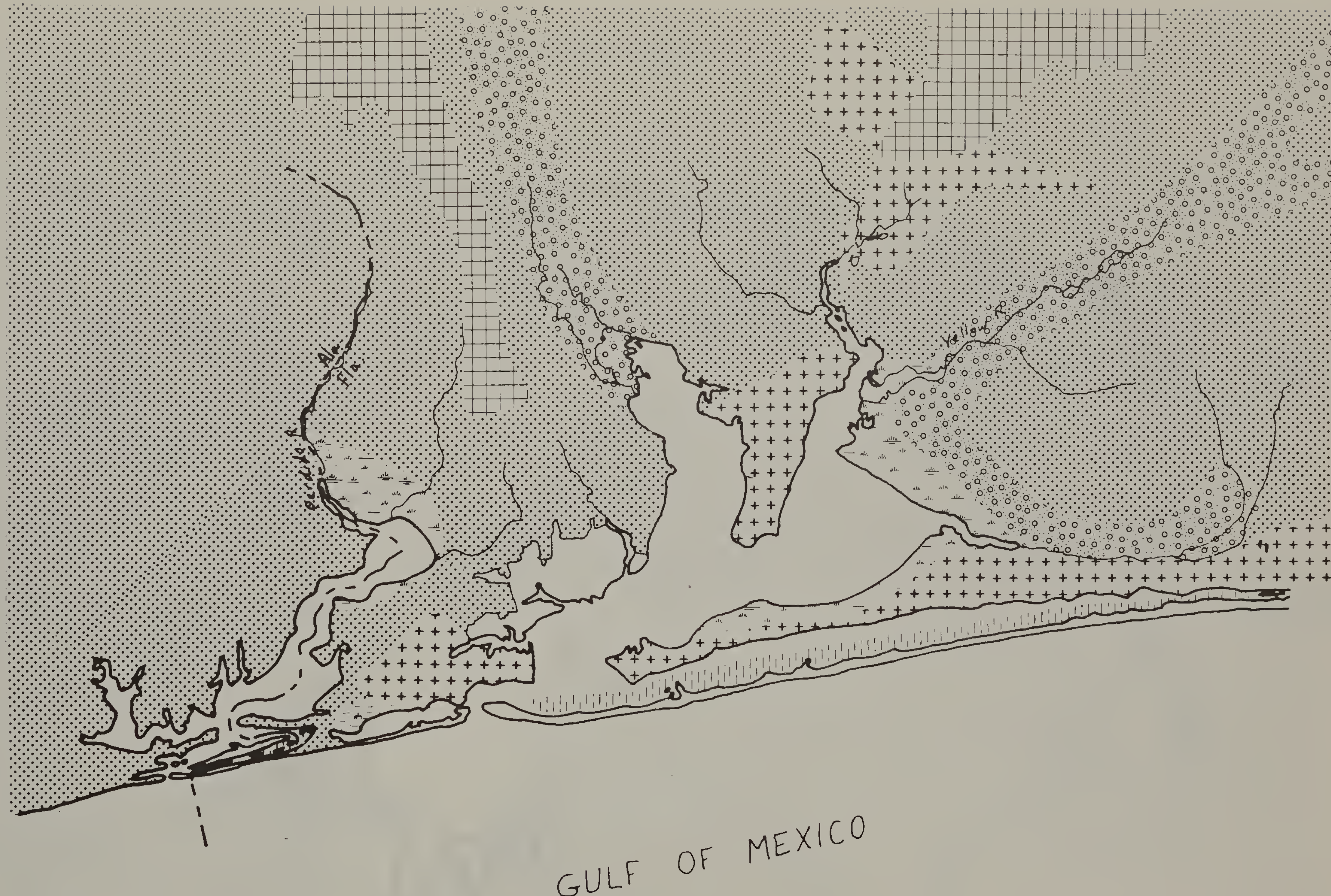


Figure 25d

Figure 25e

Figure 25f

Figure 25g

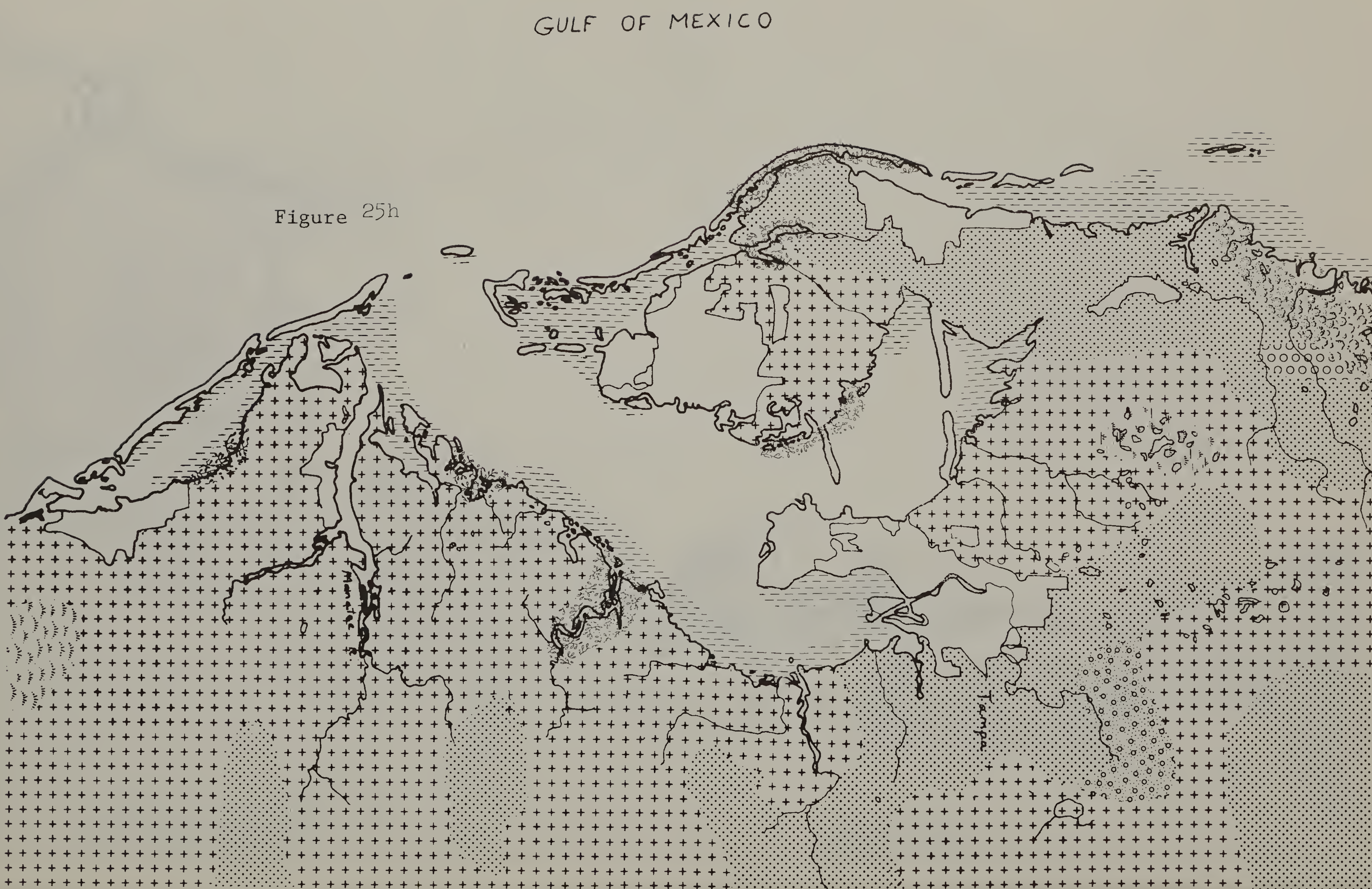


Figure 25h

along much of the coastline of the northeastern Gulf and fringe portions of most bays. They are most extensively developed on the modern Mississippi and St. Bernard Deltas of Louisiana, and in Florida between Tarpon Springs and Port St. Joe. From Tarpon Springs southward, mangrove stands occupy most of the intertidal area characteristic of salt marshes. Much of the seaward coast from Gulfport, Mississippi to Panama City, Florida, including the barrier and offshore islands, is comprised of moderate energy beaches where the intertidal zone is too narrow for salt marshes, and is characterized by sand dunes and a high sandy beach ridge immediately inland from the fore-beach.

Most salt marshes exhibit distinct zonation by the most abundant plants (Fig. 26). This zonation is controlled by a variety of factors including soil types, soil salinity, tide, elevation, drainage characteristics and pH.

In the vicinity of the Mississippi Delta, the saline marsh is generally adjacent to the beach rim and might vary from 1 to 15 miles in width. Predominating the vegetation are oystergrass, glasswort, blackrush, and saltgrass. The saline marsh merges with the broad band of brackish marsh which is further removed from the sea rim and vegetated by wire grass, coco, and threecorner grass.

Along the remainder of the coastline where salt marsh occurs, oystergrass forms an almost pure stand as an outer band where it endures the

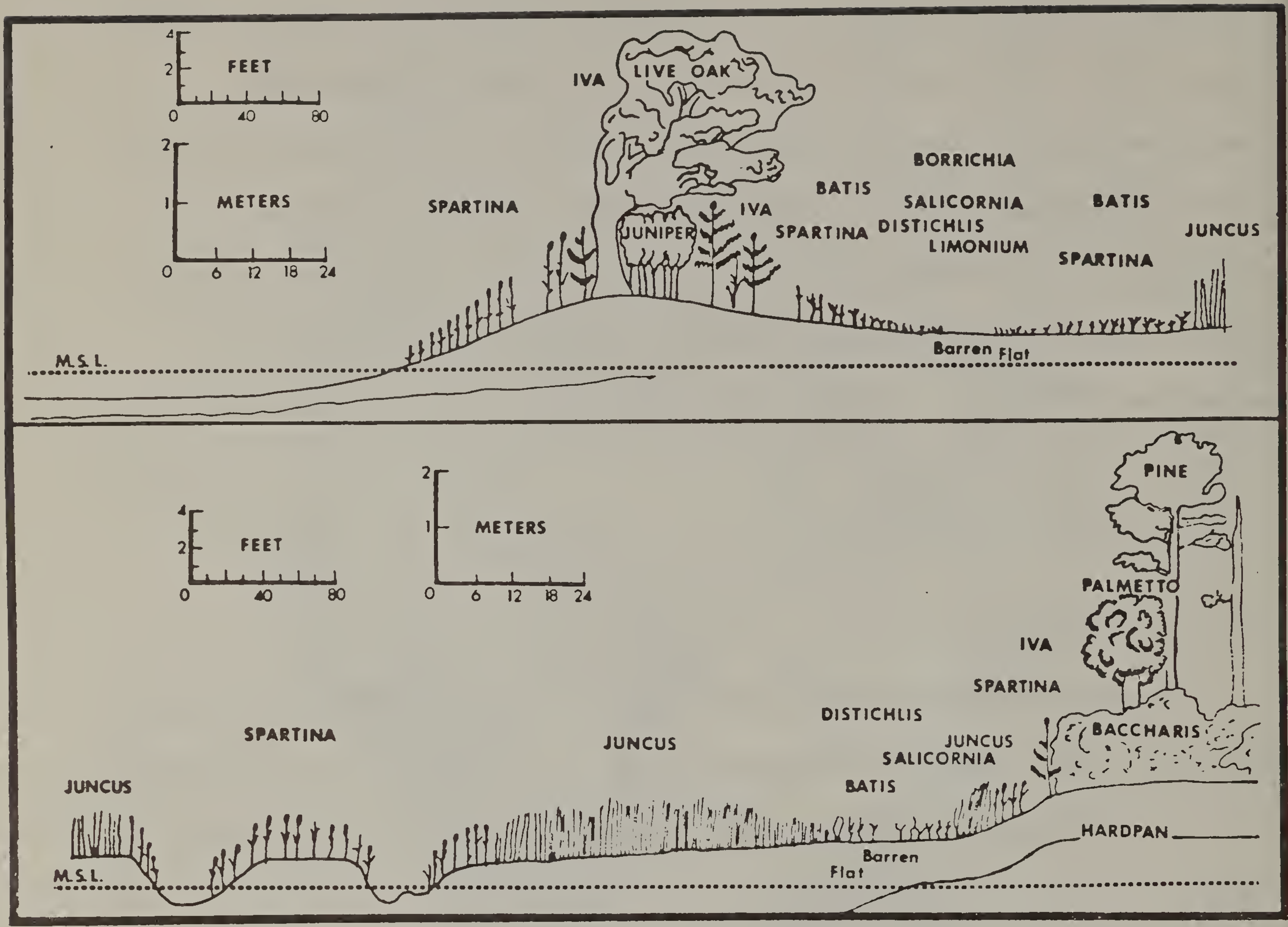


Figure 26. Diagrammatic cross section of a barrier island with fringing marsh (upper), and of a transect from tidal channels to flatwoods typical of the northern Florida coast (lower). (from McNulty, Lindall and Sykes, 1972)

deepest and longest inundation by salt water during high tide. The black, highly organic soil on which it grows continues to be saturated with salt water even during low tide.

Black rush occupies slightly higher ground, on the average, than oystergrass and forms an almost pure stand just landward of the oystergrass zone. Black rush covers the greatest area of the salt marsh and its density slows down the penetration of tidal water horizontally. The thick peat-like soil that forms beneath black rush is less permeable to water than that under any other salt marsh community. In the center of the marsh the black rush may grow to 6 or 7 feet (about 2m) while at the edge of the marsh near the flatwoods their height drops abruptly by one-half or more and they merge with the third ecological zone, the salt flats. Stunted specimens of several genera typify the flats, especially wiregrass, saltgrass, glasswort, saltwort, Borrichia, Aster, and Limonium. The fourth zone, the barrens, consists of bare ground flooded by high tides for brief periods of time. The tidal inundation alternating with long exposure to sunlight result in such high salt content of the soil that seed plants are excluded. However, diatoms and blue-green algae abound in prodigious quantities.

Annual production of dry organic matter by marsh plants is very large, probably about 2000 g/m^2 (roughly 20000 lb/acre) (Odum, 1961; Teal, 1962). The productivity 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.

Humm (op. cit.) has summarized the importance of tidal marshes in coastal ecology. He notes that:

> "Any habitat as extensive as salt marshes must be significantly involved in the coastal ecology of the eastern Gulf of Mexico. As a transition zone between low-energy sea or bay margins and gently-sloping shorelines, salt marshes exhibit at least three major ecological functions:
>
> 1 They are the site of the production of relatively large quantities of organic matter per unit area per unit of time. Some of this organic matter is stored in the marsh in the form of peat, some is recycled in the marsh through a variety of food chains, some moves out of the marsh and is dissipated at sea.
>
> 2 Salt marshes are the habitat, in some cases exclusively so, of a few species of algae and seed plants, of a large variety of invertebrate animals, of a considerable number of birds, and of a few reptiles and mammals.
>
> 3 Salt marshes provide much protection to low-lying uplands adjacent to them not only from salt water intrusion, coastal erosion, and quantities of drifting debris, but in the case of broad marshes, from destructive salt spray as well.

> While the basic productivity of salt marshes is high, since they act as coastal nutrient traps and are little affected by droughts, the significance of this productivity to man is not known. Speculation of its value has been considerable and is illustrated by the statement that 95 percent of the commercial fisheries catch in Virginia is "nurtured by the marshes" (National Geographic, volume 114, number 6, page 729, 1972). Marshes are major contributors to productivity of the Chesapeake Bay and also to the northern half of the eastern Gulf of Mexico. Their real contribution to the abundance of species utilized by man has yet to be determined."

Viewing salt marshes as a resource, Taylor, Feigenbaum, and Stursa (1973) notes that these areas act as 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.

2. Freshwater Marsh

The only freshwater marsh in the area of interest is situated in the more central region of the Mississippi delta near the distributary passes. Major species of vegetationin this marsh are: roseau cane, Eurasian water milfoil, alligator weed, duck week, water hyacinth, dogtooth grass, bulltongue, and pondweed (Stone, 1972).

Because of its remoteness from the proposed action, further discussion is not deemed necessary.

3. Mangrove Swamp 1/

The three common mangroves in the order of their abundance

1/ From Humm (1973b) and McNulty *et. al.*, (1972).

are the red mangrove, the black mangrove, and the buttonwood, and their zonation landward is in the same order (Fig. 27). A fourth and less abundant species, the white mangrove, generally grows landward of the black mangrove. Their distribution is world-wide on tropical and subtropical shores of oceans and estuaries.

Mangroves grow on peat, muck, marl, sand, or rock, and such environmental factors as killing frost and land elevation control their distribution. Their "viviparous" seedlings germinate while attached to the parent tree; seedlings detach and float in the sea, where they remain alive several months, so they can be carried long distances by currents.

As with salt marshes, mangrove stands serve as a transitional buffer zone between stretches of low-energy coastal waters and uplands on the other side. They afford greater protection from storms and hurricanes than broad salt marshes, not only against wave action and high water but also as a windbreak. Mangroves are active land-builders as well as lowland protectors. Debris that accumulates in their tangle of prop roots is partly converted into peat upon which they grow. Mangrove stands are a habitat for many species of marine algae that attach to their prop roots, along with a host of both sessile and free-living invertebrates (Fig. 27). A variety of birds are characteristic of mangroves, some of which produce rookeries on the islands, but very few animals are restricted to mangrove stands.

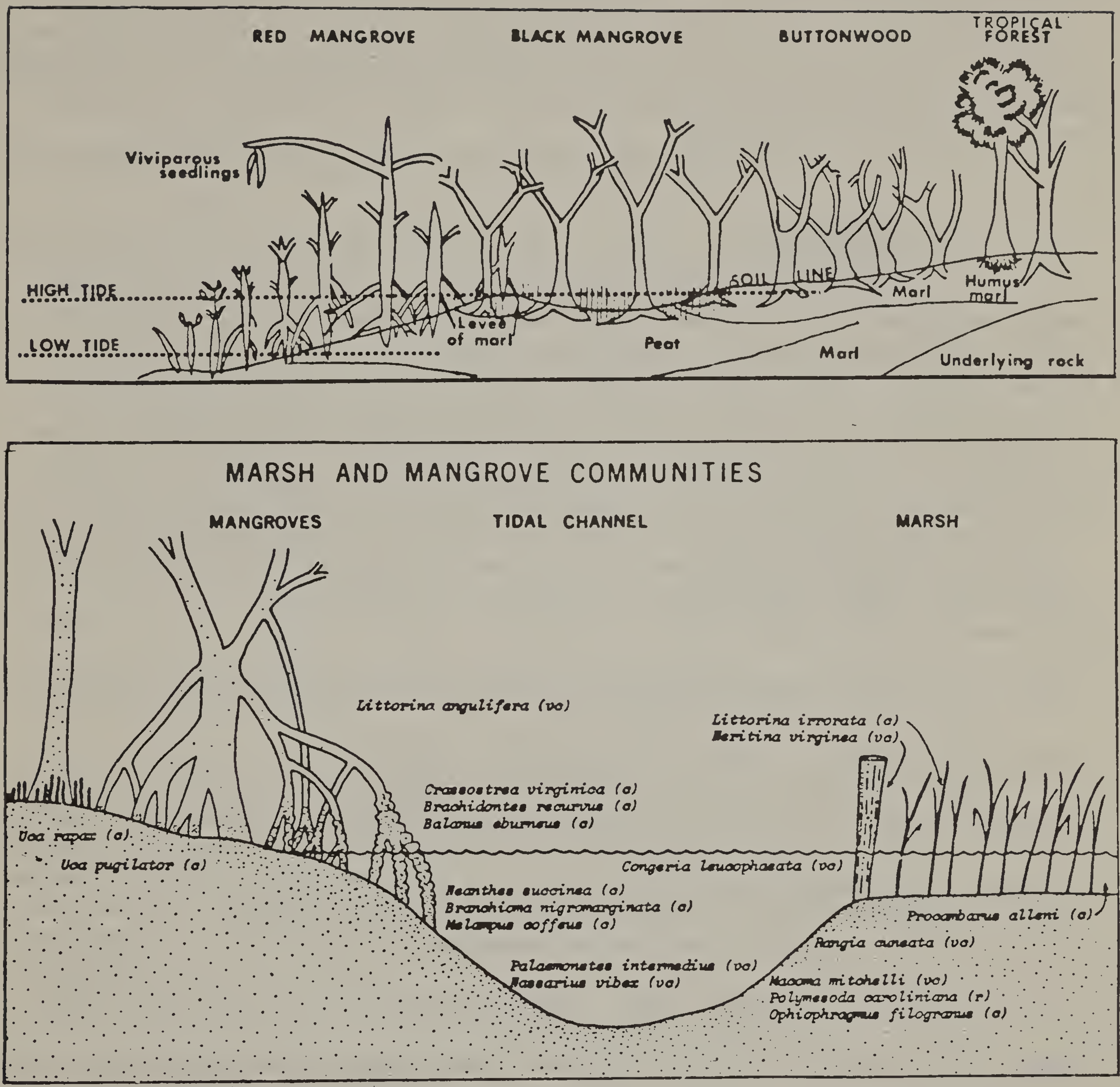


Figure 27. Upper: Diagrammatic cross section of a mangrove swamp (from McNulty et al., ibid.). Lower: Communities of a mangrove swamp and marsh. vc-very common, c-common, r-rare. Common names are listed in Attachment E. (from Collard and D'Asaro, 1973)

Organic matter such as land vegetation and mangrove leaves that is transported into the sea is decomposed or consumed there and contributes to the food supply of a host of marine organisms, or contributes to submarine peat deposits.

4. Seagrasses

Seagrasses consist of species of flowering plants that grow completely submerged (some are tidally emergent) in brackish to saline waters. They are therefore more appropriately discussed in a section on marine, rather than coastal zone, vegetation, but are included here because of the ease with which the estuarine and near-shore beds could bedepicted on the maps of Fig. 25.

These seagrasses are continuous in the eastern Gulf of Mexico from the Florida Keys to Mississippi Sound. Approximately 90 percent of seagrass beds of the eastern Gulf are outside estuaries and in the Gulf itself. Seagrasses do not do well in estuaries where the fluctuations in slainity, turbidity, and water temperature are of such magnitude as to inhibit or exclude them. The distribution and extent of seagrass beds depicted in Fig. 25 were taken largely from McNulty et. al. (1972) and may be erroneously small. Humm (1973c) notes that seagrass beds on the continental shelf have never been mapped accurately and may cover several thousand square miles. He notes that in many areas between Tarpon Springs and Apalachee Bay, seagrass beds may form a band 10 to 15 miles wide.

Temperature, light, substrate, exposure, nutrients, grazing, currents, and wave action are other factors which affect the distribution of submerged vegetation. Earle (1972) believes that grouping of species by substrate type is the most useful approach.

Few species can become established in areas of shifting sand or mud, but stable sand and mud is readily populated by seagrasses that have rhizoidal holdfasts (shoal grass, widgeon grass, which are intertidal to about 10 m depth). Turtle grass has a patchy distribution throughout much of the coastal Gulf but attains extensive development over hundreds of square miles of calcareous sand bottom overlying limestone between Tampa Bay and Cape San Blas. Associated with these turtle grass beds are numerous other species of sea grass and benthic algae.

Manatee grass grows throughout the Gulf in muddy sand at depths to at least 25 m and sometimes occurs in nearly pure stands, particularly in deep water. Widgeon grass typically occurs in shallow water of low salinity.

Although it is known primarily from river mouths and estuaries, dense stands have been found several miles offshore in the vicinity of fresh-water springs off northwestern Florida.

Humm (ibid) notes that seagrass beds exhibit at least six noteworthy environmental functions on the continental shelf of the eastern Gulf of Mexico:

(1) They serve as a sediment trap and a stabilizer of bottom sediments from the waters edge to a depth of 6 to 16 meters or more.

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

(3) 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.

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

(5) 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.

(6) 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.

5. Upland Vegetation

Communities of the uplands are remote from the proposed action and are therefore given only a brief mention.

Six upland vegetation associations were identified in the coastal zone. Pine Flatwoods: Open woodlands of one to three species of pine: longleaf, slash, and pond pines. Many herbs, saw palmetto, shrubs and small trees form an understory. Included in general flatwoods areas are small hardwood forests, many kinds of cypress swamps, prairies, marshes, and bay tree swamps.

Hardwood Forests: Mostly on rich soil uplands. These are mixed evergreen and deciduous hardwoods. Some areas are nearly original hardwood stands, but many are old second growth with pines.

Longleaf pine: Forests of longleaf pine and xerophytic oaks. Mostly on well drained uplands. The turkey oak and wire grass are common. Many former areas of this type are now citrus groves in the central section of Florida. (In Alabama and Mississippi, this classification also includes the southern slash pine.)

Swamp Forests: Consists mostly of hardwoods. Several kinds bordering on rivers and lakes. Some Bay tree, Gum, Nyssa, Titi, and Cypress zones occur in many of these hardwood swamps.

Mixed Hardwoods and Pines: Mostly on uplands of clay soils in northern section. Many differences in composition and age; some young second growth is mostly pines. The more mature forests are mostly hardwoods.

Grasslands of Prairie Type: Wet prairies on seasonally flooded lowlands. Dry prairies on seldom flooded flatlands. Many former areas of these are now improved pastures.

6. Common Coastal and Marine Birds of the Eastern Gulf of Mexico 1/

"Birds are unlike any other class of animals in their relationship to water as an environment. Although some of them are absolutely dependent upon the sea for their existence, none of them is a creature of that medium in the same sense that a marine invertebrate is, or even a marine mammal such as a whale." (Lowery and Newman, 1954).

Woolfenden and Schreiber (1973) believe there are 81 avian species that are importantly affected by the existence and condition of the saline habitats in the eastern Gulf. They list seven major avian habitats.

(1) Open Gulf waters: open, deep waters beyond 10 km from shore (pelagic seabirds)

(2) Coastal Gulf waters: open Gulf from shoreline to 10 km (mainly large fish-eating birds)

1/ Taken largely from Woolfenden and Schreiber (1973).

(3) Open beaches: sandy beaches of north coast (shorebirds, large fish-eating birds)

(4) Salt and brackish marshes: tidal areas inhabitated by typical salt marsh vegetation (rails, sparrows, ducks, shorebirds)

(5) Coastal mudflats: tidal land devoid of attached vegetation (shorebirds, ducks)

(6) Sheltered marine waters and bays: (fish, mollusk, and crustacean eating birds)

(7) Mangrove swamp (pelicans, cormorants, herons, ibises)

The following table (Table 24) lists eastern Gulf bird families.

7. Endangered and Threatened Fish and Wildlife

The species included below are the Endangered Native Fish and Wildlife species declared by the Secretary of the Interior and those "threatened" species reported in the publication Threatened Wildlife of the United States, Resource Publication 114 compiled by the Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife.

The national usage of designation "Rare or Endangered" has been replaced by the term "Endangered". The Endangered Species Conservation Act of 1969 instructs the Secretary of the Interior to seek the counsel of

Table 24. Birds of the eastern Gulf of Mexico, by family--
their habitat, residence time, food, and relative abundance.

Family	Habitat	Approximate Residence Times	Primary Food	Relative Abundance (1971)*
Loons	open Gulf waters	Oct.-Apr.	fish	3
Grebes	freshwater, sheltered coastal saltwater	Oct.-Apr.	fish, crustaceans	8
Storm petrels	open Gulf waters	May-Oct.	euphausids, offal, fish squid	0
Pelicans	sheltered coastal saltwaters, mangroves	White-Oct.-Apr. Brown-all year	fish	81
Boobies	open Gulf waters	Nov.-Apr.	fish, squid	trace
Cormorants	sheltered coastal saltwaters, mangroves	all year	fish	59
Frigatebrids	mangroves, coastal saltwaters, open Gulf	summer	fish, invertebrates	5
Herons	all except open Gulf	mixed patterns	fish, crustaceans	99
Storks	freshwater, sheltered coastal saline waters	all year	fish, invertebrates	5
Ibis, spoonbills	coastal fresh-, saltwater, mudflats	Apr.-Oct.	fish, crustaceans, insects, mollusks	56
Waterfowl	all except open Gulf	most: Oct-Mar.	variety of vegetable matter, invertebrates	334
Hawks, eagles	all except open Gulf	all year	fish, waterbirds	1
Ospreys	all except open Gulf	all year	fish	3
Rails	mangrove, salt marsh	winter or all year	invertebrates, seeds	210
American Oystercatcher	open beach, sandy mudflats, oysterbars	winter, all year	mollusks	1
Plovers	open beach, sandy mudflats	winter, all year	invertebrates	28
Sandpipers	open beach, mudflats	winter, fall, spring	invertebrates, small fish	247
Avocets, stilts	muddy, shallow protected saltwater	summer, winter	small plants, invertebrates	trace
Jeagers	Open Gulf	winter	fish	0
Gulls, terns	all except mangroves	winter, all year	fish, invertebrates	341
Skimmers	protected coastal water	winter, all year	fish	47
Sparrows	salt marshes	winter	invertebrates	trace

* No. birds per 10 census party hours.

specialists and agencies with expertise on the subject and to rely upon their combined judgment to determine whether or not an animal is "endangered with extinction". The wording of the Act is as follows:

> "A species of native fish and wildlife shall be regarded as threatened with extinction whenever the Secretary of the Interior finds, after consultation with the affected States, that its existence is endangered because its habitat is threatened with destruction, drastic modification, or severe curtailment, or because of overexploitation, disease, predation, or because of other factors, and that its survival requires assistance. In addition to consulting with the States, the Secretary shall, from time to time, seek the advice and recommendations of interested persons, and organizations, including, but not limited to, ornithologists, ichthyologists, ecologists, herpetologists, and mammalogists. He shall publich in the Federal Register the names of the species of native fish and wildlife found to be threatened with extinction in accordance with this paragraph."

Table 25. The Official List of Endangered Fish and Wildlife Species Within the Area Affected by This Proposal

Mammals	
Florida Manatee	Trichechus manatus latirostris
Finback Whale	Balaenoptera physalus
Sperm Whale	Physeter catodon
Birds	
Brown Pelican	Pelecanus occidentalis carolinensis
Southern Bald Eagle	Haliaeetus leucocephalus leucocephalus
American Peregrine Falcon	Falco peregrinus anatum
Artic Peregrine Falcon	Falco peregrinus tundrius
Ivory-Billed Woodpecker	Campephilus principalis
Red-Cockaded Woodpecker	Dendrocopus borealis
Reptiles and Amphibians	
American Alligator	Alligator mississippiensis
Fishes	
Short Nose Sturgeon	Acipenser brevirostrum

Fig. 28 portrays those additional animals which appear as threatened in the publication, Threatened Wildlife of the United States. This publication summarizes the existing knowledge of the status of native vertebrates. It is intended to be a reference for compiling the official list of Endangered Native Fish and Wildlife. Only those animals determined by the Secretary of the Interior to be threatened with extinction and named on the list which is published and amended periodically in the Federal Register are eligible for the benefits by the Endangered Species Conservation Act of 1969. The table on the following page (Tab. 26) includes those invertebrates which occur within the area affected by this proposal that appear in the publication Threatened Wildlife of the United States.

Also included in Table 26 are the peripheral and status undetermined classifications. These definitions are: A peripheral species or subspecies is one whose occurrence in the United States is at the edge of its natural range and which is threatened with extinction within the United States although not in its range as a whole. Special attention is necessary to assure retention in our Nation's fauna. A status-undetermined species or subspecies is one that has been suggested as possibly threatened with extinction but about which there is not enough information to determine its status.

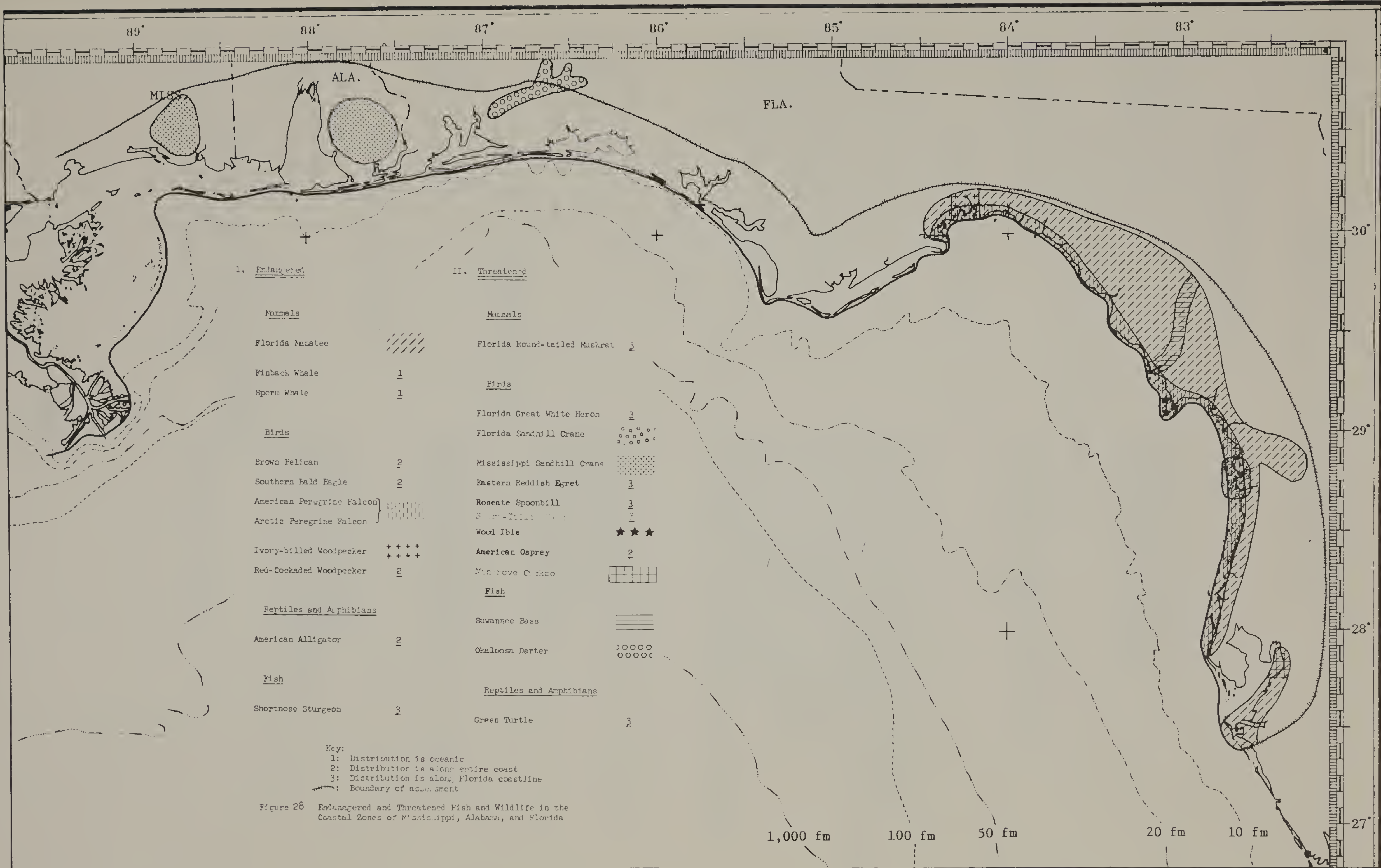


Figure 28 Endangered and Threatened Fish and Wildlife in the Coastal Zones of Mississippi, Alabama, and Florida

Table 26 Threatened, Periferal and Undetermined Status Species Within the Proposed Area

Threatened Fishes

Shortnose Sturgeon	Acipenser brevirostrum
Suwannee Bass	Micropterus notius
Okaloosa Darter	Etheostoma okaloosae

Threatened Reptiles and Amphibians

American Alligator	Alligator mississippiensis
Green Turtle	Chelonia mydas

Threatened Birds

Eastern Brown Pelican	Pelecanus occidentalis carolinensis
Florida Great White Heron	Ardea occidentalis occidentalis
Southern Bald Eagle	Haliaeetus leucocephalus leucocephalus
American Peregrine Falcon	Falco peregrinus anatum
Arctic Peregrine Falcon	Falco peregrinus tundrius
Florida Sandhill Crane	Grus canadensis pratensis
Mississippi Sandhill Crane	Grus canadensis pulla
Red-Cockaded Woodpecker	Dendrocopos borcalis
American Ivory-Billed Woodpecker	Campehilus principalis principalis

Peripheral Birds

Eastern Reddish Egret	Dichromanassa rufesceus refesceus
Roseate Spoonbill	Ajaia ajaja
Mangrove Cuckoo	Coccyzus minor
Short-tailed Hawk	Buteo brachyurus

Status-Undetermined Birds

Wood Ibis	Mycteria americana
American Osprey	Pandion haliaetus carolinensis

Threatened Mammals

Sperm Whale	Physeter catodon
Finback Whale	Balaenoptera physalus
Florida Manatee	Trichechus manatus latirostris

Status-Undetermined Mammals

Florida Round-Tailed Muskrat	Neofiber alleni

E. The Biological Environment and Communities of the Gulf of Mexico

This section is intended to point out and briefly discuss biological conditions and ecological components of the southeastern Gulf of Mexico.

1. Phytoplankton 1/

a. Estuaries

It is generally conceded that phytoplankton production in estuarine and inshore areas is exceeded by the primary production of attached seagrasses, algae, epiphytes, and benthic photosynthetic microflora. In addition, benthic plant communities (e.g., diatoms, seagrasses, filamentous algae) aid in stabilizing sediments. In most bays maximum production and/or standing crop is in upper reaches, gradually decreasing towards the mouth. It appears from several studies that the Tampa Bay system is one of the most productive estuaries along the eastern Gulf. Several eastern Gulf estuaries are the scene of heavy non-toxic phytoplankton blooms (particularly dinoflagellates) during summer months and these can cause isolated animal mortalities by lowering the available oxygen content in seawater.

b. Coastal and Open Gulf

It was mentioned above that in many areas there is a gradual decrease in primary production and/or standing crop from the

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1/ Condensed from Steidinger (1973).

estuary head to mouth. This decrease continues seaward so that embayments are generally the most fertile, followed by continental shelf regions and then open Gulf waters. There is an inverse relationship between production rates and species diversity and many coastal and estuarine species have seasonal dormant stages, i.e., are spore forming.

Both horizontal and vertical distribution of phytoplankton are dependent on: 1) population origin and life cycles, 2) supply and level of nutrients and growth factors, 3) physiological requirements and adaptability, 4) salinity and temperature, and 5) grazing pressure. In addition, vertical distribution alone is influenced by 6) vertical mixing, diffusion and water stability, and 7) depth of the lighted zone.

Research suggests that spring and summer are the seasonal peaks for standing crop and primary production in estuaries and coastal areas. Contrarily, winter may be a peak period further offshore in deeper continental shelf and open Gulf waters.

c. Red Tides

Red tides are fairly common throughout the world and are associated with areas of upwelling or heavy land runoff. In the Gulf of Mexico red tides refer to discolored patches of seawater usually accompanied by fish kills. The phytoplanktonic organisms causing these natural phenomena are dinofloagellates which produces a neurotoxin that, when in high concentrations, is capable of paralyzing and killing a variety of fishes but relatively few invertebrates. The most widespread damage is caused by the species Gymnodinum breve, a coastal species and one of four which can bloom and produce the red tide. Red tides appear to coincide with increased iron and other trace elements or chelators discharged via land runoff after heavy rains (further discussion in III.B.1.a.(1)).

2. Zooplankton 1/

a. Regulating Hydrographic Factors

In the central Gulf, the Loop Current is the dominant feature regulating plankton production and distribution. Loop Current associated upwelling significantly affects plankton on the west Florida shelf. In Gulf coastal areas seasonal variations of zooplankton standing crop and distribution are influenced by land drainage and to some extent by large annual variation in temperature. Superimposed on natural determinants is man's impact on estuarine and nearshore plankton which comes in the form of industrial and domestic alterations of water quality. As with runoff and temperature, this influence varies regionally, with greatest impact to be expected in more heavily populated coastal areas such as Tampa, Escambia and Mobile Bays.

b. Distribution and Biomass

The copepod Acartia tonsa is the principal plankton species in terms of biomass in estuaries of the eastern Gulf. Zooplank-

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1/ Condensed from Hopkins (1973).

ton diversity is lowest in the less saline heads of bays and increases seaward with increasing salinity, and is generally greater in summer than in winter.

Zooplankton biomass roughly correlates with that of phytoplankton, as described in the previous section, with highest values in bays and a general decrease toward the open Gulf. Zooplankton biomass is also controlled by predators and hydrographic features.

Three localities on the continental shelf have been identified as sustaining high zooplankton production: (1) east of the Mississippi River mouth, (2) northern part of the Florida shelf and (3) southwestern section of the Florida shelf. Regions 1 and 2 are directly influenced by river runoff, principally that from the Mississippi River. Nutrient rich runoff from the Mississippi peaks in the spring and fall. Also, the northern part of the shelf during winter is exposed to cold winds and relatively cool coastal drainage which facilitates mixing with nutrient rich deep waters. Standing crop in these waters reflects these strong seasonal influences, with highest zooplankton biomass occurring in fall and winter. Region 3 is minimally influenced by runoff or winter mixing but instead is enriched by Loop Current-generated upwelling in summer, which results in a biomass peak during this season.

3. Benthic Invertebrates 1/

a. Factors Affecting Distribution and Abundance of Benthos

Temperature serves to divide broad geographic areas into faunal zones or so-called "Faunal Provinces". Salinity is important only in estuarine environments. Wave shock and tidal exposure are important in high energy and intertidal zones. Turbidity and sediment depositional rates affect filter-feeding species and burrowing members of benthic communities. Substrate remains as the single key abiotic factor influencing the structure of all benthic communities regardless of the physico-chemical characteristics or geographic locations of the systems under investigation. Other abiotic factors that directly or indirectly affect benthic communities are pollution, man-caused sea floor disturbance, currents and physico-chemical and geographic dispersal barriers.

Community structure and distribution are ultimately the result of biotic factors such as predation, competition, physiological tolerance limits and genetic characteristics of populations.

b. Benthic Communities

Collard and D'Asaro (ibid) have selected for discussion eleven communities, or faunal assemblages that, while not mutually

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1/ Condensed from Collard and D'Asaro (1973).

exclusive in terms of latitude, depth or species composition, nonetheless are readily recognizable as being significant and different faunal sets which broadly delimit or define major types of habitats in the Gulf of Mexico. (Fig. 29 a-k) 1/

Low Salinity Communities

(1) Marshes and Deltas

These communities occur in the northeastern Gulf between the Mississippi barrier islands and Cedar Key, Florida. South of Cedar Key mangroves gradually become dominant in the marshes. These marshes are basically transitional areas where both freshwater species and marine species may be found. Thus species requiring narrow ranges of salinity variation are excluded.

(2) Marshes and Mangrove Swamps

This community occurs south of Cedar Key along the Florida coast and reaches its greatest development south of Tampa Bay.

(3) Oyster Reef Communities

Oyster reefs comprise the major sessile invertebrate community of the northeastern Gulf of Mexico. The eastern oyster is the dominant species and is most successful at lower salinities. Predators such as oyster drills and competitors like the crested oyster are more common at higher salinities.

1/ A list of common names of animals listed in Fig. 29 is presented as Attachment E.

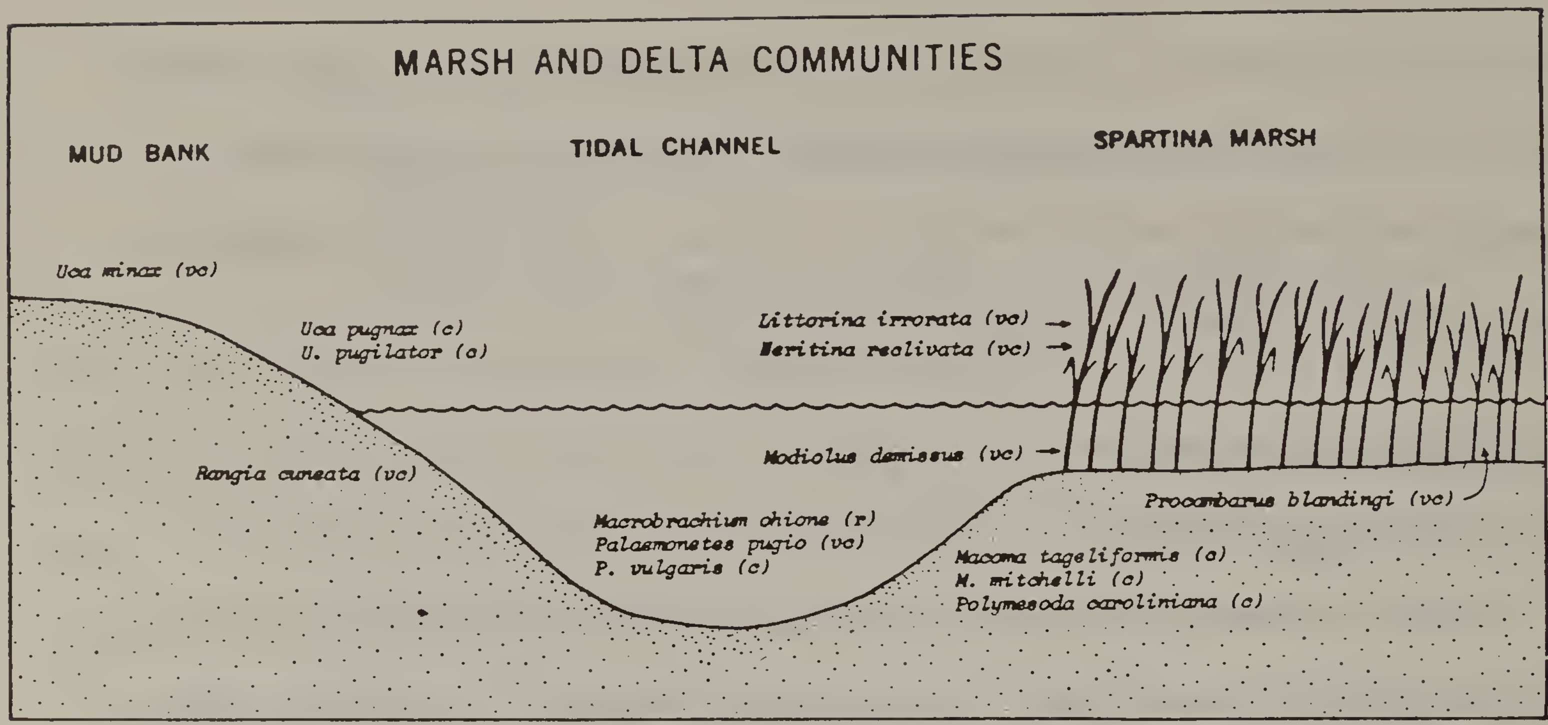


Figure 29a. Marsh and delta communities: Carolinian affinities. These communities occur in the northeastern Gulf of Mexico between the Mississippi barrier islands and Cedar Key, Florida. vc= very common, c-common, r-rare (from Collard and D'Asaro, 1973)

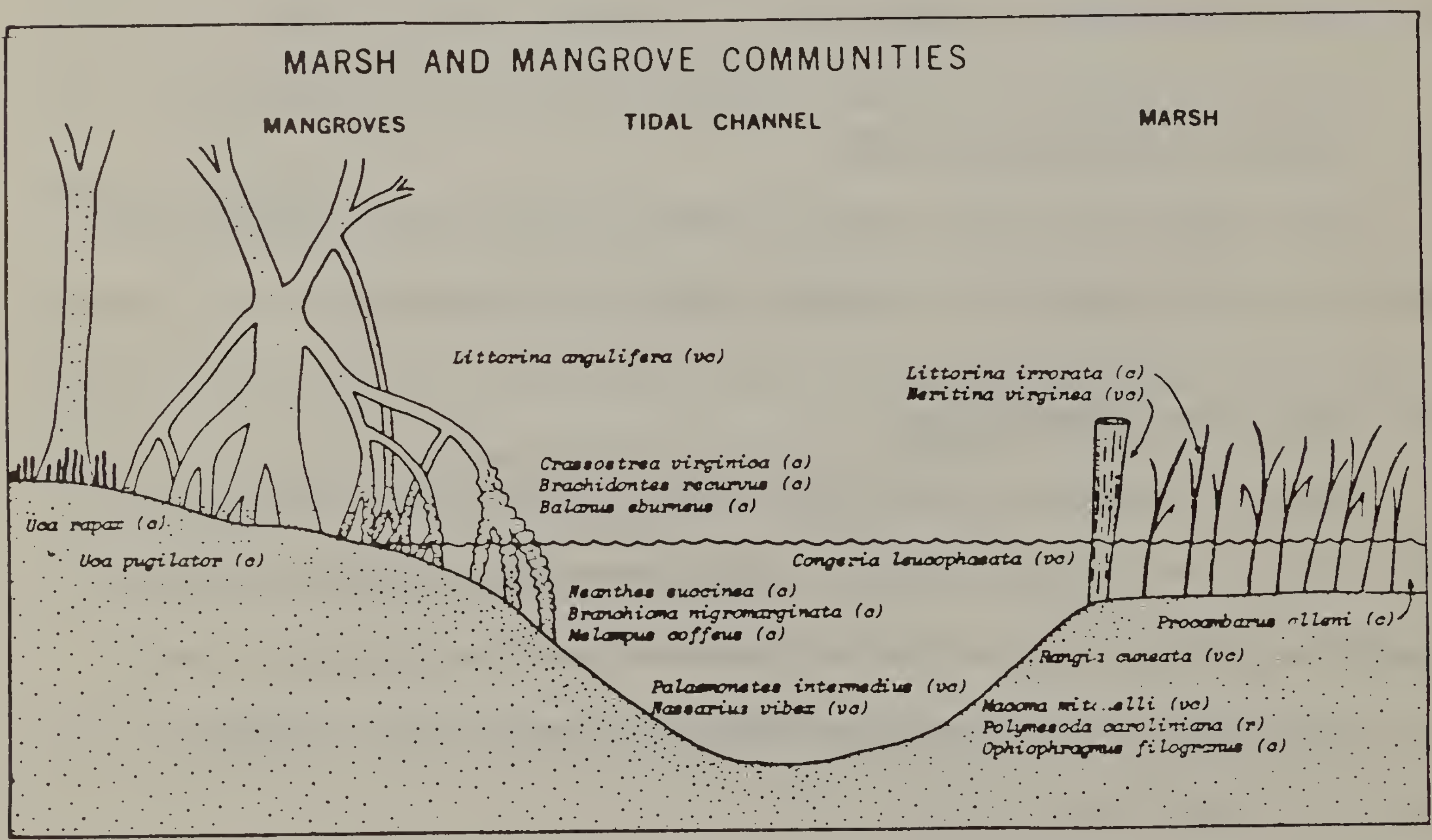


Figure 29b. Marsh and mangrove communities: West Indian affinities. These communities are sparse and scattered south of Cedar Key and are most common south of Tampa Bay. (from Collard and D'Asaro, 1973)

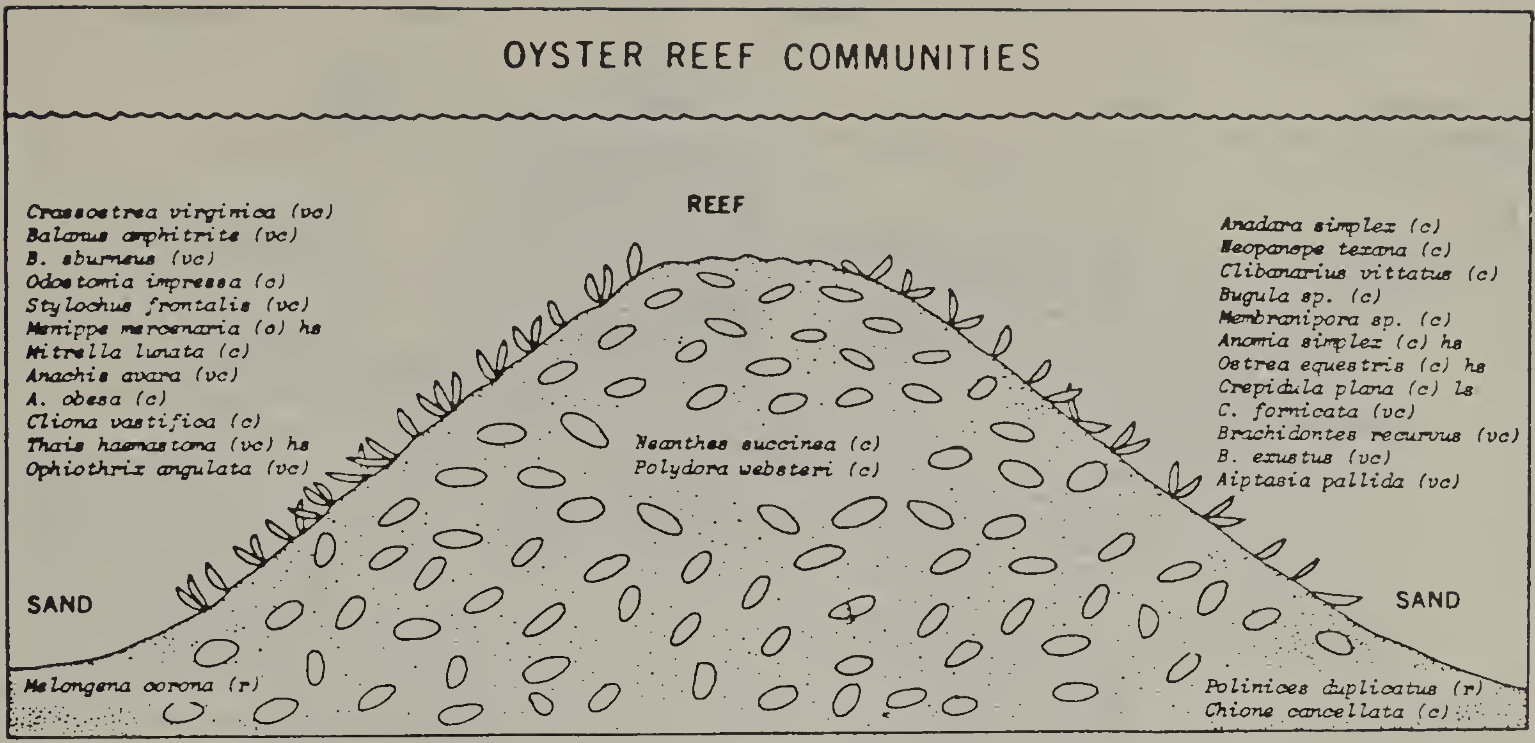


Figure 29c. Oyster reef communities: Carolinian affinities. The common eastern oyster is dominant. (from Collard and D'Asaro, 1973)

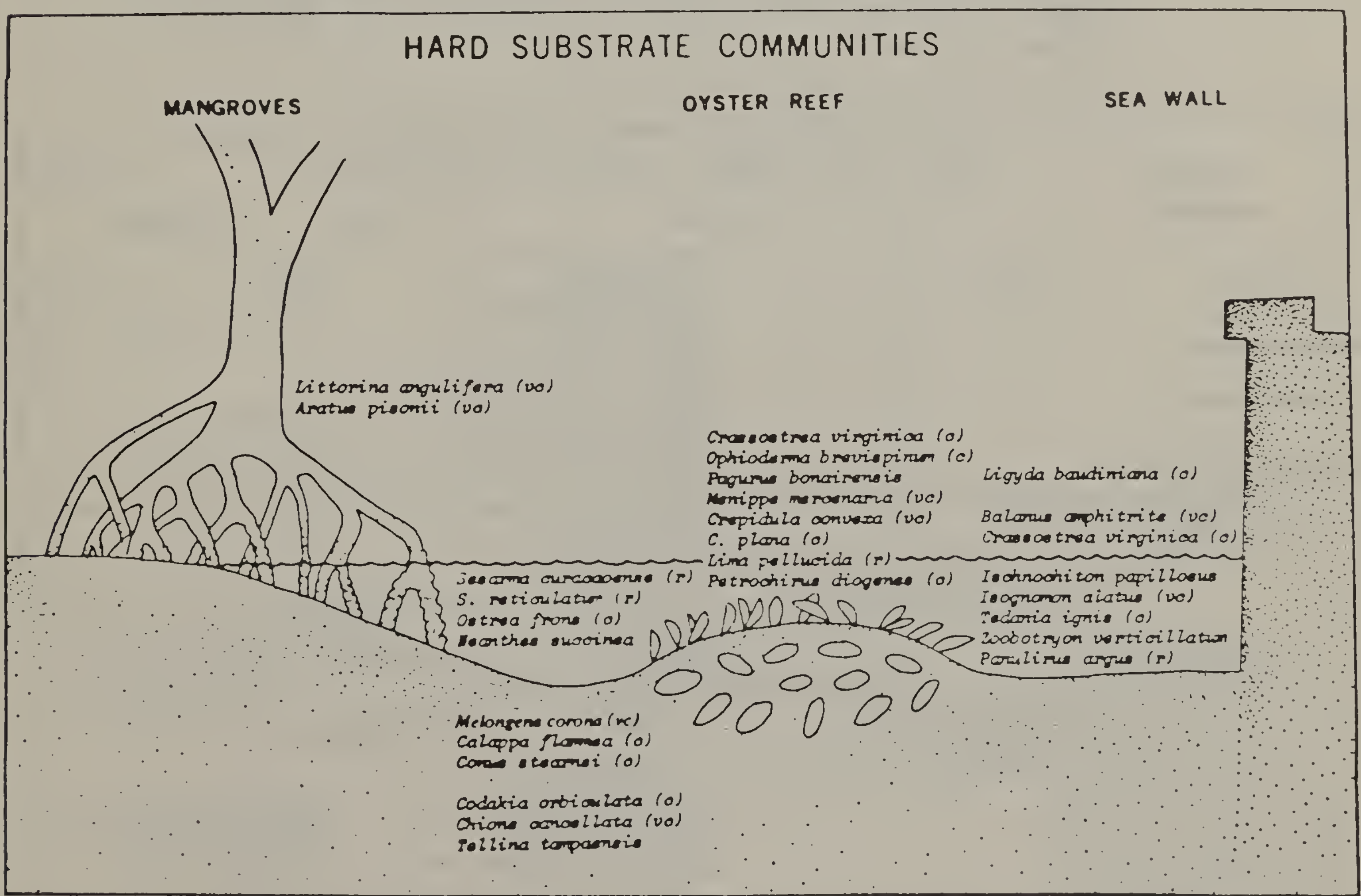


Figure 29d. Oyster, mangrove, and hard substrate communities: West Indian affinities. Dominant animals include the angulate periwinkle, mangrove crab and coon oyster. (from Collard and D'Asaro, 1973)

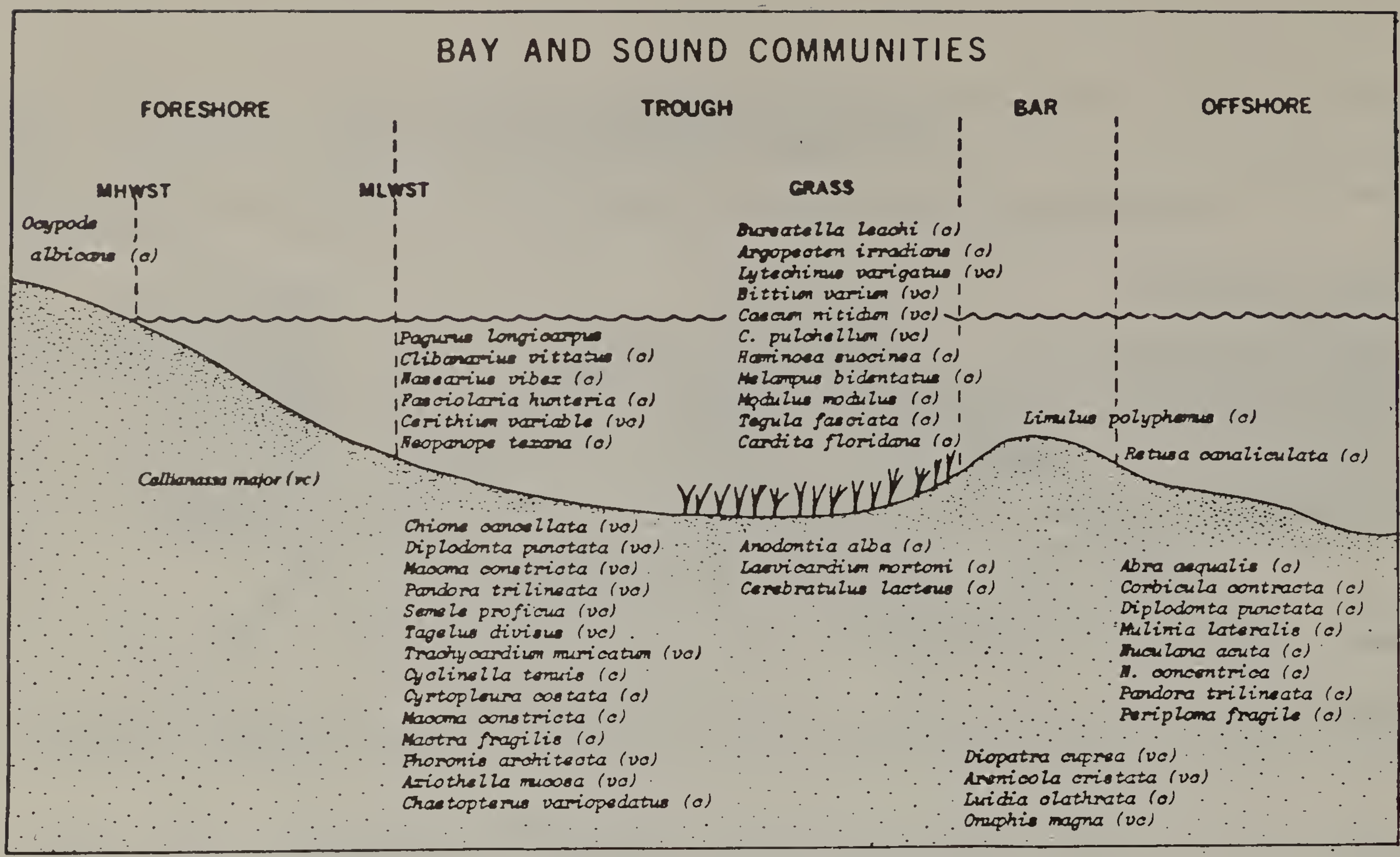


Figure 29e. Bay and sound communities: Carolinian affinities. Most species listed are wide ranging, occurring in sand and grass. Typical of northern Gulf Coast to Cedar Key. (from Collard and D'Asaro, 1973)

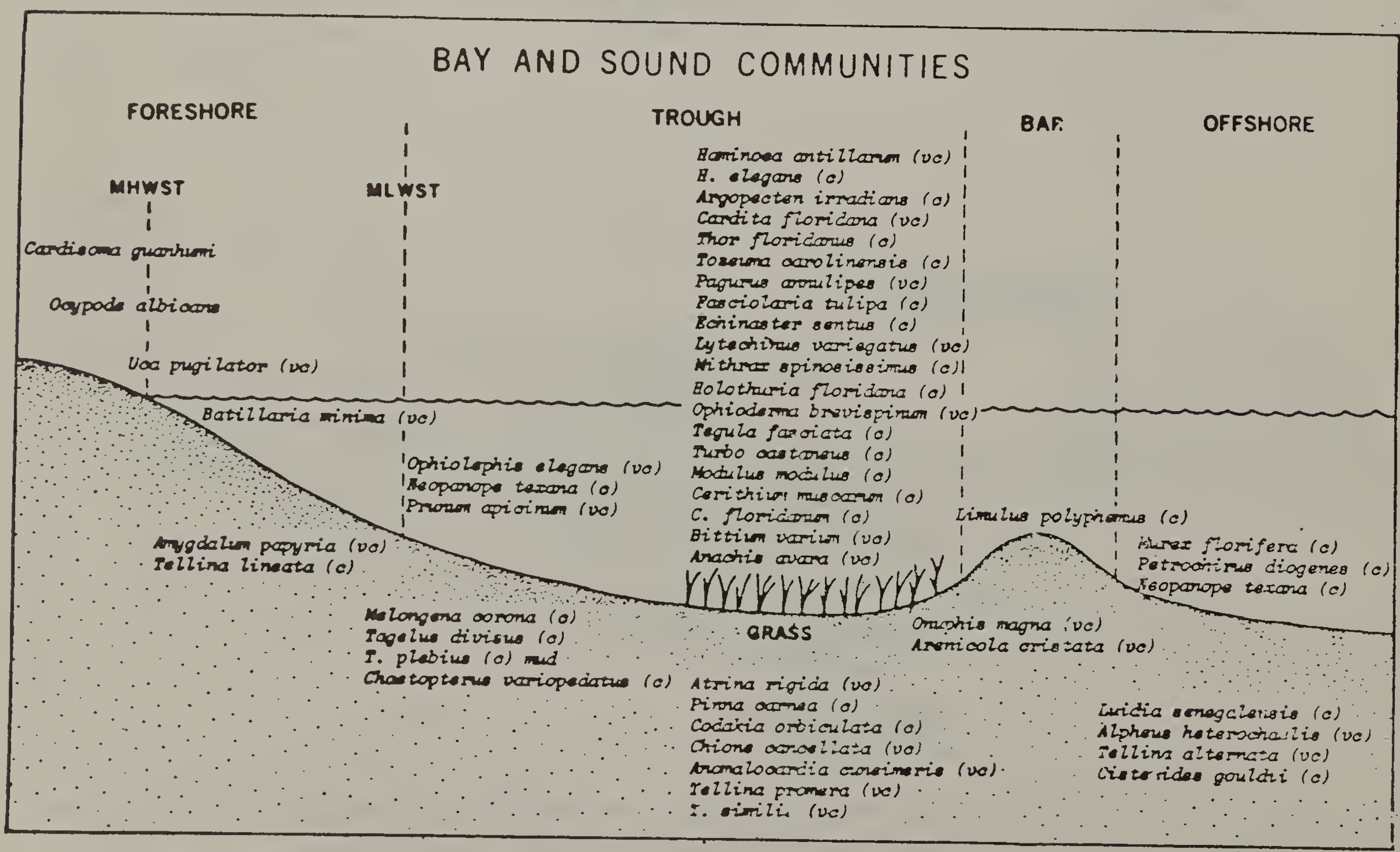


Figure 29f. Bay and sound communities: West Indian affinities. The greatest concentration of animals occurs in the turtle grass community. Scattered south of Cedar Key, common south of Tampa Bay. (from Collard and D'Asaro, 1973)

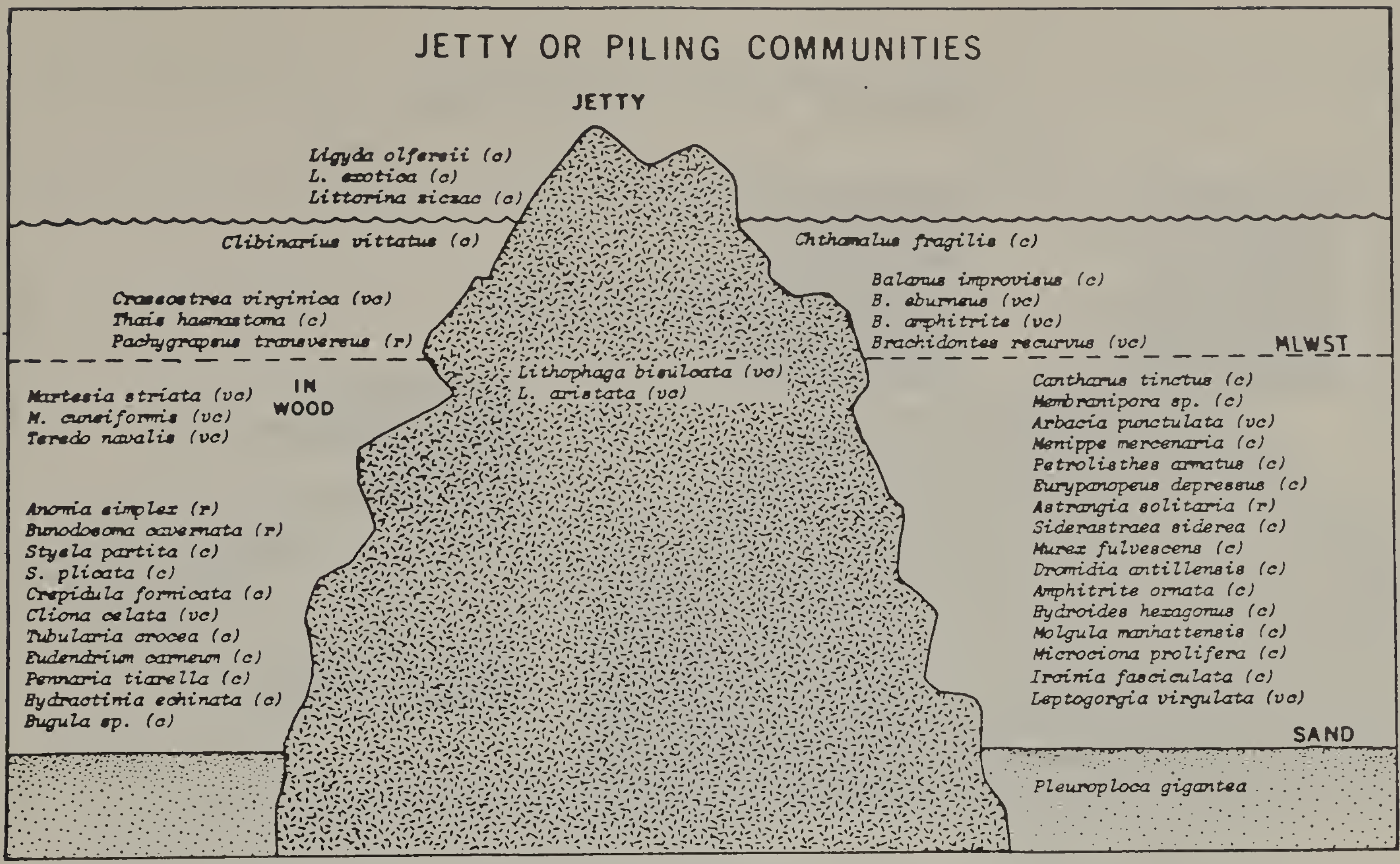


Figure 29g. Jetty or piling communities: Carolinian affinities. Common along north coast to Cedar Key. (from Collard and D'Asaro, 1973)

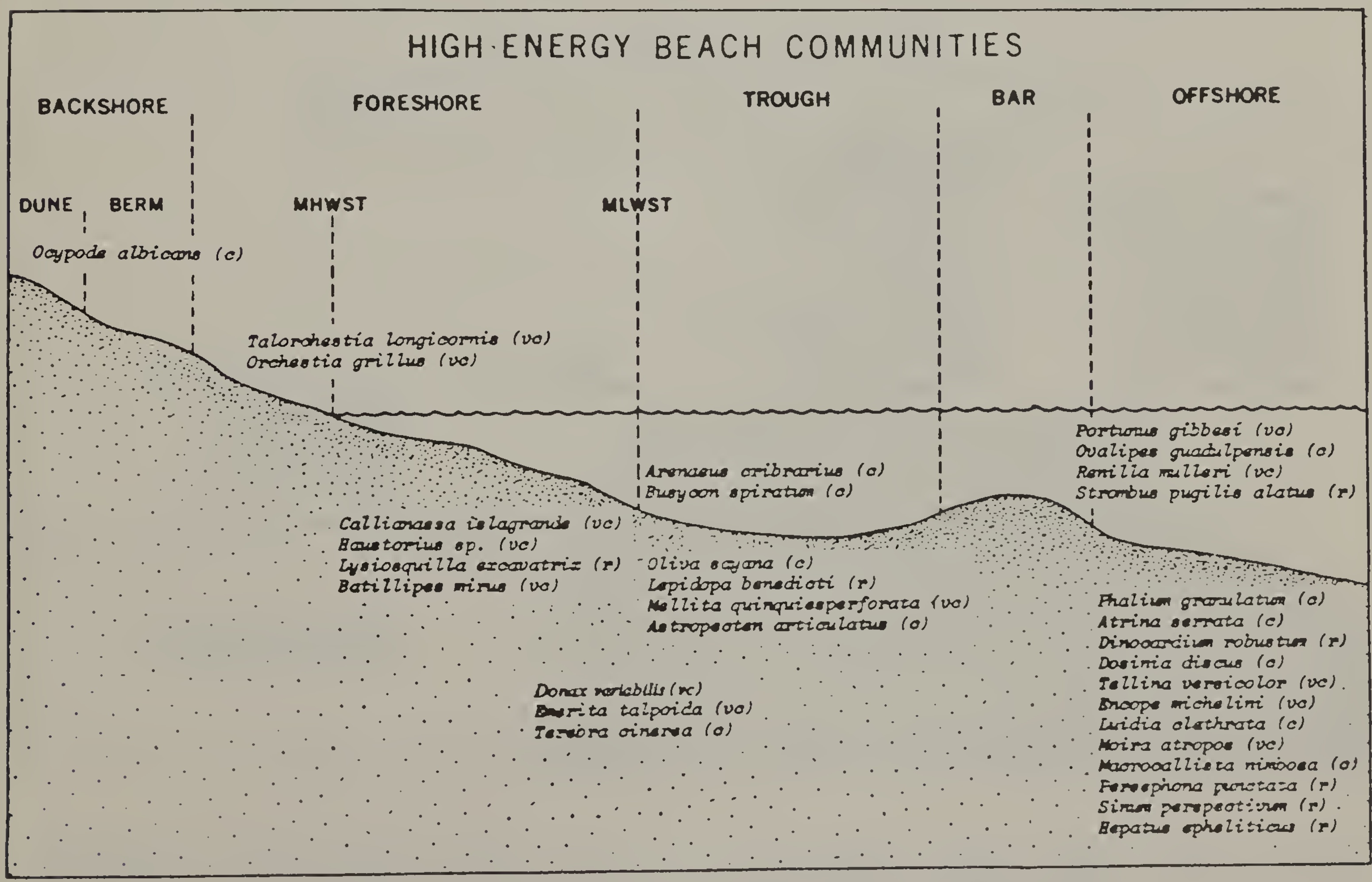


Figure 29h. High energy beach communities. Composition of these communities is essentially the same from the Mississippi barrier islands to Cape Sable. (from Collard and D'Asaro, 1973)

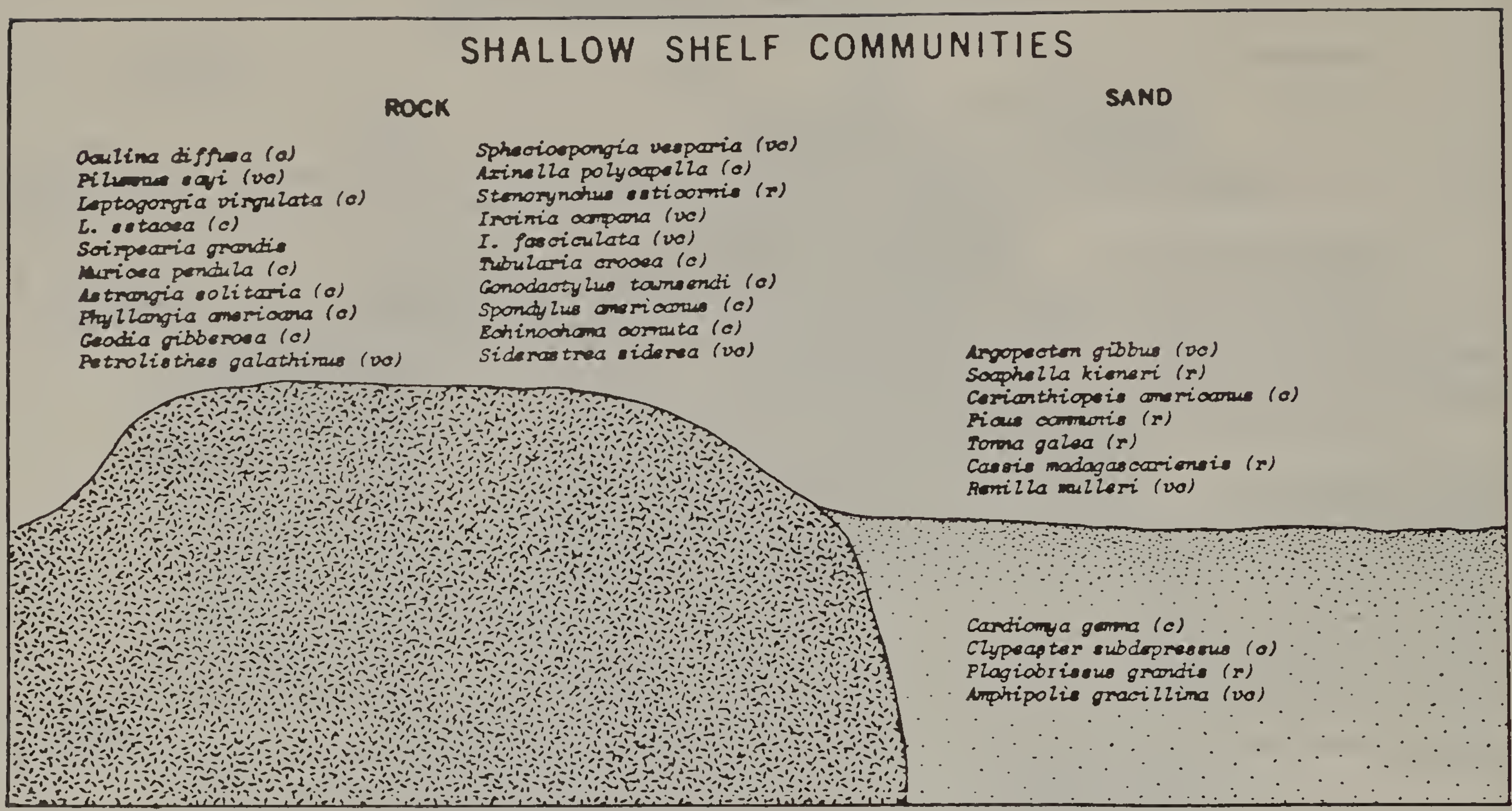


Figure 29i. Shallow shelf communities Carolinian affinities: These communities are continuous with the high energy beach and jetty communities and often contain the same species. (from Collard and D'Asaro, 1973)

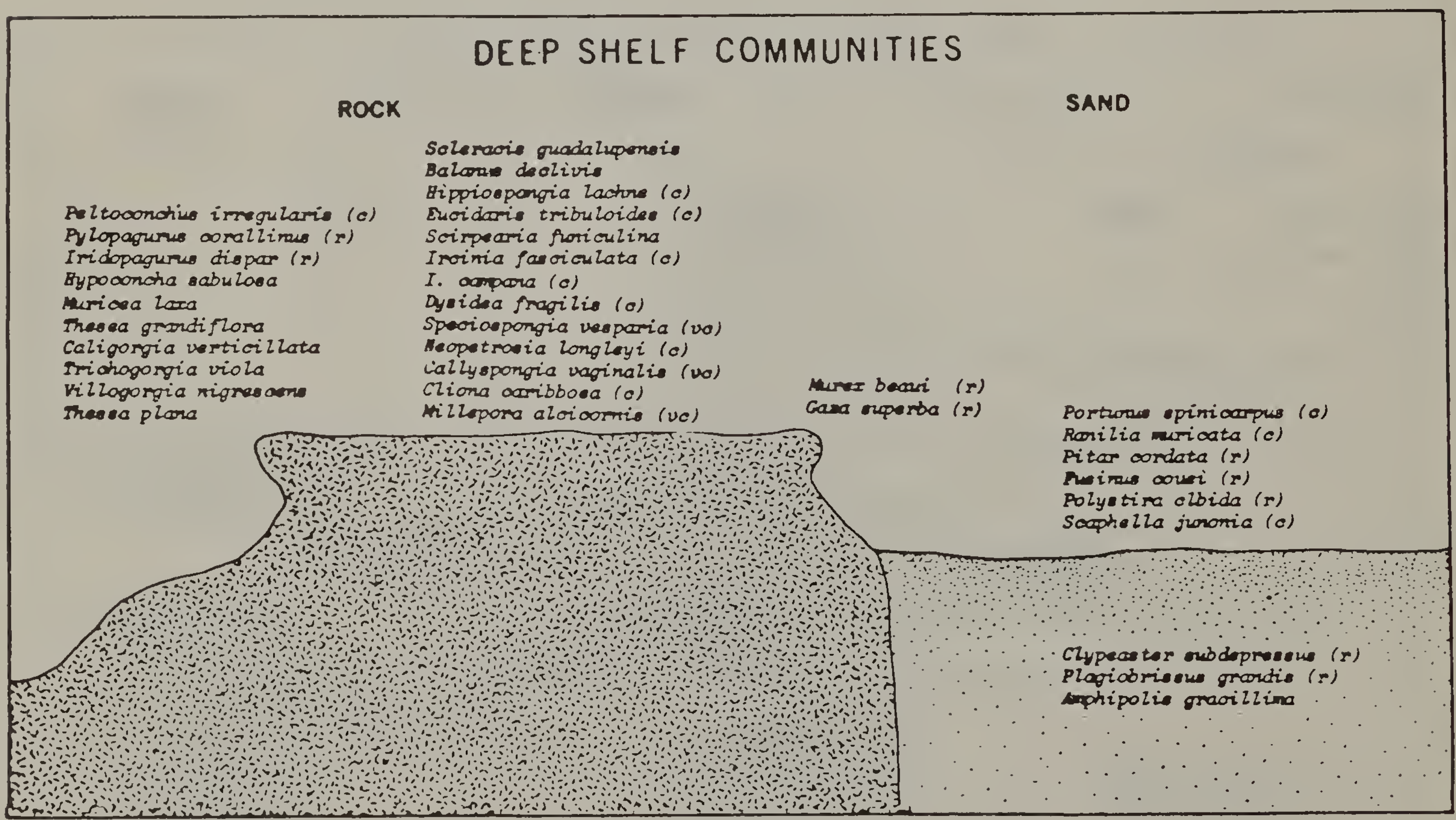


Figure 29j. Deep shelf communities: West Indian affinities. Species occurring on the shelf demonstrate strong West Indian affinities. (from Collard and D'Asaro, 1973)

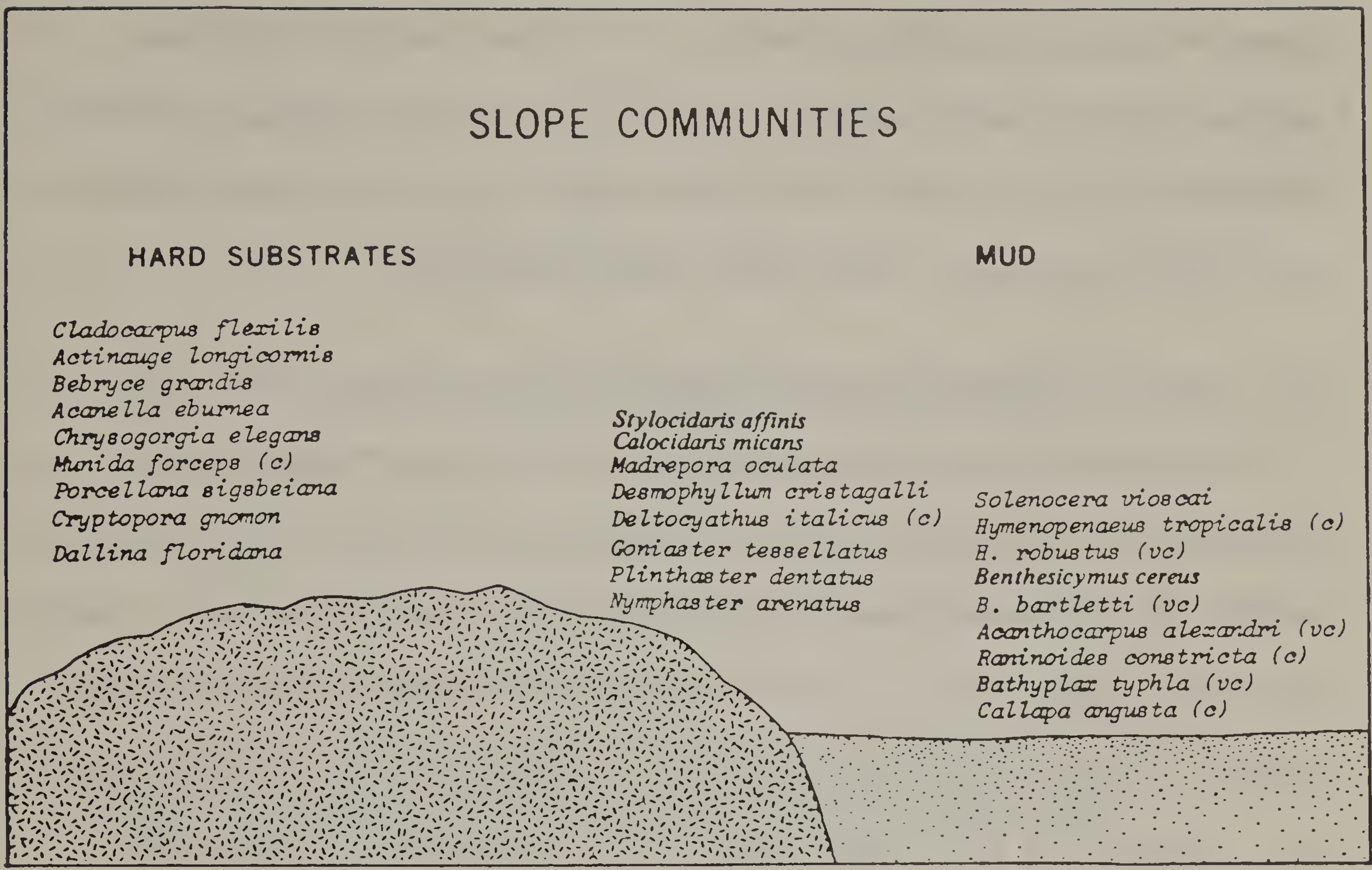


Figure 29k. Slope communities. Many species found here are common throughout the Gulf of Mexico and are found in the Atlantic Ocean and the Caribbean Sea. (from Collard and D'Asaro, 1973)

Oyster shells and spaces between both valves and shells provide a large, varied and protected habitat for other sessile organisms such as slipper shell snails, bryozoans, anemones, and many others. Predators, such as stone crabs, and commensals such as the oyster worm also find oyster reefs to be ideal habitats.

(4) Oyster, Mangrove and Hard Substrate Communities

Inshore on the southwestern coast of Florida, hard substrates are provided by roots, pier pilings, rocky groins, oyster reefs and sea walls. As in oyster communities, these hard surfaces provide firm and stable substrates for the attachment of sessile forms such as oysters, mussels, anemones, barnacles, slipper shells and the like. Pier pilings and other wood substrates also provide boring species such as the shipworm and the piddock a place of shelter. Sessile components of hard substrate communities in turn provide a complex three-dimensional sheltered environment for the more delicate annelid worms, sea slugs, tunicates, hydroids, turbellarian worms, shrimps, nemertean worms and the vulnerable young stages of many species. Finally, the community provides forage for its predatory components such as stone crabs, cones, nereid worms, and carnivorous snails, and its scavengers such as hermit crabs.

Bays, Channels and Sounds

(5) Bays and Sounds: Carolinian (northern) Affinities

Benthic communities of carolinian affinity are found in estuarine waters from Louisiana to roughly Cedar Key. This is a temperate region that is basically transitional in its faunal component and low temperatures during winter limit colonization by West Indian (south Florida, Caribbean) species that are common just offshore. Most species present are wide ranging, occurring in sand and grass.

(6) Bays, Channels and Sounds: West Indian Affinities

These communities gradually appear south of Cedar Keys, become increasingly common south of Tampa Bay and are dominant south of Cape Romano. Tropical species become increasingly common south of Tampa Bay and are dominant south of Cape Romano.

(7) Artificial Substrates: Jetty and Piling Communities - Carolinian Affinities

Community structure is similar here to that found in the oyster, mangrove, and hard substrate communities. The primary difference is that species composition is more representative of northern areas, i.e., the "Carolinian Province".

(8) High Energy Beaches

Much of the northern Gulf coastline is protected from the full force of oceanic waves by barrier islands. The seaward margins of these islands, which are exposed to waves formed at sea, are called high energy beaches. Organisms living in such areas are adapted to survive the scouring force of wave action by burrowing in the sand.

The beach flea, Emerita, and the coquina clam (Donax), are examples of animals that can bury themselves almost instantaneously. This enables them to live directly in the surf zone. Composition of these communities is essentially the same from the Mississippi barrier islands to Cape Sable.

On the other hand, much of the Florida Gulf coastline, especially south of the panhandle, is characterized by low-energy beaches. In some areas, e.g. from Lighthouse Point to Anclote Key, the combination of low wave energy and wave distribution makes the coast here essentiall a "zero energy environment." Rapid burying ability is not as necessary to successful inhabitation of these areas.

Just off surf-swept sandy beaches a trough generally occurs where benthic animals are partially protected from wave action during normal tide and surf conditions. Here are found common whelks, olive shells, sand dollars and certain starfish. At the seaward edge of shallow troughs, sand bars are found. The tops of these sand bars may be very near the sea surface, where conquia clam-isopod (Donax-Emerita) communities are again found. Seaward of the snad bar, as the beach slopes off into deeper water, a third group of animals, including the giant Atlantic cockle, the large sand dollar (Encope), the abundant short-stemmed sea pansy, Renilla, and the common starfish, Luidia, are found.

(9) Shallow Shelf Communities: Carolinian Affinities

The high energy beach intergrades with the shallow shelf community extending from about 10 to 50 meters in depth. Many species found on the sandy beach are also found here. The lower limit of the community extends to the edge of the continental shelf for numerous species. Both rocky and sandy substrate assemblages are characteristic in the Gulf from Louisiana to Cedar Key. Offshore muddy bottoms between the foot of the sandy beach and the 30-50 meter line is a community characterized by white shrimp and associates including sea pansies, onuphid tube worms, several crabs, an anemone, a number of marine snails and a hermit crab. Brown shrimp communities are also found with slight variations in species composition.

(10) Deep Shelf Communities: West Indian Affinities

In depths from about 30 to 200 meters, the benthic invertebrate fauna is generally West Indian in composition. Fish species however, are not generally West Indian in composition. This poorly known area is particularly well characterized by hard bottom sponge communites.

(11) Continental Slope Communities

Benthic communities below 130 meters show a rapid decrease in the number of individuals per species. Many species of the slope communities occur throughout the Gulf of Mexico continental slope as well as that of the Atlantic Ocean and Caribean Sea. The royal red shrimp and deep water crab, *Bathyplax*, are indicators of a slope community.

(12) Unique Environment - The Florida Middle Ground

The Florida Middle Ground is an extensive area located along the outer edge of the West Florida Shelf approximately 93 miles south of the northwest Florida coast and 100 miles northwest of Tampa (Fig. 30). It is an area of steep-profiled escarpments and prominences, an area that is poorly defined in lateral extent by gradation of topographic and biotic features to the surrounding bottom but which is considered to lie between latitudes 28° 11'N and 28° 45'N and longitudes 84° 00'W and 84° 00'W and 84° 25'W. It is a region of limestone outcrops on a drowned karst topography (Austin and Jones, unpublished MS.), the outcrops probably being Pleistocene reefs which flourished during the last interglacial, the Sangamon (Brooks, 1962). Depths throughout the region vary between 84 and 138 feet. Prominences may rise 36 to 48 feet above the surrounding bottom.

Certain physiographic, hydrological, and biological factors have allowed the development of a diverse biota dominated by tropical elements. Reef crests are covered with living invertebrates and benthic algae typical of deep-water West Indian reefs (Austin, 1970). Brooks (1962) noted the presence of living scleractinian corals (both hermatypic and ahermatypic), hydrocorals, alcyonarians (soft corals), and coralline algae. Austin (unpublished MS.) reports the predominant hermatypic corals as Millepora, Porites, and Madracis.

1/ Taken in large part from Harmon W. Shields (Director, State of Florida, Department of Natural Resources) comments and technical background in response to Draft Environmental Statement, OCS Sale #32.

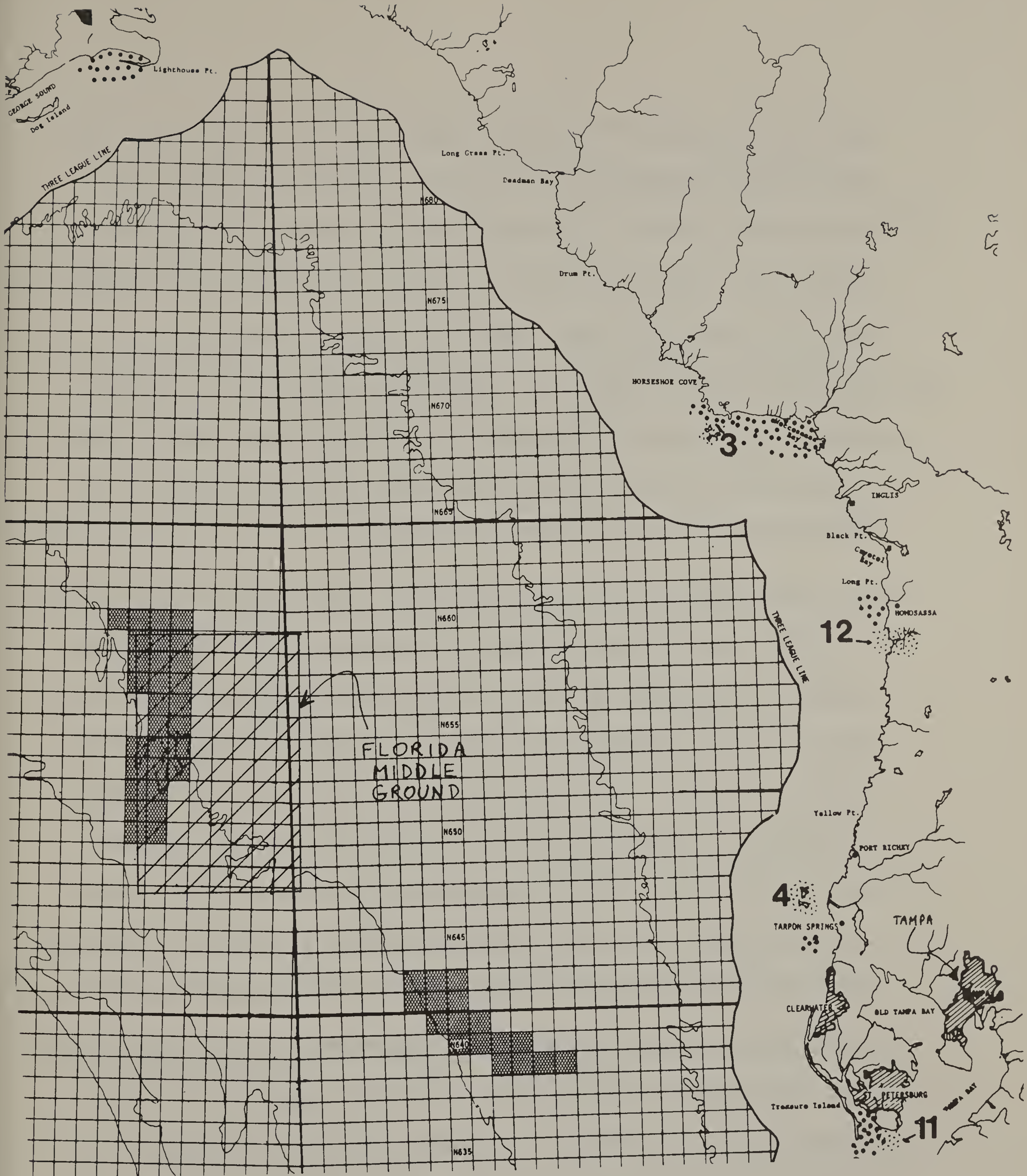


Figure 30. Northeastern Gulf of Mexico, with location of Florida Middle Ground area (diagonal lines).

With the exception of the Campeche Banks in the southern Gulf, the Florida Middle Ground has historically been the most productive and intensively fished reef areas in the entire Gulf. Despite heavy fishing from commercial vessels, high-speed partyboats, and conventional partyboats and sportfishing vessels on extended excursions, the area remains a productive source of commercial and sport fish (Austin, 1970). Presently, probably greater than 50% of the snapper-grouper fishing effort on the West Florida Shelf is centered at either the Middle Ground or at the "Elbow" 20-30 miles south of the Middle Ground.

SCUBA observations in the area indicate a large diversity and abundance of fishes (many of them tropical and subtropical reef fishes) which may not be approached at any other location on the West Florida Shelf. Reports of fish observations and hydrographical conditions have been prepared by Austin, and Austin and Jones (unpublished MSS.). Hydrographically, the region is characterized as a transition zone of three water masses, the Loop Current to the west, the West Florida estuarine waters to the east, and the Florida Bay waters to the south. Dynamic hydrographic conditions favor seasonal upwelling and associated high primary productivity along the seaward edge of the Middle Ground. From June through early September, the water column is stratified; waters above the thermocline presumably orginate from near shore, while waters below the thermocline may be from offshore (Chew, 1955). This framework of hydrographic conditions confers some stability to the region and periodically supplies it with additional nutrients through upwelling.

The physical heterogeneity of the Middle Ground area allows for greater species diversity. The high relief ledges and rocky out-croppings afford shelter for fishes and invertebrates which need or can utilize such shelter.

The reef community is apparently based nutritionally on the benthic brown algae that carpets the bottom during summer months (but disappears in winter). The appearance and disappearance of the algal community is concurrent with the formation and break-up of the thermocline, though not necessarily dependent on it (Austin, unpublished MS #1). The algae support a large population of the herbivorous crab, Mithrax plurocanthus, which is fed on by groupers and porgies. Groupers and snappers also feed on the planktivorous fish Chromis and Apogon (damselfish and cardinalfish), suggesting energy flow through the plankton-planktivorous fish - piscivorous fish food chain. The complexity of the community is also indicated by the fact that several different cleaning symbioses have been established. Cleaning organisms such as juvenile bluehead wrasses, neon gobies, banded coral shrimp and Periclimenes cleaner shrimp are conspicuously abundant.

This unique area, the Florida Middle Ground, with its reef community similar to West Indian reef communities, must be considered in assessing the impacts of various oil and gas drilling and production operations.

4. The Active Swimmers - Nekton

Individuals of this group commonly, but not always, range over broad areas, and in so doing, participate in several biotic communities. Examples are the semi-catadromous fish such as the menhaden which are pelagic plankton larvae, estuarine juveniles, and pelagic adults. Other examples are the sharks which may cruise over broad areas of oceanic, neritic and bay waters searching for prey. Nevertheless, most nekton populations are limited in range by the same environmental conditions of temperature, depth, salinity, available food materials, and type of bottom as are organisms which are less mobile.

The shallow waters of the northern Gulf comprise a large portion of the Carolina Zoogeographic Region and therefore have broadly similar species composition. About 10% of both fish and invertebrates are endemic to the Gulf. Fish species composition of the waters to the east and west of the Mississippi Delta are somewhat dissimilar though, in that the fish fauna of the northeastern Gulf is richer due mainly to the presence of a number of tropical temperature variations (Briggs, 1973).

The presence, in the inshore waters of the northeastern Gulf, of a geographically anomalous pocket of tropical fauna has been found. So far, 15 tropical species have been taken within the 60 mile stretch between Panama City and Destin, Florida.

The most important neritic nekton in the Gulf are the squid and the herring-like fishes such as themenhaden and anchovies; other common fishes are mullet, drums, jacks, mackerel, and bill fishes. These make up the larger part of the secondary consumer link in the neritic food chain and are preyed upon by a great variety and number of other fish.

Common, or abundant fishes groups, by family, are included in the following table (Tab. 27). The sharks, skates, and rays represent another group of fish families of which a few are abundant. Uncommon to rare nekton include porpoises and dolphins, sea turtles, and whales.

Table 27. Common or abundant fishes of the northeastern Gulf of Mexico. Symbols: M = Gulf of Mexico off Mississippi, from Franks, et. al., 1972; A = Alligator Harbor, Florida, from Joseph and Yerger (1956); T = Tampa Bay area, from Springer and Woodburn (1960). 1/

Common Family Name	Scientific Family Name	Location
Ten pounder, Tarpon	Elopidae	A
Herrings, Sardines, Shad	Clupeidae	M,A,T
Anchovies	Engraulidae	M,A,T
Lizard fishes	Synodontidae	M
Sea catfishes	Ariidae	A
Killifish, Chub	Cyprinodontidae	A,T
Needlefishes	Belonidae	A,T
Hake, Cods	Gadidae	M
Lefteye flounders, whiffs	Bothidae	A,M
Pipefishes	Syngnathidae	T
Seabasses, Grouper,	Serranidae	M,T
Snappers	Lutjanidae	M
Jacks, Scad, Pompanos	Carangidae	M,A,T
Mojarras, Sand Perch	Gerridae	T
Grunts, Pigfishes	Pomadasyidae	T
Drums, Butterfish, Spot, Croaker	Sciaenidae	M,A,T
Goatfishes	Mullidae	M
Porgies, Pinfish	Sparidae	M,A,T
Wrasses	Labridae	T
Cutlassfishes	Trichiuridae	M
Mackerels	Scombridae	T
Gobies	Gobiidae	T
Scropionfishes, Rockfishes	Scorpaenidae	M
Sea Robins	Triglidae	M,A
Blennies	Blenniidae	T
Cusk-eels	Ophidiidae	M
Butterfishes	Stromateidae	M
Barracudas	Sphyraenidae	T
Mullets	Mugilidae	A,T
Silversides, Glass minnows	Atherinidae	T
Toadfishes	Batrachoididae	M,A
Batfishes	Ogcocephalidae	M

1/ This table is a subjective interpretation of the original authors' notation of "common" or "abundant". Even though a species is encoded for only one location, it may be present at the others, but in our interpretation, may not be abundant.

F. Resources of the Northeastern Gulf and the Adjacent Coastal Zone

1. Land Use and Ownership in the Coastal Zone

a. Land Use

The coastal zone of the northeastern Gulf features a unique mix of land uses and economic activities. Due to the coastal environment with attractive beaches and rich fishery resources, tourism is a major industry, resulting in resort development along much of the shoreline. Use of the beach shoreline ranges from intensive development in areas such as the Gulfport-Biloxi area, Pensacola and Fort Walton beaches, Panama City beaches, and the Tampa-St. Petersburg area, to low density type development in the form of summer homes. Substantial extents of beach shoreline also remain undeveloped but offer highly attractive recreational opportunities.

The following table (Table 28) based on the U.S. Army Corps of Engineers' National Shoreline Study indicates the land uses of the shoreline in the area of concern (Stursa, 1973).

The stippled area on the following maps (Fig. 31) indicates those areas which are substantially built up, including the major population centers, commercial centers, industrial areas, and resort areas. Due to the scale used it was not possible to portray a further breakdown of land usage.

The maps are intended only to distinguish in a general way between the built up areas and agricultural or undeveloped areas in the coastal zone.

Further information on existing land use patterns and land use policies can be obtained from the various State planning agencies: (1) Florida Coastal Zone Land Use and Ownership, 1970. R.E. Ring-project coordinator. (2) Florida Coastal Zone Management Atlas, Florida Coastal Coordinating Council, 1972. (3) Regional Land Use Plan for Hancock, Harrison, Jackson, and Pearl River Counties, Mississippi. Gulf Regional Planning Commission, 1971. (4) Regional Development Plan-1995. South Alabama Regional Planning Commission, 1971. These publications represent efforts by the States involved at planning for various types of development in their coastal zones.

Table 28. Shoreline Land Use in the Coastal Zone

FLORIDA GULF COAST

Land Use	Miles of Shoreline	Percent of Shoreline
Public Recreation		5
Gulf	101	
Bay/Estuary	66	
Private Recreation		17
Gulf	165	
Bay/Estuary	449	
Non-Recreational Developed		20
Gulf	85	
Bay/Estuary	678	
Undeveloped		58
Gulf	417	
Bay/Estuary	1,706	

ALABAMA GULF COAST

Land Use	Miles of Shoreline	Percent of Shoreline
Public Recreation		9.0
Gulf	4.0	
Bay/Estuary	27.6	
Private Recreation		65.0
Gulf	30.3	
Bay/Estuary	179.6	
Non-Recreational Developed		1.5
Gulf	2.0	
Bay/Estuary	3.0	
Undeveloped		24.5
Gulf	10.1	
Bay/Estuary	95.1	

Table 28. (cont')

MISSISSIPPI GULF COAST

Land Use	Miles of Shoreline	Percent of Shoreline
Public Recreation		12.5
Gulf	0	
Bay/Estuary	31.0	
Private Recreation		43.0
Gulf	6.9	
Bay/Estuary	99.0	
Non-Recreational Developed		4.5
Gulf	0	
Bay/Estuary	9.5	
Undeveloped		40.0
Gulf	26.3	
Bay/Estuary	74.3	

LAND USE and POPULATION

Generalized areas of residential and commercial development in the coastal region

Areas of industrial development

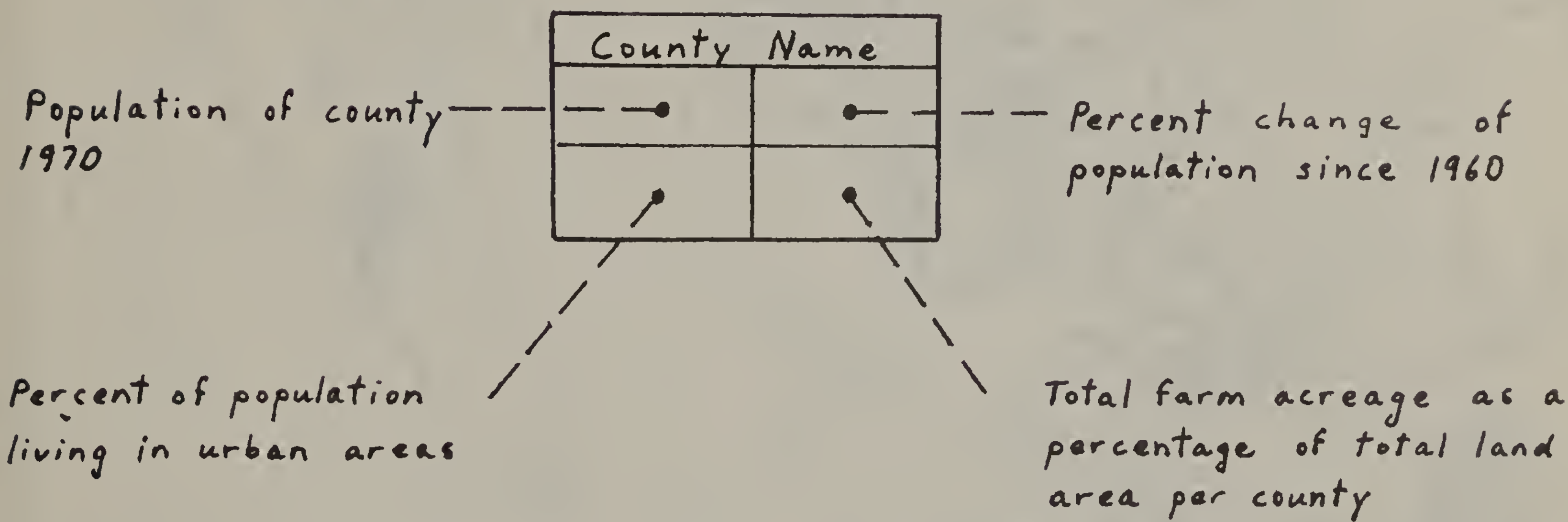
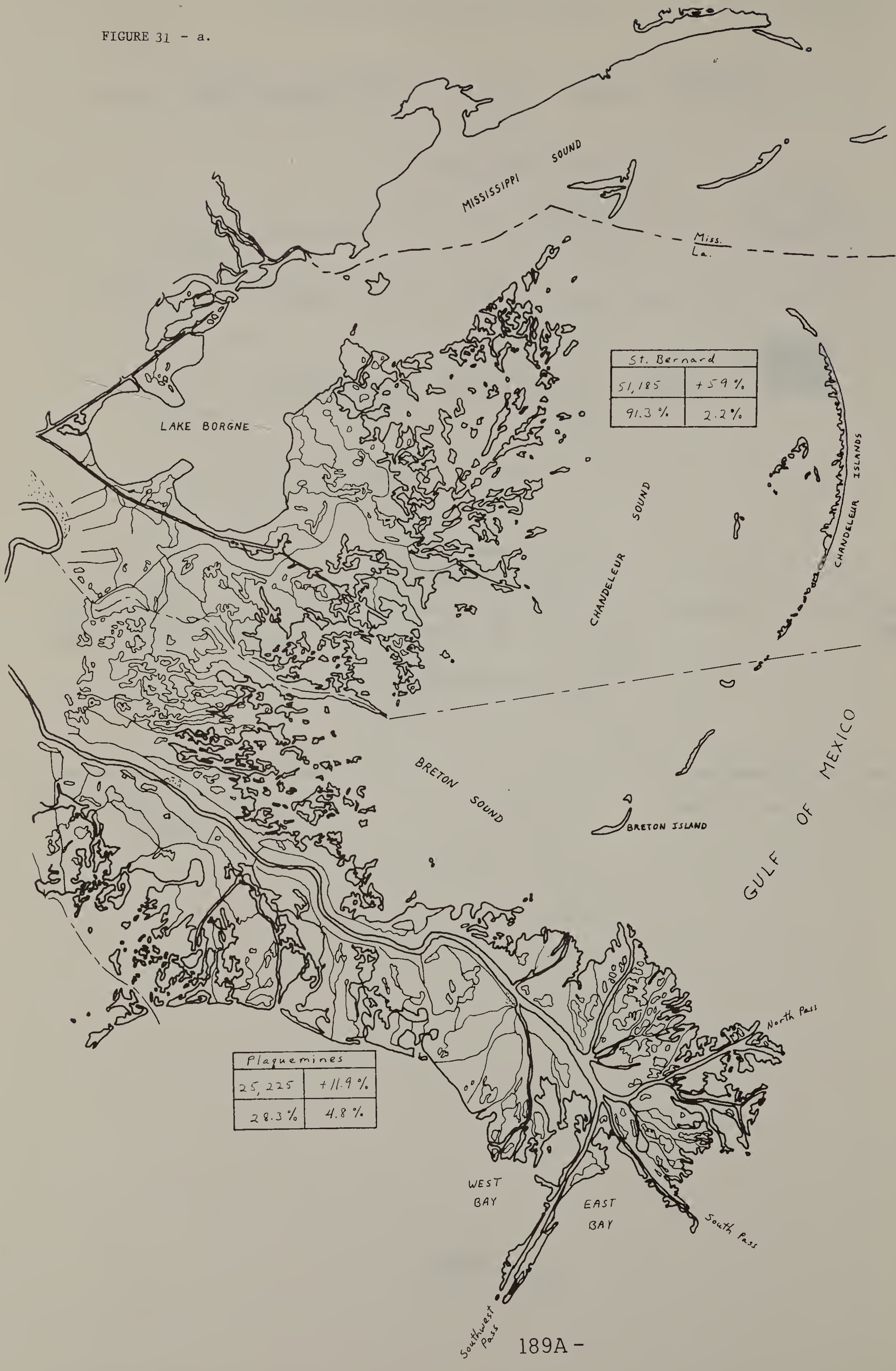
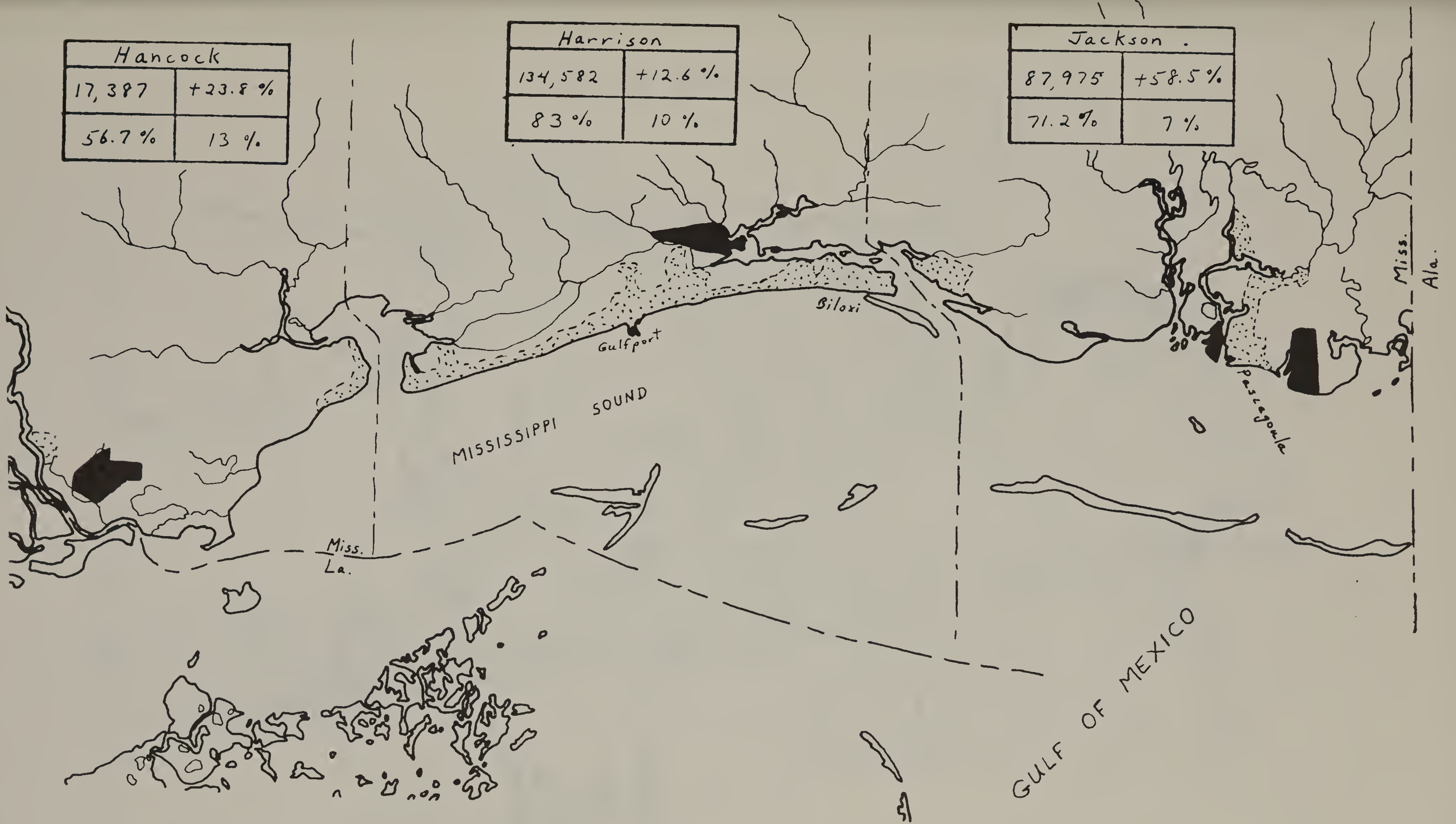


FIGURE 31 - a.

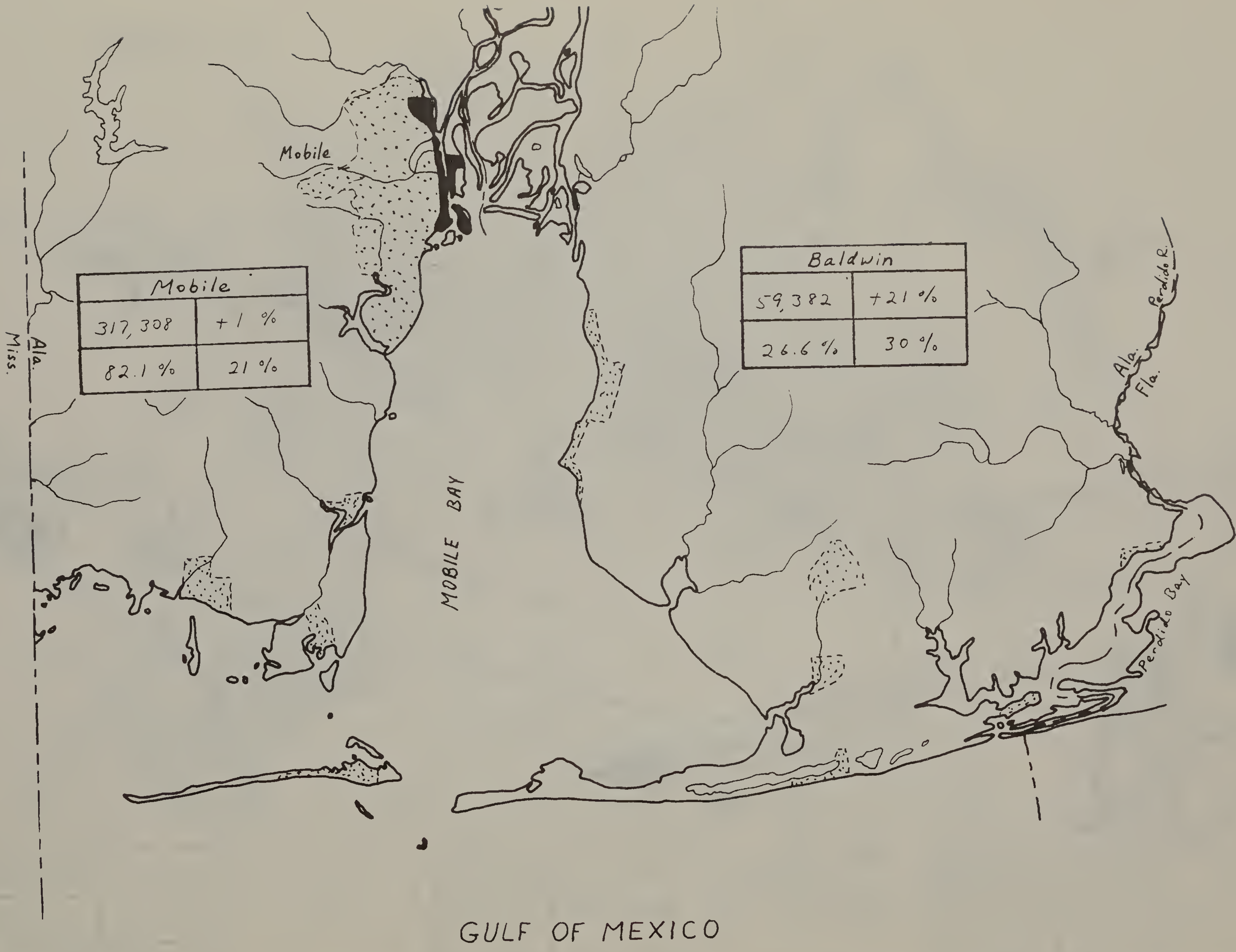


MISSISSIPPI SOUND
Miss.
La.
LAKE BORGNE
St. Bernard
51,185
+59 %
91.3 %
2.2 %
CHANDELEUR SOUND
CHANDELEUR ISLANDS
BRETON SOUND
BRETON ISLAND
GULF OF MEXICO
North Pass
Plaquemines
25,225
+11.9 %
28.3 %
4.8 %
WEST BAY
EAST BAY
South Pass
Southwest Pass



Hancock
17,387
+23.8 %
56.7 %
13 %
Harrison
134,582
+12.6 %
83 %
10 %
Jackson
87,975
+58.5 %
71.2 %
7 %
Gulfport
Biloxi
Pascagoula
MISSISSIPPI SOUND
Miss.
La.
Miss.
Ala.
GULF OF MEXICO

FIGURE 31 - b.


Mobile
Mobile
317,308
+1 %
82.1 %
21 %
Baldwin
59,382
+21 %
26.6 %
30 %
Ala.
Miss.
MOBILE BAY
Perdido R.
Ala.
Fla.
Perdido Bay
Perdido Bay
GULF OF MEXICO

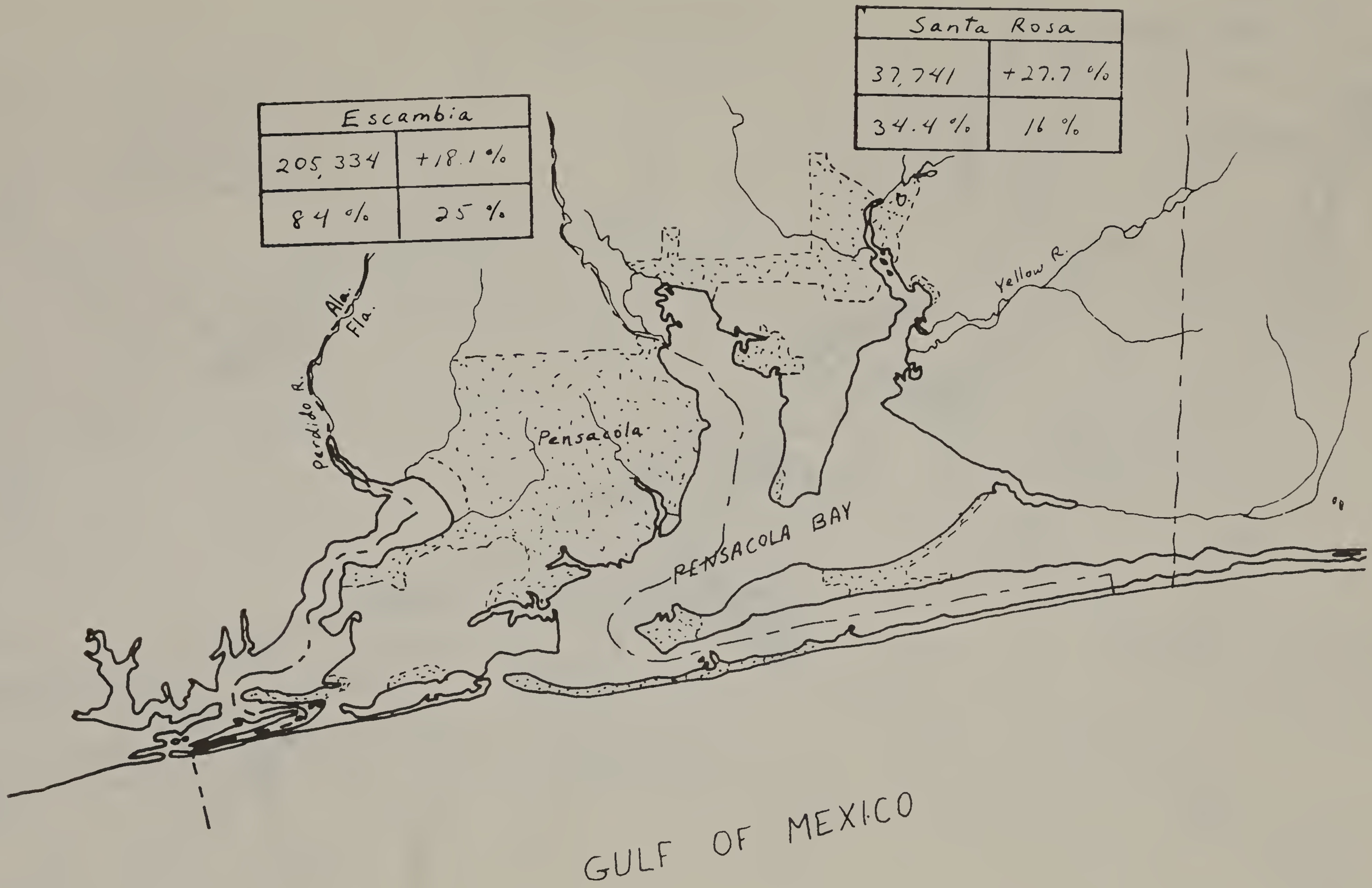

Escambia
205,334
+18.1 %
84 %
25 %
Santa Rosa
37,741
+27.7 %
34.4 %
16 %
Ala.
Fla.
Perdido R.
Pensacola
Yellow R.
PENSACOLA BAY
GULF OF MEXICO

FIGURE 31 - d.

Okaloosa
88,187
+44 2 %
52 %
13 %
Walton
16,087
+3 %
30.9 %
22 %
Bay
75,283
+121 %
76 4 %
5 %
Gulf
10,096
+16 %
43.6 %
4 %
CHOCTAWHATCHEE BAY
Fort Walton Beach
Intracoastal Waterway
Panama City
GULF OF MEXICO
ST. JOSEPH BAY
Intracoastal Waterway
Lake Wimico
Apalachicola R.
APALACHICOLA BAY

FIGURE 31 - e.

Jefferson
-8 %
0 %
42 %
Wakulla
6,308
+20 %
0 %
25 %
Wakulla R.
Saint Marks R.
Taylor
13,641
16 %
Franklin
7,065
+7.4 %
43.9 %
Not Available
APALACHEE BAY
ST GEORGE SOUND
Dog I.
St. George I
GULF OF MEXICO
Dixie
5,480
+22.3%
0 %
37 %

FIGURE 31 - f.

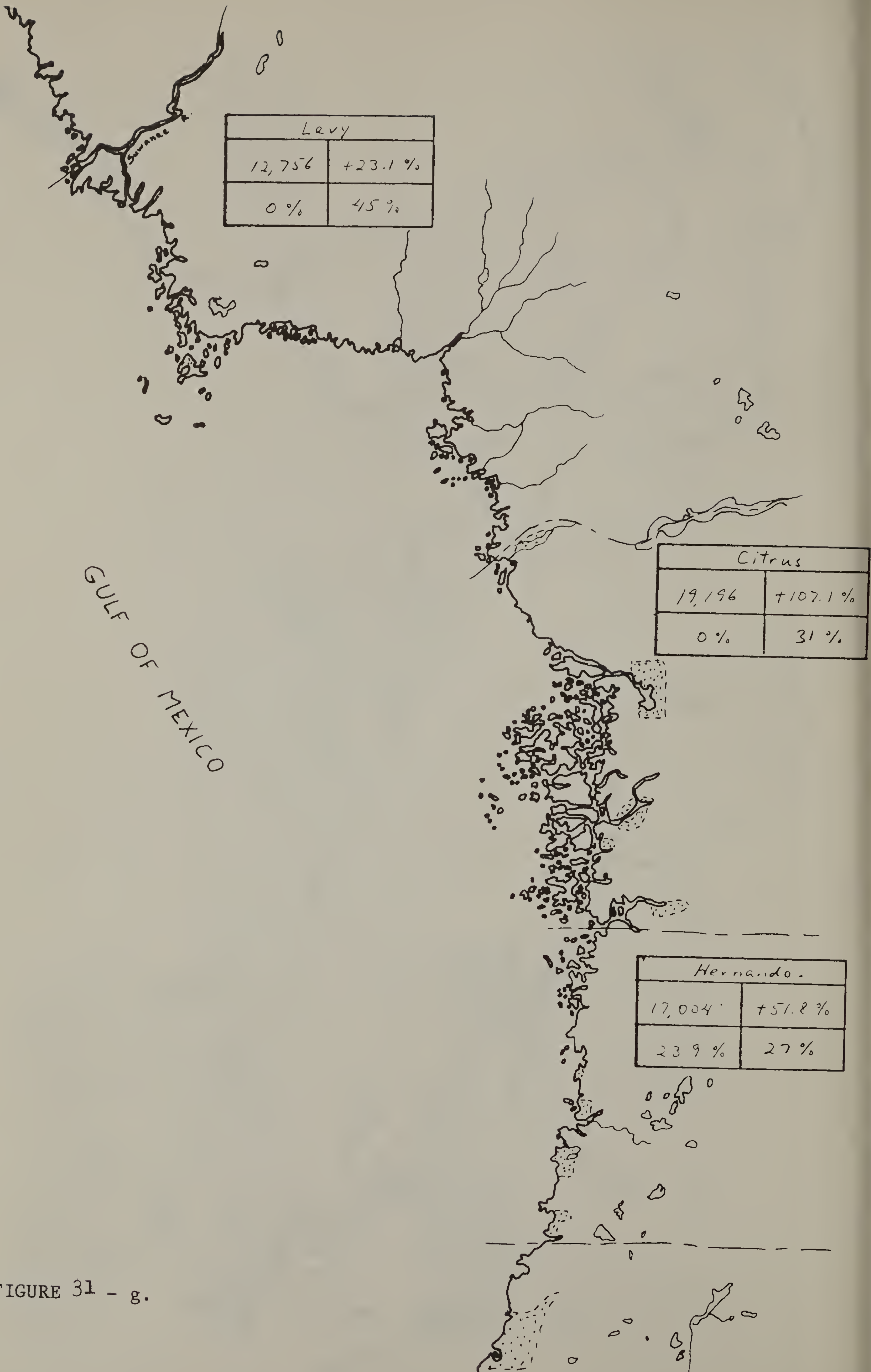

Suwanee R.
Levy
12,756
+23.1 %
0 %
45 %
Citrus
19,196
+107.1 %
0 %
31 %
GULF OF MEXICO
Hernando.
17,004
+51.8 %
23.9 %
27 %

FIGURE 31 - g.

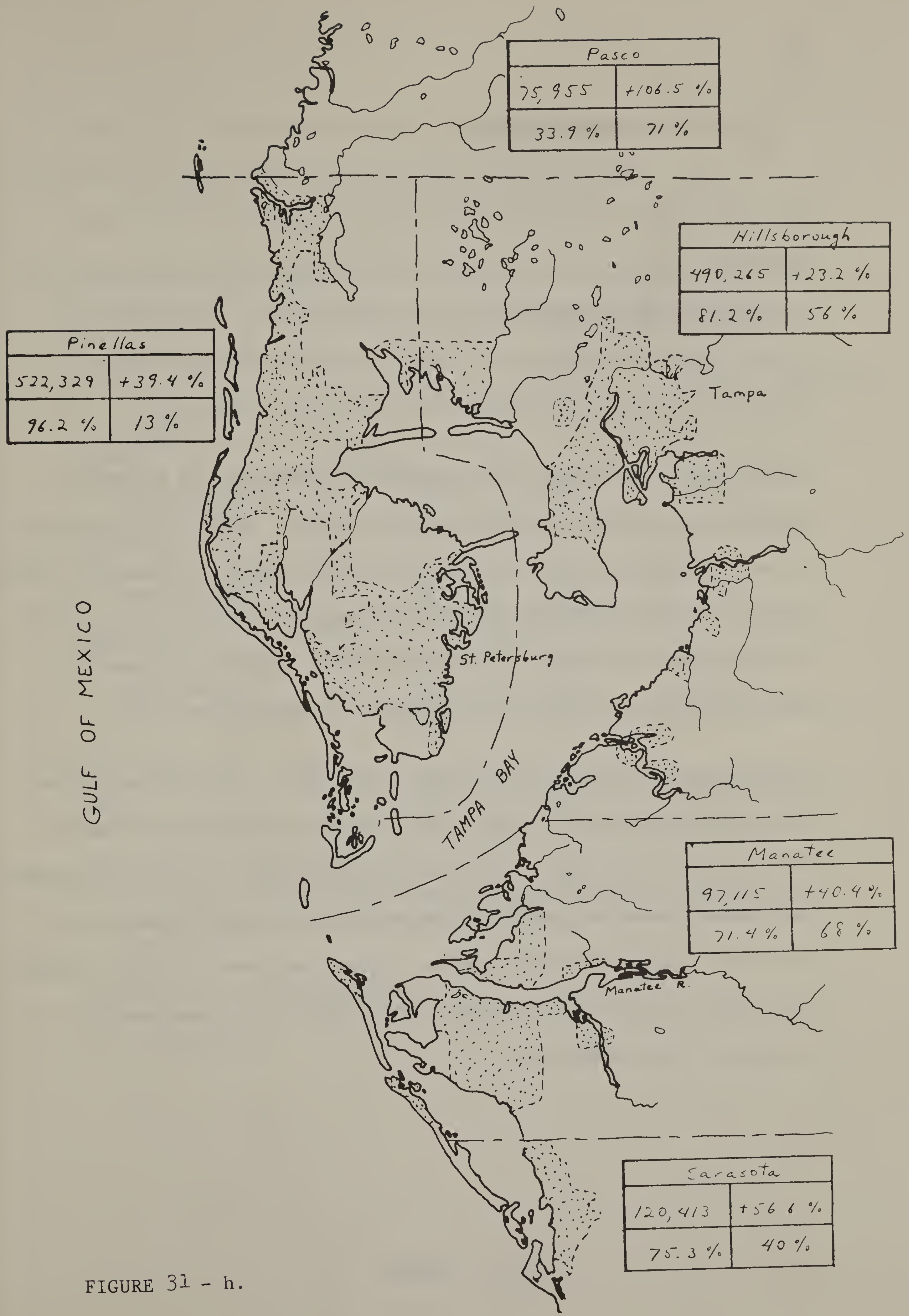

Pasco
75,955
+106.5 %
33.9 %
71 %
Hillsborough
490,265
+23.2 %
81.2 %
56 %
Pinellas
522,329
+39.4 %
96.2 %
13 %
Tampa
St. Petersburg
TAMPA BAY
GULF OF MEXICO
Manatee
97,115
+40.4 %
71.4 %
68 %
Manatee R.
Sarasota
120,413
+56.6 %
75.3 %
40 %

FIGURE 31 - h.

b. Land Ownership

The following series of maps (Fig. 32 a-h) and table (Tab. 29) indicate in generalized form, the pattern of shoreline ownership, both on the Gulf and in the bays and estuaries, along the northeastern Gulf Coast. It can be noted from the tables that the largest extent of shoreline is privately owned although there are significant amounts of federally and state owned shoreline.

Federal shoreline in this area generally represents the shoreward boundaries of national parks, wildlife refuges, and military installations. Shorelines classified as non-federal public are generally state parks, wildlife management or refuge areas, or county and city parks. Privately owned shoreline may be residential (either permanent or summer home type), tourist developments, or undeveloped land.

The State-owned waters of Louisiana, Mississippi, and Alabama extend three miles offshore. Florida's state waters extend three leagues (10.36 miles) from shore. The mean high water mark is the line between state-owned submerged lands and uplands in all four of these states. The use of state and federal parks, recreation areas, wildlife refuges, and private holdings are discussed more fully in the appropriate sections of this statement.

Table 29. Shoreline Ownership (U.S. Army, 1971a and 1971b.)

(Shore lengths in miles)

Location	Shoreline Ownership			
State & Zone 1/	Federal	Non-Federal Public	Private	Uncertain
Louisiana				
Zone V				
Gulf	101.6	59.8	53.6	
Bay/Estuary 2/	55.7	5.1	45.2	
Zone VI				
Gulf	58.5	10.0	245.5	
Bay/Estuary	0.0	0.0	0.0	
Zone VII				
Gulf	0.0	0.0	25.0	
Bay/Estuary 3/	0.0	0.0	88.0	
Louisiana Total				
Gulf	160.1	69.8	324.1	
Bay/Estuary	55.7	5.1	133.2	

1/ The National Shoreline Study for Louisiana (U.S. Army, 1971a) presented data by zones which did not correspond to parish boundaries.

2/ Mississippi River passes

3/ Lake Borgne

Table 29 (cont')

Location	Shoreline Ownership			
State & County	Federal	Non-Federal Public	Private	Uncertain
MISSISSIPPI				
Jackson				
Ocean/Gulf	14.7		6.9	
Bay/Estuary	14.0	8.1	63.7	
Harrison				
Ocean/Gulf	0.6	0.6	10.4	
Bay/Estuary	3.9	32.8	59.1	
Hancock				
Ocean/Gulf				
Bay/Estuary		1.0	31.2	
MISSISSIPPI TOTALS				
Ocean/Gulf	15.3	0.6	17.3	
Bay/Estuary	17.9	41.9	154.0	
TOTAL	33.2	42.5	171.3	
ALABAMA				
Baldwin				
Ocean/Gulf		3.3	27.9	
Bay/Estuary		2.9	183.6	
Mobile				
Ocean/Gulf	0.4	1.5	13.3	
Bay/Estuary	1.9	5.0	111.9	
ALABAMA TOTALS				
Ocean/Gulf	0.4	4.8	41.2	
Bay/Estuary	1.9	7.9	295.5	
TOTAL	2.3	12.7	336.7	

Table 29 (cont')

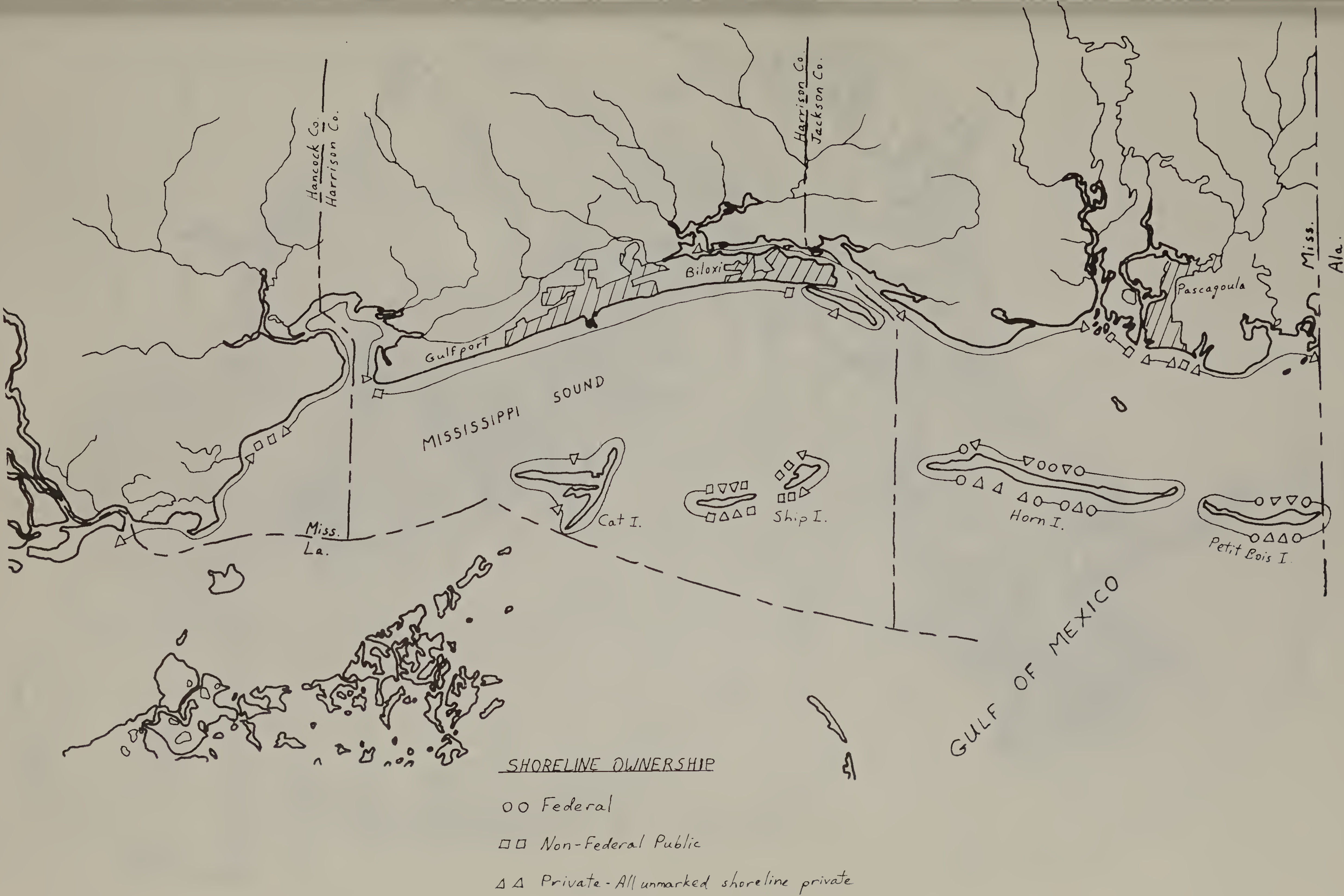
Location State & County	Shoreline Ownership Federal	Non-Federal Public	Private	Uncertain
FLORIDA				
Escambia				
Gulf	0.8	27.6	12.4	
Bay/Estuary	15.0	31.4	79.9	0.5
Santa Rosa				
Gulf	3.1			
Bay/Estuary	5.8	3.6	111.2	
Okaloosa				
Gulf	14.3	2.8	7.4	
Bay/Estuary	28.0	3.8	57.0	
Walton				
Gulf	0.5	2.1	22.6	
Bay/Estuary	8.0	1.4	56.6	
Bay				
Gulf	14.0	2.7	27.9	
Bay/Estuary	95.5	4.8	126.1	
Gulf				
Gulf	2.8	10.8	12.9	
Bay/Estuary		12.2	31.4	
Franklin				
Gulf	8.5	1.6	44.5	
Bay/Estuary	24.5	2.0	145.3	
Wakulla				
Gulf				
Bay/Estuary	35.2		40.0	
Jefferson				
Gulf	6.4			
Bay/Estuary				
Taylor				
Gulf			40.0	
Bay/Estuary				
Dixie				
Gulf		0.1	33.9	
Bay/Estuary				
Levy				
Gulf	2.0	8.0	38.0	
Bay/Estuary				
Citrus				
Gulf		17.5	12.5	
Bay/Estuary				

Table 29 (cont')

Location	Shoreline Ownership			
State & County	Federal	Non Federal Public	Public	Uncertain
FLORIDA (cont')				
Hernando				
Gulf		0.1	19.9	
Bay/Estuary				
Pasco				
Gulf			22.0	
Bay/Estuary				
Pinellas				
Gulf	0.2	17.7	17.5	
Bay/Estuary			228.0	
Hillsborough				
Gulf				
Bay/Estuary	26.0		161.0	
Manatee				
Gulf		3.0	11.0	
Bay/Estuary			176.0	
Sarasota				
Gulf	0.2	4.1	30.7	
Bay/Estuary		7.0	114.0	
FLORIDA TOTALS				
Gulf	78.8	100.1	353.2	
Bay/Estuary	238.0	66.2	1326.5	0.5

FIGURE 32 - a.

MISSISSIPPI SOUND
Cat I.
ZONE VII
Miss
La.
LAKE BORGNE
CHANDELEUR SOUND
CHANDELEUR ISLANDS
ZONE VI
St Bernard Parish
Plaquemines Parish
BRETON SOUND
BRETON ISLAND
GULF OF MEXICO
Plaquemines Parish
Jefferson Parish
Main Pass
MISSISSIPPI RIVER
North Pass
Northeast Pass
Southeast Pass
GARDEN ISLAND BAY
WEST BAY
EAST BAY
South Pass
Southwest Pass
ZONE V
SHORELINE OWNERSHIP
○ ○ Federal
□ □ Non-Federal Public
△ △ Private-All unmarked shoreline private



Hancock Co.
Harrison Co.
Harrison Co.
Jackson Co.
Biloxi
Pascagoula
Miss.
Ala.
Gulfport
MISSISSIPPI SOUND
Miss.
La.
Cat I.
Ship I.
Horn I.
Petit Bois I.
GULF OF MEXICO
SHORELINE OWNERSHIP
○○ Federal
□□ Non-Federal Public
△△ Private - All unmarked shoreline private

FIGURE 32 - b.


Mobile
Mobile Co.
Baldwin Co.
Perdido R.
Ala.
Fla.
Ala.
Miss.
MOBILE BAY
WEEKS BAY
Perdido Bay
Perdido
BON SECOUR BAY
Dauphin I.
GULF OF MEXICO
SHORELINE OWNERSHIP
○○ Federal
□□ Non-Federal Public
ΔΔ Private - All unmarked shoreline private

FIGURE 32 - c.

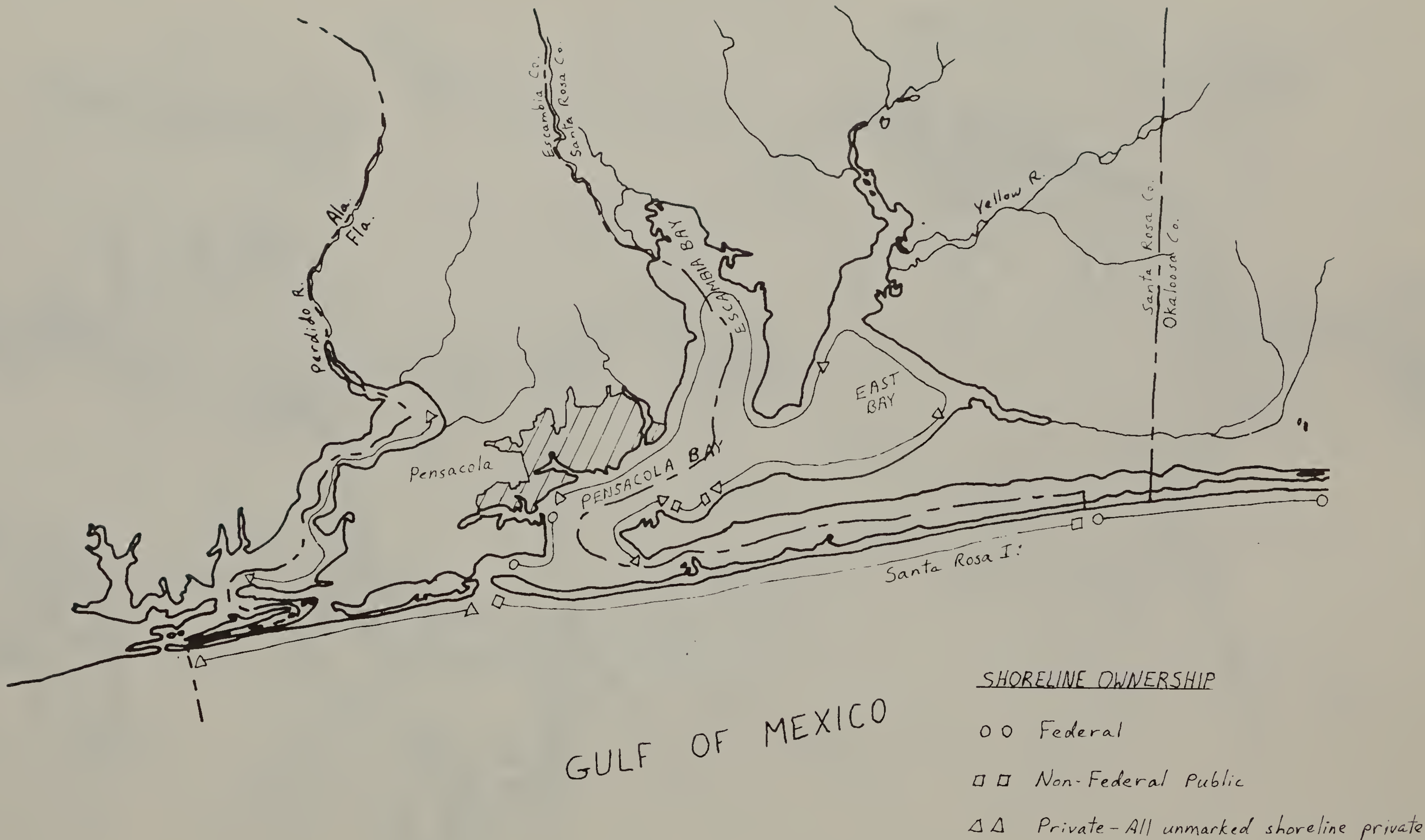

Perdido R.
Ala.
Fla.
Escambia Co.
Santa Rosa Co.
ESCAMBIA BAY
Yellow R.
Santa Rosa Co.
Okaloosa Co.
EAST BAY
Pensacola
PENSACOLA BAY
Santa Rosa I.
GULF OF MEXICO
SHORELINE OWNERSHIP
○ ○ Federal
□ □ Non-Federal Public
△ △ Private - All unmarked shoreline private

FIGURE 32 - d.

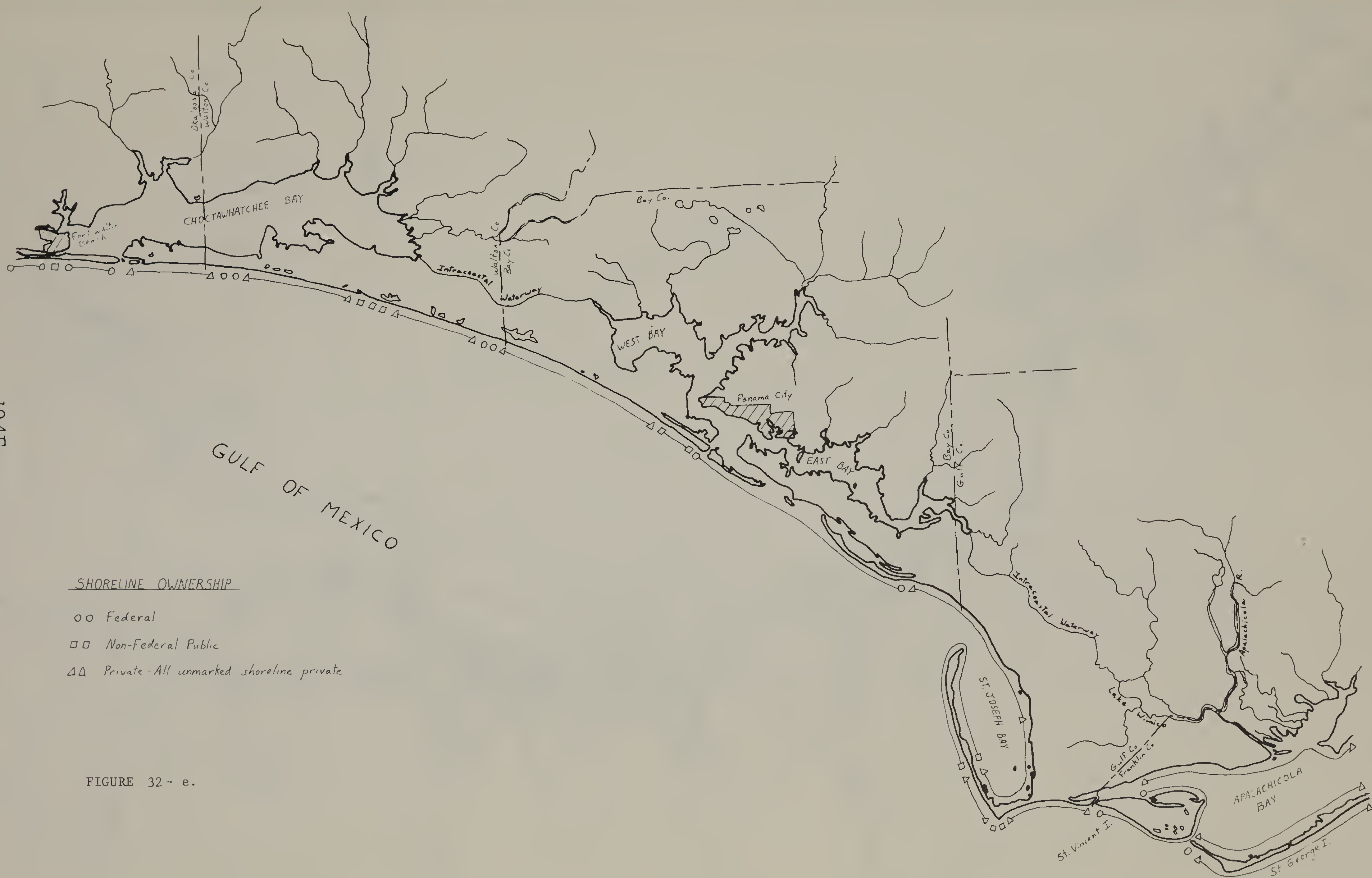

Okaloosa Co
Walton Co
Fort Walton Beach
CHOCTAWHATCHEE BAY
Intracoastal Waterway
Walton Co
Bay Co
Bay Co.
WEST BAY
Panama City
EAST BAY
Bay Co
Gulf Co
GULF OF MEXICO
ST. JOSEPH BAY
Intracoastal Waterway
Apalachicola R.
Lake Wimico
Gulf Co
Franklin Co
APALACHICOLA BAY
St. Vincent I.
St George I.
SHORELINE OWNERSHIP
○○ Federal
□□ Non-Federal Public
△△ Private - All unmarked shoreline private

FIGURE 32- e.

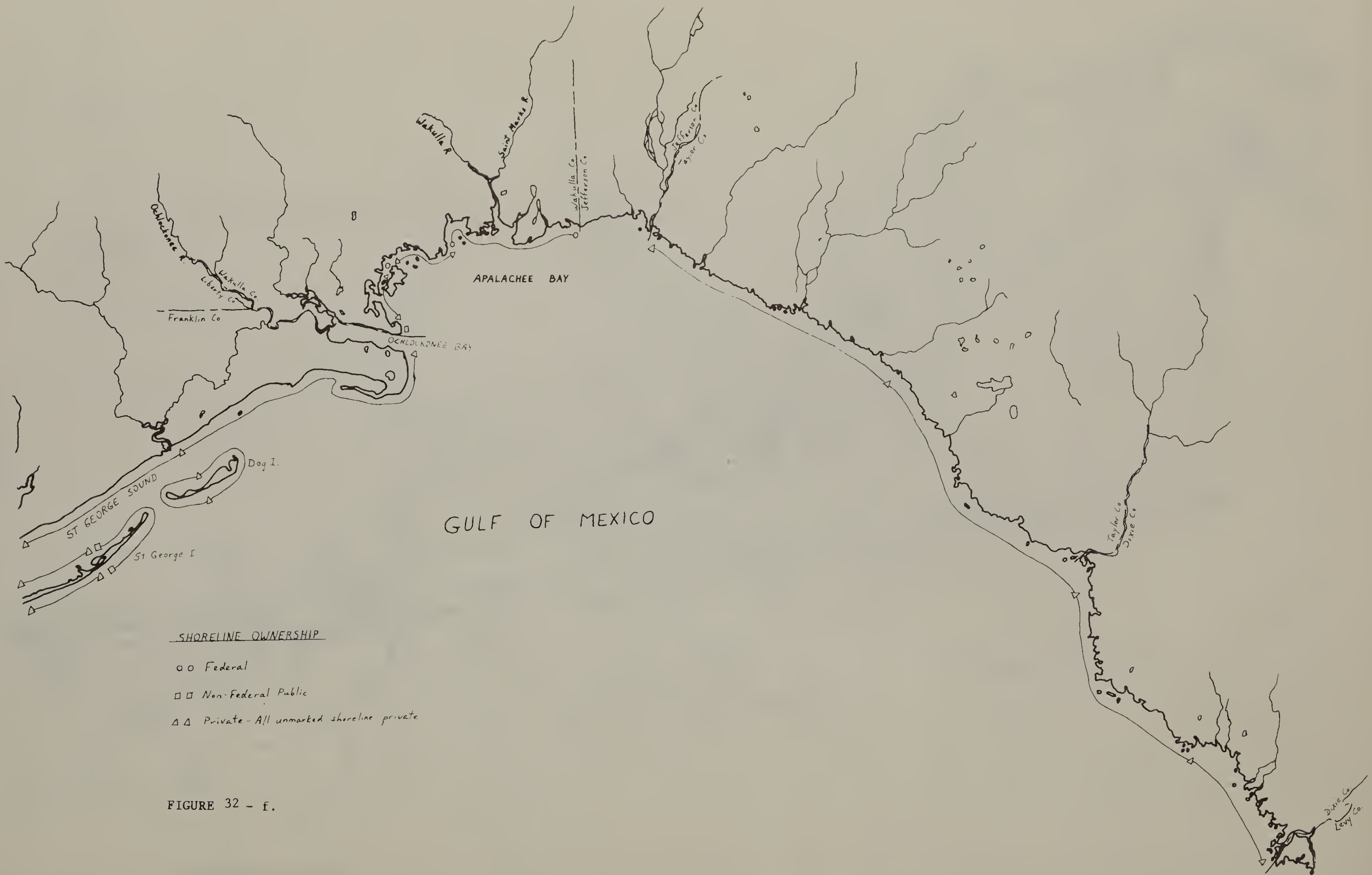
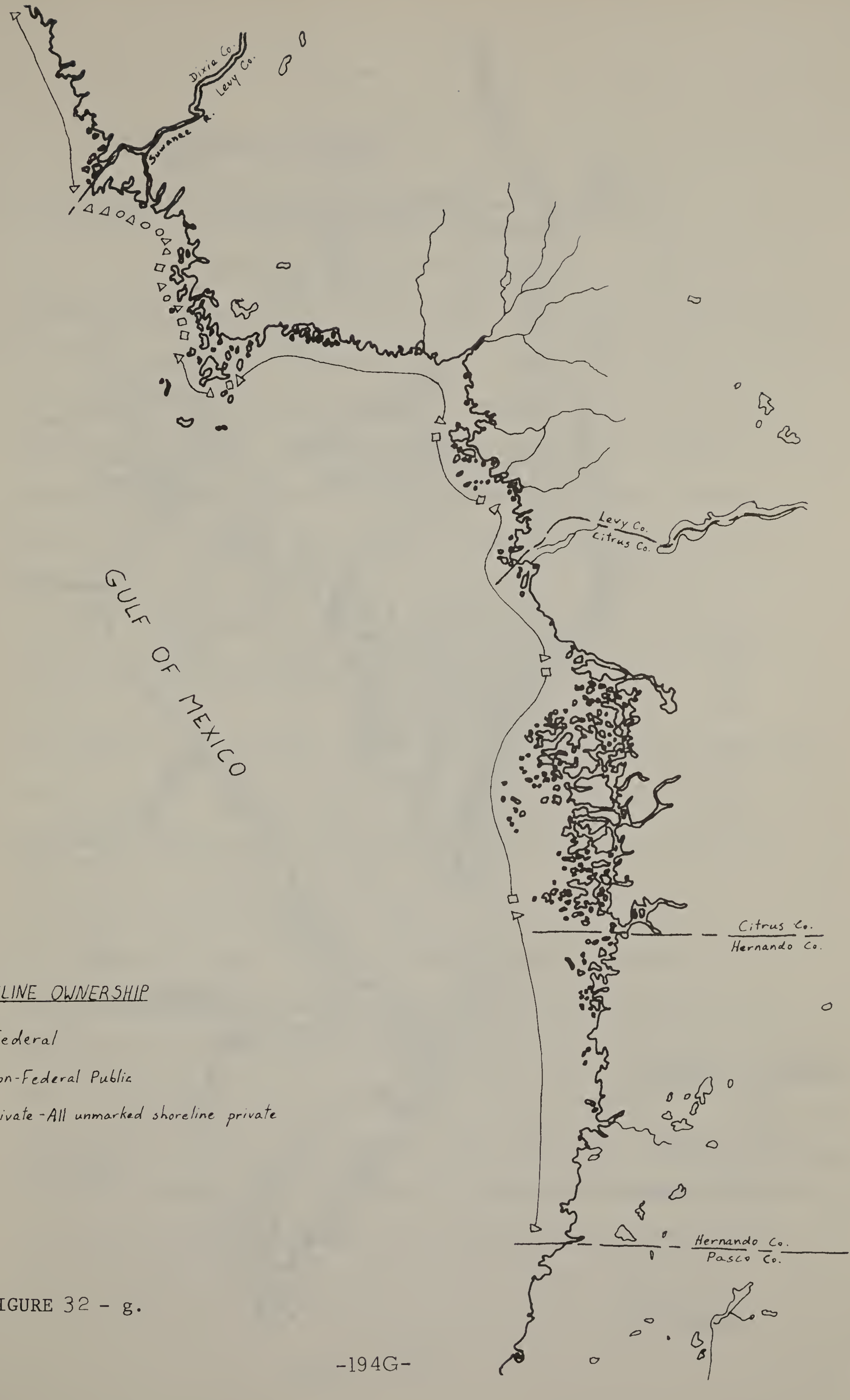

Wakulla R
Saint Marks R
Ochlockonee R
Wakulla Co
Liberty Co
Franklin Co
Wakulla Co
Jefferson Co
Jefferson Co
Taylor Co
APALACHEE BAY
OCHLOCKONEE BAY
Dog I.
ST GEORGE SOUND
St George I
GULF OF MEXICO
Taylor Co
Dixie Co
Dixie Co
Levy Co
SHORELINE OWNERSHIP
Federal
Non-Federal Public
Private - All unmarked shoreline private

FIGURE 32 – f.



SHORELINE OWNERSHIP

○○ Federal

□□ Non-Federal Public

△△ Private - All unmarked shoreline private

FIGURE 32 - g.

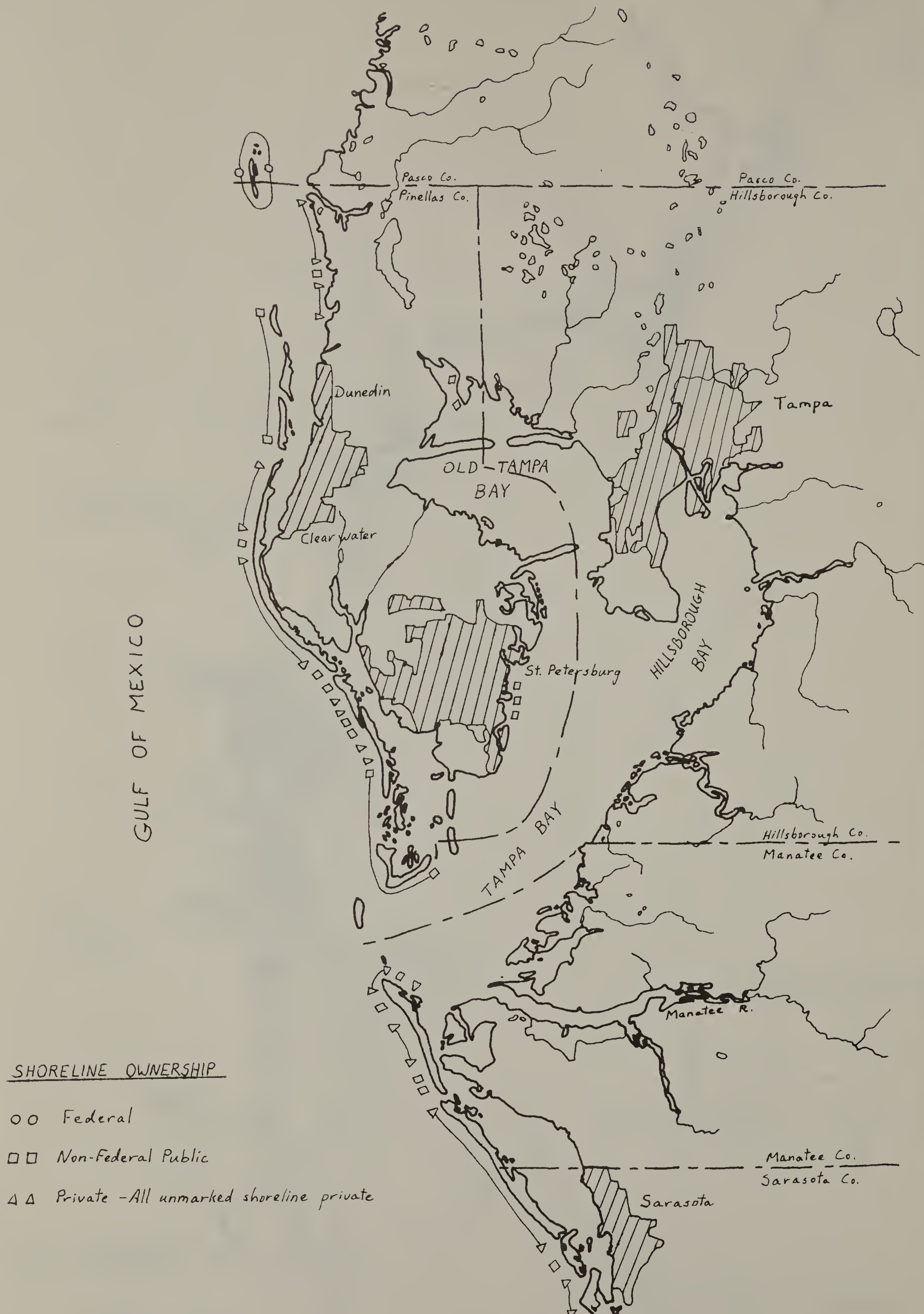

Pasco Co.
Pinellas Co.
Pasco Co.
Hillsborough Co.
Dunedin
Tampa
OLD TAMPA
BAY
Clearwater
GULF OF MEXICO
St. Petersburg
HILLSBOROUGH
BAY
TAMPA BAY
Hillsborough Co.
Manatee Co.
Manatee R.
Manatee Co.
Sarasota Co.
Sarasota
SHORELINE OWNERSHIP
○○ Federal
□□ Non-Federal Public
△△ Private -All unmarked shoreline private

FIGURE 32 - h.

2. Recreation Resources

a. Outdoor Recreation Areas, Historical and Archeological Sites

The northeastern Gulf coast offers a wide variety of recreational opportunities. The natural setting provides habitat for numerous species of fish sought by sport fishermen; attractive beaches for swimming, sunbathing, etc.; and a variety of landscapes (dunes, marshes, forests) for the observation of wildlife and scenery. The recreational opportunities of the northeastern Gulf are available not only to residents of the area but support a substantial tourist industry as well. In addition to the natural setting the coastal zone has numerous historical and archeological sites of scientific and educational value.

Following are descriptions of the various kinds of outdoor recreation areas, wildlife refuges and management areas, and historical and archeological sites, an inventory of these sites, and a series of maps showing their locations (Fig.33 a-h).

In addition to those sites inventoried here and identified on the map there are numerous other recreation facilities along the northeastern Gulf coast under county, municipal, and private administration. Due to the scale of the map being used it is impossible to map all these sites. This is not to demean their importance, however. The economics of many communities along the Gulf coast depend heavily on outdoor recreation. Therefore, there are numerous public and private facilities such as fishing piers, marinas, parks, etc.

which serve those wishing to enjoy the unique recreation activities offered by the area. Also, the expanding populations in some of the urban centers has necessitated the acquisition of more lands for recreational purposes. This activity is an on-going process and important to maintaining and improving the quality of life of the residents of the area.

The basic data sources for the maps were the State Comprehensive Outdoor Recreation Plans for the three states, (Dept. of Agri., Econ., and Rural Soc., 1972, Miss. R & D. Center, 1969, and Dept. of Natural Resources, 1971). In addition, plans published by the regional planning agencies in the coastal zones of Alabama and Mississippi were utilized (South Ala. Regional Planning Comm., 1969, and King, J. M., et. al., 1971). Unpublished materials obtained from the States of Mississippi and Florida were used to update the information contained in the comprehensive plans. 1/

1/ 1. Computer Printout of Outdoor Recreation Inventory for the Gulf Coast Recreation Inventory for the Gulf Coast Counties of Mississippi. (To be included in Mississippi State Comprehensive Outdoor Recreation Plan Scheduled for Publication in Early Fall.) Obtained from Mississippi Research and Development Center, Jackson, Mississippi.

2. Inventory of Archeological Sites in Mississippi Coastal Counties obtained from Division of History and Archives, Jackson, Mississippi.

An attempt was made to classify the data uniformly for the three states. With some revision, the classification system used by the State of Florida was easily adapted to the other two states, although some of the categories, e.g., aquatic preserves, state ornamental gardens, are found only in Florida. The 1971 Florida Comprehensive Outdoor Recreation Plan listed "State Parks" and "State Recreation Areas" in separate categories; however, the description and management objectives for these were identical. In a more recent inventory obtained from the Division of Recreation and Parks in Tallahassee, all of the areas formerly designated as "State Recreation Areas" in the coastal zone have been reclassified as "State Parks." The map reflects this change. However, the category, although no longer applicable to the Florida portion of the map, was found to be applicable to miscellaneous recreation areas in Alabama and Mississippi which were state-owned but did not fit any of the other categories and were essentially unclassified.

National Parks: The National Park Service of the U.S. Department of the Interior administers one national park within the study area, (Gulf Islands National Seashore). This area has been set aside as a unit of the National Park System because of the national interest in its natural, historical and recreational resources. A wide range of public outdoor recreational opportunities such as camping, swimming, boating, fishing, nature study, picnicking and sightseeing is available at the park.

Federal Wildlife Refuges: The Bureau of Sport Fisheries and Wildlife of the U.S. Department of the Interior has the responsibility for insuring the conservation of the country's wild birds, mammals and sport fish. The primary purposes of wildlife refuges are to provide sanctuaries for wildlife and fish by preserving breeding grounds and habitat which may be becoming scarce in other areas due to encroachment on natural habitats by agricultural, industrial, and urban development, and to provide opportunities for the scientific study of various species of wildlife and for the management and preservation of their populations. These refuges also provide import opportunities for outdoor recreation, primarily nature study and natural scenery appreciation.

State Wildlife Management Areas: The various state Game and Fish Commissions are responsible for the operation of a number of game management areas which are becoming an important part of the outdoor recreational scene. Due to the increasing demand for hunting and fishing and increasing pressure from development on natural habitats, it is necessary to set aside certain land and water areas for game and fish management purposes.

State Forests: Three state forests are located within the study area, all three located in Florida. These are maintained and operated by the State Division of Forestry. The state forests offer protection for wildlife and ecosystems, and opportunities for recreational activities exist in these forests as in the national forests. A large number of fire tower sites are maintained throughout the forests which offer limited-purpose recreational opportunities--usually for camping and picnicking.

<u>Aquatic Preserves</u>: The aquatic preserves system is unique to Florida. Florida owns, by virtue of its sovereignty, some 10,000 square miles of submerged tidal lands offshore from its extensive Atlantic and Gulf coastlines and in its numerous bays, estuaries and lagoons. Much of this submerged land supports biological, aesthetic, and other natural features important ecologically and for outdoor recreation, but all of it is potentially vulnerable to major impairment from incompatible development. To set aside certain exceptionally valuable and representative areas for perpetual public enjoyment and to preserve important natural systems, a state-wide system of aquatic preserves was established by formal dedication of the sovereignty lands involved. The subsequent management program for the preserves emphasized protection of the existing natural values as well as promotion of compatible outdoor recreational uses, such as boating, fishing, skin diving, and sightseeing. The State of Florida Board of Trustees of the Internal Improvement Trust Fund has management responsibility at present.

The following categories of recreation areas are those State-owned areas which have been developed for high-density use. Included are state parks, state recreation areas, and state ornamental gardens.

A brief description of these categories, including jurisdictional responsibilities, follows.

State Parks: These facilities in all three states are relatively spacious areas established primarily to preserve natural features of exceptional quality, historic, archeological, scientific, or other distinctive characteristics. The state parks are under the jurisdiction of the Division of State Parks in each of the three states.

State Ornamental Gardens: (Only in Florida). Areas established primarily for the public enjoyment of certain ornamental landscapes which note regional or state-wide significance. The primary management program consists of the following: (1) Use of the garden areas shall be of low intensity and restricted to such activities as sightseeing and interpretation, and (2) Use of adjacent areas suitable for more active forms of recreational involvement shall be encouraged, but not to the extent of interrupting the tranquility and passive nature of the gardens. Public usage shall be controlled in a manner to prevent deterioration of the resource.

Archeological Sites

The eastern Gulf coast contains large numbers of archeological sites which provide evidence essential to the understanding of aboriginal cultures in the area. The known sites along the coast represent the various stages in cultural development of the prehistoric inhabitants. Archeological evidence found in these sites includes shell middens, villages, burial mounds, pottery, tools and weapons.

There are known archeological sites in all the coastal counties of the area of concern. A large proportion of the sites are concentrated near the coast and along riverbanks and bay shorelines where there was easy access to food sources (fish and shellfish) and transportation routes. It is probable that there are many as yet undiscovered archeological sites in the coastal area, and likely places for their discovery are in areas such riverbanks, deltas, and islands.

It is also possible that submerged sites of archeological value may be found offshore on the continental shelf or in embayments. Sine man has inhabited the Gulf coast region for thousands of years, there was human occupation in the area at a time when the sea level was much lower than it has been in historic times. Emery and Edwards (1966) give evidence that nomadic hunters and possibly fish and mollusk eaters may have lived in areas of the Atlantic continental shelf which are now submerged. They point out that the most likely areas for findings submerged archeological sites are areas "which have received little or no cover of postglacial sediment and where rivers formerly crossed the shelf." They also indicate that projectile points and tools, about 9,000 years old, have been found in fill dredged from Terra Ceia Bay, Florida although the exact location from which the fill came is unknown.

Florida's State Underwater Archeologist, Wilburn Cockrell, has assured us of the existence of underwater archeological sites on Florida's Gulf coast. 1/ He believes that analysis of these sites will be important in modifying and correcting data in existence regarding the aboriginal inhabitants of the eastern U.S., especially in the "Archaic" and "Lithic" periods representing the earliest cultures in the area. Radio carbon dating of objects retrieved from the Warm Mineral Springs underwater site in Sarasota County has established the presence of human beings in the area as early as 10,000 years ago. (Butterfield, 1973)

Evidence indicates that since 10,000 years ago there has been a minimal rise in sea level of 40 to 60 meters, 2/ which would support the probability that some portion of the continental shelf in this region may have supported human habitation in the past.

Because of the sensitive nature of the location of archeological sites, only those major sites which are of general public knowledge or are afforded protection are shown. In Mississippi a complete

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1/ Personal communication with Wilburn A. Cockrell, Florida Dept. of State, Division of Archives, History and Records Management, 10/1/73.

2/ Personal communication with Wilburn A. Cockrell, Fla. State Underwater Archeologist, 10/2/73.

inventory of known sites was obtained from the State Archives. Although no survey has been made, the inventory includes those sites which have been reported to the State Archives and have been investigated. Due to the number of sites and the small scale of the base map, it was not possible to plot these. Instead, only the number of sites per county was listed. In Florida, the Coastal Coordinating Council has mapped the known sites by county in the Coastal Zone Management Atlas (Florida Coastal Coordinating Council, 1972). Here, too, the sites are so numerous (approximately 350) that only the number of sites per county is shown. The Coastal Zone Management Atlas is available for reference for location of individual sites; however, these locations are not precise and are true only within a section of land.

Historic Sites

The numerous historic sites located on the northeastern Gulf coast date from the earliest Spanish explorations of the area in the early 1500's. Sites included in this inventory include those listed in the National Register of Historic Places (National Park Service, 1972), National Historic Landmarks, and those sites designated by the individual states as being of historical significance.

Waters of the northeastern Gulf contain shipwrecks dating to the early 16th centry. However, locating of shipwrecks on the Outer Continental Shelf would require site surveys since they went down out of sight of land and often with all lands. Shipwrecks in Florida state waters are considered to be property of the State, which in turn lets contracts to salvage companies for the exploration of the wrecks.

Natural Landmarks

The National Park Service administers the Natural Landmarks Program. The objective of this program is to assist in the preservation of natural areas which will illustrate the diversity of the country's natural history. Registration of a site as a Natural Landmark does not change ownership. However, the owner of the area is required to preserve the natural character of the registered site in order retain its registration as a Natural Landmark.

A natural history theme study is now being conducted by Louisiana State University for the National Park Service. The purpose of this study is to identify those areas which are representative of significant natural themes in the region. It is intended that important sites or areas such as certain coastal marshes, marine environments, estuaries, barrier islands, etc., will eventually be given the status of natural landmarks in order to preserve and protect sites which represent all aspects of the natural values of the region.

Inventory Of Sites:

The following is a list of sites by category as shown on the subsequent series of maps. The numbers/letters refer to corresponding identification numbers/letters used on the maps.

NATIONAL FORESTS:

I. DeSoto National Forest (Mississippi)

II. Apalachicola National Forest (Florida)

NATIONAL PARKS:

AA. Gulf Islands National Seashore

FEDERAL WILDLIFE REFUGES:

A. St. Vincent Island

B. St. Marys

C. Cedar Keys (375 acres designated as having Wilderness Area Status)

D. Chassahowitzka

E. Anclote

F. Pinellas

G. Passage Key

H. Breton Islands

I. Delta

STATE WILDLIFE MANAGEMENT AREAS:

a. Red Creek (Mississippi)

b. St. Regis (Florida)

c. La Floresta

d. Blackwater

e. Eglin

f. Point Washington (Florida)

g. Roy D. Gaskin

h. Ed Ball

i. Liberty

j. Leon-Wakulla

k. Aucilla

l. Tide Swamp

m. Steinhatchee

n. Gulf Hammock

o. Citrus

p. Croom

q. Richloam

r. Bull Creek

s. Biloxi (Louisiana)

t. Pass A Loutre (Louisiana)

STATE FORESTS: (All located in Florida)

1. Blackwater

2. Pine Log

3. Cary

AQUATIC PRESERVES: (All located in Florida)

aa. Fort Pickens

bb. Yellow River Marsh

cc. Rocky Bayou

dd. St. Andrews

ee. St. Joseph Bay

ff. Apalachicola Bay

gg. Alligator Harbor

hh. Waccasassa Bay

ii. St. Martin's Marsh

jj. Caladesi Island

kk. Boca Ciega Sound

ll. Cockroach Bay

mm. Boca Ciega Bay

The above numbers/letters appear in boldface on the following maps.

STATE PARKS

MISSISSIPPI

A. Bucaneer (Proposed)

B. Fisherman's Wharf (Proposed)

B1. Magnolia State Park

ALABAMA

C. Meaher

D. Fort Morgan

E. Gulf Shores

F. Romar Beach

G. Alabama Point

FLORIDA

H. Blackwater

I. Fort Pickens

J. Fred Gannon Rocky Bayou

K. John Beasley

L. Grayton Beach

M. Ponce de Leon

N. Basin Bayou

O. Eden

P. St. Andrew

Q. St. Joseph

R. St. George Island

S. Ochlochnee River

T. Lake Rousseau

U. Manatee Springs

V. Fort Cooper

W. Anclote Key

X. Caladesi Island

Y. Hillsborough River

Z. Lake Manatee

AA. Torreya

STATE RECREATION AREAS

ALABAMA

a. State Boat Launch

b. U.S.S. Alabama

c. Fort Gaines

MISSISSIPPI

d. Bayou Caddy Boat Launch

e. Biloxi Small Craft Harbor and Parks Facility

STATE ORNAMENTAL GARDENS

FLORIDA

Eden

HISTORICAL-ARCHEOLOGICAL SITES

MISSISSIPPI

1. Poverty Point Archeological Site
2. Beauvoir
3. Kennedy Hill Archeological Site
4. Father Abram Ryan Home
**5. Magnolia Hotel
6. Old French House
7. Old Spanish House
8. Old Brick House
9. Fort Maurepas
10. Old Indian Springs
11. Graveline Mounds
12. Old Spanish Fort
13. Fort Massachusetts

ALABAMA

14. Blakeley
15. Spanish Fort
**16. Fort Morgan
17. Fort Gaines

**18. Fort Conde Charlotte House

*** 90 Historical Sites located in City of Mobile. (7 in National Register of Historic Places, 1972)

FLORIDA

19. Constitution Monument

20. Fort Gadsden

21. John Gorrie

*22. Fort San Marcos de Apalache

23. Forest Capital

24. Cedar Key

25. Crystal River Archeological Site

26. Yulee Sugar Mill

27. Madira Bickel Mound

28. Gamble Mansion

*29. Fort San Carlos de Barrancas

*30. Fort Walton Mound

*31. Safety Harbor Site

32. DeSoto National Memorial

* Historic Landmarks

** Sites in National Register of Historic Places 1972

Natural Landmarks

The following sites are included in the National Registry of Natural Landmarks or are considered as potential sites to be included:

Eligible Natural Landmarks

1. Manatee Springs
2. Rainbow Springs
3. Wakulla Springs

Potential Natural Landmarks

4. Atlantic White Cedar Area
5. Gulf Mammock Area
6. Mississippi Sandhill Crane Area
7. Pascagoula River Swamp
8. St. Marks Natural Area
9. Weekiwackee Spring
10. Wekiva Springs

Approximately 350 archeological sites are located in the coastal counties of Florida, but, these are too numerous to map at the scale being used. The following is a list of the number of archeological sites found in each coastal county for which the data was available.

Mississippi

County	No. of Sites
Hancock	16
Harrison	37
Jackson	48

Florida

County	No. of Sites
Okaloosa	50+
Walton	40+
Wakulla	45+
Jefferson	38+
Taylor	15
Dixie	20
Levy	10
Citrus	34
Hernando	9
Pasco	7
Pinellas	15+
Hillsborough	25+
Manatee	20+
Sarasota	12

Figure 33. LEGEND FOR THE FOLLOWING MAPS OF OUTDOOR RECREATION AREAS, HISTORICAL AND ARCHEOLOGICAL SITES

	Man-made Beach
AA.	National Parks
I.	National Forests
A.	Federal Wildlife Refuges
2.	State Forests
d.	State Wildlife Management Areas
cc.	Aquatic Preserves
F.	State Parks
8.	Historical-Archeological Sites
d.	State Recreation Areas
0	State Ornamental Gardens
	Natural Landmarks
	Proposed
***	90 Sites in Mobile

FIGURE 33 - a.


MISSISSIPPI SOUND
Miss.
La.
LAKE BORGNE
S.
CHANDELEUR SOUND
CHANDELEUR ISLANDS
H.
BRETON SOUND
H.
BRETON ISLAND
GULF OF MEXICO
I.


I.
a.
Gulfport
Pascagoula
Miss.
Ala.
MISSISSIPPI SOUND
Horn Island
AA
Miss.
La.
GULF OF MEXICO
H.
A.
B.
B1.

FIGURE 33 - b.

14.
Mobile
b.
a.
15.
18.
Ala.
Miss.
C.
Mobile Bay
Perdido R.
Ala.
Fla.
Perdido Bay
G1
F.
E.
D.
17.
c.
16.
GULF OF MEXICO

FIGURE 33 - c.

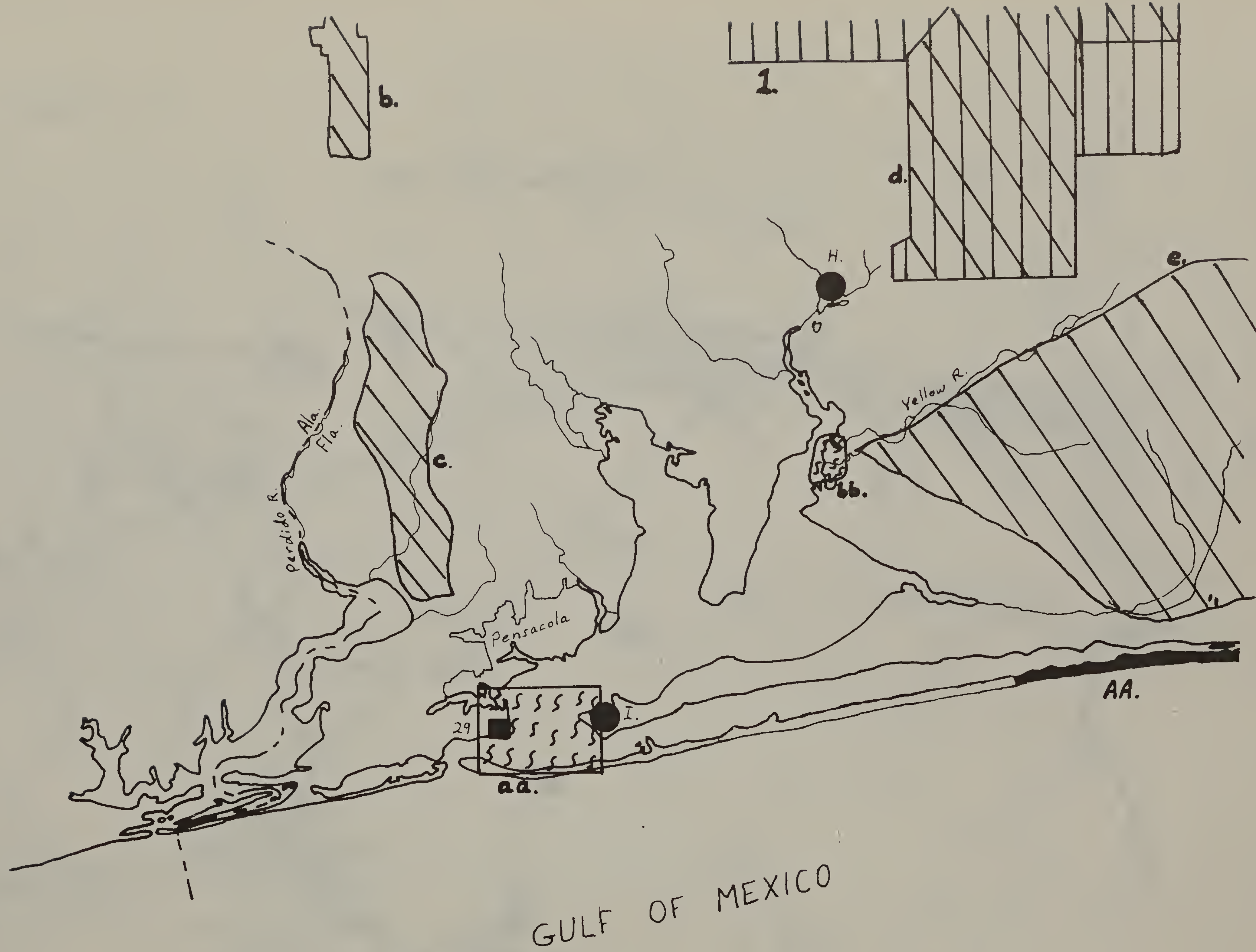

b.
1.
d.
H.
e.
Ala.
Fla.
Perdido R.
c.
Yellow R.
bb.
Pensacola
29
I.
aa.
AA.
GULF OF MEXICO

FIGURE 33 - d.

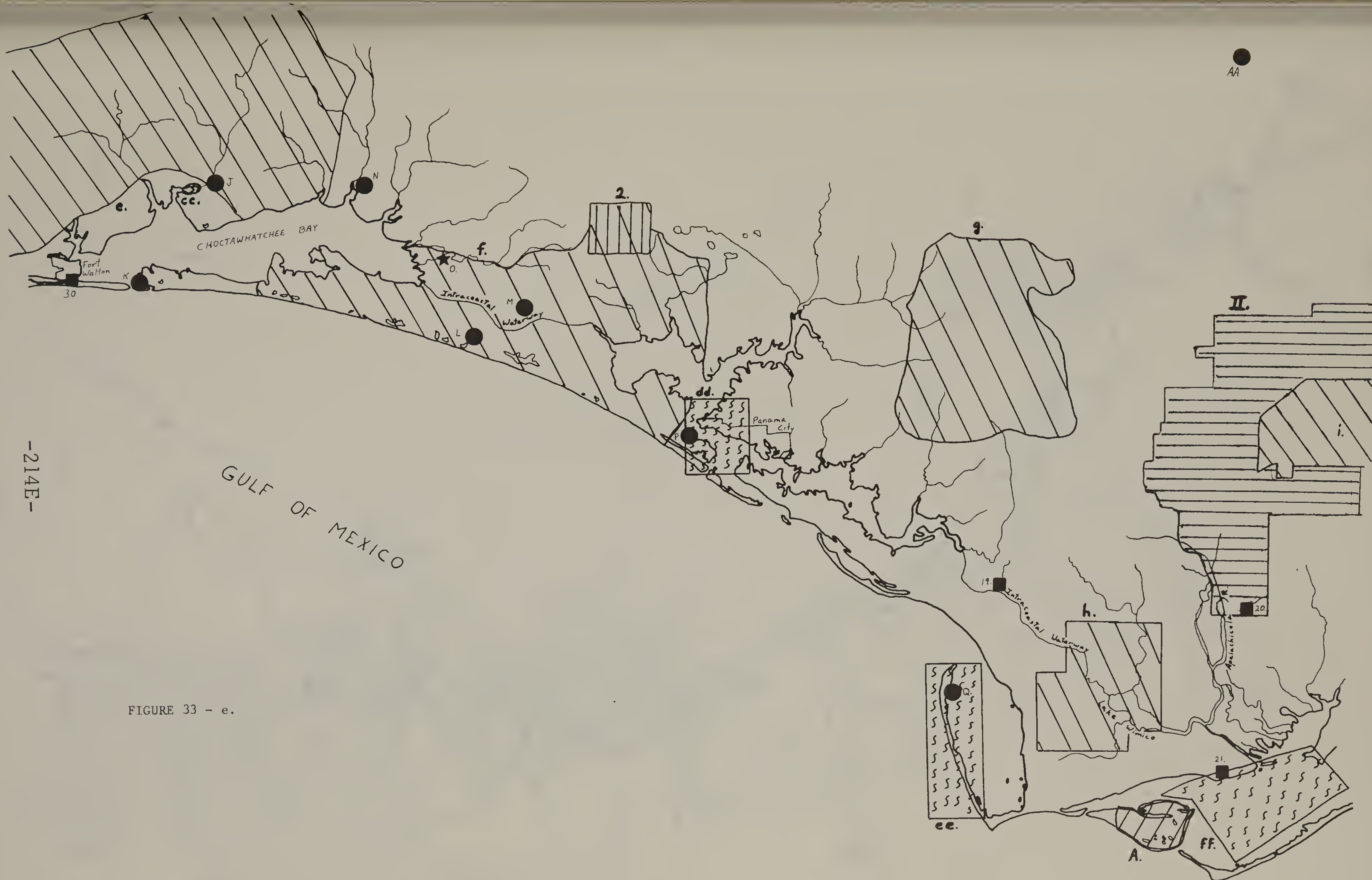

AA
e.
cc.
J
N
2.
CHOCTAWHATCHEE BAY
f.
O.
g.
Fort Walton
30
K
Intracoastal Waterway
M
L
II.
dd.
Panama City
P
i.
GULF OF MEXICO
19.
Intracoastal Waterway
h.
R
20.
Apalachicola
Q.
Lake Wimico
21.
ee.
A.
ff.

FIGURE 33 - e.


II.
j.
i.
k.
l.
m.
B.
3
22.
23
S.
R.
Wakulla R.
Saint Marks R.
Ochlockonee R.
APALACHEE BAY
GULF OF MEXICO

FIGURE 33 - f.

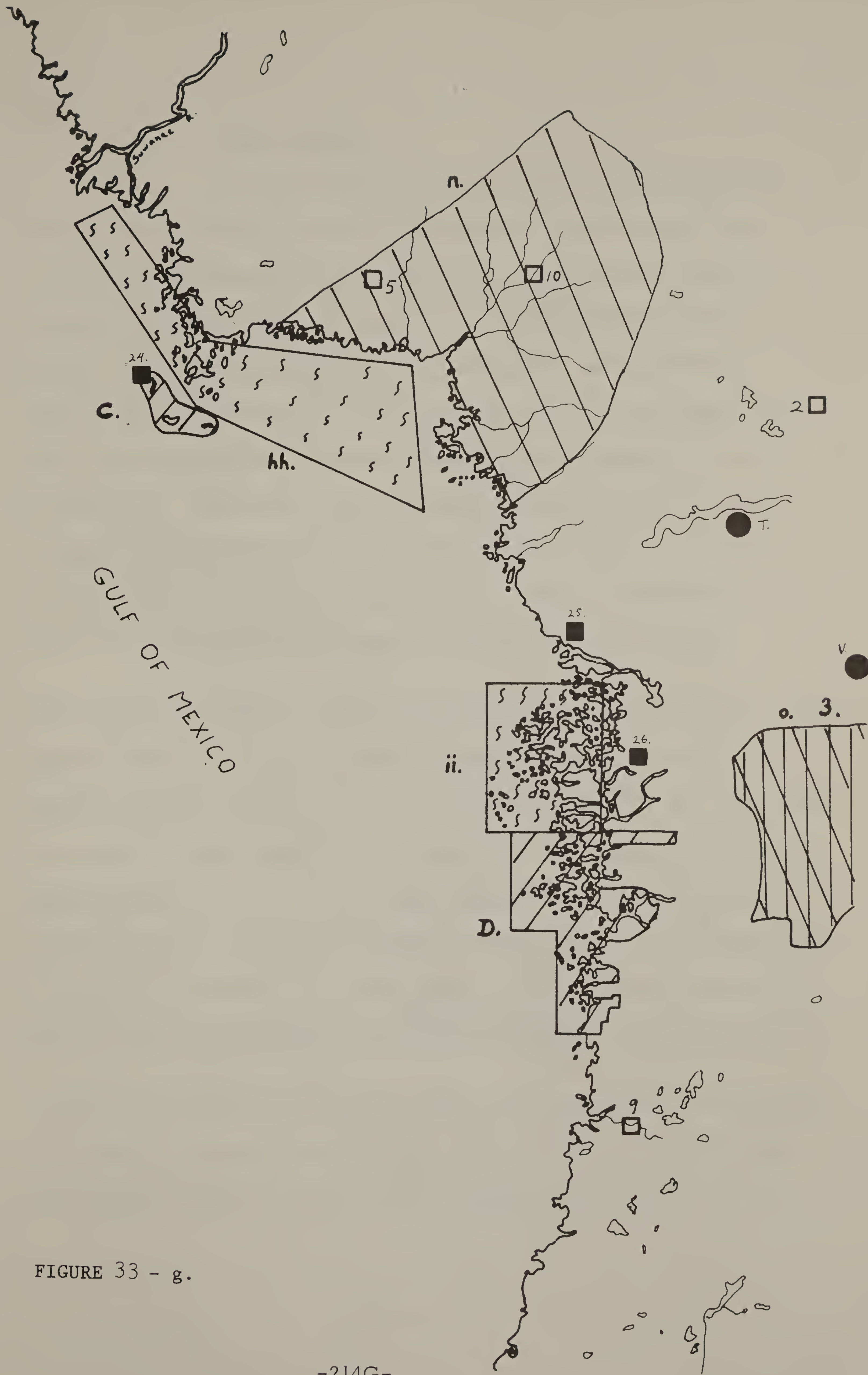


FIGURE 33 - g.

b. Sport Fishing

Saltwater sport fishing is one of the most popular outdoor recreation activities in the northeastern Gulf region and is a significant factor in the economy of the coastal zone. The sport fishing activity, catch, and value has been inadequately recorded. Recently the National Marine Fishery Service has established two sport fishing laboratories in the Gulf area and has undertaken, with their port sampling of commercial products, the gathering of sport fishing data. Therefore, these renewable resources will be better defined in succeeding years. At the present time very little data is available for the proposed lease area. However, information is available from several nationwide surveys for the Gulf region.

There were 2.3 million saltwater anglers in the Gulf during 1970. These anglers caught 486 million pounds of fish and spent $405 million. (Dept. of Commerce, 1973). This catch was 29 percent of the total poundage of Gulf fishery landings. The data fall within the estimation of Taylor (Taylor, J. L., et. al. 1973) who predicted that sport fish landings in the Gulf would approximate one-third to one-half the volume of commercial landings (2 million pounds). The sportsman expenditure was 2.4 times the commercial dockside value (Dept. of Commerce, 1973).

In 1971 sportfishing on Florida's Gulf coast contributed $200 million to Florida's economy (Stursa, 1973). Mississippi and Alabama also have important sport fish industries although their economic impact is smaller than that of Florida. Sport fishing is an important recreational activity in Louisiana, too, occurring throughout the delta region and offshore.

Sport fishermen in the northeastern Gulf have fishing access by bridges, causeways, and artificial reefs. Some individuals may use their own private boats, or may fish from party or charter boats. There are numerous fishing piers, both public and private along the Gulf coast from Mississippi to Florida. Although statistics are not available to indicate the intensity of use of fishing piers as differentiated from boat fishing, it is apparent from the number of fishing piers and from the number of people observed using them that this is a very popular means of fishing.

Party boat fishing is characterized by the use of a large boat in the range of 55 to 65 feet carrying a large number of people. Bottom fishing consumes the majority of fishing time, although less often drift fishing and trolling methods are used. Party boats usually charge a set fee per person and may require a certain minimum of passengers aboard before they make a trip.

Charter boat fishing is characterized by the use of a smaller boat, about 30 to 45 feet in length, carrying up to 6 or 8 persons. Trolling is the primary method used.

In recent years, the establishment of artificial reefs has become popular in the Gulf of Mexico. These artificial reefs, made of old

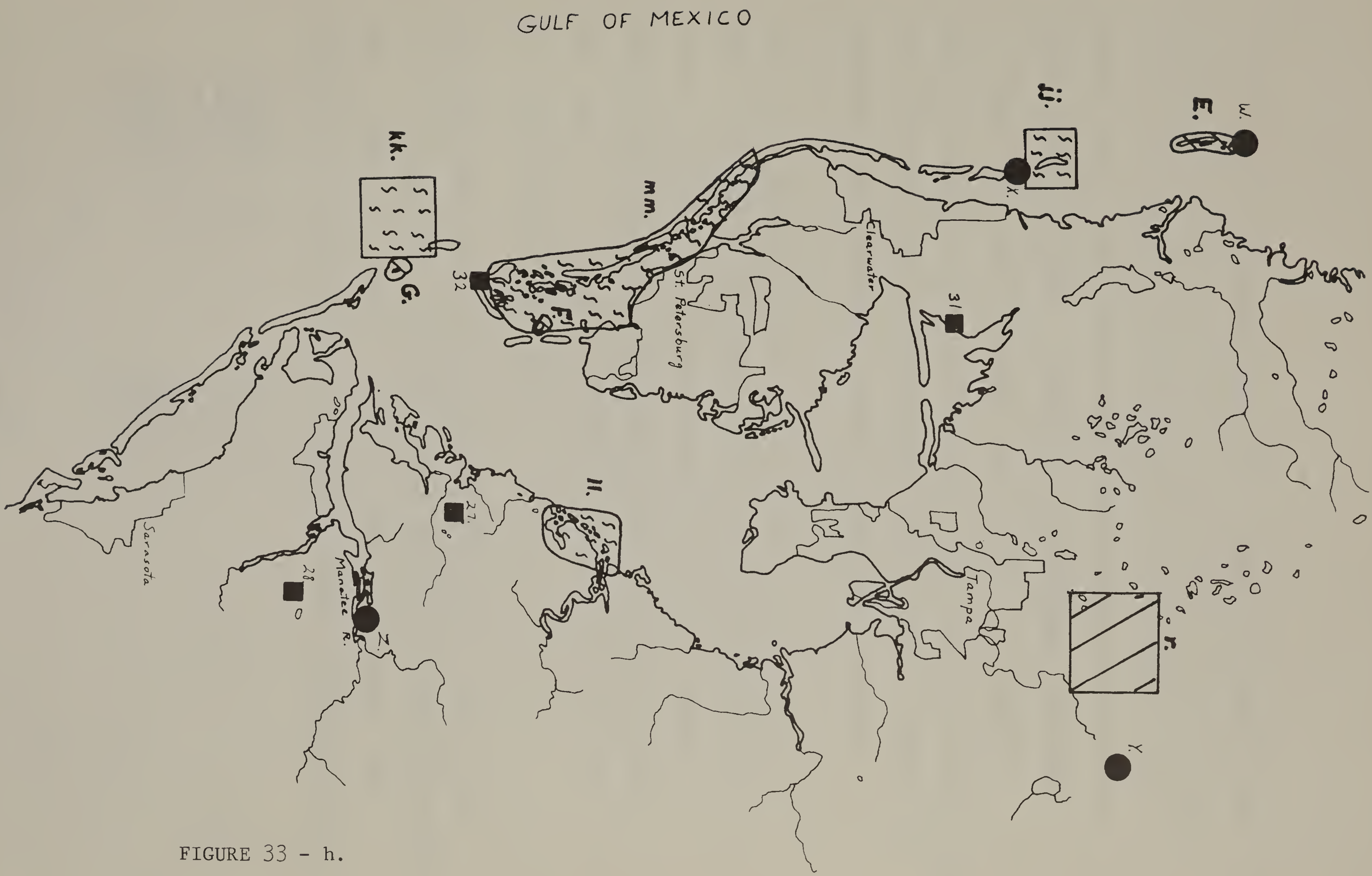

GULF OF MEXICO
kk.
mm.
E.
W.
X.
G.
F.
32
31
St. Petersburg
Clearwater
ll.
27.
28
Sarasota
Manatee R.
Z.
Tampa
r.
Y.

FIGURE 33 - h.

car bodies, tires, concrete pipes, ships, rubble, and numerous other materials provide additional surface area of hard substrate on which numerous types of algae and invertebrate species may grow. These organisms are available as food for foraging species, which in turn, attract predatory fishes. In addition to the expanded food chain and trophic food level potentials, the artificial reefs serve as refuge, protection, and orientation sites. These new sites by attracting and concentrating fish species improve fishing success. However, the population size of fish species are not necessarily increased.

There are 95 artificial reefs constructed or in some construction phase within eastern Gulf coastal waters. An undetermined number of private permits are anticipated throughout the region. Except for sunken liberty ships the artificial reefs are within the 10 fathom depth countour. The majority of the Florida structures are within five miles distance from shore.

Additional plans are being initiated for utilizing 15 liberty ships for fish attractions. Mississippi has five artificial reefs (Christman, 1973), Alabama-five (Saingle, 1973) and Florida-85 (Bryant, 1973). The Florida artificial reefs are listed by county. (See also Fig.34).

Escambea - 6	Dixie - 2
Okaloosa - 8	Levy - 9
Walton - 4	Citrus - 1
Bay & Gulf -22	Pasco - 1
Franklin - 4	Pinellas - 14
Wakulla - 5	Manatee - 4
Taylor - 1	Sarasota - 4

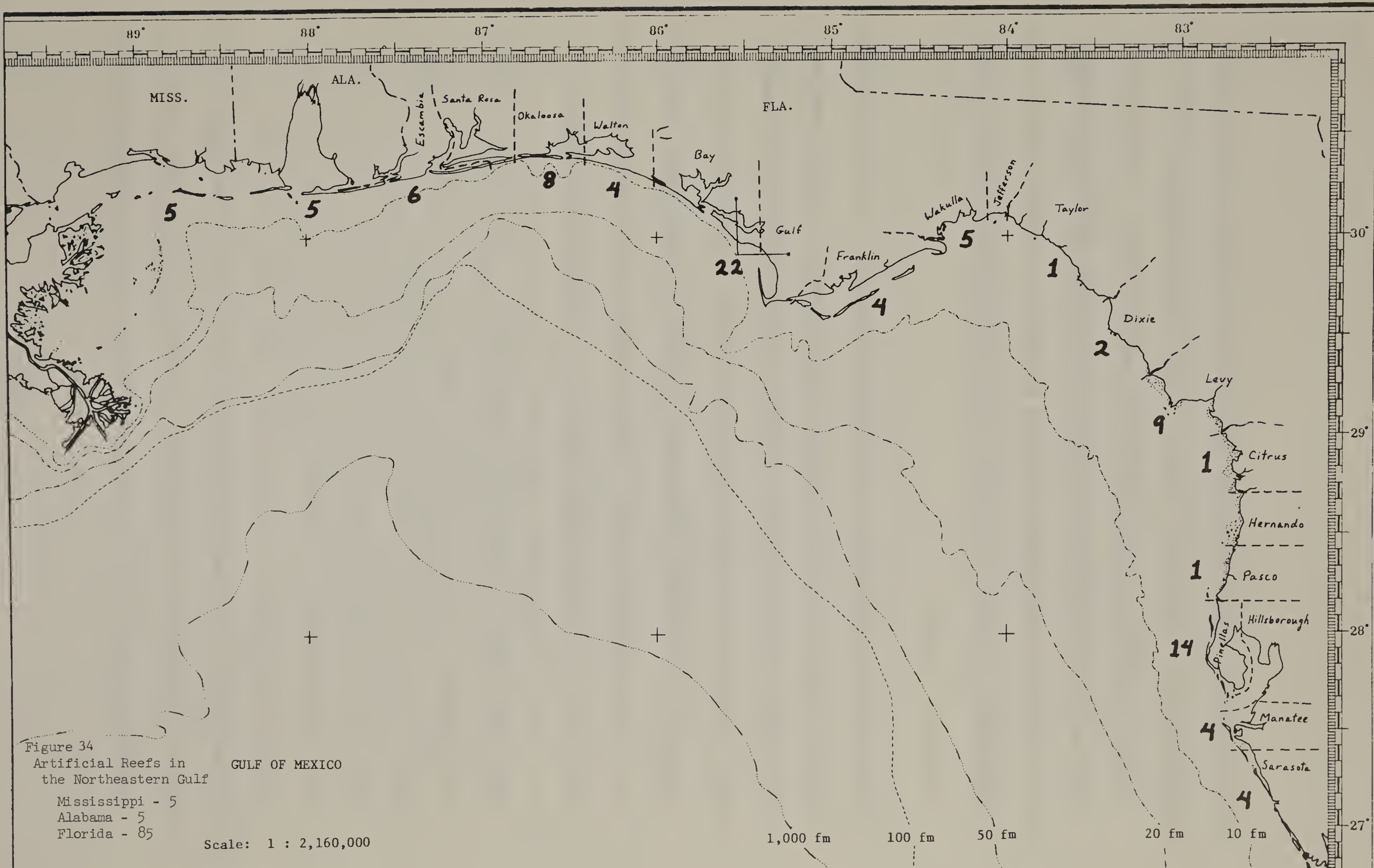


Figure 34
Artificial Reefs in the Northeastern Gulf

Mississippi - 5
Alabama - 5
Florida - 85

As indicated on the following map (Fig. 35) it is estimated that approximately 80% of all fishing activity occurs within twelve miles of shore (National Marine Fisheries Service, 1972). A further rationale for the location of this twelve-mile line was the consideration of the maximum distance a party or charter boat can travel and return to shore in one day and allow adequate time for fishing in place of anchor.

Although fishing grounds are located throughout the northeastern Gulf, the most heavily fished areas are found offshore between Pensacola and Panama City and offshore between St. Petersburg and Sarasota. Major fishing grounds are shown and data for sport fishing user-occasions in Florida is presented in terms of zones (Moe, 1963) on the following map (Fig. 35). The two zones which concern this proposed sale are the Northwest Coast and the Upper West Coast.

Upper West Coast: (Carabelle to Bradenton). This region roughly corresponds to Recreation Planning Regions II, III, V, and VII. This is Florida's most important sport fishing region with 25,244,150 user occasions reported for this activity in 1970. (These include user occasions for the Sarasota area which is somewhat south of the region as described.) Of this total, more than 23,000,000 is represented by St. Petersburg-Sarasota area (Dept. of Natural Resources, 1971). The region from Apalachicola to Tarpon Springs has the most favorable weather for fishing and greatest tourism coincident with the spring and summer months. There is very little offshore fishing activity during the winter months. Pinellas County (St. Petersburg area) also has heavy fishing pressure during the summer, but the impetus of tourism results in substantial fishing activity in the winter also. Tarpon, redfish, king mackerel, snook, spanish mackerel, cobia, seatrout groupers and bill fish are among those fish caught in this area.

Northwest Coast: This zone extends from Pensacola to south of Panama City and roughly corresponds to the State Recreation Planning Region I (Dept. of Natural Resources, 1971). The most sought after and most numerous fish in the catch of sport and commercial vessels is the red snapper. Rocky areas, wrecks of ships and airplanes and other irregularities of the bottom are the most productive. In the eastern section of the area, there is often a coral growth on the exposed rock as well as other invertebrate organisms. The dominant species taken by the party and commercial boats in this area include: (1) red snapper; (2) black grouper; (3) vermillion snapper; (4) scamp; (5) porgy; (6) red grouper. During 1970 the number of user occasions for saltwater sportfishing in this region was reported to be 5,347,201 (Dept. of Natural Resources, 1971).

There were 40,000 user-occasions of saltwater sport fishing in Alabama in 1969 (Dept. of Agri., Econ., and Rural Sociology, 1972). The most popular species caught in Alabama's Gulf and estuarine waters are tarpon, king mackerel, red snapper, mullet, shrimp, crab, and oysters.

Mississippi's saltwater fishing activities occur primarily in the months from May through September. Biloxi is the principal base for deepsea fishing activities. Spanish mackerel, tarpon and redfish are among the more popular fish sought, but other migratory species may be caught in certain seasons.

Figure 35. Legend: Sport Fishing

Seaward limit (12 miles) of most heavily fished area

Inshore and Coastline fish habitat and Fishery

Reef and other oceanic fish habitat and fishery

Bill fish habitat

Reef and other oceanic fish intensively fished

Bill fish, area of greatest catch

Roman numerals indicate Recreation Planning Region.

Arabic numerals indicate user occasions.

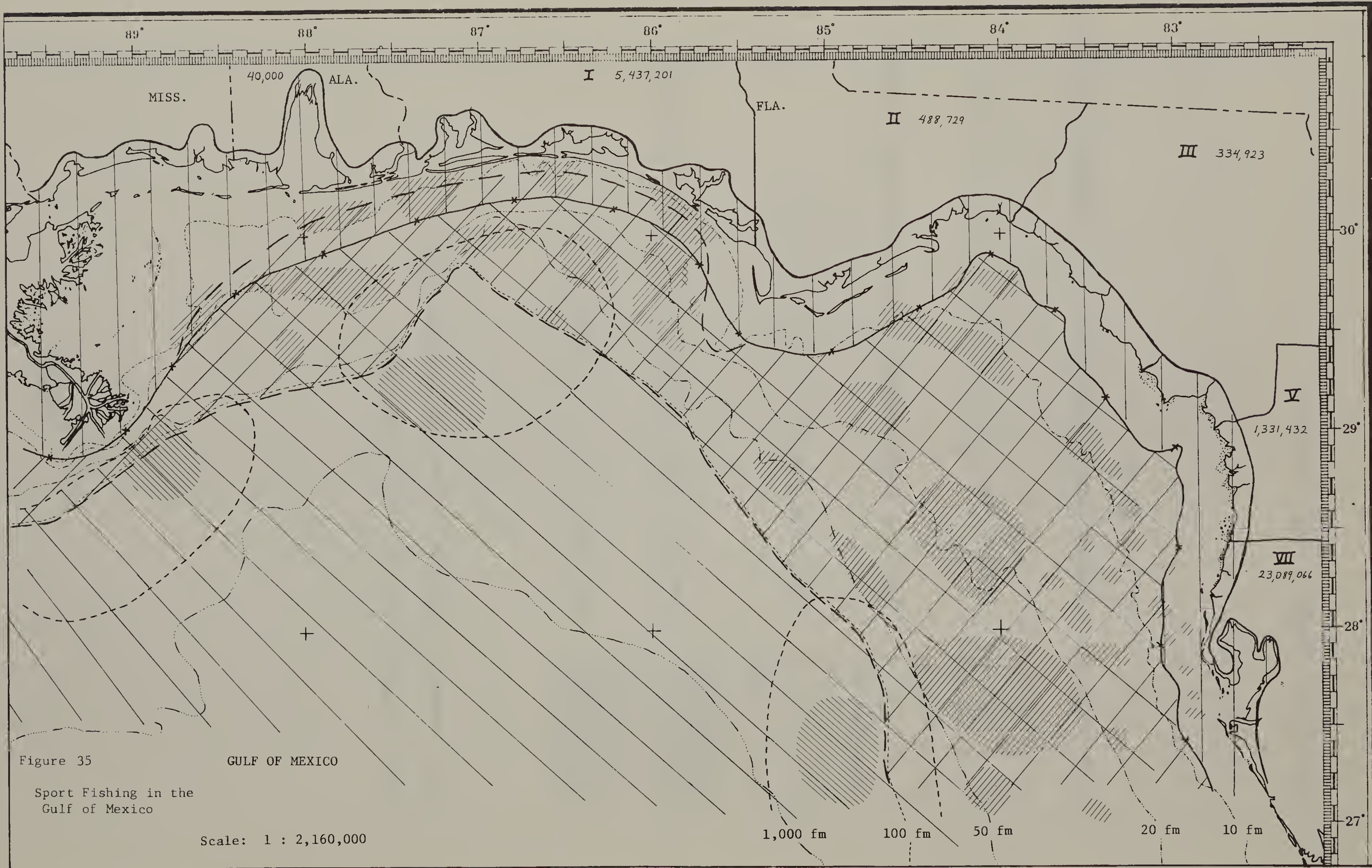


Figure 35

Sport Fishing in the Gulf of Mexico

Scale: 1 : 2,160,000

3. Industry in the Coastal Zone

The economy of the coastal zone of the Northeastern Gulf is based on a variety of industries and on recreation and commercial fishery resources as discussed above (sections II. F., 2 and 5). The type and distribution of industry in this area is primarily influenced by the local and regional resource base and labor force, and by access to transportation facilities.

In addition to tourism, recreation, and commercial fishing, the major industries along Florida's Gulf Coast are manufacturing, construction, agriculture, and phosphate mining. Values for each of these industries is given below (Stursa, 1973):

Manufacturing (value added)	$550 million (1970)
Tourism (amount spent by tourists)	$500 million (1970)
Construction	$400 million (1968)
Agriculture (value to farmers)	$130 million (1970)
Phosphate Mining (value at mines)	$125 million (1968)

The largest single industry on Florida's Gulf coast is food processing, (Stursa, 1973) including processing and canning of citrus fruits and vegetables, dairy plants, breweries, and meat packing plants. Pulp, paper, and chemical plants are aslo major manufacturing interests in the area. Pensacola and the Tampa area are the major industrial centers on Florida's Gulf Coast.

Agriculture along Florida's Gulf Coast is dominated by cultivation of citrus fruits, cattle raising, and vegetable production which in turn contribute to the support of the area's food processing industry.

Mobile is one of Alabama's leading industrial centers and the state's only sea port. The predominant industries in the Mobile area are pulp and paper production, food processing, steel fabrication, shipbuilding, and oil refining.

Timber production is an important economic activity in southern Alabama. Agriculture is limited to livestock raising and truck farming.

The area around Pascagoula is the most heavily industrialized area on the Mississippi coast. The major industries here are shipbuilding and repair, chemicals, oil refining, paper, and textiles. Biloxi is a center for commercial fishing and related industries, lumber industries, and is a major commercial center for Mississippi coastal zone. Gulfport and Pass Christian also are centers for commercial fishing and food processing, while Gulfport also produces steel, chemical, and glass products.

Agriculture production in the Mississippi coastal zone is limited to soybean and hay production for livestock feed and truck farming. Timber production accounts for the use of much coastal zone land, and supports the pulp and paper industries in the area.

4. Ports and Shipping

The ports and harbors along the Gulf Coast from Tampa to Corpus Christi are shown in Table 30 The major ports in Louisiana and Texas are included to show the magnitude of water borne traffic over the entire area where the crude oil production originating from the proposed tracts may eventually have to be transported by barges or tankers.

Of the more than 438 million tons of freight that passed through the 17 ports and harbors of Table 30 only 17 percent was handled by the seven harbors in the Mississippi, Alabama, Florida coast nearest the proposed sale area. The Gulf Intercoastal Waterway a sheltered, coastwise channel at least 12 feet deep traverses the entire area as far east as the eastern end of St. George Island in Franklin County, Florida. The majority of the coastwise barge traffic uses this route and, therefore, does not get out into the open gulf.

Of the 438.5 million tons of freight handled through the gulf ports in 1971, 178.5 million tons or almost 41 percent was crude oil and petroleum products. Also, of these same 438.5 million tons of freight, 112.2 million tons, or a bit more than 25 percent moved in foreign trade (imports plus exports) and of this foreign trade only 10.9 million tons (8.6 million tons imports plus 2.3 million tons exports) or less than 10 percent was crude oil and petroleum products.

Table 30 Major Ports & Harbors
U.S. Gulf Coast - Year 1971 1/

Harbor	Maximum Depth (Feet)	Freight Traffic (Short Tons x 1000) Total	Petroleum 2/	Vessels (Inbound) Total	Tankers & Tank Barges 3/
Tampa-including St. Petersburg, Fla.	35.0	35,321	8,036	12,523	842
Port St. Joe, Fla.	37.0	689	625	311	187
Panama City, Fla.	34.0	1,677	1,024	1,608	430
Pensacola, Fla.	33.0	1,082	739	1,142	500
Mobile, Ala.	42.0	24,919	4,225	13,350	1,756
Pascagoula, Miss.	40.0	10,099	5,892	8,346	2,553
Gulfport, Miss.	30.0	1,315	29	551	45
Lake Charles, La.	34.0	19,218	14,594	17,002	6,591
Baton Rouge, La.	40.0	47,017	13,702	18,453	7,883
New Orleans, La.	36.0	120,067	20,157	68,673	19,656
Port Arthur, Tex.	42.0	23,296	20,073	8,907	3,985
Beaumont, Tex.	33.0	30,980	23,275	11,836	5,929
Houston, Tex.	38.0	68,424	34,280	30,886	10,430
Texas City, Tex.	36.0	17,952	12,366	8,299	5,794
Galveston, Tex.	41.0	3,953	117	2,396	294
Freeport, Tex.	36.0	5,723	662	3,716	1,372
Corpus Christi, Tex. (incl. Harbor Island)	37.5	26,754	18,756	6,917	3,499
Total 17 ports		438,486	178,552	214,916	71,746

1/ Waterborne Commerce of the United States - Calendar Year 1971 Part 2 Waterways and Harbors Gulf Coast, Mississippi River System and Antilles - Department of the Army, Corps of Engineers.

2/ Includes Crude oil, gasoline, Jet fuel, kerosene, Distillate Fuel Oil, Residual Fuel Oil, Lubricating Oil and Greases, and LPG.

3/ Somewhat understated as this column includes only tanker and tankbarges and no tugs or towboats which are included in the preceeding column.

5. Commercial Fisheries of the Northeastern Gulf

a. Introduction

The Gulf of Mexico is second only to the Peruvian coast in terms of production and value of fish. Since the first statistical survey of Gulf fisheries was made in 1880 which reported a harvest of 23.6 million pounds worth $1.2 million (Thompson and Arnold, 1971), the Gulf fisheries catch has reached about 1.7 billion pounds worth approximately $165 million annually (Taylor, J. L. et. al., 1973). In 1967, the Gulf fishing fleet contained approximately 4,000 vessels and 10,000 boats manned by 20,000 fishermen, supported by over 800 fish wholesaling and processing facilities with over 13,000 employees (Thompson and Arnold, 1971).

Thompson and Arnold (1971) give the following historical account of the Gulf fisheries:

"The Gulf fisheries have been in a period of accelerated expansion since 1940. This is quite different from the fisheries in other regions, which are mainly static or declining. The marked increase in quantity and value of Gulf fishery products during the last quarter of a century was primarily due to expansion in the shrimp and menhaden fisheries. Blue crab catches also increased substantially. A new fishery was started in 1952 to supply a variety of small trawl-caught bottom fishes--previously unutilized--for manufacture into pet food. Catches of other species,

> of which there are 50 to 60, were maintained with relatively minor deviations around their long-term average."
>
> The shrimp fishery and industrial bottom fishery grew by expanding the fishing grounds. "The industrial fishery for the pelagic menhaden expanded production by intensifying its harvest of the resource on traditional grounds. These are in shallow coastal waters off Mississippi and Louisiana and one small area off western Florida. Menhaden fishing along most of Texas and all of Alabama normally is prohibited by State Law... The fishing grounds for other species of fish in the gulf have remained unchanged through the years. The snapper and grouper grounds are the same today as they were before the turn of the 20th century. Seatrout, mullet, drum, and other estuarine-dependent species are caught in bays, passes, and along the beaches as they always have been... Similarly, the fishing grounds for shellfish (other than shrimp) have changed little."

Historical statistical data show that total catches for many popular Gulf species have maintained reasonably constant levels in recent years despite growing fishing efforts indicating that fisheries in the shallow, nearshore waters may be approaching maximum sustained yield and in some locales could be declining because of pollution. While it is true that some of the less popular and underutilized species, such as mullet, have a significant potential for increased harvest in shallow waters, the catch has been held constant owing to a lack of markets. In the main, major new expansion of gulf fisheries will probably have to come from fishing farther offshore in increasingly deeper waters. Exploratory fishing by the Bureau of Commercial Fisheries (Wathne, 1959; Bullis and Thompson, 1970) has shown that commercial quantities of a number of desirable species can be caught along the outer edge of the continental shelf and over the deep gulf. Some of these species are:

depth, fathoms	species	fishing method
30-50	brown shrimp, porgy, atlantic croaker, butterfish	trawl
shelf beyond 50	hake, wenchman, rattails	trawl
100	yellowedge grouper	longline
150-200	tilefish	longline, trawl
200-300	royal red shrimp	trawl
330-350	swordfish	longline
100-1000+	yellowfin tuna	longline

b. Important Commercial Species and Their Generalized Biology

The distribution and life history of Gulf of Mexico fish and shellfish vary between species but general groupings, with some overlap, can be identified. On the basis of these characteristics, fishery species are classed as resident, semi-catadromous, or seasonal migrant. These terms are discussed in the following sections.

(i) Resident Species

Resident species complete their life cycle in estuaries and are dependent on this zone most of the time. Oysters, crabs and spotted seatrout are classed as resident species although blue crabs and spotted seatrouts may for a short time, venture into shallow coastal waters. All three species contribute significantly to the commercial fishery, and spotted seatrout and blue crab are also sought by recreation fishermen.

(ii) Semi-Catadromous

Semi-catadromous species spawn in the Gulf of Mexico, the young migrate to their estuarine nursery area, where they grow to sub-adults; then they return to the ocean where their life cycle is completed. Some species may return to the estuaries for short periods as adults. Major species include white shrimp, brown shrimp, pink shrimp, menhaden, Atlantic croaker, spot, black drum, red drum, sand seatrout, southern flounder, and saltwater sheepshead. As noted above, these species contribute significantly to the commercial fishery, and, except for menhaden, are also caught in great numbers by sport fishermen.

(iii) Seasonal Migrant Species

The seasonal migrants generally reside in the nearshore waters of the continental shelf during the summer season, and some may forage briefly in the estuaries. They appear in late spring as the waters warm and depart as the water temperature declines in the fall. They either winter in the warmer offshore waters of the Gulf of Mexico or migrate to warmer coastal waters off Mexico or southern Florida. Some spend considerable time in the vicinity of the oil and gas platforms. Major species are the spanish and king mackerel, tarpon, ladyfish, and several species of jack, bluefish and cobia. Several of these, in other areas of the Gulf, are semi-catadromous. Other species found in the offshore waters include marlin, sailfish, wahoo, and a variety of tuna, sharks, skates and rays.

c. An Overview of the Fisheries

(i) Commercial Finfish

The commercial finfish map (Fig. 36) depicts the following information; the inshore and coastline fishery, the menhaden fishery; the mullet fishery; the industrial bottom fish fishery; and the reef and other oceanic fish fishery.

The inshore and coastline fishery extends to a seaward limit of approximately 12 miles from shore in most of the northeastern Gulf. Within this area, nearly 80% of all fishing activity occurs (National Marine Fisheries Service, 1972). It is also within this area that the estuarine dependent marine fish including bluefish, catfish, croaker, black drum, red drum, eel, flounder, grunts, kingfish, menhaden, mullet, perch, seatrout, spot, and others are taken.

Menhaden is the leading fishery product in the U.S. in terms of pounds landed. In the northeastern Gulf, the menhaden fishery extends to western Florida, but is concentrated between Louisiana and Mobile Bay. The annual catch is about 400 million pounds (Taylor, J. L., et. al., 1973) in this area. Menhaden are caught by the purse seine method and are used primarily for fish meal, oil, and fish solubles.

The mullet fishery in the northeastern Gulf depends primarily on the black mullet and accounts for the largest portion of Florida's west coast finfish catch. Production peaks are in the fall. Mullet are caught by gill nets and usually sold fresh or dry salted, and are also important items in the bait fisheries.

The industrial bottom fish fishery, now the third largest fishery in the Gulf (Taylor, J. L., et. al., 1973) is located between Fort Walton, Florida and the Mississippi River Delta in shallow waters. Fish sought by this industry include croaker, spot, and sand and silver seatrout among others. The most common method of fishing is trawling with an otter trawl. The primary uses of industrial bottom fish are pet food, fish meal, and mink food and crab bait.

The Reef and other Oceanic Fish Fishery consists of the reef type fishes, which are bottom feeders and are attracted to irregular bottom configurations, and the highly migratory pelagic fishes. The reef fishes include groupers, grunts, hogfish, jewfish, scamps, sea bass, snappers, tilefish, and triggerfish. The other oceanic fish which are generally surface feeders are: bluefish, blue runner, bonito, cabio, cigarfish, crevalle, dolphin, king mackerel, tenpounder and tripletail.

Of these fish, red snapper is the most valuable commercial species. Snappers and groupers are caught on hand and power-driven reels on offshore banks in the northern Gulf and the Campeche grounds. The Gulf coast of Florida, especially Pensacola, is the center for the snapper and grouper fishery.

(ii) Shellfish, Excluding Shrimp

Among shellfish, exluding shrimp, oysters are the most valuable catch. Blue crabs and oysters are found virtually throughout the northeastern Gulf coastal area, while other shellfish (sunray-venus clams; hard clams, stone crabs, bay scallops, turtles, and sponges) are taken on a more localized basis. The sponge fishery is located offshore Tarpon Springs, Florida, where although the supply of sponges exceeds the demand, it supports a substantial tourist industry. Cedar Keys, Florida is the center of the commercial harvesting of turtles as well as being the center of important crab, oyster, and finfish fisheries. See map (Fig. 37).

(iii) Shrimp

The shrimp fishery in the eastern Gulf represents about one quarter (31 million pounds) and one-fifth ($23 million) the volume and value of the entire Gulf's shrimp harvest (Taylor, J. L., *et. al.*, 1973). The three most important species taken are the brown shrimp, *Penaeus aztecus*; white shrimp, *P. setiferus*; and pink shrimp, *P. duorarum*. Royal red shrimp and rock shrimp are also utilized but have not reached their full potential as fisheries. Shrimp fishing vessels range up to 50 gross tons and travel as far as the Campeche grounds. Larger vessels employ double trawls and are capable of making extended trips, up to 50 days. The smaller vessels usually employ a single trawl and fish close to shore with an average trip of 2 to 4 days (Taylor, J. L., *et. al.*, 1973). See map (Fig. 38).

d. Commercial Fishery Landings in the Northeastern Gulf

The following statistics (Table 31) indicate the volume of commercial fish landings for 1971 in Louisiana, Mississippi, Alabama, and Florida's west coast. Louisiana's catch includes that which was landed outside the area of immediate concern. In the finfish category, only the five major species for each state in terms of pounds landed are listed separately. Figure 39 gives the value and volume of Gulf landings from 1949 through 1971.

Table 31. Commercial Fishery Landings for 1972 in Louisiana, Mississippi, Alabama, and Florida

Louisiana

Species	Pounds
Fish	
Drum, Black	539,935
Drum, Red	888,668
Flounder (Unclassified)	507,240
Menhaden	932,695,610
Seatrout Spotted	1,699,834
Shellfish, etc.	
Crabs, Blue	15,184,640
Shrimp (heads on)	82,987,746
Oysters (meats)	8,747,274
Squid	444

Mississippi

Species	Pounds
Fish	
Croaker	484,400
Menhaden	178,273,000
Seatrout (Spotted)	254,370
Snapper, Red	2,265,650
Unclassified for industrial	62,827,000
Shellfish, etc.	
Crabs, Blue, hard	1,440,879
Lobsters, Spiny	191,000
Shrimp, saltwater (heads on)	7,776,499
Oyster (meats)	1,220,310

Table 31. (cont')

Alabama

Species	Pounds
Fish	
Croaker	9,432,999
Flounders (Unclassified)	1,169,772
Mullet	1,513,397
Seatrout (White)	936,165
Snapper, Red	1,050,591
Shellfish, etc.	
Crabs, Blue, hard	1,612,406
Lobsters, Spiny	38,974
Shrimp, Saltwater (heads on)	17,548,851
Oysters (meats)	1,069,515
Squid	3,616

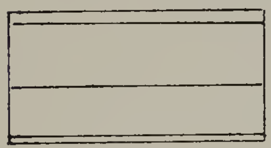
Florida, West Coast

Species	Pounds
Fish	
Groupers	6,478,655
King mackerel	1,378,141
Mullet, Black	26,863,573
Snapper, Red	3,691,197
Spanish mackerel	6,532,300
Shellfish, etc.	
Clambs, Sunray Venus	214,962
Crabs, Blue, hard	10,673,130
Crabs, Stone	1,925,021
Lobster, Spiny	5,149,302
Oysters	3,230,967
Scallops, Bay	35,161
Shrimp (heads on)	22,827,752
Squid	12,727
Turtles, Green	128,081
Turtles, Loggerhead	2,260
Sponges, Grass	837
Sheepswool	14,228
Yellow	5,011

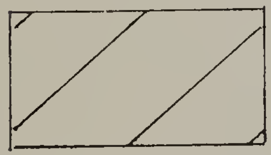
Figure 36. Legend: Commercial Finfish Fishery

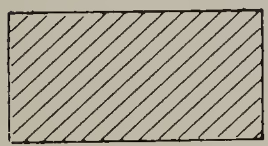
 Seaward limit (12 miles) of most heavily fished area

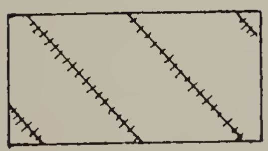
 Inshore and Coastline fishery

 Industrial Bottomfish fishery

 Concentrated Menhaden fishery

 Reef and Other Oceanic fish fishery

 Concentrated Reef fish fishery

 Mullet fishery

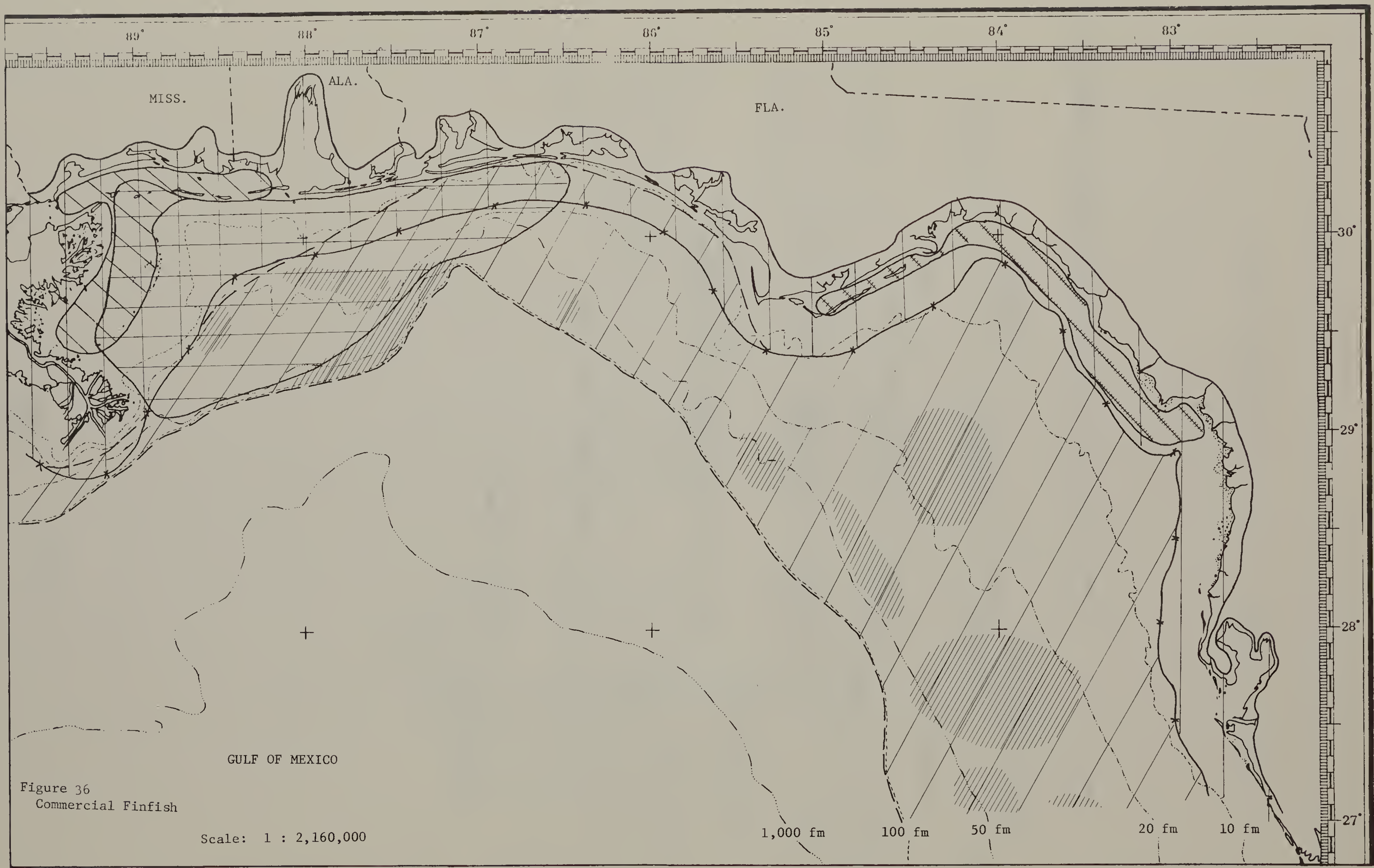
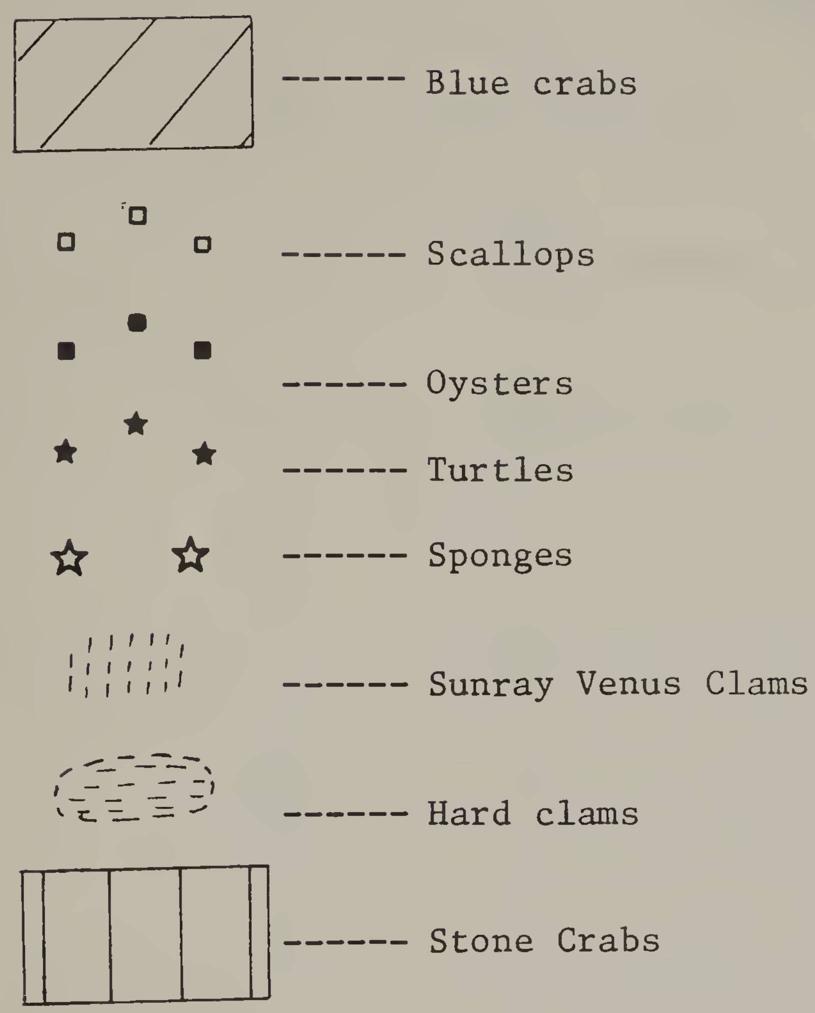


Figure 36
Commercial Finfish

Figure 37. Legend: Shellfish Fishery (Excluding shrimp)



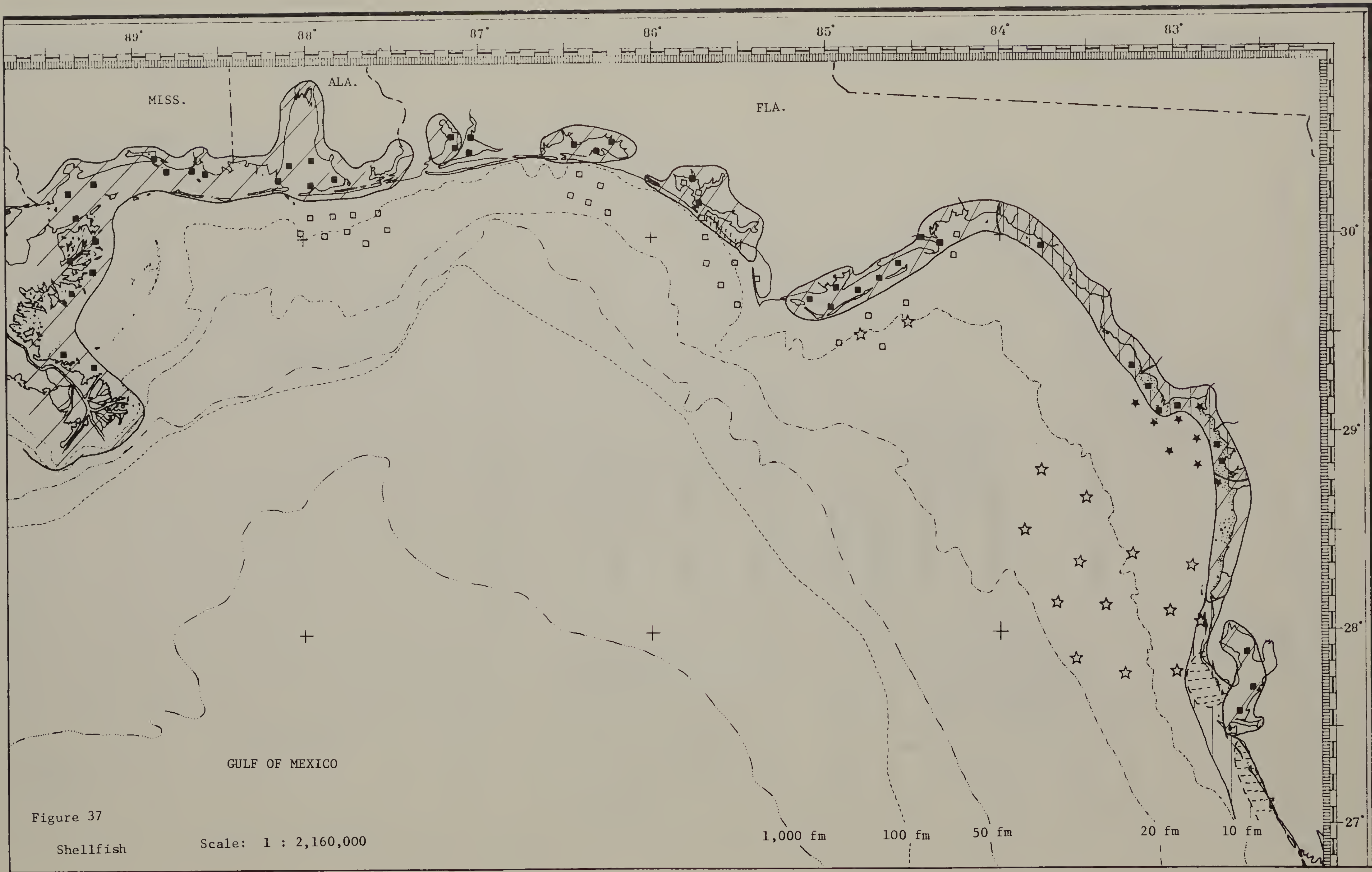
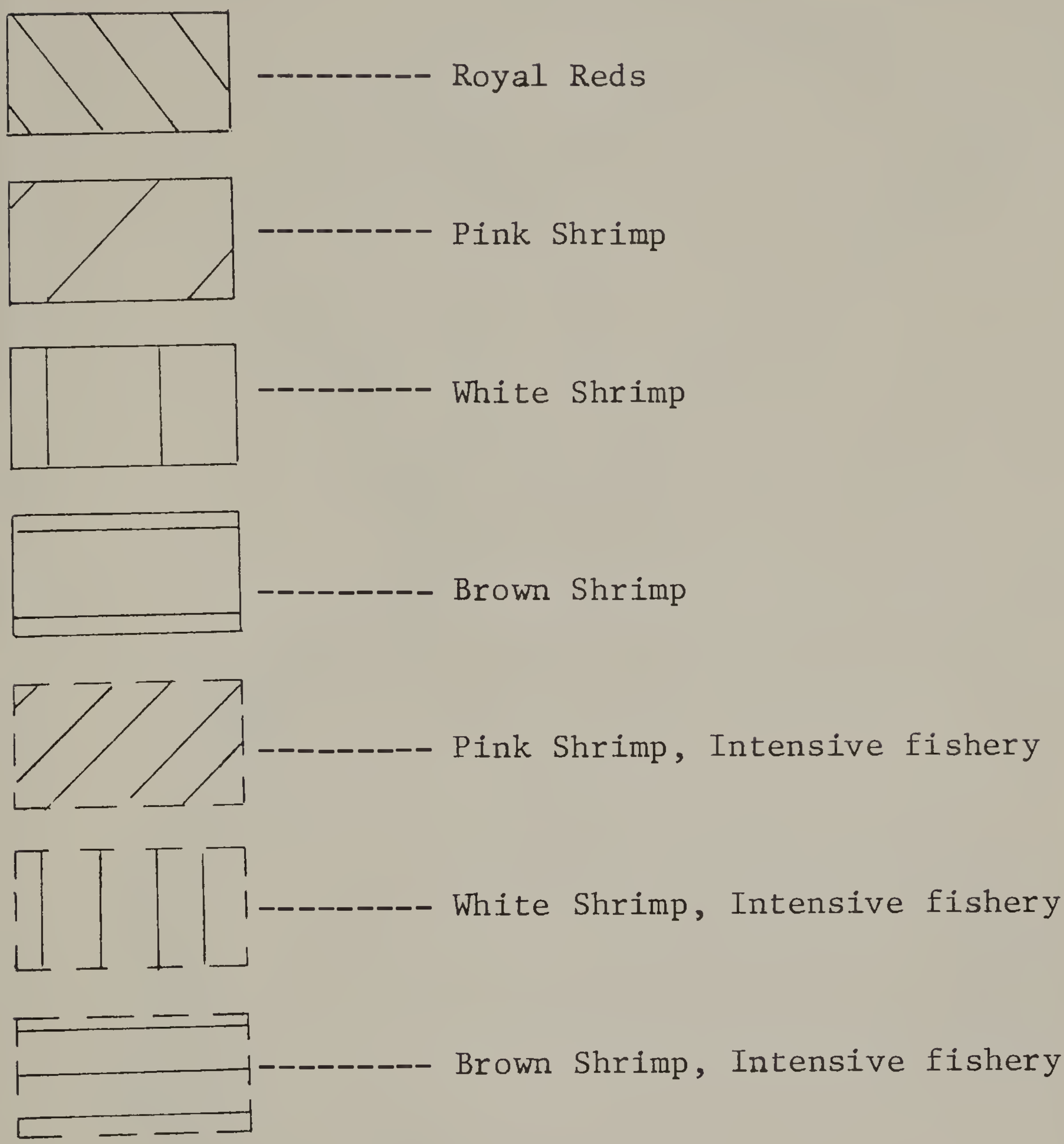


Figure 37

Shellfish

Scale: 1 : 2,160,000

Figure 38. Legend: Shrimp Fishery



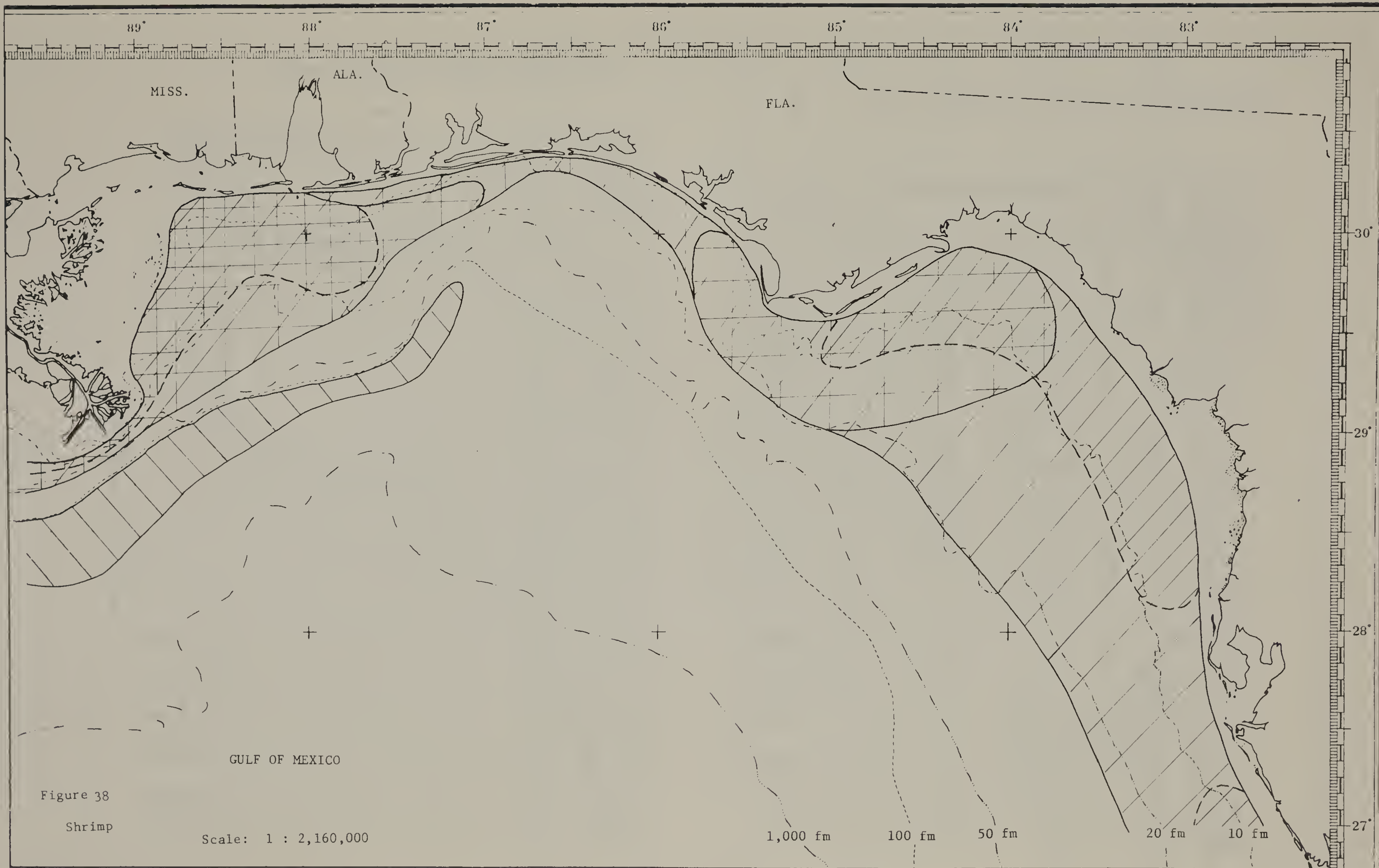
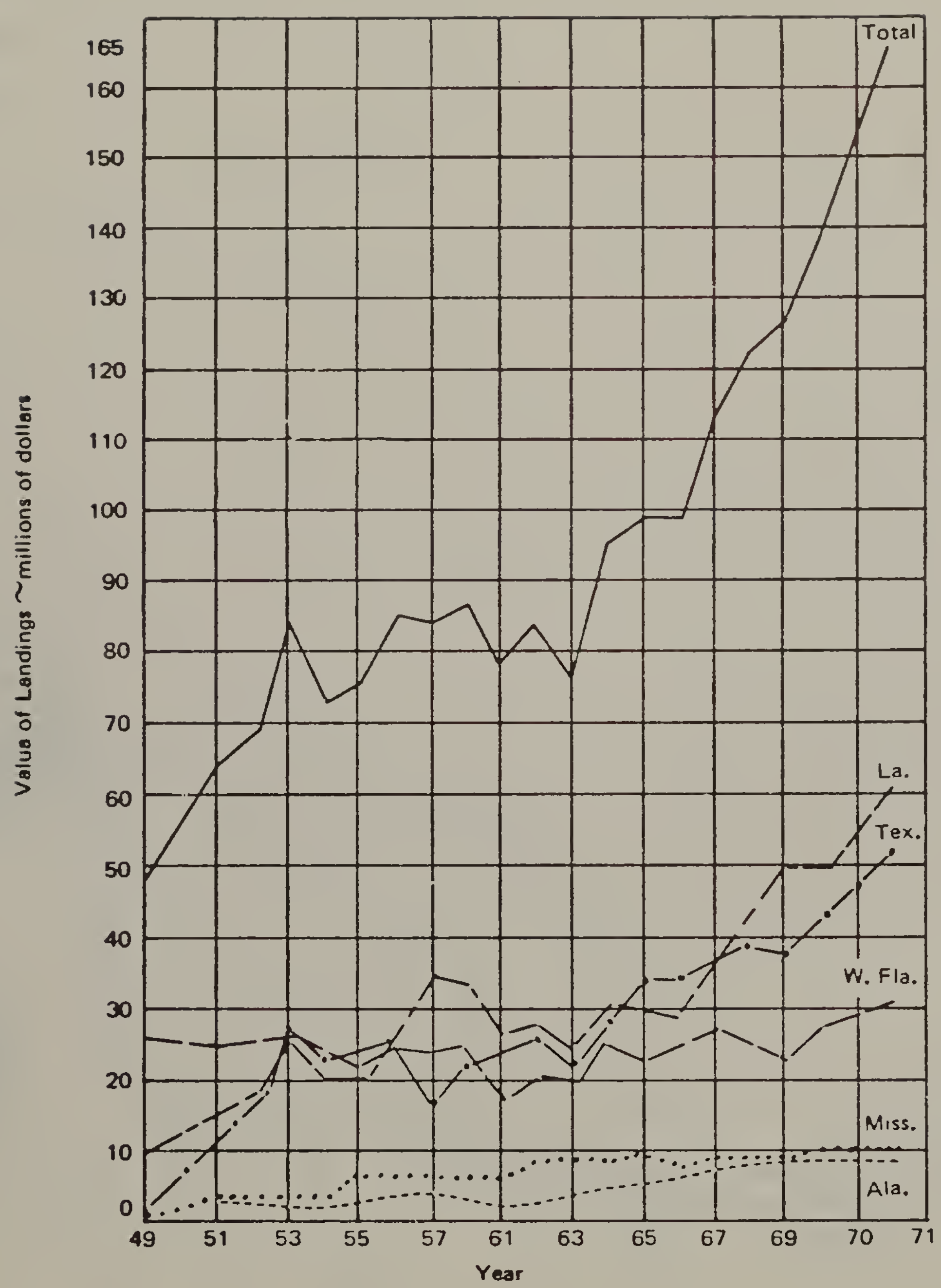
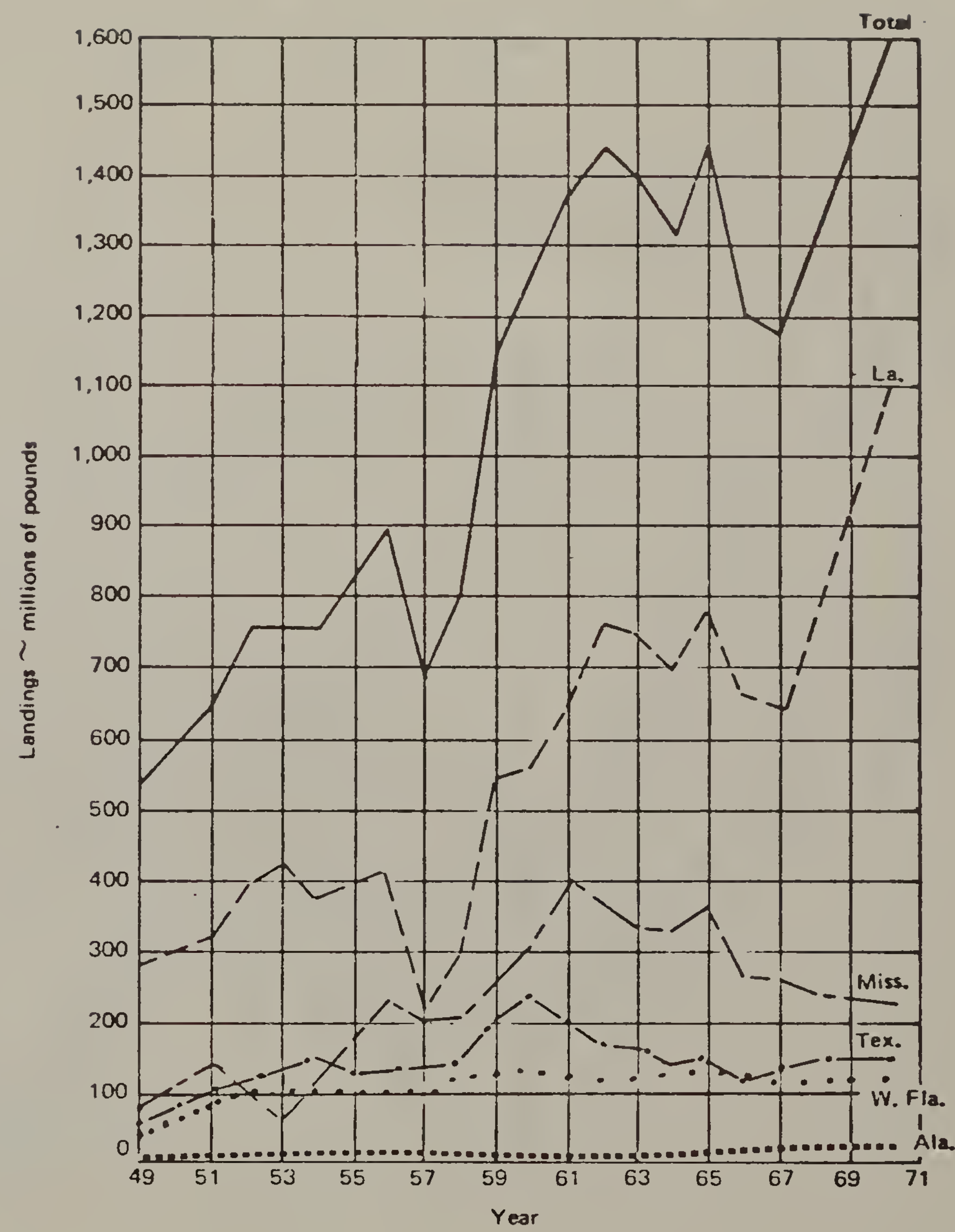


Figure 38

Shrimp



Value of Gulf Landings (1948-1970)



Gulf Landings, All Species (1948-1970)

Figure 39. Value and Volume of Gulf Landings. (From Taylor, J. L., et. al., 1973)

e. Aquaculture

The coastal zone of the northeastern Gulf has considerable potential for aquaculture. There are at present a number of experimental and commercial attempts at aquaculture being made. The focus of most of these ventures is on the production of high yield, high priced species, such as shrimp, oysters, stone crabs, spiny lobsters, and pompano.

To date, shrimp farming appears to be the most commercially successful. Marifarms Incorporated of Panama City, Florida is the largest commercial shrimp farming enterprise in the world. Its project involves 2500 acres and plants, cultivates, harvests and processes the shrimp. Production in 1971 amounted to 500,000 pounds, mostly white shrimp (Taylor, J. L., et. al., 1973).

Some of the other aquaculture projects (experimental or commercial) on the Gulf coast are located at Cedar Key (oysters), Key West (bait shrimp), Tampa Bay (oysters), lower Mobile Bay (pompano), and Crystal Bay, Florida (shrimp).

6. Oil and Gas Resources

As of April 30, 1973, there were 6,003 wells with 9,721 completions capable of producing oil and gas in the OCS of the Gulf of Mexico. All of these are located offshore Texas and Louisiana. There are no leases in Federal areas offshore Mississippi, Alabama, or Florida. Oil and gas production in 1971 from the OCS leases in the Gulf of Mexico accounted for approximately 387 million barrels of oil and 2.8 trillion cubic feet of gas with 1.5 billion gallons of gas liquids, with a total market value of $2.01 billion. Since the inception of the OCS leasing program, the cumulative value of offshore production in the Gulf of Mexico through 1971 has been $10.3 billion.

7. Historical and Projected Economic Growth

The OBERS Projections of Regional Activity in the United States 1/ was used as the basis for this discussion. These regional projections covered population, employment, and income for major industries for the years 1980, 1990, and 2000, with 1969 as the base year. Analysis on the regional level uses the unit of the "BEA economic area", developed by the Bureau of Economic Analysis of the U. S. Department of Commerce. The emphasis on cities as the hubs around and within which integrated economic activity concentrates, provided the conceptual framework for the deleneations of these BEA economic areas.

The areas landward of the proposed sale are contained in five of these BEA Economic Areas, Nos. 137 (Mobile, Alabama), 39 (Pensacola, Florida), 38 (Tallahasse, Florida), 34 (Jacksonville, Florida), and 37 (Tampa - St. Petersburg, Florida), as shown in the following figures (Fig. 40). For each of these areas, two tables, reproduced from the OBERS report, appear in Attachment H. To obtain regional data, national projections were made for components of the gross national product, which were then converted into income originating from

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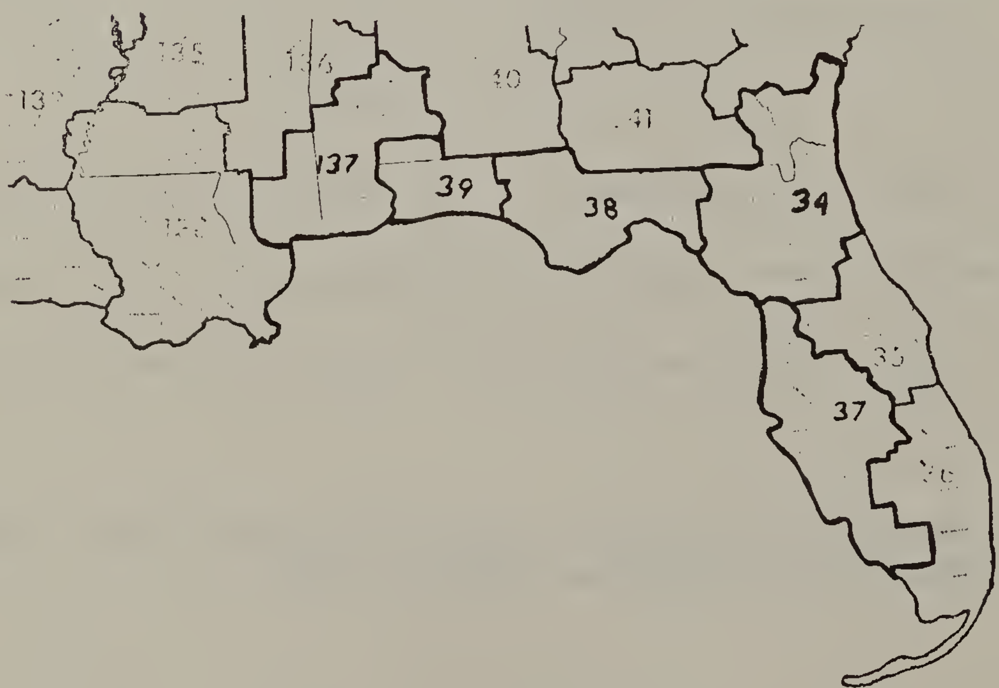
1/ U. S. Water Resources Council, 1972 OBERS Projections, Regional Economic Activity in the United States, 1972.

major industries. National projections were disaggregated into regional projections using a proportionate growth factor between the region and the nation for each industry or growth component.

It was assumed that most factors influencing this proportionate growth factor would continue, that regional earnings per worker and income per capita would tend to converge on the national average, that regional employment/population would move toward the national ratio, and that workers will migrate to areas of expanding job opportunities.

Figure 40. BEA Economic Areas in the MAFLA Region



BEA Economic Area 137

BEA Economic Area 137 is found in southeastern Mississippi and southwestern Alabama. The Mississippi counties are: George, Green, Harrison, Jackson, and Stone. The Alabama counties are: Baldwin, Clarke, Conecuh, Mobile, Monroe, Washington, and Wilcox. Population per square mile was 67 persons in 1970. The two most densely populated counties, Mobile County in Alabama and Harrison County in Mississippi, accounted for over 62 percent of the economic areas's population in 1970.

Population in Economic Area 137 was 724 thousand in 1970, an increase of 8.9 percent from 1960, compared with a 13.3 percent increase for the U. S. Total employment was 250,260 according to the 1970 census of population. Manufacturing comprised 22.3 percent of total employment, wholesale and retail trade, 18.1 percent; professional services, 14.2 percent; and business services, 9.3 percent. OBERS projections indicate that the area's total employment will increase at an average annual rate of 1.58 percent from 1970 to 2020. Manufacturing employment and professional services are expected to increase more rapidly than the total.

Earnings in the economic area derived from the Government (27.7 percent of the total), manufacturing (27.2 percent), wholesale and retail trade (13.9 percent), and services (11.6 percent). OBERS projections show an average annual increase in earnings of 4.30 percent from 1970 to 2020.

Petroleum refineries operating in 1970 were located in Jackson County, Mississippi and Mobile County, Alabama. Operable capacity of the three refineries was 154,000 barrels per calendar day, according to the Bureau of Mines. Crude oil input for 1970 was estimated at 53.4 million barrels. Employment was 1,623 persons, averaging 32,900 barrels of crude oil input per employee in 1970. Based on OBERS projections of employment, annual crude oil input per employee will rise to 125,000 barrels in 2020.

BEA Economic Area 39

BEA Economic Area 39 is located in the Western Florida panhandle but also includes one Georgia county, Escambia. The Florida counties are: Escambia, Santa Rosa, Oklaloosa, and Walton.

Population density was 82 persons per square mile in 1970. By far the most densely populated country (309 persons per square mile) in the area, Escambia County joins Santa Rose county to form the Pensacola Standard Metropolitan Statistical Area. The two largest counties contained nearly 77 percent of the area's population.

Population in 1970 was 382 thousand, an increase of 21.9 percent compared to the U. S. rate of 13.3 percent. Average rate of growth to 2020 was projected to be .88 percent.

Total employment was 142,272. Armed forces comprised 20.4 percent ot total employment; wholesale and retail trade, 16.8 percent; professional services, 13.3 percent; and manufacturing, 12.6 percent.

Average annual rate of increases of total employment is projected to be 1.03 percent to 2020. Armed forces employment is expected to provide a smaller percent of total jobs in 2020. Manufacturing, and wholesale and retail trade will grow at about the same rate as the total.

Earnings from Government contributed the largest portion of total earnings (44.9 percent in 1970), followed by manufacturing, 17.6 percent; wholesale and retail trade, 12.2 percent; and services, 11.2 percent.

Earnings are projected to increase at an average annual rate of 3.87 percent to 2020. Rates for the leading sectors are: Government 3.63 percent; manufacturing, 3.72 percent; wholesale and retail trade, 4.21 percent; and services, 4.58 percent.

BEA Economic Area 38

BEA Economic Area 38 is located in the Florida panhandle and includes the counties of Bay, Calhoun, Franklin, Gadsden, Gulf, Holmes, Jackson, Jefferson, Leon, Liberty, Madison, Taylor, Wakulla, and Washington.

Population density in the economic area was 37 persons per square mile in 1970. The two most densely populated counties, Bay and Leon, which is the Tallahassee Standard Metropolitan Statistical Area, had densities of 154 and 101 persons per square mile.

Population was 344,000 in 1970, an increase of 10.8 percent from 1960. Average annual rate of population growth from 1970 to 2020 was projected to be 1.65 percent.

Total employment in 1970 was 126,399. Of this total, professional services comprised 22.4 percent; wholesale and retail trade, 18.9 percent; manufacturing, 10.6 percent; and civilian Government, 10.0 percent. Total employment from 1970 to 2020 is expected to increase at an average annual rate of 1.72 percent. Employment in manufacturing is expected to increase at a slower rate than the total, and professional services, civilian Government, and wholesale and retail trade at a more rapid rate.

Earnings in the economic area came from Government (43.0 percent of the total), wholesale and retail trade, 16.0 percent; manufacturing, 12.6 percent; and services, 10.4 percent. From 1970 to 2020 earnings are projected to increase at an average annual rate of 4.92 percent. Earnings from Government will rise at 5.05 percent; manufacturing, 4.11 percent; services, 5.54 percent.

One refinery was operating in 1970 at St. Marks in Wakulla County. According to the Bureau of Mines, operating capacity was 3,000 barrels per calendar day. Employment is projected to increase from 111 in 1970 to 200 in 2020, but total crude input is projected to increase from 942,000 barrels to about 9,000,000 barrels in 2020, with a corresponding five fold increase in crude oil input per employee.

BEA Economic Area 34

BEA Economic Area 34 is located in southeastern Georgia and northeastern Florida. The counties in Florida are: Alachua, Baker, Bradford, Clay, Columbia, Dixie, Duval, Gilchrist, Hamilton, Lafayette, Levy, Marion, Nassau, Putnam, St. Johns, Suwanee, and Union. The counties in Georgia are: Brantly, Camden, Chareton, Glynn, McIntosh, Pierce, and Wau.

Population per square mile was 67 persons in 1970. Two Florida counties, Alachua County and Duval County, contained over 60 percent of the economic area's population in 1970. Duval County, which is the Jacksonville, Florida Standard Metropolitan Statistical Area, had a density of 690 persons per square mile.

Population in the economic area was 1.05 million in 1970, an increase of 19.1 percent from 1960. Total employment was 404,728 in 1970. Wholesale and retail trade comprised 20.9 percent of total employment; and manufacturing, 13.8 percent. OBERS projections indicate that employment will increase at an average annual rate of 1.53 percent from 1970 to 2020. Manufacturing and business services employment are expected to increase at about the same rate as total employment.

Personal income is projected to grow at an average annual rate of 4.53 percent, compared with 4.24 percent for the U. S. as a whole, in the years from 1970 to 2020.

Earnings in the economic area originate from the Government (27.9 percent), wholesale and retail trade (19.1 percent) and manufacturing (14.9 percent). Earnings are expected to increase at an average annual rate of 4.42 percent. Average annual growth rates of earnings from different sectors are: Government, 4.64 percent; manufacturing, 4.12 percent; services, 5.05 percent; and wholesale and retail trade, 4.41 percent.

BEA Economic Area 37

BEA Economic Area 37 is located in the western Florida peninsula and includes the counties of Charlotte, Citrus, Collier, DeSoto, Hardee, Hernando, Highlands, Hillsborough, Lee, Manatee, Pasco, Pinellas, Polk, and Sarasota.

Population per square mile was 149 persons in 1970, an increase of more than 159 percent from 1950 density of 58 persons per square mile. (Pinellas is the most densely populated county (1,971 persons per square mile) followed by Hillsborough (472 persons)). These two counties make up the Tampa-St. Petersburg Standard Metropolitan Statistical Area.

Population in the economic area was 1.80 million in 1970, an increase of 38.4 percent from 1960. Population forecasts show an average annual growth rate of 1.70 percent from 1970 to 2020.

Total 1970 employment was 608,529. Of this, wholesale and retail trade comprised 24.5 percent; professional services, 16.4 percent; business services, 11.5 percent: manufacturing, 10.9 percent; contract construction, 9.1 percent.

Employment is projected to grow at an average annual rate of 1.86 percent from 1970 to 2020. Business services, manufacturing, and contract construction are projected to grow at about the same rate as total employment.

Earnings in the economic area originate from wholesale and retail trade (21.1 percent of the total), services (17.7 percent), manufacturing, (15.8 percent), and Government (15.5 percent).

Earnings are projected to increase at an average annual rate of 4.70 percent from 1970 to 2020. Rates for the individual sectors are wholesale and retail trade, 4.47 percent; services, 5.20 percent; manufacturing; 4.63 percent; and Government, 5.29 percent.

Commercial Fisheries

Fisheries are a major factor in the Florida economy. Black mullet was the leading finfish caught in the Florida Gulf. Other species important in the Florida commercial fishing industry are Spanish mackerel, grouper, red snapper, spotted sea trout, king mackerel, blue runner, and pompano. Among crustaceans, shrimp is the most important. Of all the states, Florida ranked seventh in 1971 and eighth in 1972 in volume of commercial landings and sixth in 1971 and fifth in 1972 in value of landings.

Commercial fishing is less important in the economy of Alabama. Shrimp has accounted for over half of all commercial landings in Alabama, although only a small part is caught in Alabama waters.

Mississippi ranked fifth in 1971 and 1972 in volume of landings and fourteenth in 1971 and sixteenth in 1972 in value of commercial landings. Commercial fisheries have a vital role in the economy of the southern counties. The leading species caught are oysters, shrimps, crab, and menhaden, which is the largest part, by weight, of the total catch. The volume of fish caught off Mississippi has increased steadily since 1880 except for a few years.

The following table (Table 32) shows volume and value of 1971 commercial landings in Mississippi, Alabama, and Florida's West Coast.

Table 32. Value and Volume of Commercial Fishery Landings by State

1971

	Fish		Shellfish	
	Pounds	*Dollars	Pounds	*Dollars
Mississippi	384,464,715	7,404,997	12,435,125	5,296,146
Alabama	15,137,135	1,875,215	19,100,638	11,936,931
Florida West Coast	63,203,994	10,418,189	44,281,280	20,769,657

*Value represents amount received for the catch delivered to the dock.

Source: Current Fisheries Statistics No. 5919, Florida Landings, Annual Summary 1971; No. 5920, Alabama Landings, Annual Summary 1971; No. 5921, Mississippi Landings, Annual Summary 1971, NOAA, U. S. Dept. of Commerce, Washington, D. C., 1972.

Other water-oriented activities provide both income and recreation in the MAFLA area. The close proximity to water, the mild semi-tropical climate, and the variable terrain attract many tourists and residents to the coast. Commercially operated fishing camps, docks, piers, boat ramps, charter boats, campgrounds, and equipment rentals serve the outdoor recreation demands. Expenditures for boats, firearms and ammunition, fishing tackle, camping equipment, plus incidental costs for food, lodging, and gasoline provide further economic benefits. The tourist industry is also an important source of tax revenue. In 1969, 34 percent of Florida's retail sales tax, and 5 percent of Mississippi's sales tax was collected from out-of-state tourists. In 1970, 10 percent of Alabama's sales tax was collected from tourists.

The following table (Table 33) shows number and expenditures of out-of-state tourists in the coastal counties of Mississippi, Alabama, and Florida. The importance of these counties in the tourist industry, especially in Florida, is evident. In 1969, the 23 Florida counties listed attracted one-quarter of total tourists visiting the state; the three Mississippi counties attracted 20.5 percent of total tourists visiting Mississippi; the two Alabama counties attracted only 9.9 percent of total tourists visiting Alabama. Tourists

Table 33. TOURISM DURING 1969 FOR 28 COUNTY, TRI-STATE AREA

State County	1969 No. of Out-of-State Tourists	1969 Expenditures by Out-of-State Tourists ($1,000)	1969 % of Total Tourists in Each State
Mississippi (State totals)	19,700,000	187,000	
Hancock	153,090	1,458	0.10
Harrison	3,118,395	29,699	15.80
Jackson	904,000	8,611	4.60
Sub-Total	4,175,485	39,768	20.50
Alabama (State totals)	30,200,000	310,000	
Mobile) Baldwin)	2,990,000	30,500	9.90
Sub-Total	2,990,000	30,500	9.90
Florida (State totals)	21,965,910	5,242,164	
Escambia	273,515	65,270	1.20
Santa Rosa	7,657	1,827	0.03
Okaloosa	172,244	41,100	0.80
Walton	25,736	6,141	0.12
Bay	664,196	158,500	3.00
Gulf	5,271	1,257	0.02
Franklin	4,700	1,121	0.02
Wakulla	3,887	927	0.02
Jefferson	9,654	2,303	0.04
Taylor	11,883	2,835	0.05
Dixie	7,162	1,709	0.03
Levy	9,295	2,218	0.04
Citrus	43,089	10,280	0.19
Hernando	18,344	4,377	0.08
Pasco	108,275	25,830	0.50
Pinellas	1,800,379	429,600	8.20
Hillsborough	720,883	172,000	3.30
Manatee	264,118	63,030	1.20
Sarasota	504,212	1,827	2.30
Charlotte	65,901	15,720	0.30
Lee	418,948	99,980	1.90
Collier	147,474	35,190	0.70
Monroe	384,945	91,860	1.80
Sub-Total	5,671,768	1,080,102	25.84
GRAND TOTAL	12,837,253	1,150,370	

Reproduced from: Army Corps of Engineers, Report on Gylf Coast Deep Water Port Facilities - Texas, Louisiana, Mississippi, Alabama, and Florida, Appendix F, Volume I, p. II-1-200.

in all the counties listed spent $1,150,370,000 in 1969, 20.1 percent of all expenditures by tourists in the three states. The counties listed attracted 17.9 percent of the tourists visiting Mississippi, Alabama, and Florida.

Income and Employment

More specific to the coastal region, Table 34 shows some economic and social parameters for the coastal counties landward of the proposed sale area. Those Mississippi and Alabama counties with the highest population and industrial base are seen to generally exceed their state averages in median family income. In Florida, all coastal counties fall below the state average median income, with the sparsely populated counties generally well below the state averages. Unemployment rates are generally better than the state averages.

Table 34. SOCIAL AND ECONOMIC PROFILES FOR COASTAL COUNTIES - 1970

State	County	Total Population	% of Civilian Working Force Unemployed	Median Family Income	% of Families With Income Less Than Poverty Level
Mississippi		2,216,850	5.0	6,071	29
	Hancock	17,387	5.6	6,485	21
	Harrison	134,582	4.2	7,233	17
	Jackson	87,975	4.6	8,548	11
Alabama		3,444,148	4.5	7,266	21
	Mobile	317,308	5.5	7,811	19
	Baldwin	59,382	4.3	7,338	18
Florida		6,789,383	3.8	8,267	13
	Escambia	205,334	5.2	8,027	12
	Santa Rosa	37,741	3.9	7,707	16
	Okaloosa	88,187	6.5	7,876	12
	Walton	16,087	3.3	5,828	26
	Bay	75,283	4.3	7,416	15
	Gulf	10,096	2.2	7,322	20
	Franklin	7,065	3.7	4,338	31
	Wakulla	6,308	2.9	6,128	26
	Jefferson	8,778	2.8	5,519	35
	Taylor	13,641	2.3	6,814	24

Table 34 Cont'd

Dixie	5,480	3.1	5,666	26
Levy	12,756	2.8	5,821	23
Citrus	19,196	5.4	5,563	19
Hernando	17,004	3.7	5,863	21
Pasco	75,955	4.8	4,998	18
Pinellas	522,325	3:5	7,642	9
Hillsborough	490,260	3.7	8,162	13
Manatee	97,115	2.8	6,591	13
Sarasota	120,413	2.2	7,739	12
Total Coastal Counties	2,445,658			

G. Existing Environmental Quality Problems in Nearshore and Coastal Zones 1/

1. Water Pollution

Water quality degradation occurs from sewage and industrial pollutions, dredging operations, pesticides, urban and agricultural run-off, changes in hydrological regime, shipping, offshore oil operations, etc. We have been able to gather limited information and quantification of the following water quality problems.

a. Mississippi

According to the Environmental Protection Agency, the water quality in the estuaries and bays of Mississippi is degraded primarily by the discharge of inadequately treated industrial waste. The pollution contribution from municipal sources is rather minor. So far, biological damage has not been detected in commercial fish species. However, industrial pollution, a major contributor of coliform bacteria, has forced the closing of beds containing almost half of the available oysters in some years. Other significant waste sources along the Mississippi Gulf coast are the Long Beach-Bay Saint Louis area, Biloxi-Gulfport area, and Pascagoula-Moss Point area.

b. Alabama

Water quality degradation in the Mobile Bay area is primarily the result of municipal and industrial discharges from sources

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1/ Sources of Information: Mississippi: Stursa (1973); Alabama: Crance (1971); Stursa (1973), Swingle (Unpub. Rep. of Ala. Mar. Resources Lab, 1972); Florida: McNulty, Lindal, and Sykes (1972), Stursa (1973), Taylor (1970). Also, Environmental Protection Agency review of the Draft Statement.

in Mobile. Sewage outfalls from commercial development along the Alabama Gulf coast are minor and result in only localized water quality degradation.

There were 23 sources of domestic pollution in Mississippi Sound, Mobile Bay and the Mobile River Delta as of a July, 1970 inventory. The effluent from 19 of these sources averaged 25.592 million gallons per day, and amount of treatment ranged from untreated to a high degree of secondary treatment. Unknown amounts of domestic sewage also enter the waters from ships, septic tanks, seafood processing plants and other sources. This has resulted in the permanent closing to shellfishing of about 28% of Mobile Bay. From time to time, other major oyster reefs have been closed temporarily.

Waters of Mississippi Sound, Mobile Bay and its rivers receive discharges from more than 30 industrial plants (July, 1970 inventory). The average daily effluent from 16 of these sources was 801.7297 million gallons with two major paper mills being the largest contributors. The effects of these industrial effluents upon the marine biota and environment have apparently not yet been assessed. However, on July 1, 1970, the Federal Water Quality Administration and the Alabama Public Health Department informed the public that fish from certain areas of the Mobile Delta contained levels of mercury as high as 2.5 ppm and were unsafe for human consumption. Chemical plants using mercury in the manufacture of chlorine were suspected.

The presence of certain pesticides in oysters in Mobile Bay were studied in 1969. Conclusions were that the levels of pesticides found presented no immediate health problem.

c. Florida

Domestic pollution is greatest in the Tampa Bay system and industrial pollution is greatest in the northern estuaries. In a 1971 study, 402 sources of pollution were identified along the Florida Gulf Coast. In the study it was estimated that polluted areas make up 31% of the area of all west coast estuaries. If Florida Bay is excluded, then the polluted area amounts to 43% of the total estuarine area. Ten of the estuarine areas strongly affected by pollution are: Caloosahatchee River, Sarasota Bay system, Hillsborough Bay, Old Tampa Bay, Boca Ciega Bay, Fenholloway River, St. Joseph Bay, St. Andrew Bay, Escambia Bay, Pensacola Bay, and Perdido Bay.

Besides bacterial levels, very few studies on other pollutants have been done for Florida's Gulf coast. DDT-effects on brown pelican eggs have been investigated; apparently the problem is most critical in southeastern Florida but also has been noted in Pinellas County. A PCB has been detected in the biota, water, and sediments of Escambia Bay. In 1970 Tampa Bay was polluted by 5,000-10,000 gallons of Bunker C fuel oil, causing considerable damage to seabirds and beaches, but not long term results of this spill have been reported. Minor oil spills have occurred in Pensacola Bay and St. Joseph Harbor. Perdido Bay receives discharge from a paper mill located on the Florida side along with inadequately treated waste discharged into Bayou Marcus. There are no significant discharges, industrial or municipal, into Perdido Bay from Alabama sources.

2. Dredging

Deterioration of the environment by dredging can result from removal of benthos and benthic habitat in the path of the dredge, turbidity of the water and burial of the benthic community where the spoil is discharged, loss of aquatic habitat by emergent spoil banks and fingerfill real estate development, alteration of natural drainage and tidal patterns by deep channels and spoil banks, erosion and saltwater intrusion in wetland areas, resuspension of toxic materials previously buried in the sediments, and perhaps others. Dredging is carried out for several purposes: landfill operations, creation and maintenance of navigation channels and canals, sand and shell dredging, and pipeline laying.

a. Mississippi

The lack of large urban areas on the Mississippi Gulf coast has kept the need for filling marshland to a minimum. Dredging of channels and maintenance of "Gold Coast" artificial beaches have been done at intervals, but very little has been reported with regard to biologically harmful effects of this dredging.

Pipelines have been laid across Mississippi Sound from coastal Louisiana oil fields to the Pascagoula refinery.

b. Alabama

The most harmful dredging project in Alabama has been the Mobile Ship Channel, which, along with its spoil banks has seriously altered circulation and sedimentation patterns within the bay. Apparently, above average rates of sediment accumulation are occurring in the southwestern portion of Mobile Bay. The effects of dredging on aquatic animals in the Mobile Bay system have been investigated on at least two occasions; the investigators observed no adverse effects in either case.

c. Florida

The rise in boat registrations in Gulf coast counties, up more than 1000% from 1960 to 1970, has resulted in a demand for marinas and channels to accommodate navigation and anchorage. Navigation channel dredging, begun in the 1800's, has been accelerating at a rapid pace during the twentieth century, especially since the middle 1950's. During one project, the West Coast Inland Waterway from Anclote to Fort Myers, 14 million cubic yards of material was displaced. A great deal of additional dredging and filling has been done to provide waterfront real estate development with housing sites and waterway access.

About 20% of Boca Ciega Bay has been destroyed by dredge-fill development. As a result, the normal pattern of tidal circulation has been drastically changed and an enormous volume of silt and clay has been redeposited in a natural basin north of the Pinellas County Bayway, and in the access canals between fingerfills. The dredged area and the area where material was placed were effectively lost as habitat, the dredged channel was generally too deep for regrowth of marine grasses, and spoil areas were inundated. During one study it was estimated that the annual standing crop destroyed was 1,133 metric tons of seagrasses and 1,812 metric tons of associated marine life.

Statewide, as of 1967, of 796,000 acres of original estuarine habitat, 59,700 acres have been lost to dredging. In addition, another estimated 23,521 acres of Florida's Gulf coast have been filled by housing, industry and other development through 1967.

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