United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, GA 30365

EPA 904/9-86-143
December 1986

EPA

Environmental Impact Statement (EIS) for the Pensacola, Fl., Mobile, Al., and Gulfport, Ms. Dredged Material Disposal Site Designation

Final

NEPA COLLECTION
Transportation Library
Northwestern University Library
Evanston, IL 60201

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET
ATLANTA, GEORGIA 30365

Final Environmental Impact Statement for the Pensacola, FL, Mobile, AL, and Gulfport, MS Dredged Material Disposal Site Designation

Prepared by

U.S. Environmental Protection Agency
Region IV
Atlanta, Georgia 30365

Cooperating Agency

U.S. Army Corps of Engineers
Mobile District

Attached is the final environmental impact statement (EIS) for the Pensacola, FL, Mobile, AL, and Gulfport, MS ocean dredged material disposal site designations. This EIS presents the information needed to evaluate and recommend areas for disposal of dredged material in the Gulf of Mexico offshore Pensacola, Mobile, and Gulfport.

Comments on this EIS will be received until 30 days from the date of the publication of its Notice of Availability in the Federal Register which is expected to be February 6, 1987. Comments should be addressed to:

Ms. Sally Turner, Chief
Marine Protection Section
U.S. Environmental Protection Agency
345 Courtland Street NE
Atlanta, Georgia 30365

Commercial (404) 347-2126
FTS 257-2126

Please disregard the address printed on page viii of the EIS.

APPROVED BY:

Lee A. DeHihns III, Deputy

Jack E. Ravan
Regional Administrator

JAN 27 1987
Date

SUMMARY SHEET

ENVIRONMENTAL IMPACT STATEMENT
for
PENSACOLA, FLORIDA
MOBILE, ALABAMA
GULFPORT, MISSISSIPPI
OCEAN DREDGED MATERIAL DISPOSAL
SITES DESIGNATION

( ) Draft

(x) Final

( ) Supplement to Draft

ENVIRONMENTAL PROTECTION AGENCY
CRITERIA AND STANDARDS DIVISION

1. Type of Action

(X) Administrative/Regulatory Action

( ) Legislative Action

2. Description of proposed action.

The proposed action is the designation of the (1) Pensacola, Florida, (2) Mobile, Alabama, and (3) Gulfport, Mississippi Ocean Dredged Material Disposal Sites (ODMDS), to be managed by the U.S. Environmental Protection Agency (EPA), Region IV. The boundary coordinates for the Pensacola Alternative Site are: 30°17'24"N, 87°18'30"W; 30°17'00"N, 87°19'50"W; 30°15'36"N, 87°17'48"W; 30°15'15"N, 87°19'18"W. This site covers an area of 2.48 nmi^2, is approximately 1.5 nmi from Perdido Key, and is proposed to receive final designation for the disposal of dredged materials resulting from dredging in the Pensacola area.

The boundary coordinates for the Mobile Existing Site are: 30°10'00"N, 88°07'42"W; 30°10'24"N, 88°05'12"W; 30°09'24"N, 88°04'42"W; 30°08'30"N, 88°05'12"W; 30°08'30"N, 88°08'12"W. This site covers an area of 4.75 nmi^2, is approximately 4 nmi from Mobile Point, and is proposed to receive final designation for the disposal of dredged materials resulting from dredging in the Mobile area.

The boundary coordinates for the Existing Gulfport Site (eastern) are: 30°11'10"N, 88°58'24"W; 30°11'12"N, 88°57'30"W; 30°07'36"N, 88°54'24"W; 30°07'24"N, 88°54'48"W; Existing Gulfport Site (western) 30°12'00"N, 89°00'30"W; 30°12'00"N, 89°59'30"W; 30°11'00"N, 89°00'00"W; 30°12'00"N, 88°56'30"W; 30°06'36"N, 88°57'00"W; 30°10'30"N, 89°00'36"W. Each site covers an area of 2.47 and 5.22 nmi^2, respectively, is approximately 1 nmi from Ship Island, and is proposed to recieve final designation for the disposal of dredged materials resulting from dredging in the Gulfport area.

The purpose of the action is to provide an environmentally acceptable ocean location for the disposal of dredged materials, which complies with the environmental impact criteria of the Ocean Dumping Regulations (40 CFR Parts 220-229).

3. Environmental effects of the proposed action.

Adverse environmental effects of the proposed action may include: (1) mounding, (2) smothering of some members of the benthos, and (3) increases in suspended sediment concentrations. Adverse impacts within the site are unavoidable, but the disposal operations will be regulated to prevent unacceptable environmental degradation outside the site boundaries.

4. Alternatives to the proposed action.

The alternatives to the proposed action are: (1) no action, which would allow the interim designation of the Existing Pensacola, Mobile, and

Gulfport ODMDSs to expire in January 1985, after which, use of the sites would be discontinued, (2) permanent designation of the interim sites, or (3) designation of alternative ocean sites for disposal of dredged materials.

5. Federal, State, public, and private organizations from whom comments have been requested:

Federal Agencies and Offices

Advisory Council on Historical Preservation
Council on Environmental Quality
Department of Commerce
  Maritime Administration
  National Oceanic and Atmospheric Administration (NOAA)
Department of Defense
  Army Corps of Engineers (CE)
  Department of the Navy
Department of Health and Human Services
Department of the Interior
  Bureau of Land Management
  Bureau of Outdoor Recreation
  Fish and Wildlife Service
  Geological Survey
Department of State
Department of Transportation
  Coast Guard
National Science Foundation

States and Municipalities

Florida Department of Environmental Regulation
Office of the Governor, Florida
Pensacola Chamber of Commerce
Secretary of State, Florida
West Florida Regional Planning Office
Alabama Conservation and Natural Resources Department

Alabama State Historical Commission

City of Mobile

Mobile Area Chamber of Commerce

South Alabama Regional Planning Commission

Gulf Regional Planning Division

Southern Mississippi Planning and Development

Gulf of Mexico Fishery Management Council

Private Organizations

American Littoral Society

Audobon Society

Environmental Defense Fund

National Academy of Sciences

National Wildlife Federation

Resources for the Future

Sierra Club

Water Pollution Control Federation

Academic/Research Institutions

Dauphin Island Sea Lab, Alabama

State University of Florida

6. The Final statement was officially filed with the Director, Office of Environmental Review, EPA.

7. Comments are due 30 days from the date of EPA's publication of Notice of Availability in the Federal Register which is expected to be ____________.

Comments should be addressed to:

Mr. John M. Hill
Criteria and Standards Division (WH-585)
Environmental Protection Agency
Washington, D.C. 20460

Copies of the Final EIS may be obtained from:

Environmental Protection Agency
Criteria and Standards Division
Washington, DC 20460
(202) 755-2927

The Final Statement may be reviewed at the following location:

Environmental Protection Agency, Region IV
345 Courtland Street
Atlanta, GA 30365

SUMMARY

The Environmental Impact Statement (EIS) provides information required for the decisionmaking process, with respect to final designation of the Pensacola, Mobile, and Gulfport ODMDSs. The purpose of the proposed action is to provide the most feasible and environmentally acceptable location for the disposal of material dredged from the Pensacola Channel area, Mobile Channel area, and Gulfport Channel area. Summarized below are highlights of each chapter of the EIS, conclusions of the EIS, and organization of the EIS.

PURPOSE AND NEED FOR ACTION

Disposal sites in the ocean are needed to receive material dredged from the Pensacola Channel area, Mobile Channel area, and Gulfport Channel area. Without dredging, operating depths of the main entrance channel of the respective harbors would decrease, thus limiting economically important ship traffic to and from the ports of Pensacola, Mobile, and Gulfport. The U.S. Army Corps of Engineers (CE), which performs the dredging operations, has determined that disposal in the ocean is the most reasonable method at present (CE, 1980b; 1979b; 1976).

The Environmental Protection Agency (EPA), the agency responsible for designating ocean disposal sites, approved the Pensacola, Mobile, and Gulfport Existing Sites for interim use in 1977 (40 CFR Part 228) based on historical use of the these sites; the sites had been used since at least 1970, and perhaps from as early as the 1930's. The use of any site under interim designation will continue only if EPA grants that site a final designation. EPA must either terminate an interim site or designate it for continued use by January 1985.

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Alternatives to the proposed action include no action, or designation of an alternative ocean disposal site (other than Existing Sites). Past dredging projects in the Pensacola, Mobile, and Gulfport areas have demonstrated the need for the ocean disposal option. Therefore it is EPA's responsibility to designate an ocean disposal site in these areas so that the ocean disposal option can be considered along with other feasible alternatives. This EIS specifically addresses this need and does not consider non-ocean alternatives for disposal of dredged material.

By taking no action the present ocean sites would not receive final designations, nor would alternative ocean disposal sites be designated. Consequently, the CE would not have EPA-recommended ocean disposal sites available in the area, thus precluding ocean dumping as a disposal method for dredged material. Therefore, the CE would be required to: (1) develop information sufficient to select an acceptable site for disposal in the ocean, (2) modify or cancel a proposed dredging project which depends on disposal in the ocean as the most feasible method of disposal of dredged material.

Three general ocean environments off Pensacola, Mobile, and Gulfport are considered as potentially suitable areas in which to locate an ODMDS. These are: (1) nearshore area (located from 0 to 10 nmi offshore; depths less than 20m), (2) mid-Shelf area (located from approximately 10 to 50 nmi offshore; depths from 20 to 200m), and (3) deepwater area (located at a distance greater than 50 nmi offshore; depths greater than 200m). Within these areas there are locations that would not be suitable for an ODMDS because of interferences with other resources. For example, areas of significant bottom relief, such as artificial and natural reefs, obstructions, fish havens, and offshore banks are scattered throughout the nearshore and mid-Shelf regions; these areas are unique habitats which support valuable fishery resources and are sensitive to the effects of dredged material disposal. Also, the passes between the barrier islands were eliminated from further consideration because they represent important passageways for commercially important species which migrate between the Gulf and the Mississippi Sound, and its adjacent estuaries and bays. Alternative Sites/Areas located in nearshore, mid-Shelf, and deepwater environments were selected to minimize interferences with environmental and economic resources. The Existing and Alternative Sites/Areas are shown in Figure S-1. Two areas, the Mid-Shelf Alternative Area and Deepwater Alternative Area, are considered potential alternative regions in which to locate an ODMDS. An ODMDS within the Mid-Shelf Alternative Area, if selected, would receive dredged materials from Mobile and/or Gulfport entrance channels. An ODMDS within the Deepwater Alternative Area, if selected, would receive dredged materials from Pensacola, Mobile, and/or Gulfport entrance channels. Information describing the characteristics of the sites/areas, including geographic location, area, water depth, bottom topography, and distance from shore are presented in Table S-1.

The Existing and Alternative Sites/Areas are evaluated and compared by application of the 11 specific criteria for site selection listed at 40 CFR §228.6 of the Ocean Dumping Regulations. The following criteria are considered most important in the comparison:

- Criteria 1 (geographical position of the sites) and 5 (feasibility of surveillance and monitoring): The Existing Sites are located closer to the dredging channel and shore than the Alternative Sites. Surveillance and monitoring will be facilitated by use of the Existing Sites.

- Criterion 7 (existence and effects of current and previous dumping): Dredged material has been dumped at the Existing Sites, and no long-term or cumulative effects have been detected; impacts appear to be localized and short-term. Recolonization rates by benthic organisms after dredged material disposal at the Existing Pensacola Site may be improved by increasing the area of the site. With the exception of the Nearshore Pensacola Alternative Site, no dumping has occurred at the other Alternative Sites/Areas.

- Criterion 9 (existing water quality and ecology of the sites): Water quality at the Existing Sites and Nearshore Alternative Sites is influenced by nearshore mixing processes, river discharges, and storms. Waters of this high-energy environment are often turbid,

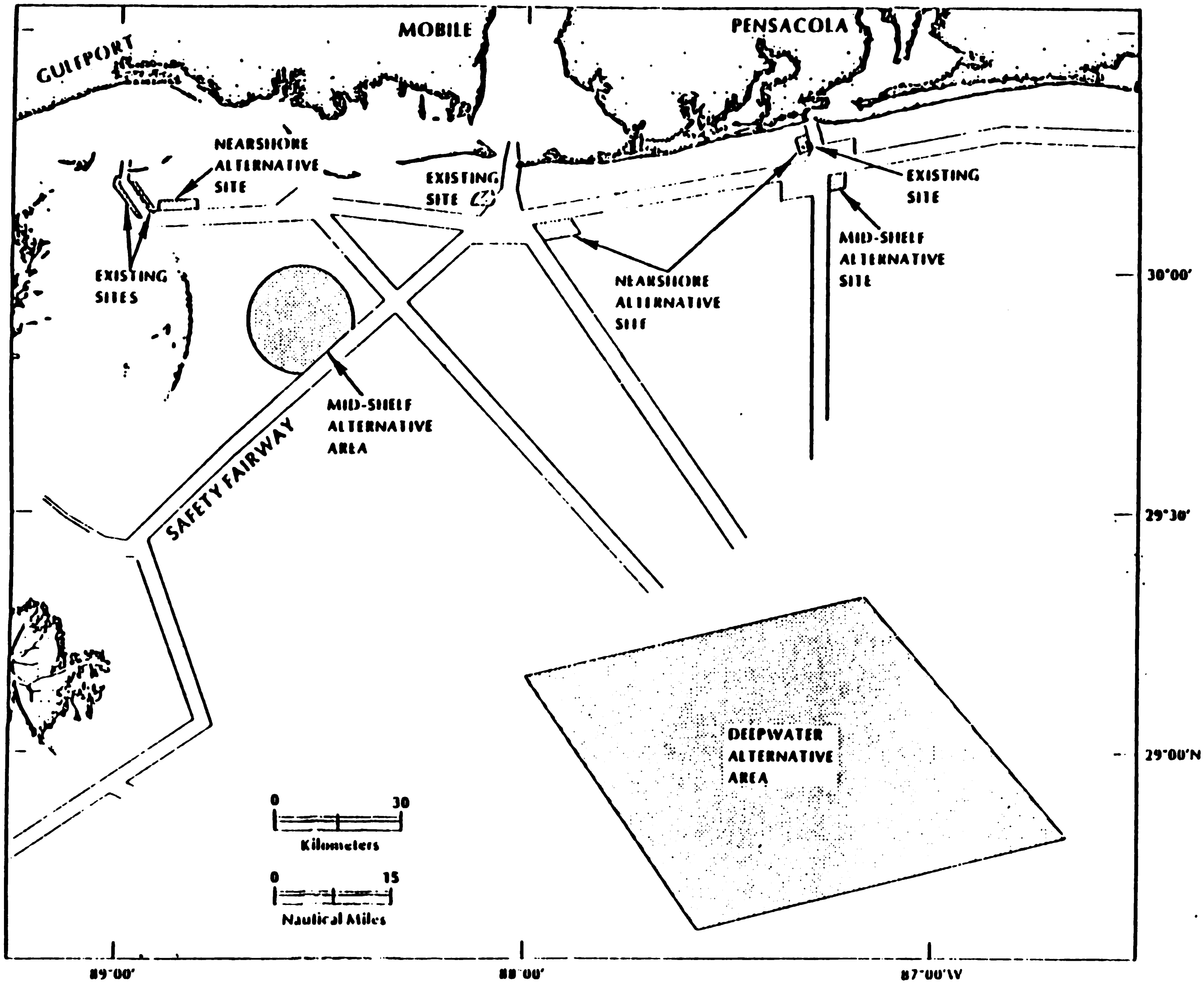


Figure S-1. Existing and Alternative Sites/Areas

TABLE S-1
GEOGRAPHICAL POSITION, DEPTH OF WATER, BOTTOM TOPOGRAPHY, AND DISTANCE FROM COAST

Site/Area	Boundary Coordinates	Water Depth (m)	Bottom Topography	Distance Offshore
Pensacola				
Existing Site	30°16'48"N, 87°19'00"W 30°16'42"N, 87°18'18"W 30°16'18"N, 87°18'12"W 30°16'30"N, 87°19'24"W 30°16'00"N, 87°19'24"W Area = 0.64 nmi^2	8 to 14	Slope 0.003 to SSW; sand	2.3 nmi from Perdido Key
Nearshore Alternative Site	30°17'24"N, 87°18'30"W 30°17'00"N, 87°19'50"W 30°15'36"N, 87°17'48"W 30°15'15"N, 87°19'18"W Area = 2.48 nmi^2	8 to 18	Slope 0.003 to SSW; sand	1.5 nmi from Perdido Key
Mid-Shelf Alternative Site	30°12'33"N, 87°15'42"W 30°10'33"N, 87°15'42"W 30°12'51"N, 87°13'26"W 30°10'54"N, 87°13'26"W Area = 4.00 nmi^2	21 to 23	Slope 0.003 to SSE; hard sand	7.2 nmi from Perdido Key
Mobile				
Existing Site	30°10'00"N, 88°07'42"W 30°10'24"N, 88°05'12"W 30°09'24"N, 88°04'42"W 30°08'30"N, 88°05'12"W 30°08'30"N, 88°08'12"W Area = 4.75 nmi^2	12 to 16	Slope 0.001 to SW; sand and silt	4.2 nmi from Mobile Point
Nearshore Alternative Site	30°05'15"N, 87°58'20"W 30°05'39"N, 87°55'45"W 30°06'18"N, 87°59'15"W 30°06'48"N, 87°56'39"W Area = 4.05 nmi^2	14 to 18	Slope 0.001 to SW; hard sand	7.2 nmi from Mobile Point

TABLE 2-1 (continued)

Site/Area	Boundary Coordinates	Water Depth (m)	Bottom Topography	Distance Offshore
		Mobile-Gulfport		
Mid-Shelf Alternative Area	29°54'00"N, 88°32'00"W (center coordinates of circular area) Area = 120 nmi^2 (approximate)	23 to 29	Slope 0.0007 to SE; sandy	24 nmi from Ship Island; 25 nmi from Mobile Point (approximate)
		Gulfport		
Existing Site (Eastern)	30°11'10"N, 88°58'24"W 30°11'12"N, 88°57'30"W 30°07'36"N, 88°54'24"W 30°07'24"N, 88°54'48"W Area = 2.47 nmi^2	7 to 9	Slope 0.0004 to SE; silt, clay, and fine sand	1.2 nmi from Ship Island
Existing Site (Western)	30°12'00"N, 89°00'30"W 30°12'00"N, 88°59'30"W 30°11'00"N, 89°00'00"W 30°07'00"N, 88°56'30"W 30°06'36"N, 88°57'00"W 30°10'30"N, 89°00'36"W; Area = 5.22 nmi^2	6 to 9	Slope 0.0006 to SE; silt, clay, and fine sand	0.7 nmi from Ship Island
Nearshore Alternative Site	30°09'30"N, 88°48'48"W 30°09'18"N, 88°54'30"W 30°08'00"N, 88°48'42"W 30°07'48"N, 88°54'24"W Area = 7.50 nmi^2	9 to 12	Slope 001 to SE; sand and silt	4.3 nmi from Ship Island
		Pensacola, Mobile, and Gulfport		
Deepwater Alternative Area	29°10'00"N, 88°00'00"W 29°20'00"N, 87°10'00"W 28°50'00"N, 86°40'00"W 28°38'00"N, 87°35'00"W Area = 1,500 nmi^2	493 to 2376	Slope 0.03 to SE; clay, silt, fine sand, and rock in Canyon	61 nmi from Perdido Key; 64 nmi from Mobile Point; 81 nmi from Ship Island (approximate)

and nutrient and trace metal concentrations are approximately an ordr of magnitude greater than more stable offshore waters. The biotic communities of the Existing Sites have been surveyed, and are characteristic of unstable sandy substrates (Results of IEC Surveys, 1980 EPA Construct Number 68-01-4610). Results of DMRP studies indicate that effects of dredged material disposal are minimized at disposal sites in naturally unstable (high-energy) environments. Site-specific surveys are limited for the alternatives; thus, additional studies may be necessary to provide adequate baseline information. However, mid-Shelf and deepwater areas typically more stable than nearshore areas with better water quality and decreased biomass of benthic organisms. It has been suggested that recovery of benthic populations following disposal may be slower in more stable environments.

Mitigating measures taken to protect the environments of the Existing Sites, Nearshore Alternative Sites, Mid-Shelf Alternatives Site/Area, and Deepwater Alternative Area may not be necessary because of the high natural variability of the shallow-water environment, and the diluting capacity of the receiving waters in the deepwater environments.

The CE District Engineer and EPA Regional Administrator may establish a monitoring program to supplement historical data. The primary purpose of the monitoring program is to determine whether disposal at the designated ODMDS significantly affects areas outside the ODMDS, and to detect significant long-term effects occuring in or around the site. Elements of the monitoring plan, if established, should include: (1) bathymetric surveys of the ODMDS and adjacent areas to detect shoaling (2) bioassay and bioacccumulation studiend on appropriate marine organisms using material dredged from the Pansacola, Mobile, and Gulfport entranct channels to determine toxicity; (3) analysis of trace metals in sediments taken from the ODMDS and adjacent areas to detect movement of dredged material outside of site boundaries, and to detect changes in sediment quality in the vicinity of the ODMDS; and (4) analysis of benthic communities to detect long-term effects of disposal on biota in the vicinity of the ODMDS. The elements described above do not necessarily apply to each ODMDS; a more detailed discussion of the monitoring plan for each ODMDS is included in Chapter 2.

AFFECTED ENVIRONMENT

The nearshore region is a high-energy environment affected by river discharges, tides, open Gulf circulation (e.g., Loop Current), and seasonal weather patterns. Currents are generally swift in this region, particularly near the barrier islands. A strong westerly longshore current (average speeds 1.0 to 2.5 kn) has been responsible for erosion and migration of the barrier islands. Existing and Alternative Sites in the nearshore region are located 1 to 7 nmi seaward of the islands, thus current speeds may be somewhat slower at these sites. Vertical mixing of the water column may be restricted during summer by a density gradient formed by lower salinity waters (outflow from rivers from spring and summer rainy season) overriding high-salinity bottom waters. Warming of surface waters during the summer usually results in a thermally stratified water column, and dissolved oxygen concentrations are typically lower in bottom waters during this season. Sediments of the nearshore region range from predominantly sand off Pensacola, to silty sand off Ship Island (offshore Gulfport); the proportion of fines increases as the Mississippi Delta is approached. Storms periodically occur and resuspend and transport sediments in this environment. Benthic communities at the Existing Sites were dominated by deposit feeding organisms (e.g., polychaetes, sipunculids, and arthropods). Many of the species possess short generation times, characteristic of unstable sandy substrates (e.g., spionid, magelonid, and capitellid polychaetes). Differences in species composition between the Existing Sites appears related to sediment grain size. Several commercially important finfish and shellfish species migrate through nearshore areas to and from the Mississippi Sound, and adjacent bays and estuaries.

The mid-Shelf environment is affected by Loop Current intrusions, river discharges, and seasonal weather patterns. Currents of the mid-Shelf region are not well known, but are considered slower than those in the nearshore region. Off Mobile, near-bottom currents in the mid-Shelf region generally flow at right angles to the direction of the predominant wind at speeds ranging from 0.4 to 0.9 kn. During hurricanes bottom sediments may be resuspended over most of the Shelf. The water column is stratified during summer; however, dissolved oxygen concentrations beneath the thermocline remain higher than concentrations in shallower water. Sediments of the mid-Shelf region follow the same distributional trends as in the nearshore region (i.e., the proportion of fine sediments increase as the Mississippi Delta is approached). Numerous rocky outcrops occur in the mid-Shelf region off Pensacola, but decrease towards Mobile; the Mississippi-Alabama reef-interreef facies occurs along the Shelf edge. The abundance and diversity of organisms is highest in the vicinity of these outcrop areas, and considerably less over sandy and silty sediments. Biomass of benthic infaunal organisms generally decreases with increasing depth in the Gulf; polychaetes generally dominate the benthic community.

Environmental characteristics of the Deepwater Alternative Area are relatively stable and strongly influenced by the Loop Current. A strong seasonal thermocline develops during the summer, while the bottom of the permanent thermocline remains near 300m. Seasonal variations in temperature, salinity, and dissolved oxygen are not as great as those of nearshore and mid-Shelf environments. Currents of the Deepwater Alternative Area are oriented parallel to bottom contours, with velocities ranging from 0.04 to 0.3 kn. Sediments range from silt and clay to heterogenous sediments (ranging from clay to rock) of the De Soto Canyon. Biomass of benthic fauna is relatively low; polychaetes generally dominate the benthic community.

At present, hopper dredges remove an average of 740,664 yd^3 (every 4 to 5 years) from the Pensacola Entrance Channel, 485,776 yd^3 (every 1-3 years) from the Mobile Bar Channel, and 649,290 yd^3 (every 1 to 3 years) from the Gulfport Ship Island Bar Channel per dredging cycle (dredging is not always on an annual basis). All material dumped at an ocean disposal site must be acceptable for ocean disposal according to the criteria set forth in the Ocean Dumping Regulations (40 CFR §227).

ENVIRONMENTAL CONSEQUENCES

The Existing Pensacola, Mobile, and Gulfport Sites have been used since at least 1970. Dredged sediments range from predominantly sand at Pensacola to silty sand at Gulfport. The dredged material is texturally similar to disposal site sediments. Recent site surveys by EPA/IEC (Appendix A) detected no significant adverse effects to the water or sediment quality, nor cumulative changes in the biota which could be attributed to previous dumping. Concentrations of suspended particulate matter, trace metals, and chlorinated hydrocarbons in waters overlying each ODMDS were similar to those at adjacent reference stations, and within ranges reported in the literature for nearshore waters of the northeastern Gulf. Similarly, sediment texture and sediment concentrations of trace metals and chlorinated hydrocarbons were characteristic of nearshore sediments. Macrofauna and epifauna collected during EPA/IEC surveys were both seasonally and spatially variable. However, species composition and abundance were similar between disposal site and reference stations, indicating that no significant changes to the benthic community have resulted from previous dredged material disposal. In addition, species composition and abundance were similar between the Mobile Existing Site and reference station during the June EPA/IEC survey, despite dredged material disposal in February and March, indicating that recolonization apparently occurred within at least 3 months.

Minor and temporary effects of dredged material disposal at the Pensacola, Mobile, and Gulfport ODMDSs may include some increases in suspended sediment concentrations, mounding, and smothering of benthic infauna. Nearshore waters turbidity levels fluctuate as a result of storm activity, flood runoff and similar events. Persistant mounding or accumulation of sediments is precluded by natural sediment transport processes and sediment dispersion during winter storms. Smothering of infaunal organisms will result from dredged material disposal. Recolonization rates are dependent on larval recruitment and settling patterns, and the abilities of infaunal organisms to burrow upward through deposited dredged material. Overburdens at the Existing Pensacola Site are thought to approach the upper limit, through which motile benthic organisms can burrow, based on historical average disposal volumes. Therefore, recolonization rates may be improved by increasing the area of the Existing Site so that the overburden is decreased in thickness.

No previous dumping has occurred at the Alternative Sites, with the exception of the Pensacola Nearshore Alternative Site. No persistant changes in water quality would be expected; however, dredged material disposal may alter the existing sediment texture at some sites (e.g., Mid-Shelf and Deepwater Alternatives). Adverse impacts of dumping on biota would include smothering of infauna and potential alterations of the composition of benthic assemblages. No direct toxicity of dredged sediments to benthic organisms would be anticipated.

Disposal operations do not interfere with any long-term use of resources. The only resources lost by disposal are: sand for landfill, energy (e.g., fuel) expended, and costs of dredging operations. The losses are offset by the benefit to commerce from dredging the channels.

CONCLUSIONS

In general, the Existing Sites fulfill all criteria for site selection and are preferred over the Alternative Sites/Areas based on evaluation of EPA's 11 site-specific criteria, and because of historical use. However, potential impacts to the benthic community may be lessened at a larger Pensacola Site. Therefore, it is recommended that the Pensacola Nearshore Alternative Site be selected instead of the Existing Site. This Alternative Site is a geographic extension of the Existing Site and covers an area previously used for disposal of dredged material. This larger area is not only needed to lessen the impact on the benthic community but also to facilitate site management. If monitoring detects that the material is migrating off the site in significant quantities such that impacts to beaches or other amenities is likely, steps must be taken to change disposal methods, or terminate disposal. A buffer zone is needed around the actual disposal area so that movement of this kind can be detected before the material reaches the site boundaries.

It is also recommended that the Pensacola site be used only for disposal of predominantly sand dredged material. The background data and field studies have shown this site to be acceptable for sand disposal, but the impacts of disposal of finer silt and clay particles would be different. This should not present any problems as the majority of sediments proposed for dumping in the Pensacola site are sand (Thompson Engineering Testing Inc., Dec. 1984). However if finer sediments are proposed for ocean dumping, another area must be located and formally designated.

ORGANIZATION OF THE EIS

This EIS is organized as follows:

- Chapter 1 specifies the purpose and need for the propsed action, presents initial background information relevant to the dredging and disposal sites, and discusses the legal framework guiding EPA's selection and designation of disposal sites, along with the CE's responsibilities in ocean disposal of dredged material.

- Chapter 2 presents alternatives, including the proposed action, the specific criteria used in evaluating alternatives, applies the 11 site selection criteria to the Existing and Alternative Sites, and discusses guidelines for monitoring the ODMDSs.

- Chapter 3 describes the affected environment of the Existing and Alternative Sites, and the history of dredged material disposal at Pensacola, Mobile, and Gulfport Existing Sites.

- Chapter 4 analyzes the environmental consequences of dredged material disposal at the Existing and Alternative Sites.

Chapters 5 and 6 and Appendixes A and B provide supplementary information. Chapter 5 lists the authors of the EIS. Chapter 6 contains a glossary and lists abbreviations and references cited in the text. Appendix A presents results and discussion of the EPA/IEC survey data. Appendix B describes the effects of severe storms and hurricanes on the nearshore region of the Gulf of Mexico.

CONTENTS

Chapter		Page
	SUMMARY	xi
	PURPOSE AND NEED FOR ACTION	xi
	ALTERNATIVES INCLUDING THE PROPOSED ACTION	xii
	AFFECTED ENVIRONMENT	xviii
	ENVIRONMENTAL CONSEQUENCES	xix
	CONCLUSIONS	xxi
	ORGANIZATION OF THE EIS	xxi
1	PURPOSE AND NEED FOR ACTION	1-1
	PURPOSE AND NEED	1-4
	Marine Protection, Research, and Sanctuaries Act	1-4
	Corps of Engineers National Purpose and Need	1-6
	Corps of Engineers Local Need	1-7
	EPA Purpose and Need	1-7
	INTERIM DISPOSAL SITES	1-8
	Site Studies	1-8
	Site Designation	1-10
	LEGISLATION AND REGULATION BACKGROUND	1-11
	Federal Legislation	1-11
	Federal Control Programs	1-13
	INTERNATIONAL CONSIDERATIONS	1-20
2	ALTERNATIVES INCLUDES THE PROPOSED ACTION	2-1
	NO-ACTION ALTERNATIVE	2-2
	NONE-OCEAN DISPOSAL ALTERNATIVES	2-2a
	SELECTION OF ALTERNATIVE SITES	2-3
	Nearshore Area	2-3
	Mid-Shelf Area	2-11
	Deepwater Area	2-13
	Conclusion	2-16
	DETAILED CONSIDERATION OF THE ALTERNATIVE SITES	2-16
	Geographical Position, Depth of Water, Bottom Topography and Distance From Coast	2-16
	Location in Relation to Breeding, Spawning, Nursery, Feeding, or Passage Areas of Living Resources in Adult and Juvenile Phases	2-19
	Location in Relation to Beaches and Other Amenity Areas	2-21

CONTENTS (Continued)

Types and Quantities of Wastes Proposed to be Disposed of, and Proposed Methods of Release Including Methods of Packing the Waste, If Any 2-23
Feasibility of Surveillance and Monitoring 2-24
Dispersal, Horizontal Transport, and Vertical Mixing Characteristics of the Area Including Prevailing Current Direction and Velocity, If Any . . . 2-25
Existence and Effects of Current and Previous Discharges and Dumping in the Area (Including Cumulative Effects) 2-28
Interference With Shipping, Fishing, Recreation, Mineral Extraction, Desalination, Fish and Shellfish Culture, Areas of Special Scientific Importance, and Other Legitimate Uses of the Ocean 2-31
The Existing Water Quality and Ecology of the Site as Determined by Available Data or By Trend Assessment on Baseline Surveys 2-33
Potentiality for the Development or Recruitment of Nuisance Species in the Disposal Site 2-36
Existence At or In Close Proximity to the Site of Any Significant Natural or Cultural Features of Historical Importance 2-36

CONCLUSIONS 2-37

RECOMMENDED USE OF THE SITES 2-40
Permissable Material Loadings 2-40
Monitoring the Disposal Sites 2-40
Guidelines for the Monitoring Plan 2-41

3 AFFECTED ENVIRONMENT 3-1

ENVIRONMENTAL CHARACTERISTICS 3-2
Climate 3-2
Physical Oceanography 3-7
Geology 3-18
Water Column Chemistry 3-26
Sediment Chemistry 3-31
Biology 3-36

SITE HISTORY 3-56

DREDGED MATERIAL CHARACTERISTICS 3-58
Pensacola 3-58
Mobile 3-59
Gulfport 3-60

OTHER RESOURCES 3-62
Fisheries 3-62
Shipping 3-69
Marine Recreation 3-70
Military Activities 3-71
Oil and Gas Exploration and Development 3-73

CONTENTS (Continued)

Cultural Resources. 3-75
Marine Sanctuaries. 3-77
Active Ocean Disposal Sites 3-78
Present and Future Studies. 3-78

4 ENVIRONMENTAL CONSEQUENCES. 4-1

EFFECTS ON PUBLIC HEALTH AND SAFETY 4-1

EFFECTS ON AESTHETICS 4-4

EFFECTS ON THE ECOSYSTEM. 4-4
Water Quality 4-4
Sediment Quality. 4-9
Biota 4-11
Threatened and Endangered Species 4-15
Fisheries 4-16

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS AND
MITIGATING MEASURES. 4-17

RELATIONSHIP BETWEEN SHORT-TERM USES AND
LONG-TERM PRODUCTIVITY 4-18

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES. 4-19

5 COORDINATION. 5-1
PREPARATION OF THE DRAFT EIS. 5-1
PREPARATION OF THE FINAL EIS. 5-2
SECTION 7 COORDINATION. 5-2
COASTAL ZONE MANAGEMENT PLANS CONSISTENCY DETERMINATIONS. 5-3
COMMENTS ON DRAFT EIS AND COMMENT RESPONSES 5-4

6 GLOSSARY, ABBREVIATIONS, REFERENCES 6-1
GLOSSARY. 6-1
ABBREVIATIONS 6-13
REFERENCES. 6-15

APPENDIX A REPORT OF FIELD A-1

APPENDIX B HURRICANE AND STORM EFFECTS ON THE
GULF OF MEXICO INNER SHELF CURRENTS B-1

APPENDIX C ALTERNATIVES ANALYSIS C-1

APPENDIX D PRELIMINARY RESULTS OF THE PENSACOLA,
FLORIDA OCEAN DREDGED MATERIAL
DISPOSAL SITE D-1

CONTENTS (Continued)

ILLUSTRATIONS

Figure		Page
S-1	Existing and Alternative Sites/Areas	xiv
1-1	Location of the Proposed Pensacola ODMDS Relative to the Existing Site, Discontinued Disposal Areas, and Entrance Channel	1-2
1-2	Location of the Proposed Mobile ODMDS Relative to the Bar Channel	1-3
1-3	Location of the Proposed Gulfport ODMDS Relative to the Ship Island Bar Channel	1-5
1-4	Dredged Material Evaluation Cycle	1-16
2-1	Pensacola Existing (Interim) Site, and Nearshore and Mid-Shelf Alternative Sites	2-5
2-2	Mobile Existing (Interim) and Nearshore Alternative Sites	2-8
2-3	Gulfport Existing (Interim) and Nearshore Alternative Sites	2-10
2-4	Existing and Alternative Sites/Areas	2-14
2-5	Deepwater Alternative Area	2-15
3-1	Monthly Minimum, Mean, and Maximum Air Temperatures at Dauphin Island, Alabama from 1974 to 1977	3-3
3-2	Monthly Precipitation at Dauphin Island, Alabama from 1974 to 1977	3-4
3-3	Annual Wind Roses at Dauphin Island, Alabama--Averaged from 1974 to 1977	3-5
3-4	Preferred Tracks of Extratropical Cyclones in the Gulf of Mexico	3-6
3-5	Probability of Tropical Cyclone, Hurricane or Great Hurricane Occurring in Any Year at Pensacola, Mobile, and Gulfport	3-7
3-6	Water Masses and Currents in the Gulf of Mexico During May 1970	3-9
3-7	Surface Salinities in the Gulf of Mexico (January 1965)	3-13
3-8	Surface Salinities in the Gulf of Mexico (May 1964)	3-14
3-9	Generalized Circulation Patterns Occurring Near the Pensacola, Mobile, and Gulfport Existing Sites	3-16
3-10	Wind Measured at Dauphin Island, Alabama and Near-Bottom Current Roses Measured 14 nmi South of Dauphin Island for July and November 1976	3-17
3-11	Major Geologic Features of the Mississippi, Alabama, and Western Florida Continental Shelf	3-20
3-12	Sediment Distribution on the Mississippi, Alabama, and Western Florida Shelf	3-23
3-13	Sand and Silt-Clay Distribution in the Mobile-Gulfport Mid-Shelf Alternative Area	3-24
3-14	Offshore Fishing and Use Areas at the Existing Sites and Vicinity	3-66
3-15	Existing, Proposed, and Developed Oil and Gas Leases at the Existing and Alternative Sites and Vicinity	3-74

CONTENTS (Continued)

TABLES

Number		Page
S-1	Geographical Position, Depth of Water, Bottom Topography, and Distance from Coast	xv
1-1	Responsibilities of Federal Departments and Agencies for Regulating Ocean Disposal under MPRSA	1-14
2-1	Geographical Position, Depth of Water, Bottom Topography, and Distance from Coast	2-17
3-1	Range of Water Column Characteristics During January and June 1980 EPA/IEC Surveys	3-27
3-2	Range of Sediment Characteristics During January and June 1980 EPA/IEC Surveys	3-33
3-3	Range of Trace Metal Concentrations in Sediments from MAFLA Stations (20 to 40m Depths) in the Vicinity of Pensacola, Mobile, and Gulfport Existing Sites	3-34
3-4	Range of Heavy Metal Concentrations in Sediments in the Vicinity of Nearshore Pensacola Sites, and from MAFLA Stations Near Mobile-Gulfport Mid-Shelf Alternative Area, and Deepwater Alternative Area	3-35
3-5	Concentrations of Dominant Phytoplankton from MAFLA Stations in the Vicinity of the Mid-Shelf Alternative Area	3-37
3-6	Concentrations of Dominant Copepod Genera from MAFLA Stations in Vicinity of the Mid-Shelf Alternative Area	3-39
3-7	Life History Aspects of Some Commercial and Recreational Species Commonly Caught in Nearshore Regions of the Gulf	3-40
3-8	Migratory Behavior of Some Coastal Nekton Common to the Gulf	3-41
3-9	Fish Captured at Pensacola, Mobile, and Gulfport Existing Sites and Vicinity During January and June 1980 EPA/IEC Surveys	3-43
3-10	Common Macrofauna Collected During EPA/IEC Surveys in January and June 1980	3-47
3-11	Dominant Polychaete Taxa Found in Mobile-Gulfport Mid-Shelf Alternative Area and Vicinity	3-49
3-12	Dominant Epifauna of the Nearshore Continental Shelf (4 to 20m)	3-50
3-13	Dominant Epifauna of the Middepth Continental Shelf (30 to 90m)	3-52
3-14	Dominant Epifauna of the Deep Continental Shelf (90 to 200m)	3-53
3-15	Species of Marine Mammals in the Gulf of Mexico	3-54
3-16	Threatened and Endangered Species of the Florida, Mississippi, and Alabama Gulf Coast	3-57
3-17	Dredged Material Volumes Disposed at Pensacola, Mobile, and Gulfport Existing Sites from 1970 to 1981	3-59
3-18	Analyses of Entrance Channel Sediment Samples from Pensacola Harbor, Florida	3-60
3-19	Elutriate Analyses of Sediment and Water Samples for Chemical and Heavy Metals Constituents Collected from Pensacola Harbor, Florida	3-61
3-20	Analyses of Entrance Channel Sediment Samples Collected from Mobile Harbor, Alabama	3-62
3-21	Elutriate Analyses of Sediment and Water Samples for Chemical and Heavy Metals Constituents Collected from Mobile Harbor, Alabama	3-63

CONTENTS (Continued)

3-22 Analyses of Ship Channel Sediment Samples Collected from Gulfport Harbor, Mississippi 3-64

3-23 Elutriate Analyses of Sediment and Water Samples for Chemical and Heavy Metals Constituents Collected from Gulfport Harbor, Mississippi 3-65

3-24 Military Installations in Northeastern Gulf of Mexico 3-72

3-25 Wrecks and Obstructions at Existing and Alternative Sites/Areas and Vicinity 3-76

3-26 Mississippi Sound and Adjacent Areas Study Parameters 3-79

5-1 List of Preparers 5-1

Chapter 1

PURPOSE AND NEED FOR ACTION

> The ports of Pensacola, Mobile, and Gulfport handle large volumes of domestic and foreign commodities, thus contributing significantly to the economies of northwest Florida, Alabama, and Mississippi. Harbor access for deep draft ships depends on dredging of the entrance channels to maintain authorized depths. The action proposed in this EIS is the final designations of environmentally acceptable Pensacola, Mobile, and Gulfport Ocean Dredged Material Disposal Sites.

The action proposed in this Environmental Impact Statement (EIS) is the final designation for continuing use of Ocean Dredged Material Disposal Sites (ODMDS) in the Pensacola, Mobile, and Gulfport areas. The purpose of proposed action is to provide the most environmentally acceptable location for the disposal of materials dredged from the Pensacola Channel area, Mobile Channel area, and Gulfport Ship Island Channel area. The EIS presents the information needed to evaluate the suitability of ocean disposal areas for final designation for continuing use, and is based on one of a series of disposal site environmental studies. The environmental studies and final designation process are being conducted in accordance with the requirements of the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) (86 Stat. 1052, as amended (33 U.S.C.A. §1401 et seq.); Environmental Protection Agency's (EPA) Ocean Dumping Regulations and Criteria (40 CFR 220-229); and other applicable Federal environmental legislation.

Based on an evaluation of all reasonable alternatives, the proposed action in this EIS is to permanently designate the interim-designated Mobile and Gulfport ODMDSs, and the Pensacola Nearshore Alternative Site. The boundary coordinates of the Pensacola Alternative Site (Figure 1-1) are: 30°17'24"N, 87°18'30"W; 30°17'00"N, 87°19'50"W' 30°15'36"N, 87°17'48"W; 30°15'15"N, 87°19'18"W. The site is approximately 1.5 nmi , has an average depth of 11m, and an approximate area of 2.5 nmi^2. The boundary coordinates of the Mobile Existing Site (Figure 1-2) are: 30°10'00"N, 88°07'42"W; 30'10'24"N,

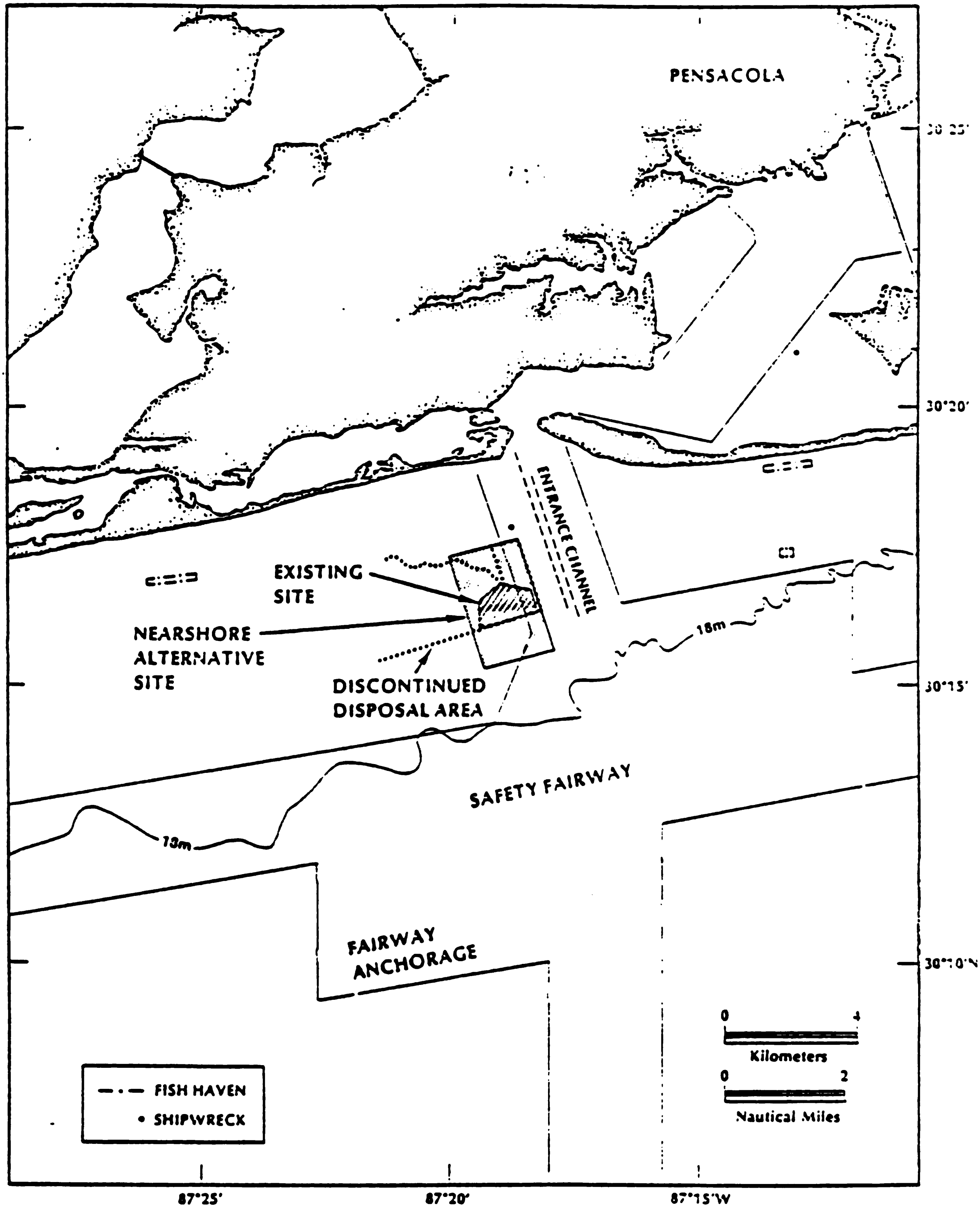


Figure 1-1. Location of the Proposed Pensacola ODMDS Relative to the Existing Site, Discontinued Disposal Areas, and Entrance Channel

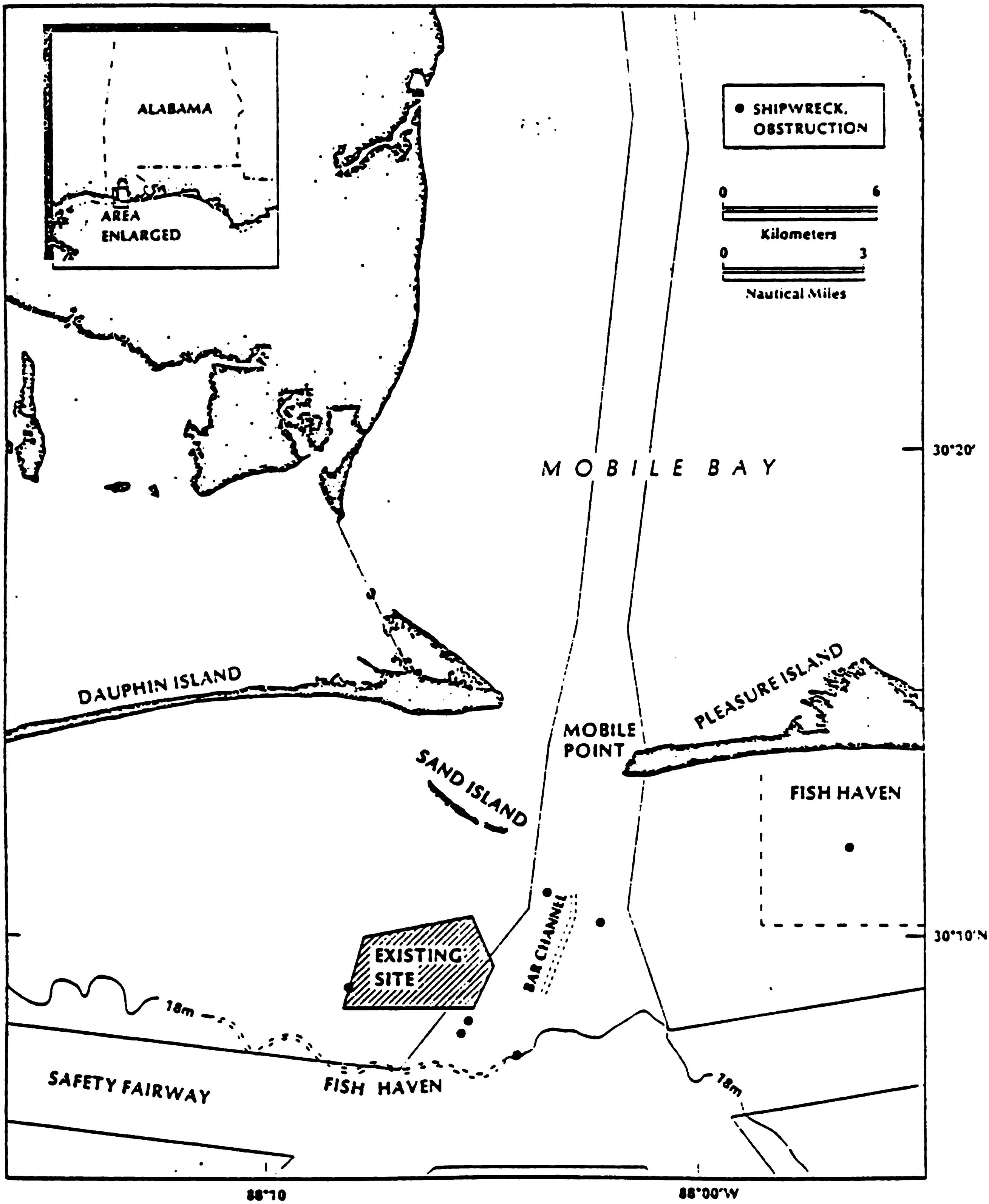


Figure 1-2. Location of the Proposed Mobile ODMDS Relative to the Bar Channel

88°05'12"W.; 30°09'24"N., 88°04'42"W.; 30°08'30"N., 88°05'12"W.; 30°08'30"N., 88°08'12"W. The site is approximately 4.2 nmi offshore, has an average depth of 14m, and an approximate area of 4.8 nmi^2.

The boundary coordinates of the Gulfport Existing Sites (Figure 1-3) are: Western Site: 30°12'00"N., 89°00'30"W.; 30°12'00"N., 88°59'30"W.; 30°11'00"N., 89°00'00"W.; 30°07'00"N., 88°56'30"W.; 30°06'36"N., 88°57'00"W.; 30°10'30"N., 89°00'36"W.; Eastern Site: 30°11'10"N., 88°58'24"W.; 30°11'12"N., 88°57'30"W.; 30°07'36"N, 88°54'24"W.; 30°07'24"N., 88°54'48"W. The Existing Sties (western and eastern) are approximately 12 and 14 nmi from the mainland coast, and 0.7 and 1.2 nmi from Ship Island; they have average depths of 8.2 and 9.1m, and approximate areas of 5.2 and 2.5 nmi^2, respectively.

The Pensacola, Mobile, and Gulfport ODMDS's as delineated above, would be designated for the disposal of dredged material. The Pensacola site will be designated for disposal of predominantly sand sized materials only. The site may be used for disposal of the dredged material only after evaluation of each Federal project or permit application has established that the dispsoal is within site capacity and in compliance with the criteria and requirements of EPA and the U.S. Army Corps of Engineers (CE) regulations.

PURPOSE AND NEED

MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

The MPRSA was enacted in October 1972. Congressional intent for this legislation as expressed in the Act is:

> Sec. 2(b). The Congress declares that it is the policy of the United States to regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of any material which would adversely affect human helath, welfare, amenities, or the marine environment, ecological systems, or economic potentialities.

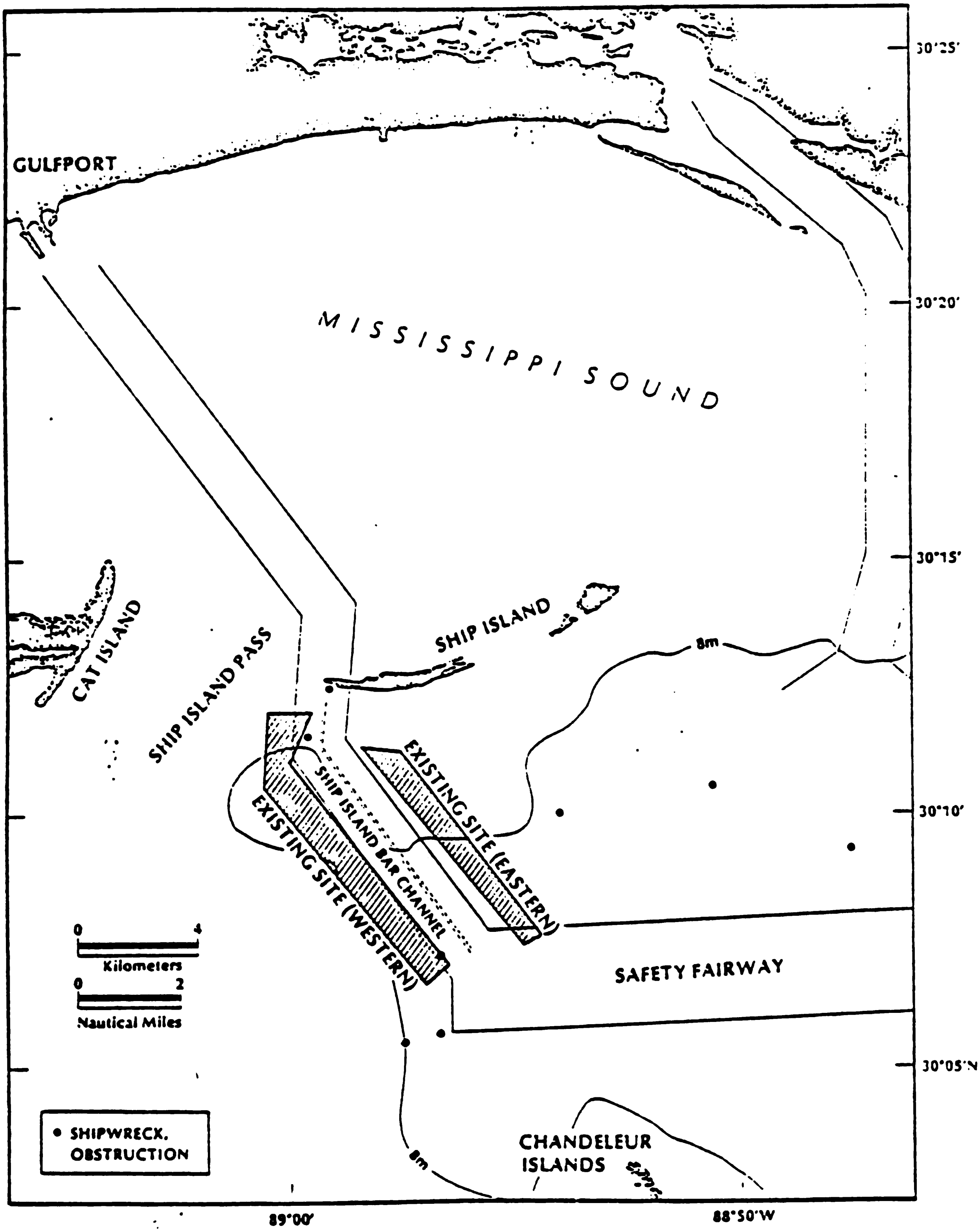


Figure 1-3. Location of the Proposed Gulfport ODMDS Relative to the Ship Island Bar Channel

(c). It is the purpose of this Act to regulate (1) the transportation by any person of material from the United States and, in the case of United States vessels, aircraft, or agencies, the transportation of material from a location outside the United States, when in either case the transportation is for the purpose of dumping the material into ocean waters, and (2) the dumping of material transported by any person from a location outside the United States, if the dumping occurs in the territorial sea or the contiguous zone of the United States.

Title I of the MPRSA, which is the act's primary regulatory section, authorizes the Administrator of EPA (Section 102) and the Secretary of the Army acting through the CE (Section 103) to establish ocean disposal permit programs for nondredged and dredged materials, respectively. Title I also requires EPA to establish criteria, based on those factors listed in Section 102(a), for the review and evaluation of permits under the EPA and CE permit program. In addition, Section 102(c) of Title I authorizes EPA, considering criteria established pursuant to Section 102(a), to designate recommended ocean disposal sites or times for dumping of nondredged and dredged material.

CORPS OF ENGINEERS NATIONAL PURPOSE AND NEED

Section 103 of Title I requires the CE to consider in its evaluation of Federal projects and Section 103 permit applications the effects of ocean disposal of dredged material on human health, welfare, or amenities, or the marine environment, ecological systems, and economic potentialities. As part of this evaluation, consideration must be given to utilizing, to the extent feasible, ocean disposal sites designated by the EPA pursuant to Section 102(c). Since 1977 the CE has used those ocean disposal sites designated by EPA on an interim basis. Use of these interim-designated sites for ocean disposal has been an essential element in the CE's compliance with the requirements of the MPRSA and its ability to carry out its statutory responsibility for maintaining the nation's navigable waterways. To continue to maintain U.S. waterways, the CE considers it essential that environmentally acceptable ocean disposal sites be identified, evaluated, and permanently designated for continued use pursuant to Section 102(c). These sites will be used after review of each project has established that the proposed ocean disposal of dredged material is in compliance with the criteria and requirements of EPA and CE regulations.

CORPS OF ENGINEERS LOCAL NEED

Pensacola, Mobile, and Gulfport are major ports of northwestern Florida, Alabama, and Mississippi, respectively, and support a large shipping commerce (with a combined total of approximately 40 million tons in 1978) (CE, 1978). Maintaining these ports is vital to the economy of the northeastern Gulf region.

The entrance channels to Pensacola, Mobile, and Gulfport harbors must be dredged periodically because natural sedimentation processes cause them to shoal. The CE is responsible for planning the maintenance dredging, and conducting the necessary dredging and disposal operations. For the CE's Mobile District to maintain the entrance channels of the harbors to their authorized depths, material should be dredged from each entrance channel on an as-needed (every 1 to 5 years) basis (J. Walker, personal communication*).

The CE has requested the EPA to permanently designate ocean disposal sites suitable for continued disposal of dredged material from entrance channels to Pensacola, Mobile, and Gulfport harbors.

EPA PURPOSE AND NEED

As previously stated, the CE has indicated a need for locating and designating environmentally acceptable ocean dredged material disposal sites to carry out its responsibilities under the MPRSA and other Federal statutes. Therefore, in response to the CE's state need, EPA, in cooperation with the CE, has initiated the necessary studies pursuant to the requirements of 40 CFR 228.4(e) to select, evaluate, and possibly designate the most suitable site for the ocean disposal of dredged material. This document has been prepared to provide the public and decisionmakers with relevant information to assess the impacts associated with the final designation for three of the sites

---

*J. Walker, U.S. Army Corps of Engineers (Mobile District) Mobile, Alabams (1982).

proposed for final designation, Pensacola, Mobile, and Gulfport ODMDSs. It is not anticipated that the CE will conduct any further environmental studies with respect to the selection of these sites.

INTERIM DISPOSAL SITES

On 11 January 1977, EPA promulgated final Ocean Dumping Regulations and Criteria to implement MPRSA. The Regulations set forth criteria and procedures for the selection and designation of ocean disposal sites. In addition, the regulations designated 129 ocean sites for the disposal of dredged material to allow the CE to fully comply with the purpose and procedural provisions of the MPRSA. These sites could be used for an interim period by the CE, pending completion of site designation studies as required by the Regulations. Use of the interim-designated sites by the CE would be dependent on compliance with the requirements and criteria contained in EPA's Ocean Dumping Regulations and Criteria.

Those sites given interim designation were selected by EPA in consultation with the CE, with the size and location of each site based on historic use. The interim designation would remain in force for a period not to exceed 3 years from the date of the final promulgation of the Regulations. However, due to the length of time required to complete the necessary environmental studies and operating restraints of both a technical and budgetary nature, environmental studies were not completed within the approved 3-year period. As a result, the Regulations were amended in January 1980 to extend the interim designation for those sites currently under study for a period not to exceed 3 years, while the remaining sites' interim status was extended indefinitely, pending completion of studies and determination of the need for continuing use.

SITE STUDIES

In mid-1977, EPA, by contract, initiated environmental studies on selected nondredged material disposal sites. The studies were designed to characterize the sites' chemical, physical, and biological features and to provide the data needed to evaluate the suitability of each site for continuing use. All studies are being conducted in accordance with the appropriate requirements of Part 228 of the EPA Ocean Dumping Regulations and Criteria. Results of these studies are being used in the preparation of an EIS for each site where such a statement is required by EPA policy. The CE, to assist EPA in its national program for locating and designating suitable sites for the ocean disposal of dredged materials, agreed in 1979 to join the contract effort by providing funds for field surveys to collect and analyze baseline data. Data from each field survey and other relevant information are being used by EPA in disposal site evaluation study and EISs to ascertain the acceptability of an interim site and/or other sites for final designation. In addition to providing funds, the CE agreed to further assist EPA by providing technical review and consultation.

The EPA, in consultation with the CE, selected 25 areas containing 59 interim-designated ODMDSs for study under the EPA contract. Regional priorities and possible application of the data to similar areas were considered in this selection process. For some selected areas, an adequate data base was found to exist; consequently, field studies for these areas were considered unnecessary for disposal site evaluation studies. For the remaining selected areas, it was determined that surveys would be required for an adequate data base to characterize the physical, chemical, and biological features and to determine the suitability of one or more sites in these areas for permanent designation. Field surveys were initiated in early 1979 and were completed in mid-1981.

The studies are directed to the evaluation of alternative ocean disposal sites for the disposal of dredged material in an area. Based on the data from the disposal site evaluation study and other relevant information, an EIS will be prepared for each of the 25 selected areas. These EIS's only address those issues germane to the selection, evaluation, and final designation of environmentally acceptable ODMDSs. As a result, the data and conclusions contained in Chapters 2, 3, and 4 are limited to those significant issues relevant to site designation (i.e., analyses of impacts on site and adjacent area from the disposal of dredged material). Non-ocean disposal alternatives for the Pensacola, Mobile and Gulfport sites were evaluated by the Corps of Engineers (CE, 1980b; 1978b; 1976). Each of these studies indicated that an ocean disposal site was needed either alone or in conjunction with other disposal options.

SITE DESIGNATION

In accordance with the EPA's Ocean Dumping Regulations and Criteria, site designation will be by promulgation through formal rulemaking. The decision by EPA to designated one or more sites for continuing use will be based on appropriate Federal statutes, disposal site evaluation study EIS, supporting documentation and public comments on the Draft EIS, Final EIS, and the public notice issued as part of the proposed rulemaking.

In the event that one or more selected areas are deemed suitable for final designation, it is EPA's position that the site designation process, including the disposal site(s) evaluation study and the development of the EIS, fulfill all statutory requirements for the selection, evaluation, and designation of an ODMDS.

The EIS and supporting documents provide the necessary information to determine whether the proposed site(s) is suitable for final designation. In the event that an interim-designated site is deemed unacceptable for continuing use, the interim designation will be terminated and either the no-action alternative will be selected (no site will be designated) or one or more alternative sites will be selected/designated. Furthermore, final site designation infers only EPA's determinations that the proposed site is suitable for the disposal of dredged material. Approval for use of the site will be determined only after reveiw of each project to ensure that the proposed ocean disposal of dredged material is in compliance with the criteria and requirements of EPA and CE regulations.

LEGISLATION AND REGULATION BACKGROUND

FEDERAL LEGISLATION

Despite legislation dating back almost 100 years for the control of disposal into rivers, harbors, and coastal waters, ocean disposal of dredged material was not specifically regulated in the United States until passage of the MPRSA in October 1972. The first limited regulation was provided by the Supervisor of New York Harbor Act of 1888, which empowered the Supervisor (a U.S. Navy line officer) to prevent the illegal deposit of obstructive and injurious materials in New York Harbor, its adjacent and tributary waters, and Long Island Sound. In 1952 an amendment provided that the Secretary of the Army appoint a Corps of Engineers officer as Supervisor and, since that date, each New York District Engineer has automatically become the Supervisor of the Harbor. In 1958 an amendment extended the act to apply to the harbors of Hampton Roads, Virginia, and Baltimore, Maryland. Under the 1888 act, the Supervisor of the Harbor established sites in the Hudson River, Long Island Sound, and Atlantic Ocean for dumping certain types of materials. Further limited regulation was provided by the River and Harbor Act of 1899, which prohibited the unauthorized disposal of refuse into navigable waters (Section 13) and prohibited the unauthorized obstruction or alteration of any navigable water (Section 10).

The Fish and Wildlife Coordination Act was passed in 1958. Its purpose was "...to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs...." The law directed that water-resource projects, including channel deepening, be performed "with a view to the conservation of wildlife resources by preventing loss of and damage to such resources...." This was a first step towards concern for ocean areas. After the passage of this law, the CE (backed by judicial decisions) could refuse permits if the dredging or filling of a bay or estuary would result in significant unavoidable damage to the marine ecosystem.

Passage of the National Environmental Policy Act (NEPA) of 1969 (PL 91-190, 42 USC Parts 4321-4347, 1 January 1970) reflected public concern over the environmental effects of man's activities. Subsequently, particular attention was drawn to the effects of dredged materials by the River and Harbor Act of 1970 (PL 91-611). This act initiated a comprehensive nationwide study of dredged material disposal problems. Consequently, the CE established the Dredged Material Research Program (DMRP) in 1973, a 5-year, $30-million research effort. Objectives were (1) to understand why and under what conditions dredged material disposal might result in adverse environmental impacts, and (2) to develop procedures and disposal options to minimize adverse impacts (CE, 1977).

Two important acts were passed in 1972 that specifically addressed the control of waste disposal in aquatic and marine environments: (1) the Federal Water Pollution Control Act Amendments (FWPCA), later amended by the Clean Water Act of 1977, and (2) the MPRSA. Section 404 of the FWPCA established a permit program, administered by the Secretary of the Army acting through the Chief of Engineers, to regulate the discharge of dredged material into the waters of the United States (as defined at 33 CFR 323.2[a]). Permit applications are evaluated using guidelines jointly developed by EPA and the CE. Section 404(c) gives the EPA Administrator authority to restrict or prohibit dredged material disposal if the operation will have unacceptable adverse effects on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding grounds), wildlife, or recreational areas. Procedures to be used by EPA in making such a determination are found at 40 CFR 231.

MPRSA regulates the transportation and ultimate dumping of barged materials in ocean waters. The act is divided into three parts: Title I--Ocean Dumping, Title II--Comprehensive Research on Ocean Dumping, and Title III--Marine Sanctuaries. This EIS is concerned only with Title I of the act.

Title I, the primary regulatory section of MPRSA, establishes the permit program for the disposal of dredged and nondredged materials, mandates determination of impacts and alternative disposal methods, and provides for enforcement of permit conditions. The purpose of Title I is to prevent or strictly limit the dumping of materials that would unreasonably affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities. Title I of the act provides procedures for regulating the transportation and disposal of materials into ocean waters under the jurisdiction or control of the United States. Any person of any nationality wishing to transport waste material from a U.S. port, or from any port under a U.S. flag, to be dumped anywhere in the oceans of the world, is required to obtain a permit.

Title I prohibits the dumping into ocean waters of certain wastes, including radiological, biological, or chemical warfare agents, and all high-level radioactive wastes. In March 1974, Title I was amended (PL 93-253) to bring the act into full compliance with the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, discussed below under "International Considerations." The provisions of Title I include a maximum criminal fine of $50,000 and jail sentence of up to 1 year for every unauthorized dump or violation of permit requirements, or a maximum civil fine of $50,000. Any individual may seek an injunction against an unauthorized dumper with possible recovery of all costs of litigation.

FEDERAL CONTROL PROGRAMS

Several Federal departments and agencies participate in the implementation of MPRSA requirements, with the lead responsibility given to EPA (Table 1-1). In October 1973, EPA implemented its responsibility for regulating ocean dumping under MPRSA by issuing the Final Ocean Dumping Regulations and Criteria which were revised in January 1977 (40 CFR 220-229). The Ocean Dumping Regulations established the procedures and criteria to apply for dredged material permits (Part 225), enforce permit conditions (Part 226), evaluate permit applications for environmental impact (Part 227), and designate and manage ocean disposal sites (Part 228).

OCEAN DUMPING EVALUATION PROCEDURES

The Ocean Dumping Regulations specify the procedures for evaluating the effects of dredged material disposal. The EPA and CE evaluate Federal projects and permit applications for non-Federal projects to determine (1) whether there is a demonstrated need for ocean disposal and that other

TABLE 1-1
RESPONSIBILITIES OF FEDERAL DEPARTMENTS
AND AGENCIES FOR REGULATING OCEAN DISPOSAL UNDER MPRSA

Department/Agency	Responsibility
U.S. Environmental Protection Agency	Issuance of waste disposal permits, other than for dredged material
	Establishment of criteria for regulating waste disposal
	Enforcement actions
	Site designation and management
	Overall ocean disposal program management
	Research on alternative ocean disposal techniques
U.S. Department of the Army Corps of Engineers	Issuance of permits for transportation of dredged material for disposal
	Recommendation of disposal site locations
U.S. Department of Transportation Coast Guard	Surveillance
	Enforcement support
	Issuance of regulations for disposal vessels
	Review of permit applications
U.S. Department of Commerce National Oceanic and Atmospheric Administration	Long-term monitoring and research
	Comprehensive ocean dumping impact and short-term effect studies
	Marine sanctuary designation
U.S. Department of Justice	Court actions
U.S. Department of State	International agreements

environmentally sound and economically reasonable alternatives do not exist (40 CFR 227 Subpart C), and (2) compliance with the environmental impact criteria (40 CFR 227 Subparts B, D, and E). Figure 1-4 outlines the cycle used to evaluate the acceptability of dredged material for ocean disposal.

Under Section 103 of MPRSA, the Secretary of the Army is given the authority, with certain restrictions, to issue permits for the transportation of material dredged from non-CE projects for ocean disposal. For Federal projects involving dredged material disposal, Section 103(e) of MPRSA provides that "the Secretary [of the Army] may, in lieu of the permit procedure, issue regulations which will require the application to such projects of the same criteria, other factors to be evaluated, the same procedures, and the same requirements which apply to the issuance of permits..." for non-Federal dredging projects involving disposal of dredged material. Consequently, both Federal and non-Federal dumping requests undergo identical regulatory reviews. The only difference is that, after the review and approval of the dumping request, non-Federal projects are issued an actual permit. The CE is responsible for evaluating disposal applications and granting permits to dumpers of dredged materials; however, dredged material disposal sites are designated and managed by the EPA Administrator or his designee. Consequently, dredged material generated by Federal and non-Federal projects must satisfy the requirements of the MPRSA (as detailed in the Ocean Dumping Regulations) to be acceptable for ocean disposal.

ENVIRONMENTAL IMPACT CRITERIA

Section 103(a) of the MPRSA states that dredged material may be dumped into ocean waters after determination that "the dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, or economic potentialities." This applies to the ocean disposal of dredged materials from both Federal and non-Federal projects. To ensure

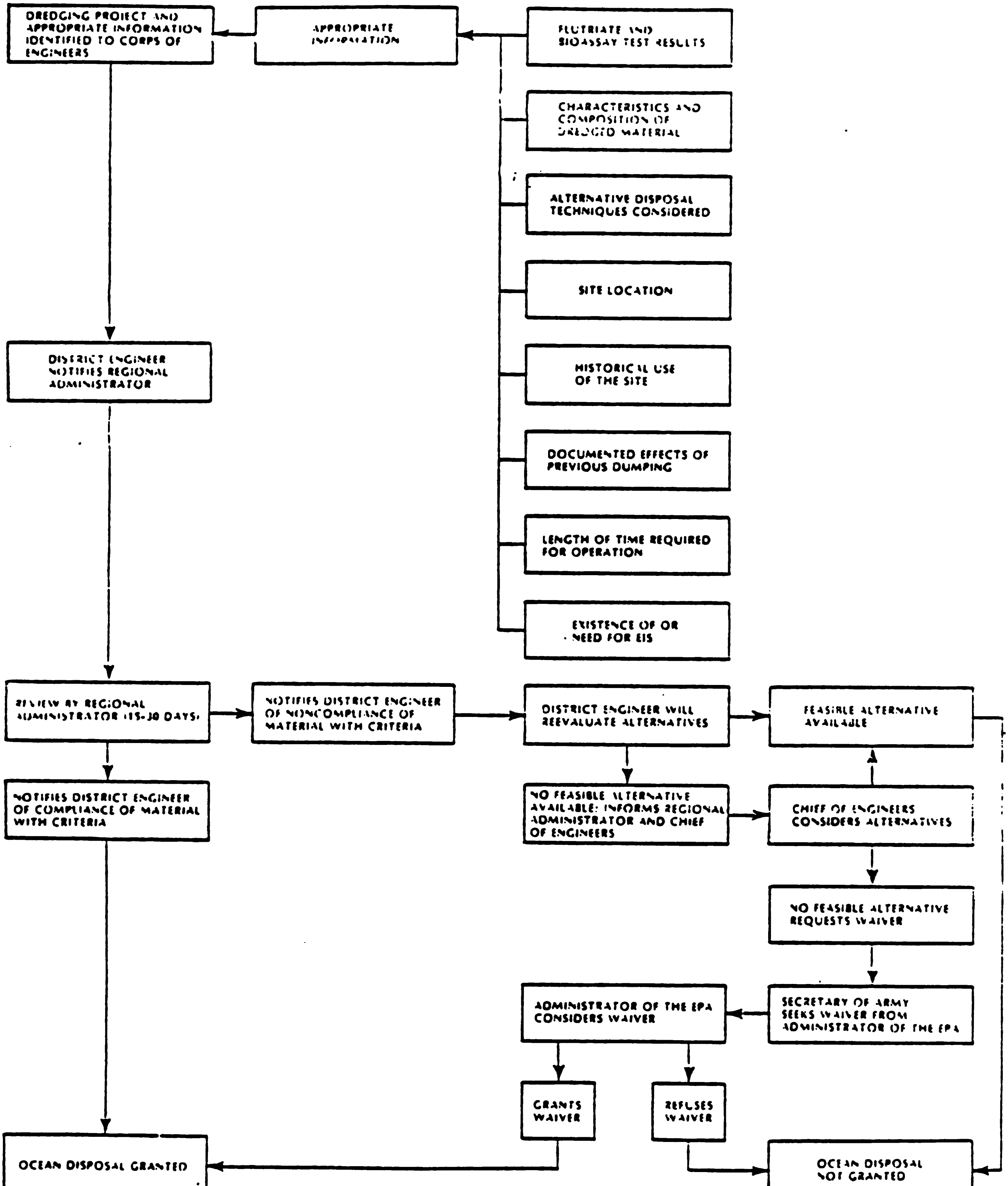


Figure 1-4. Dredged Material Evaluation Cycle

that ocean dumping will not unreasonably degrade or endanger public health and the marine environment, the Ocean Dumping Regulations restrict the transportation of all materials for dumping, specifically:

- Prohibited materials: High-level radioactive wastes; materials produced or used for radiological, chemical, or biological warfare; materials insufficiently described to apply the Criteria (40 CFR 227); and persistent inert synthetic or natural materials which float or remain suspended and interfere with fishing, navigation, or other uses of the ocean.

- Constituents prohibited as other than trace contaminants: Organohalogens; mercury and mercury compounds; cadmium and cadmium compounds; oil; and known or suspected carcinogens, mutagens, or teratogens.

- Strictly regulated materials: Liquid waste constituents immiscible with or slightly soluble in seawater (e.g., benzene), radioactive materials, wastes containing living organisms, highly acidic or alkaline wastes, and wastes exerting an oxygen demand.

Dredged material is environmentally acceptable for ocean disposal without further testing if it satisfies any one of the following criteria:

- Dredged material is composed predominantly of sand, gravel, rock, or any other naturally occurring bottom material with particle sizes larger than silt, and the material is found in areas of high current or wave energy...

- Dredged material is for beach nourishment or restoration and is composed predominantly of sand, gravel, or shell...

- When: (i) the material proposed for dumping is substantially the same as the substrate at the proposed disposal site; and (ii) the [proposed dredging] site...is far removed from known existing and historical sources of pollution so as to provide reasonable assurance that such material has not been contaminated by such pollution. (40 CFR 227.13[b])

If dredged material does not meet the above criteria, then further testing of the liquid, suspended particulate, and solid phases is required. The Ocean Dumping Regulations require that the liquid phase "not contain... constituents in concentrations which will exceed applicable marine water quality criteria after allowance for initial mixing" (40 CFR 227.6), and that "bioassays on the liquid phase of the dredged material show that it can be discharged so as not to exceed the limiting permissible concentration..." (40 CFR 227.13).

The suspended particulate and solid phases must be tested using bioassays which can demonstrate that dredged materials will not cause the "occurrence of significant mortality or significant adverse sublethal effects including bioaccumulation due to the dumping..." and that the dredged material "can be discharged so as not to exceed the limiting permissible concentration...." The bioassays ensure that "no significant undesirable effects will occur due either to chronic toxicity or to bioaccumulation." The required testing ensures that dredged material contains only constituents which are:

> (1) present in the material only as chemical compounds or forms (e.g., inert insoluble solid materials) non-toxic to marine life and non-bioaccumulative in the marine environment upon disposal and thereafter, or (2) present in the material only as chemical compounds or forms which, at the time of dumping and thereafter, will be rapidly rendered non-toxic to marine life and non-bioaccumulative in the marine environment by chemical or biological degradation in the sea; provided they will not make edible marine organisms unpalatable; or will not endanger human health or that of domestic animals, fish, shellfish, or wildlife. (40 CFR 227.6)

PERMIT ENFORCEMENT

Under MPRSA the Commandant of the U.S. Coast Guard (USCG) is assigned responsibility by the Secretary of Transportation to conduct surveillance of disposal operations to ensure compliance with the permit conditions and to discourage unauthorized disposal. Alleged violations are referred to EPA for appropriate enforcement. Civil penalties include a maximum fine of $50,000; criminal penalties involve a maximum fine of $50,000 and/or a 1-year jail term. Where administrative enforcement action is not appropriate, EPA may request the Department of Justice to initiate relief actions in court for violations of the terms of MPRSA. Surveillance is accomplished by means of spot checks of disposal vessels for valid permits, interception or escorting of dump vessels, use of shipriders, and aircraft overflights during dumping.

The Commandant of the Coast Guard has published guidelines for ocean dumping surveillance and enforcement in Commandant Instruction 16470.2B, dated 29 September 1976. An enclosure to the instruction is an Interagency Agreement between the CE and the USCG regarding surveillance and enforcement responsibilities over federally contracted ocean dumping activities associated with Federal Navigation Projects. Under the agreement, the CE "recognizes that it has the primary surveillance and enforcement responsibility over these activities." The CE directs and conducts the surveillance effort over CE contract dumpers engaged in ocean disposal activities, except in New York and San Francisco; the USCG retains primary responsibility for surveillance in these two areas. In all other areas, the USCG will respond to specific requests from the CE for surveillance missions. The USCG retains responsibility for surveillance of all dredged material ocean dumping activities that are not associated with Federal Navigation Projects.

OCEAN DISPOSAL SITE DESIGNATION

EPA is conducting studies of various disposal sites in order to determine their acceptability. The agency has designated a number of existing disposal sites for use on an interim basis until studies are completed and formal designation or termination' of each site is decided (40 CFR 228.12, as amended 16 January 1980, 45 FR 3053).

Under Section 102(c) of MPRSA, EPA is authorized to designate sites and times for ocean disposal of acceptable materials. Therefore, EPA established criteria for site designation in the Regulations. These include general and specific criteria for site selection and procedures for designating the sites for disposal. If it appears that a proposed site can satisfy the general criteria, then the specific criteria for site selection will be considered. Once designated, the site may be monitored for adverse disposal impacts. The criteria for site selection and monitoring are detailed in Chapter 2.

INTERNATIONAL CONSIDERATIONS

The principal international agreement governing ocean dumping is the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention), which became effective in August 1975, upon ratification by 15 contracting countries including the United States (26 UST 2403: TIAS 8165). There are now 44 contracting parties. Designed to control dumping of wastes in the ocean, the Convention specifies that contracting nations will regulate disposal in the marine environment within their jurisdiction and prohibit disposal without permits. Certain hazardous materials are prohibited (e.g., radiological, biological, and chemical warfare agents, and high-level radioactive matter). Certain other materials (e.g., cadmium, mercury, organohalogens and their compounds; oil; and persistent, synthetic, or natural materials which float or remain in suspension) are also prohibited as other than trace contaminants. Other materials (e.g., arsenic, lead, copper, zinc, cyanides, fluorides, organosilicon, and pesticides) are not prohibited from ocean disposal, but require special care. Permits are required for ocean disposal of materials not specifically prohibited. The nature and quantities of all ocean-dumped material, and the circumstances of disposal, must be periodically reported to the Inter-Governmental Maritime Consultative Organization (IMCO), which is responsible for administration of the Convention.

U.S. ocean dumping criteria are based on the provisions of the London Dumping Convention (LDC) and include all the considerations listed in Annexes I, II, and III of the LDC. Agreements reached under the LDC also allow exclusions from biological testing for dredged material from certain locations. These agreements are also reflected in the U.S. ocean dumping criteria. Thus, when a material is found to be acceptable for ocean dumping under the U.S. ocean dumping criteria, it is also acceptable under the LDC.

Chapter 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

The proposed action is the final designation for continuing use of ODMDSs in the Pensacola, Mobile, and Gulfport areas. The purpose of the proposed action is to provide the most environmentally acceptable location for the disposal of materials dredged from the Pensacola Entrance Channel, Mobile Bar Channel, and Gulfport Ship Island Bar Channel. In addition to the interim-designated Existing Sites, other sites located in the nearshore, mid-Shelf, and deepwater ocean environments are discussed. The 11 criteria at 40 CFR §228.6 are the bases for comparing the environmental impacts associated with dredged material disposal at each of the Alternative Sites. The potentially significant environmental impacts resulting from dredged material disposal are smothering of benthic fauna, increased water turbidity, and shoaling. The no-action alternative to the proposed action is rejected because a decision of either final designation, termination of the use of the Existing Sites, or designation of Alternative Sites is required.

Three general ocean environments exist offshore Pensacola, Mobile, and Gulfport, and are considered as potentially suitable areas in which to locate an ocean disposal site. These are: (1) nearshore area--from 0 to 10 nmi offshore with depths less than 20m, (2) mid-Shelf area--from approximately 10 to 50 nmi offshore with depths from 20 to 200m and (3) deepwater area--greater than 50 nmi offshore with depths greater than 200m. The Existing Sites are located in the nearshore area. Alternative areas, in which a new ODMDS could be located, were initially screened on the basis of environmental and economic suitability. Hence, areas of significant bottom relief, such as artificial and natural reefs, obstructions, fish havens, and offshore banks, were eliminated from further consideration because these areas generally support a diverse and abundant marine community and valuable fishery resources. Areas within the passes between the barrier islands were eliminated because they represent important passageways for fish, invertebrates, and reptiles which migrate between the Gulf and the Mississippi Sound, and its adjacent bays and estuaries. Areas with active or proposed oil and gas lease tracts were avoided in selection of Alternative Sites, but such activities alone were not considered a sufficient cause for eliminating an area from further consideration. Alternative Sites/Areas located in the nearshore, mid-Shelf, and deepwater environments were selected to minimize interference with environmental and economic resources, and are evaluated further and compared with the Existing Sites. Evaluations and comparisons are based on the 11 criteria listed at 40 CFR §228.6 of the Ocean Dumping Regulations. Recommendations for the use and monitoring of the ODMDs, are discussed in this chapter.

NO-ACTION ALTERNATIVE

The no-action alternative to the proposed action would be to refrain from designating ocean sites for the disposal of dredged material from the Pensacola, Mobile, and Gulfport areas. Three Existing Sites are currently designated on an interim basis. These interim designations are scheduled to expire in December 1988, unless formal rulemaking is completed earlier, which either: (1) designates the interim sites for continued use, or (2) selects and designates alternative sites.

By taking no action, the present ocean sites would not receive final designation, nor would alternative ocean disposal sites be designated. Consequently, the CE would not have EPA-recommended ocean disposal sites available in the area, thus precluding ocean dumping as a disposal method for this dredged material. In this case, the CE would be required to either: (1) develop information sufficient to select acceptable ocean sites for disposal, or (2) modify or cancel proposed dredging projects which depend on disposal in the ocean as the only feasible method for the disposal of dredged material.

NON-OCEAN DISPOSAL ALTERNATIVES

Non-Ocean disposal alternatives were evaluated in previous Corps of Engineers (CE) studies (CE, 1980b; 1978b; 1976) (Appendix C). It was determined from those studies that ocean disposal sites are needed for each of the areas. This does not mean that land based disposal or any other feasible alternatives mentioned in the Environmental Protection Agency's (EPA) Ocean Dumping Regulations and Criteria (40 CFR §227.15) are being permanently set aside in favor of ocean disposal. The need for ocean disposal must be evaluated for each Federal Project or permit application. These evaluations include considerations of the availability and environmental acceptability of other feasible alternatives. Designation of an ocean disposal site presents one option for the disposal of dredged material.

In its past studies, the CE, which performs the dredging operation, has determined that disposal in the ocean is the most reasonable method at present (CE, 1980b; 1978b; 1976). In addition, the studies of the areas indicated that non-ocean alternatives for disposal of dredged material are generally not available. The CE considered the non-ocean alternatives to be less desirable because of the lack of appropriate equipment and increased costs of transporting dredged material from the dredging site to a land disposal site.

During its studies of dredging and dredged material disposal in the Pensacola area, the CE (1978) considered Gulf disposal; overboard and Gulf disposal; diked shoreline and Gulf disposal; and upland and Gulf disposal. The use of a designated ocean disposal site (Gulf disposal) was a part of each of the options. The possible use of some of the dredged material for beach nourishment was considered in connection with Gulf disposal.

The CE (1980) considered Mobile Bay island and fill; open water disposal; upland disposal; and Mobile Bay Island or fill and Gulf disposal in its past studies of dredging and dredged material disposal in the Mobile area. The open water disposal and the Mobile Island or fill and Gulf disposal contained variations utilizing a designated ocean disposal site. Continuation of existing disposal methods also was indicated.

A large number of alternatives were studies by the CE (1976) in connection with dredging and dredged material disposal in the Gulfport area. After intial consideration, the alternatives were narrowed to generally open water disposal; construction of islands; deposition in thin layers; use of specially designed equipment. Disposal in a designated ocean disposal site would be involved in a continuation of existing practices, and depending of the location of the particular dredging, in each of the foregoing

SELECTION OF ALTERNATIVE SITES

General criteria (Ocean Dumping Regulations at 40 CFR §228.5) used to select an ocean disposal site are:

- The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of diposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shell-fisheries, and regions of heavy commercial or recreational navigation.

- Locations and boundaries of the disposal sites will be so chosen that temporary perturbations in water quality...can be...reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

- The sizes of ocean disposal sites will be limited in order to localize any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long range impacts.

- ...wherever feasible, designate ocean dumping sites beyond the edge of the Continental Shelf and other such sites that have been historically used. (40 CFR 228.5)

The nearshore, mid-Shelf, and deepwater areas offshore Pensacola, Mobile, and Gulfport are considered, using the general criteria listed above, as possible locations for ocean disposal sites.

NEARSHORE AREA

The nearshore area is defined in this EIS as that part of the Continental Shelf extending seaward from the barrier islands to depths of 20m between

Gulfport, Mississippi, and Pensacola, Florida, and including Mobile, Alabama. Physical and biological characteristics of the nearshore area are influenced by runoff from rivers, longshore sediment transport, waves, and storms. Chemical processes are affected primarily by seasonal nutrient cycling, water column stratification, and river runoff. Periodic hurricanes, tropical cyclones, and winter "northers" can severely disturb bottom sediments and override normal processes. According to Holliday (1978) "high-energy erosional zones generally can accept large volumes of dredged material with little apparent net change to the bottom."

The nearshore area is used intensively by commercial and noncommercial shipping, boating, and finfishing and shellfishing activities. In addition, some oil and gas development has been proposed for this area. Fish havens, artificial reefs, obstructions, and shipwrecks are numerous within the area, and because of fishery and potential cultural resources, would not be suitable areas in which to locate an ODMDS. Additionally, areas within the passes between the barrier islands would not be suitable areas for an ODMDS because they represent important passageways for living resources which migrate between the Mississippi Sound and the Gulf.

Disposal of dredged material from the Pensacola Entrance Channel, Mobile Bar Channel, and Gulfport Ship Island Bar Channel has occurred previously within the nearshore area, primarily at the Existing Sites. The Existing Sites received interim designations based on historical usage, and did not necessarily satisfy the criteria defined in §228 of the Ocean Dumping Regulations. Selection of alternative sites within the nearshore area for receiving dredged material are discussed in further detail below, with particular regard to minimizing interferences with other activities and resources.

PENSACOLA

Disposal of dredged sediments from the Pensacola Entrance Channel has occurred previously in the nearshore area, primarily in the vicinity of the Existing Site (Figure 2-1). The Existing Site is 2.3 nmi offshore of Perdido

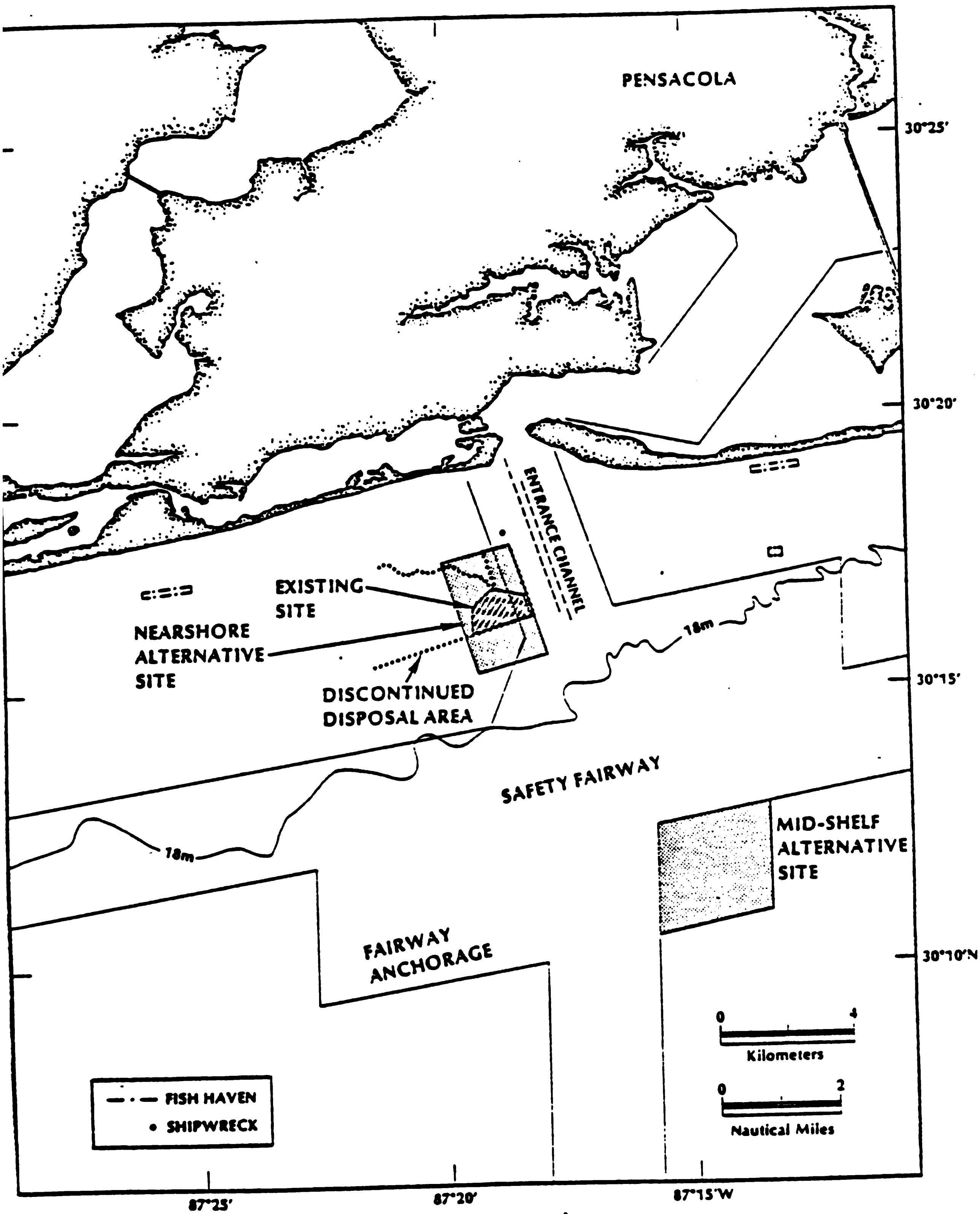


Figure 2-1. Pensacola Existing (Interim) Site, and Nearshore and Mid-Shelf Alternative Sites

Key and covers an area of 0.64 nmi^2, which is small in comparison to other ODMDSs receiving similar volumes of dredged material (e.g., Mobile and Gulfport Existing Sites).

The CE has indicated that the "coordinates initially furnished to the Environmental Protection Agency (EPA) for this disposal area [Existing Site] represented more of a target area than the actual area of use" (J. Meredith, personal communication*). Additionally, the CE has requested that "the disposal area serving the Pensacola Entrance Channel be enlarged to reflect the area used in the past" (R. Krizman, personal communication**). An average of 740,000 yd^3 are dredged from the Entrance Channel per dredging cycle (approximately every 5 years), which if evenly distributed throughout the Existing Site would result in an overburden of about 26 cm (10 in.). This amount of overburden approaches the upper limits of thickness through which many motile benthic organisms can migrate (Maurer et al., 1978; see Chapter 4 of this EIS, "Benthos"). This same volume of material would only result in about 3 to 4 cm (1 to 2 in.) of overburden at the Mobile Existing Site (4.75 nmi^2 area). Because there may be the potential to reduce environmental impacts to the benthos at a site larger than the Existing Site (assuming even distribution of the material), a larger alternative site will be considered.

Also, in order to manage the site effectively so that impacts do not reach beyond the site boundary, a larger site is needed. Monitoring will detect movement of the material and a "buffer zone" is needed so that measures can be taken to modify disposal operations if movement of the material appears likely to impact known amenities.

The office of the Secretary of State, Tallahassee, Florida has expressed concern over natural (not dumped on) ocean bottom areas receiving dredged material because of the high potential for unreported archeological sites (e.g., shipwrecks) in the area (J. Palmer, personal communication†). Therefore, in an effort to reduce the amount of new ocean bottom affected by disposal operations, the CE was asked to provide coordinates for a Nearshore Alternative Site which reflected where dredged material disposal has occurred in the past. The Nearshore Alternative Site (area of 2.48 nmi^2) incorporates

*J. Meridith, U.S. Army Corps of Engineers, Mobile District, Alabama (1981)
**R. Krizman, U.S. Army Corps of Engineers, Mobile District, Alabama (1982)
†J. Palmer, Archaeologist II, Division of Archives, History and Records Management, Secretary of State, Tallahassee, Florida (1981)

the area of the Existing Site, extends west and north in the vicinity of discontinued disposal areas, and extends south where past disposal of dredged material has occurred (R. Krizman, personal communication*; Figure 2-1). This alternative site is further evaluated and compared with the Existing Site.

MOBILE

Disposal of dredged Mobile Bar Channel sediments has previously occurred in the nearshore area, primarily at a site 4.2 nmi from Mobile Point (Existing Site; Figure 2-2). This site covers an area of 4.75 nmi^2. Potential conflicts with site use include: a steel schooner ("Tulsa") built in 1909 and lost in 1943, which reportedly lies at the western boundary of the site; two unidentified obstructions which occur within 1 nmi of the southeastern boundary of the site; an extensive fish haven located approximately 1 nmi south of the site; and proposed oil and gas development in the area. The nearshore area in the vicinity of the Existing Site is considered below for potential locations that may be suitable for siting an alternative ODMDS:

- Locations north of the Existing Site are generally unsuitable because of shallow depths. Utilization of a site in this area would be limited by the depth requiremeents of equipment used by the CE for dredging operations of the Bar Channel.

- Locations east of the Existing Site are generally unsuitable because prevailing westerly currents could transport dumped sediment back into the Bar Channel, thereby accelerating the shoaling rate. In addition, shipwrecks and an extensive fish haven occur east of the site.

- Locations south of the Existing Site, north of the safety fairway, are unsuitable because of the presence of an extensive fish haven and unidentified obstructions. However, southeast of the Existing Site and south of the safety fairway is an area free of known shipwrecks, obstructions, and fish havens which may be suitable.

* op. cit. pg 2-6

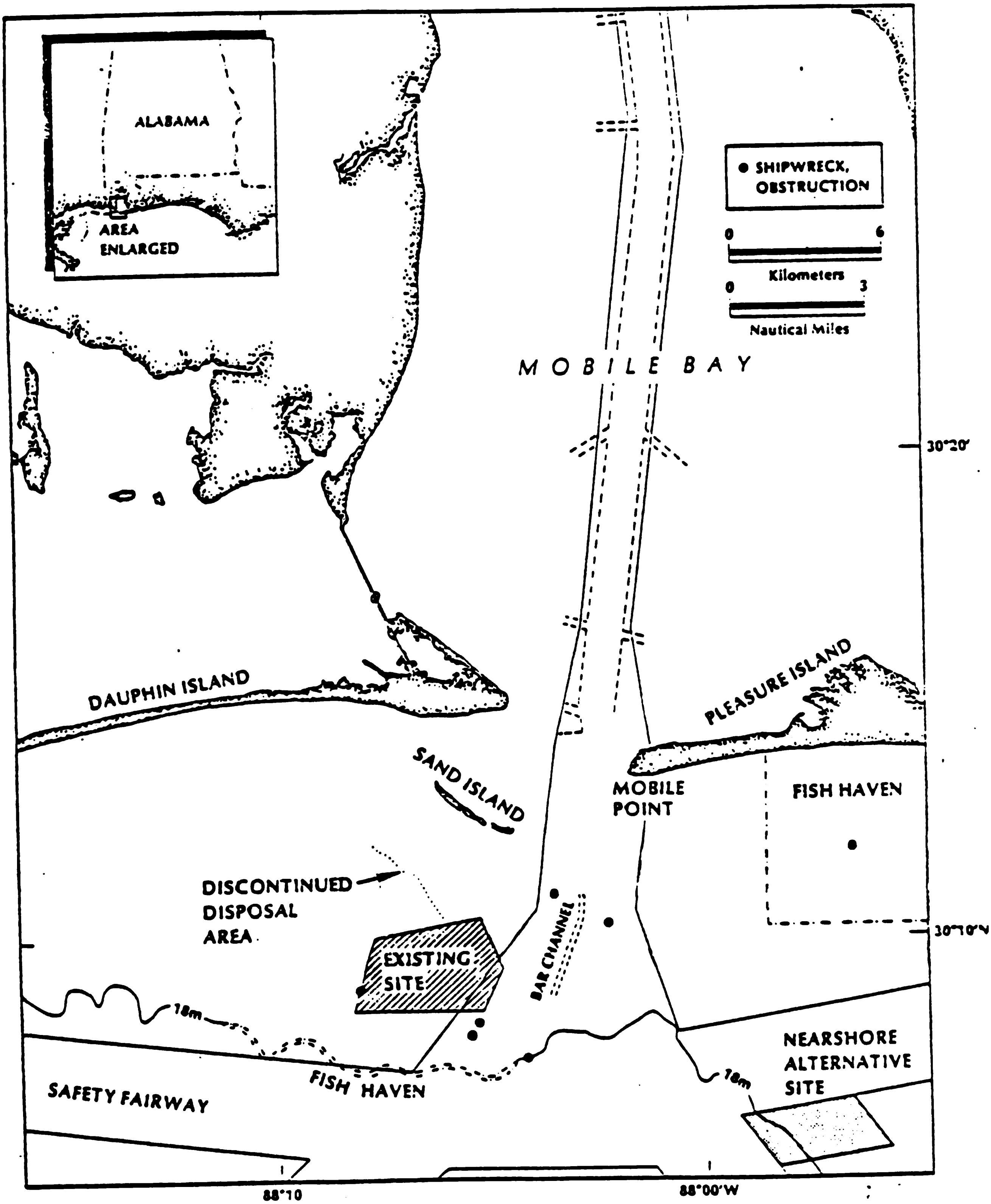


Figure 2-2. Mobile Existing (Interim) and Nearshore Alternative Sites

This area is also within a region selected by the CE (1980b; candidate area 1, figure 12) as a candidate disposal area for receiving new-work dredged material, and is outside the proposed oil and gas lease area offshore Mobile Bay. No dredged material has been dumped in this area and no site-specfic surveys have been conducted.

- West and northwest of the Existing Site is an area (about 10 mi^2) free of shipwrecks, obstructions, and fish havens which may be suitable. In addition, a discontinued disposal area occurs within this area. This area is also within a larger region selected by the CE (1980b; candidate area 2, figure 12) as a candidate disposal area for receiving maintenance-dredged material. This area is, however, within the area of proposed oil and gas leases--Nos. 67-69 (Figure 3-15). Because the status of these leases are proposed rather than active, locating an ODMDS within this region does not present a conflict with other resources at the present time.

In summary, there are two areas west and southeast of the Existing Site that may be suitable for locating an alternative ODMDS. Because there is less potential for future conflict with site use in the southeastern area (e.g., no proposed oil and gas development), a Nearshore Alternative Site (area of 4 mi^2) is selected from the southeastern area for further evaluation and comparison with the Existing Site (Figure 2-2).

GULFPORT

Disposal of dredged Gulfport Ship Island Bar Channel sediments has occurred previously in the nearshore area, primarily at two sites located 0.7 and 1.15 nmi from Ship Island (Existing Sites [western and eastern], respectively; Figure 2-3). These sites cover an area of 5.22 and 2.47 nmi^2, respectively. Potential conflicts with site use include two unidentified obstructions at the eastern boundary (north and south) of the western site, and shallow depths. Light loading of hopper dredges has been required in the past because of shallow depths (<8m) in northern portions of the sites (particularly the

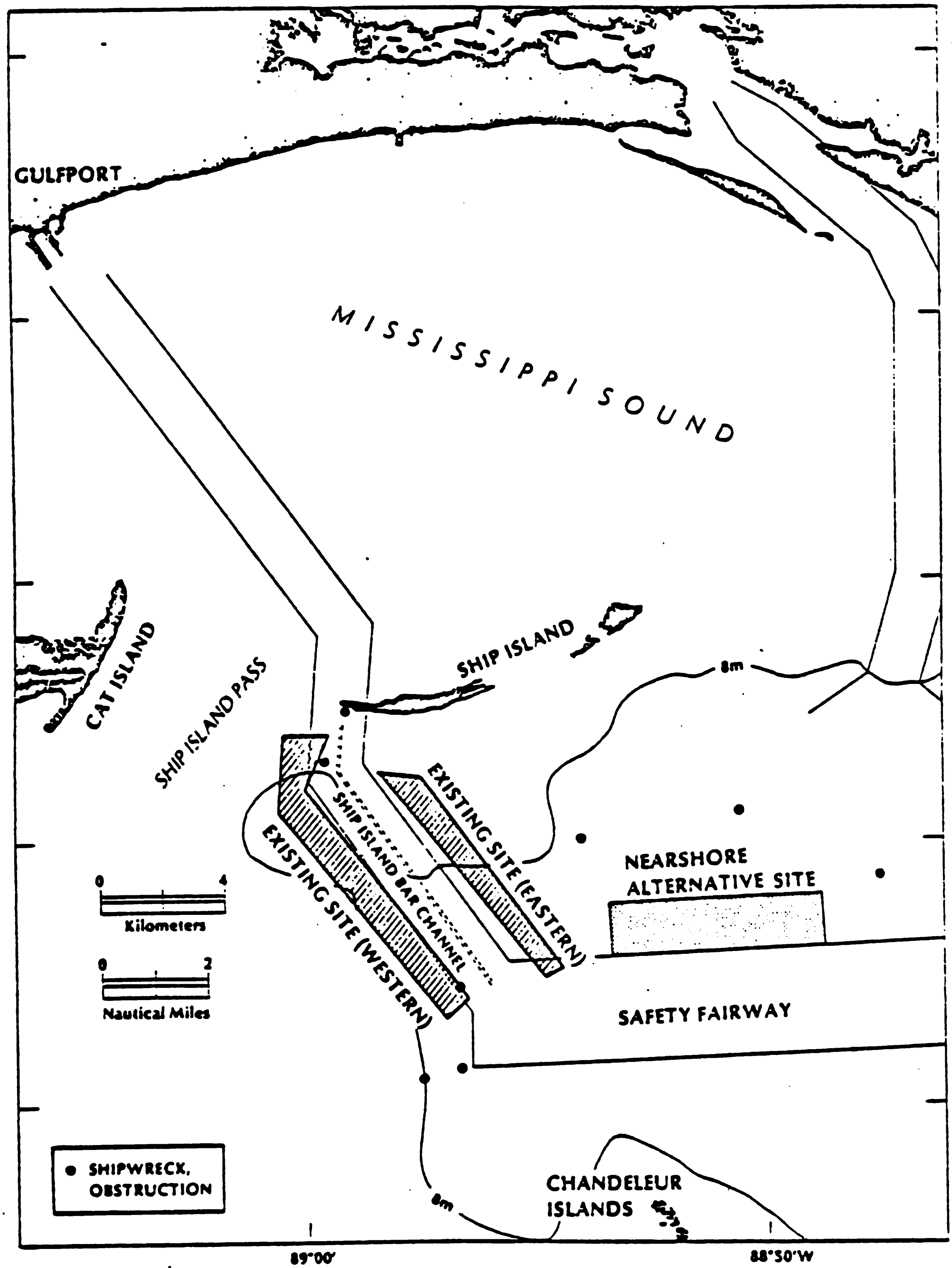


Figure 2-3. Gulfport Existing (Interim) and Nearshore Alternative Sites

eastern site) (R. Rogers, personal communication*). Future utilization of the sites will depend on depth requirements of equipment used; however, smaller hopper dredges are expected to be available (J. Walker, personal communication†). The nearshore area in the vicinity of the Existing Sites is considered below for locations which may be suitable for siting an alternative ODMDS:

- Locations north, west, and southwest of the Existing Sites are generally unsuitable because of shallow depths. Utilization of a site in these areas would be limited by the depth requirements of equipment used by the CE for dredging operations of the Ship Island Bar Channel.

- Locations southeast of the Existing Sites are generally unsuitable because of the shallow depths in vicinity of the Chandeleur Islands.

- East of the Existing Sites, north of the safety fairway, is an area (about 8 nmi^2) free of shipwrecks, obstructions, and fish havens which may be suitable. No dredged material has been dumped in this area and no site specific surveys have been conducted.

In summary, there is one area east of the Existing Sites which may be suitable for an ODMDS. A Nearshore Alternative Site of similar area to the Existing Sites (7.5 nmi^2) is selected for further evaluation and comparison with the Existing Sites (Figure 2-3).

MID-SHELF AREA

The mid-Shelf area extends seaward of the nearshore area to depths of 200m. Physical and biological characteristics are influenced by seasonal

---

* R. Rogers, Ocean Dumping Coordinator, EPA Region IV, Atlanta, Georgia (1981)
† J. Walker, U.S. Army Corps of Engineers, Mobile District, Alabama (1982)

oceanographic and climatic patterns, and episodic Loop Current intrusions. The effects of dredged material disposal at mid-Shelf sites are not well known because the mid-Shelf region "...does not contain many disposal sites and few studies have been undertaken with respect to the fate of dredged material deposited on the open Shelf" (Holliday, 1978). However, results of Dredged Material Research Program (DMRP) studies indicate that recovery of benthic populations following disposal is generally slower in more stable environments, and when there is significant difference between disposal site and dredged sediments (Hirsch et al., 1978). Thus, dredged material disposal could affect organisms in the mid-Shelf area to a greater extent than in the nearshore area because environmental stability increases with increasing depth. No disposal of dredged material has occurred in the mid-Shelf area, delineated in this EIS.

The mid-Shelf area supports valuable commercial fish and shrimp fisheries. In the western portion of the area (west of Mobile) important shrimp and bottomfish resources exist. In the eastern portion of the area (between Mobile and Pensacola) hard-bottom areas support important fisheries (e.g., red snapper). Additionally, fish havens, obstructions, shipwrecks, and offshore banks occur within the area, and represent valuable fishing and potential cultural resources. Some oil and gas exploration and production occurs within the area, predominantly offshore Louisiana. Selection of alternative areas for receiving dredged material are discussed below, with regard to minimizing interferences with other activities and resources.

PENSACOLA

The Shelf off Pensacola is approximately 30 nmi wide. Rock formations with associated corals and other invertebrates occur at depths of 25 to 30m and, become more numerous approaching the reef-interreef facies along the Shelf edge (Moe, 1963). These outcrops represent important resource areas that would not be suitable for locating an ODMDS. Since the locations of these unique reefs are not well known, identifying alternative sites for dredged material disposal within this region is difficult. There is, however, an area southeast of the Existing Site, south of the safety fairway, which may be suitable for an ODMDS because it has depths shallower than 25m; therefore, rock formations may not be present. A Mid-Shelf Alternative Site, with an area of 4 nmi^2, and located adjacent to the safety fairways in a region free from known shipwrecks, obstructions, or fish havens (Figure 2-1), is selected for further evaluation and comparison with the Pensacola Existing Site.

MOBILE AND GULFPORT

The Shelf off Alabama and Mississippi is approximately 70 nmi wide. Several offshore banks, and numerous fish havens, obstructions, and reef areas occur south of Mobile Bay (Figure 3-13). These areas would not be suitable for an ODMDS because of valuable fishery resources. East of the Chandeleur Islands is an area equidistant from Mobile and Gulfport, which is free of known shipwrecks, obstructions, and fish havens. This area was investigated as part of the Mississippi, Alabama, Florida (MAFLA) Outer Continental Shelf Study sponsored by the Bureau of Land Management (1974-1978), and was found to be low in diversity and abundance of benthic species. This area is, however, within a larger region fished for shrimp and bottomfish. A Mid-Shelf Alternative Area (about 130 nmi^2), within which an ODMDS could be located, is selected adjacent to the safety fairways (at depths greater than 20m) for further evaluation and comparison with the Mobile and Gulfport Existing Sites (Figure 2-4).

DEEPWATER AREA

The Deepwater Alternative Area (Figures 2-4 and 2-5) considered herein, is about 64 nmi from Mobile Point, in waters deeper than 400m. This area has been reported as one of three favorable areas for receiving dredged material in open waters of the Gulf (Pequegnat et al., 1978). This area was considered favorable by Pequegnat et al. (1978) because it is outside the principal economic and sportfisheries regions, and the receiving capacity of the deep ocean should ameliorate effects from dredged material disposal. This Deepwater Alternative Area (1,500 nmi^2), within which an ODMDS could be located, is selected for further evaluation and comparison with the Pensacola, Mobile, and Gulfport Existing Sites (Figure 2-5).

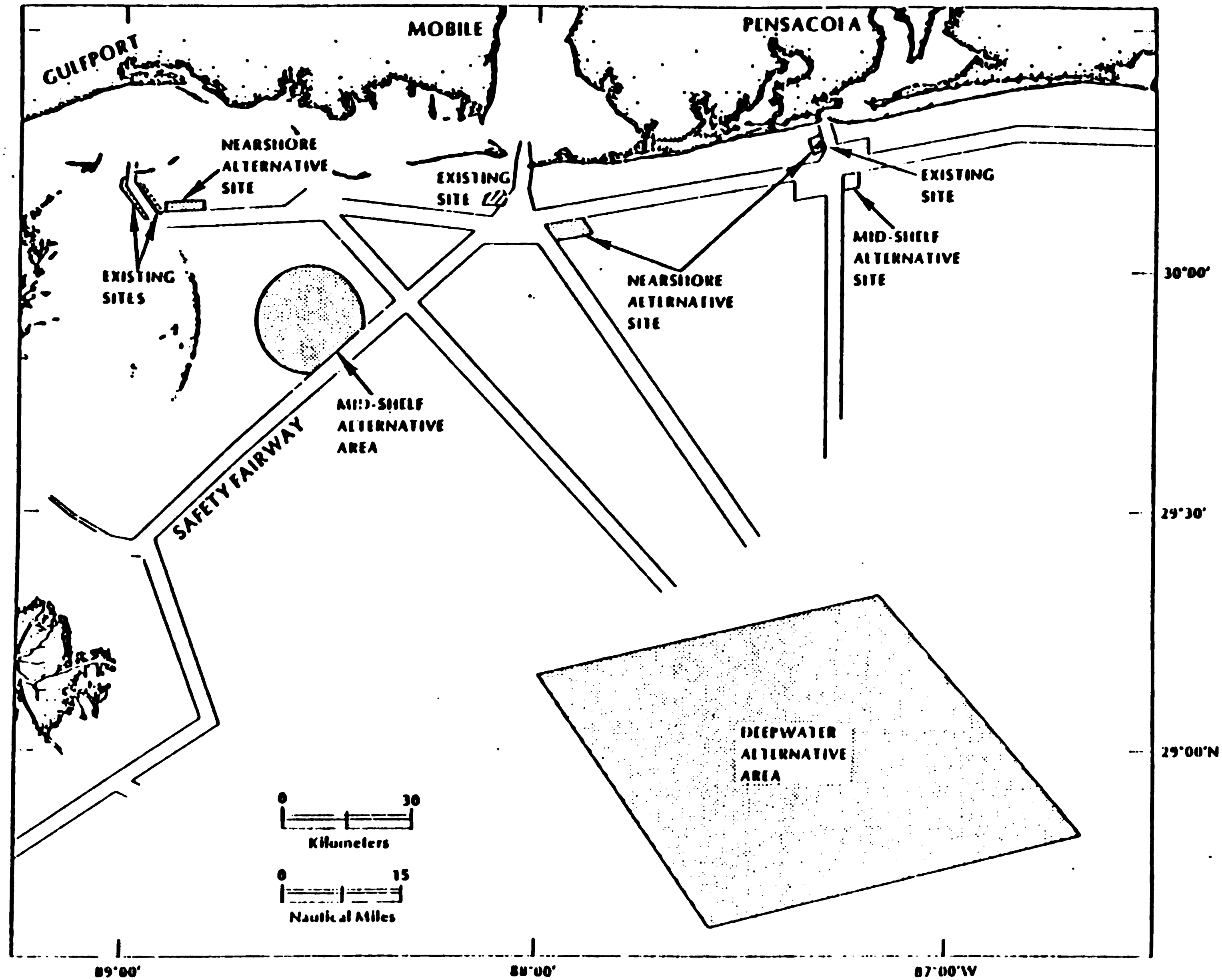


Figure 2-4. Existing and Alternative Sites/Areas

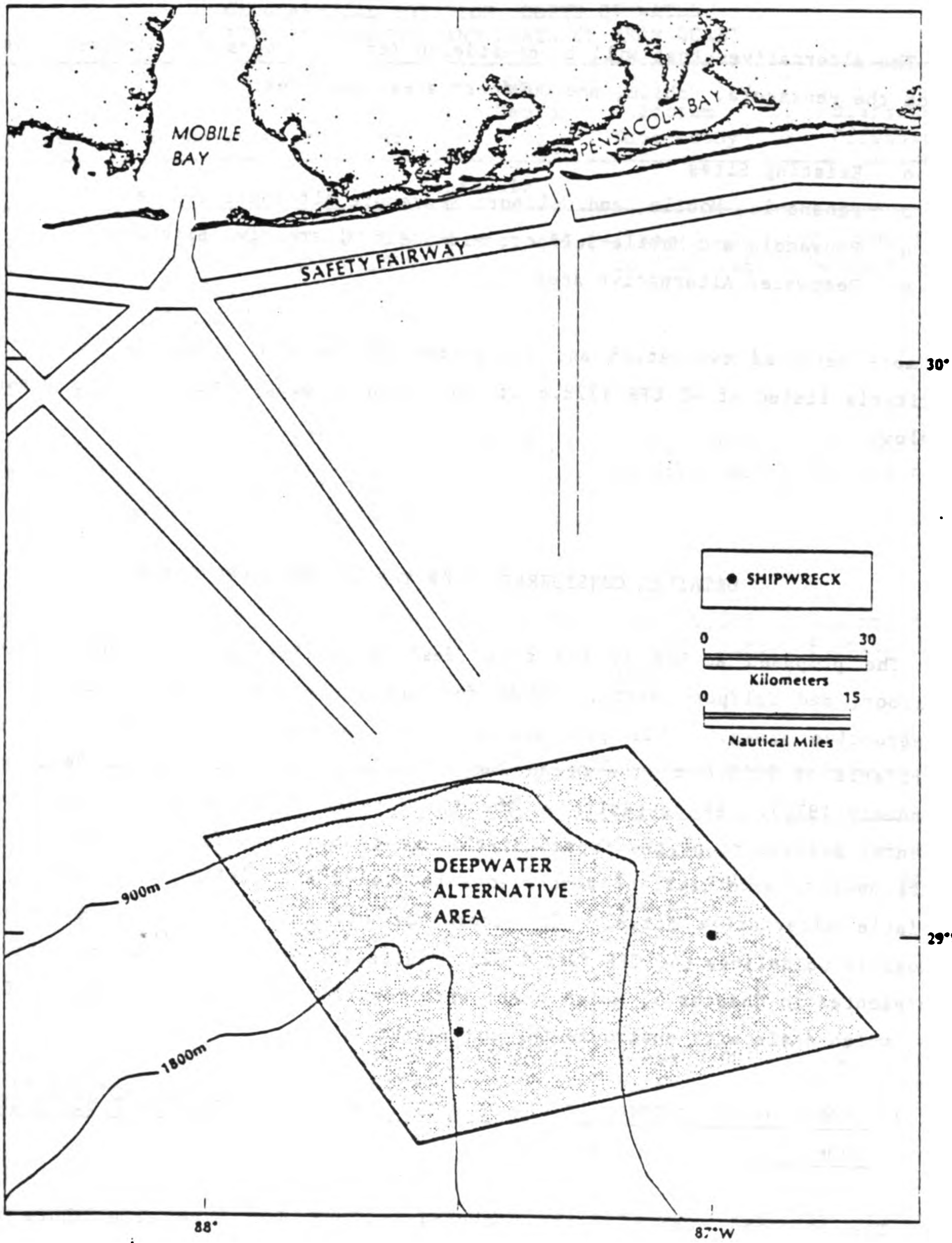


Figure 2-5. Deepwater Alternative Area

CONCLUSION

The alternatives that will be considered for the disposal of dredged material from the Pensacola, Mobile, and Gulfport areas includes:

- o Existing Sites
- o Pensacola, Mobile, and Gulfport Nearshore Alternative Sites
- o Pensacola and Mobile-Gulfport Mid-Shelf Alternative Site/Area
- o Deepwater Alternative Area

A more detailed evaluation and comparison of these alternatives using the 11 criteria listed at 40 CFR §228.6 of the Ocean Dumping Regulations is presented below.

DETAILED CONSIDERATION OF THE ATLERNATIVES SITES

The proposed action is the final designations to Pensacola Harbor, Mobile Harbor, and Gulfport Harbor ODMDSs for disposal of material dredged from the respective areas. This proposal is based on evaluation of the 11 specific criteria of §228.6 of the Ocean Dumping Regulations (40 Federal Register, 11 January 1977). EPA established the 11 criteria to constitute "...an environmental assessment of the impact of the use of the site for disposal," and they are used to make critical comparisons between the Existing Sites and the other viable Alternative Sites. In accordance with the council on Environmental Quality Guidelines (40 CFR Part 1502), discussion of sites relies on information presented in Chapter 3, which deals with the affected environments, and Chapter 4, which deals with environmental consequences.

(1) GEOGRAPHICAL POSITION, DEPTH OF WATER, BOTTOM TOPOGRAPHY AND DISTANCE FROM COAST (40 CFR §228.6[a][1])

The location, water depths, togography, and distances from shore of all Alternatives Sites are summarized in Table 2-1.

TABLE 2-1
GEOGRAPHICAL POSITION, DEPTH OF WATER,
BOTTOM TOPOGRAPHY, AND DISTANCE FROM COAST

Site/Area	Boundary Coordinates	Water Depth (m)	Bottom Topography	Distance Offshore
Pensacola				
Existing Site	30°16'48"N, 87°19'00"W 30°16'42"N, 87°18'18"W 30°16'18"N, 87°18'12"W 30°16'30"N, 87°19'24"W 30°16'00"N, 87°19'24"W Area = 0.64 nmi^2	8 to 14	Slope 0.003 to SSW; sand	2.3 nmi from Perdido Key
Nearshore Alternative Site	30°17'24"N, 87°18'30"W 30°17'00"N, 87°19'50"W 30°15'36"N, 87°17'48"W 30°15'15"N, 87°19'18"W Area = 2.48 nmi^2	8 to 18	Slope 0.003 to SSW; sand	1.5 nmi from Perdido Key
Mid-Shelf Alternative Site	30°12'33"N, 87°15'42"W 30°10'33"N, 87°15'42"W 30°12'51"N, 87°13'26"W 30°10'54"N, 87°13'26"W Area = 4.00 nmi^2	21 to 23	Slope 0.003 to SSE; hard sand	7.2 nmi from Perdido Key
Mobile				
Existing Site	30°10'00"N, 88°07'42"W 30°10'24"N, 88°05'12"W 30°09'24"N, 88°04'42"W 30°08'30"N, 88°05'12"W 30°08'30"N, 88°08'12"W Area = 4.75 nmi^2	12 to 16	Slope 0.001 to SW; sand and silt	4.2 nmi from Mobile Point
Nearshore Alternative Site	30°05'15"N, 87°58'20"W 30°05'39"N, 87°55'45"W 30°06'18"N, 87°59'15"W 30°06'48"N, 87°56'39"W Area = 4.05 nmi^2	14 to 18	Slope 0.001 to SW; hard sand	7.2 nmi from Mobile Point

TABLE 2-1 (continued)

Site/Area	Boundary Coordinates	Water Depth (m)	Bottom Topography	Distance Offshore
Mobile-Gulfport				
Mid-Shelf Alternative Area	29°54'00"N, 88°32'00"W (center coordinates of circular area) Area = 130 nmi^2 (approximate)	23 to 29	Slope 0.0007 to SE; sandy	24 nmi from Ship Island; 25 nmi from Mobile Point (approximate)
Gulfport				
Existing Site (Eastern)	30°11'10"N, 88°58'24"W 30°11'12"N, 88°57'30"W 30°07'36"N, 88°54'24"W 30°07'24"N, 88°54'48"W Area = 2.47 nmi^2	7 to 9	Slope 0.0004 to SE; silt, clay, and fine sand	1.2 nmi from Ship Island
Existing Site (Western)	30°12'00"N, 89°00'30"W 30°12'00"N, 88°59'30"W 30°11'00"N, 89°00'00"W 30°07'00"N, 88°56'30"W 30°06'36"N, 88°57'00"W 30°10'30"N, 89°00'36"W; Area = 5.22 nmi^2	6 to 9	Slope 0.0006 to SE; silt, clay, and fine sand	0.7 nmi from Ship Island
Nearshore Alternative Site	30°09'30"N, 88°48'48"W 30°09'18"N, 88°54'30"W 30°08'00"N, 88°48'42"W 30°07'48"N, 88°54'24"W Area = 7.50 nmi^2	9 to 12	Slope 0.001 to SE; sand and silt	4.3 nmi from Ship Island
Pensacola, Mobile, and Gulfport				
Deepwater Alternative Area	29°10'00"N, 88°00'00"W 29°20'00"N, 87°10'00"W 28°50'00"N, 86°40'00"W 28°38'00"N, 87°35'00"W Area = 1,500 nmi^2	493 to 2376	Slope 0.03 to SE; clay, silt, fine sand, and rock in Canyon	61 nmi from Perdido Key; 64 nmi from Mobile Point; 81 nmi from Ship Island (approximate)

(2) LOCATION IN RELATION TO BREEDING, SPAWNING, NURSERY, FEEDING, OR PASSAGE AREAS OF LIVING RESOURCES IN ADULT OR JUVENILE PHASES (40 CFR §228.6[a][2])

EXISTING SITES

The Pensacola and Mobile Existing Sites are in the vicinity of Pensacola Bay and Mobile Bay, respectively, which are important nursery and spawning areas for a number of commercially important species of fish and shrimp. The Gulfport Existing Sites are in the vicinity of Mississippi Sound, which similarly constitutes a productive nursery and spawning area. In addition, the Gulfport Sites are located near (within 1 nmi or less) Ship Island Pass, an important passage area for these species. Movement of nekton into estuaries occurs mainly from January to June; migration back into the Gulf typically occurs from August to December. Seasonal variations in abundances of nekton at the Existing Sites are expected to coincide with the migration patterns of coastal species.

The Existing Sites have predominantly sand (Pensacola) to silt and clay (Gulfport) bottoms, with associated species characteristic of northeastern Gulf waters. These sites do not represent unique habitats, but rather constitute small areas within the larger nearshore area. There are, however, fish havens/artificial reefs in the vicinity of some of the sites, which may represent unique habitat areas. For instance, an extensive fish haven is located approximately 1 nmi south of the Mobile Existing Site. Bottom currents may periodically transport dumped material toward this sensitive area. Transport of dumped material off Pensacola and Gulfport is not as great a concern because fish havens are located at distances greater than 4 nmi from the Pensacola Existing Site, and 1.5 nmi east of the eastern Gulfport Existing Site, which should be upstream of the prevailing current flow.

NEARSHORE ALTERNATIVE SITES

The Pensacola Nearshore Alternative Site is a geographic extension of the Existing Site; therefore, the above discussion of the Existing Site would equally apply to the Nearshore Alternative Site.

The Mobile Nearshore Alternative Site is located 7.2 nmi southeast of Mobile Point and the entrance to Mobile Bay, and is therefore not directly in the major passage area of species which migrate to and from Mobile Bay. The nearest fish haven is located more than 4 nmi to the east, which because of distance should not be affected by dredged material disposal.

The Gulfport Nearshore Alternative Site is located more than 5 nmi southeast of Ship Island Pass and is not, therefore, directly in the passage area of species which migrate to and from the Mississippi Sound. The nearest fish havens are north and east of the Site; prevailing currents indicate that these are upstream areas. However, these sensitive areas are at distances within 1.5 nmi of the Nearshore Alternative Site; therefore, they may be periodically affected by redistributed dumped material (e.g., from storm conditions).

MID-SHELF ALTERNATIVE SITE/AREA

The Pensacola Mid-Shelf Alternative Site is located more than 7 nmi southeast of the entrance to Pensacola Bay and is not, therefore, directly in the major passage area of species which migrate to and from Pensacola Bay. Hard-bottom and rocky outcrop areas reportedly occur in the vicinity of the Mid-Shelf Alternative Site; however, it is impossible to state whether sensitive areas would be affected by dredged material disposal because their exact locations are not known.

The Mobile-Gulfport Mid-Shelf Alternative Area is located at least 10 nmi from major passage areas of species that migrate to and from the Mississippi Sound and Mobile Bay. The Area is within a larger region used intensively for commercial shellfishing and finfishing. Several valuable species range over a wide area in this region of the Gulf; therefore, a site selected from this Area should represent only a small portion of their geographic range.

DEEPWATER ALTERNATIVE AREA

The Deepwater Alternative Area may be a feeding area for oceanic fish; however, there are no uniques migratory passage areas in the vicinity. Pequegnat et al. (1978) selected the Deepwater Alternative Area in order to avaoid shallow-water habitats of valuable shellfish and finfish. One criterion used (Pequegnat et al., 1978) was that the Area is "...outside the principal economic and sports fisheries regions, including the royal red shrimp and pelagic fisheries."

(3) LOCATION IN RELATION TO

BEACHES AND OTHER AMENITY AREAS (40 CFR §228.6[a][3])

EXISTING SITES

Amenity areas in the vicinity of the Pensacola Existing Site are Pensacola Bay, Fort Pickens State Park Aquatic Preserve (part of Gulf Islands National Seashore), and beaches on Perdido Key and Santa Road Island. Prevailing southwesterly currents should not transport dumped material toward Pensacola Bay and local beaches. If site monitoring detects movement of the material towards these areas in significant quanities, steps will be taken to alter the disposal operation or discontinue disposal at the site.

Amenity areas in the vicinity of the Mobile Existing Site include Mobile Bay and beaches on Dauphin and Pleasure Islands. Casino Pier, a 500-to 600-ft. pier, is also an important attraction on Dauphin Island. The Mobile Existing Site is located at least 4 nmi from these areas. An extensive fish haven is located approximately 1 nmi south of the site, and bottom currents may periodically transport dumped material toward this sensitive area.

Amenity areas in the vicinity of the Gulfport Existing Sites include the Mississippi Sound and Ship Island (part of Gulf Islands National Seashore). The sites are located 0.7 and 1.2 nmi from the island, where swimming, fishing, hiking, and picknicking take place. Although, prevailing currents should carry dumped sediments away from the island during most of the year, there remains the potential that dumped material may be periodically redistributed toward the island.

NEARSHORE SITES

The Pensacola Nearshore Alternative Site is a geographic extension of the Existing Site; therefore, the above discussion of the Existing Site would equally apply to the Nearshore Alternative Site.

The Mobile Nearshore Alternative Site is at least 7 nmi from amenity areas on Dauphin and Pleasure Islands, and in Mobile Bay. Because of distance and prevailing currents, dumped dredged material should not affect these areas.

The Gulfport Nearshore Alternative Site is 4.3 nmi from Ship Island. Because of distance and prevailing currents, dumped dredged material should not affect amenity areas on the island. Fish havens, representing fishery resource areas, occur within 1.5 nmi of the Nearshore Alternative Site. Although prevailing currents should not transport dumped material toward these areas, there exists the potential for periodic sediment transport in their direction (e.g., storm conditions).

MID-SHELF ALTERNATIVE SITE/AREA

The Pensacola Mid-Shelf Alternative Site is located more than 7 nmi from Pensacola Bay and beaches; therefore, disposal should have no significant adverse impact on coastal amenities.

The Mobile-Gulfport Mid-Shelf Alternative Area is located far (>10 nmi) from nearshore amenity areas; therefore, disposal should have no significant adverse impacts on coastal amenities.

DEEPWATER ALTERNATIVE AREA

The Deepwater Altarnative Area is more than 60 nmi from the nearest land; therefore, disposal should have no significant adverse impact on beaches and other nearshore amenities.

(4) TYPES AND QUANTITIES OF WASTES PROPOSED TO BE DISPOSED OF, AND PROPOSED METHODS OF RELEASE, INCLUDING METHODS OF PACKING THE WASTE, IF ANY (40 CFR §228.6[a][4]

ALL SITES

Material previously dumped at Pensacola, Mobile, and Gulfport ocean disposal sites resulted from dredging of the Entrance Channel, Bar Channel, and Ship Island Bar Channel, respectively. Quantities of material dredged and the frequency of dredging operations has varied in the past, and is expected to vary in the future; dredging is on an as-needed basis, and is scheduled according to availability of funds and equipment (J. Walker, personal communication*). For example, during the period 1970 to 1981, an average of 740,664 yd^3 of dredged material was removed from the Pensacola Entrance Channel per dredging cycle (based on years dredging occured—every 4 to 5 years), but 1,732,615 yd^3 of material was removed in a single year (1971); at Mobile, an average of 485,776 yd^3 of dredged material was removed in a single year (1971); at Gulfport, an average of 649,290 yd^3 of dredged material was removed from the Ship Island Bar Channel per dredging cycle (every 1 to 3 years), but 1,751,500 yd^3 of material was removed in a single year (1977). Thus, the quantities of material to be dumped at the ODMDSs depend on the dredging requirements of the respective areas. All material dumped at ocean disposal sites must comply with the requirements of the Ocean Dumping Regulations, and must be environmentally acceptable for ocean disposal.

In addition disposal at the Pensacola site will be limited to sand sized particles only. Information supporting this site designation is based on the fact that predominantly sand sized particles exist in the Pensacola area. The effect of disposing significant quantities of silt and clay sized particles is unknown and is therefore restricted.

Analysis of material dredged from the Pensacola Entrance Channel show that 93% of the material is sand. Because the sediments are composed primarily of sand and occur in areas of high wave energy, the sediments were determined to be environmentally acceptable for ocean disposal without further testing, in accordance with 40 CFR §227.13 (b)(1) (CE, 1978e). Analysis of material dredged from the Mobile Bar Channel show that an average of 86% of the material is sand. Because the sediments are composed primarily of sand and occur in areas

*J. Walker, U.S. Army Corps of Engineers, Mobile District, Alabama (1982) or high wave energy, the sediments were determined to be environmentally acceptable for ocean disposal without further testing, in accordance with 40 CFR §227.13(b)(1) (CE, 1978f).

In an evaluation report completed on 7 June 1978, the District Engineers concluded that the dredged material from the Gulfport Harbor Bar Channel may be considered substantially the same as the substrate at the disposal site. Therefore, the material is excluded from further technical evaluation in accordance with 40 CFR Section 227.13(a)(3).

Hopper dredges are used for the maintenance dredging of the Pensacola Entrance Channel, Mobile Bar Channel, and Gulfport Ship Island Bar Channel (J. Walker, personal communication†). The dredged material is not packaged, and is released when the bottom doors of the hoppers are opened while the vessel is underway within the site.

(4) <u>FEASIBLILITY OF SURVEILLANCE AND MONITORING</u> (40 CFR §228.6[a][5])

ALL SITES

Surveillance of all Existing and Nearshore Alternative Sites, and the Pensacola Mid-Shelf Alternative Site could be conducted by either U.S. Coast Guard aircraft or day-use boats. Because of the proximity of the Gulfport Existing Sites to Ship Island, use of shore-based observers may be possible. The Mobile-Gulfport Mid-Shelf Alternative and Deepwater Alternative Areas are located farther from land; therefore, the use of shipriders or aircraft would be necessary for surveillance.

---

*J. Meridith, Acting Chief Operations Division, U.S. Army Corps of Engineers, Mobile District, Alabama (1982)

†J. Walker, U.S. Army Corps of Engineers, Mobile District, Alabama (1982)

Monitoring (discussed in detail later in this chapter) is feasible at all sites. However, if the Pensacola Mid-Shelf Alternative Site is located in a hard-bottom area, a more complex monitoring plan would be required than for a site with a sand or silt-clay bottom. Also, costs could be higher for monitoring a site in the Mid-Shelf Alternative or Deepwater Alternative Areas because of longer travel time requirements, and for sampling at deeper depths.

(6) <u>DISPERSAL, HORIZONTAL TRANSPORT, AND VERTICAL MIXING CHARACTERISTICS OF THE AREA INCLUDING PREVAILING CURRENT DIRECTION AND VELOCITY, IF ANY</u> (40 CFR §228.6[a][6])

EXISTING AND NEARSHORE ALTERNATIVE SITES

In shallow water nearly all the dredged material falls to the bottom immediately after dumping (Pequegnat et al., 1978). Only a small portion of the finer fraction is lost from the main settling surge, and this portion settles as individual particles. The finer particles usually take much longer to reach the bottom than the coarser fraction. Because dredged sediments from Gulfport consist of fine-grained particles, turbidity plumes may persist longer at a Gulfport ODMDS than at a Pensacola or Mobile ODMDS, which will receive coarser-grained material. However, after measuring turbidity levels before, during, and after dredging of the Gulfport Ship Channel in Mississippi Sound, it was concluded that "Dredging had no significant or lasting effect on the levels of turbidity and suspended solids in the water column. The effects of dredging on the background levels are insignificant when compared to [the effects of] shrimping and natural events of weather" (Water and Air Research, Inc., 1975).

Sediment dispersion and transport in the nearshore area is controlled by prevailing wave energy, longshore drift, and storm-induced waves and currents. There is a strong westward-flowing longshore current along the Gulf side of the barrier islands, with speeds averaging 1 to 2.5 kn, and increasing to 2.5 to 5 kn when augmented by tidal flows (Boone, 1973). Westward sediment transport is most dramatically illustrated in the westward drift of the barrier islands. In addition, longshore sediment transport averages 130,000 yd^3 annually at the mouths of Perdido and Pensacola Bays (ibid.).

The Existing and Nearshore Alternative Sites are located from approximately 1 to 7 nmi offshore, and probably have somewhat slower current speeds than near the barrier islands. Currents have not been measured at the Existing or Nearshore Alternative Sites. However, because strong bottom currents are responsible for the erosion and migrations reported for the barrier islands and the mouths of Perdido and Pensacola Bays, significant long-term accumulations of dredged material should not occur in the nearshore region. In addition, frequent storm passage should redistribute remaining sediments. During hurricane Camille in 1969, bottom currents of 3.1 kn were measured in the nearshore area off Pensacola (Murray, 1970).

A bathymetric survey of the Gulfport Existing Sites did not detect any sediment mounds from dredged material disposal (CE, 1979c). A bathymetric survey of the Mobile Existing Site revealed a northwesterly ridge (approximately 1m high) running through the southern portion of the site (CE, 1979d). Because natural shoaling of about 2m has been reported for the 10 to 15m depth range for the years 1851 to 1951 (Henry and Shenton, 1955), it is not possible to conclude whether the ridge in the Mobile Existing Site represents a sandbar, or is the result of dredged material disposal. No bathymetric surveys have been conducted at the Pensacola Existing Site.

The flushing characteristics of the nearshore region are generally good during the winter. However, during the summer density stratification may occur, thereby potentially restricting vertical mixing (TerEco, 1978). This phenomenon is often reflected in lowered dissolved oxygen concentrations in bottom waters.

A consideration in selecting a location for an ODMDS is the potential for disposal sediments to be transported by currents back into the dredged channel, thus accelerating the shoaling rate and creating additional maintenance work. This is of particular concern for the Gulfport Existing Sites, which occur immediately east and west of the Channel. Although sand movement along Ship Island occurs to the east during part of the year, the primary sand movement is to the west and south. Thus, material deposited in the northern end of the Existing Site (eastern) may again have to be redredged from the Channel, thereby increasing the dredging frequency and costs (R. Rogers, personal communication*).

MID-SHELF ALTERNATIVE SITE/AREA

Currents have not been measured at either the Pensacola or Mobile-Gulfport Mid-Shelf Alternative Site/Area; however, factors affecting circulation from the nearshore area to offshore areas up to 36m in depth include wind, tides, bottom topography, density discontinuities, and open-Gulf circulation (i.e., Loop Current) (TerEco, 1978). Currents measured offshore Mobile in the mid-Shelf region (southwest of Mobile Nearshore Alternative Site), ranged from 0.4 to 0.9 kn. Near-bottom waters tended to flow about 90 degrees to the right of the sustained wind direction (ibid.). For instance, currents were primarily directed towards the east in June and July with southwesterly winds; towards the west during September-January with northerly winds; and transitional in May and August with variable winds (Schroeder, 1976).

The Mid-Shelf Alternatives are in waters which are less than 30m in depth, and are considered to have good flushing characteristics (TerEco, 1978). However, during the summer, density stratification may occur and restrict vertical mixing. It has been suggested that during summer it would be advisable to place dredged materials in deeper water (e.g., mid-Shelf region), where the water layer beneath the thermocline is thicker and contains a larger quantity of oxygen than in shallow water, (TerEco, 1978).

DEEPWATER ALTERNATIVE AREA

Shoaling is unlikely to occur in the Deepwater Alternative Area because of spreading and dispersion of the sediment as particles settle through at least 400m of water (Pequegnat et al., 1978). In deep water (e.g., Deepwater Alternative Area), bottom-water motions are generally not considered sufficient to move deposited sediments (Hirsch et al., 1978; Holliday, 1978),

---

* R. Rogers, Ocean Dumping Coordinator, EPA Region IV, Atlanta, Georgia (1981)

although Pequegnat et al. (1978) stated that internal waves may contribute to sediment transport along the Continental Slope. Molinari et al. (1979) reported bottom currents near the Deepwater Alternative Area oriented parallel to bottom contours, with velocities ranging from 0.04 to 0.3 kn.

(7) <u>EXISTENCE AND EFFECTS OF CURRENT AND PREVIOUS DISCHARGES AND DUMPING IN THE AREA (INCLUDING CUMULATIVE EFFECTS)</u> (40 CFR §228.6[a][7])

EXISTING SITES

The Existing Sites have been used since at least 1970. During the period 1970 to 1981 approximately 3, 4, and 5 million yd^3 were dumped at the Pensacola, Mobile, and Gulfport Existing Sites, respectively. EPA/IEC surveys did not detect significant adverse nor cumulative effects from previous dredged material disposal (Appendix A). For instance, species and abundances of infauna and epifauna generally were similar between the Existing Site and reference station(s), and similar to those described for comparable nearshore regions of the northeastern Gulf. Trace metal and CHC concentrations in epifauna collected within the disposal sites were low and below U.S. Food and Drug Administration action levels for fish and shellfish. In addition, water column and sediment parameters measured at the Existing Sites were typically similar in value to measurements taken at the reference stations. Also, values were generally within or below levels reported in the literature for the area and, where applicable, were within the quality criteria for marine waters.

One exception to the above-stated trends, however, occurred at Gulfport. Significantly higher lead concentrations were detected in Existing Site sediments than in reference station sediments (Appendix A). However, sediment composition was also different between the sites; Existing Site sediments were predominantly silt and clay, and the reference station sediments were primarily sand. The higher metal concentration in the Existing Site sediments may be related to grain size, since it has been reported that higher metal concentrations are generally associated with finer-grained sediments, such as those which naturally occur off the Mississippi Delta (Dames and Moore, 1979). However, dredged sediments from Gulfport contained higher concentrations of mercury, cadmium, and lead than either the Existing Site or reference station (Davis, 1978), indicating that metal enrichment of disposal site sediments could result from dumping. In any event, metal concentrations in the Gulfport Existing Site sediments were within ambient ranges reported for nearshore sediments of the northeastern Gulf. Another exception occurred at Mobile, where one reference station (Station 7 located south of Existing Site) had significantly higher lead concentrations in its sediments in June than January, and significantly higher concentrations than at any of the other stations (including those within the Existing Sites) during both survey periods. Dumping ocurred at the Existing Site (February-March 1980) between the survey periods, and sediment grain size composition at reference Station 7 was similar between surveys. Because sediment lead concentrations were low in Existing Site sediments, and other parameters (water column, sediment, biotic) measured at the reference station were not significantly different between surveys or other stations, it is not possible to conclude whether the high lead concentrations were the result of the February-March dredged material disposal. In addition, lead concentrations in dredged sediments have been reported to be a low 0.5 mg/kg (Davis, 1978).

Although, no long-term or irreversible effects of disposal at the Existing Sites were evident from EPA/IEC survey data, temporary or reversible effects may include (1) increases in suspended sediment concentrations, (2) localized mounding, (3) possible releases of ammonia, phosphorus, and some trace constituents, and (4) smothering of some benthic organisms.

Natural concentrations of suspended particulates in the area are high and seasonally variable due to river discharge and resuspension of nearshore bottom sediments. Because of high background turbidity levels, the effects of temporary increases in turbidity from dredged material disposal should be minimal (Water and Air REsearch Inc., 1975; Wright, 1978). In any event turbidity associated with dredged material disposal is short term and levels should return to ambient values as the material settles to the ocean floor.

Discrete mounds of dredged material may occur as a result of dumping activities. However, dumped material should be transported and dispersed by currents and storm-induced flows, thus decreasing the likelihood of significant accumulation and shoaling within the disposal sites.

Results of elutriate analyses showed slight releases of TOC, phosphorus, and zinc from Pensacola dredged sediments; ammonia and phosphorus releases from Mobile dredged sediments; and ammonia, phosphorus, and arsenic releases from Gulfport dredged sediments. Results of DMRP studies indicate that releases such as these do not cause chronic water quality problems because concentrations are rapidly decreased due to dilution and mixing (Brannon et al., 1978; Wright, 1978). No bioassay or bioaccumulation studies have been conducted since the dredged material meets the exclusion criteria of 40 CFR Sec. 227.13.

Smothering of some benthic organisms, particularly species of limited motility (e.g., tube-dwelling polychaetes), have probably resulted from dredged material disposal. Results of DMRP studies indicate that recolonization of the affected area is fairly rapid when the site is located in a high-energy environment and dredged materials are similar in composition to disposal site sediments. Recolonization rates by benthic organisms have not been measured at the Existing Sites, but it is anticipated that they would be rapid because many of the species collected at the Existing Sites and reference stations are considered opportunistic and adapted for life in unstable areas (e.g., respond to periodic burial from storm activity), and dredged sediments are similar to those at the Existing Sites. This is supported by the June EPA/IEC Survey, which shows that despite dumping in February and March, species composition and abundances were similar between disposal site and reference stations at Mobile. However, recolonization may be slower at the Pensacola Existing Site because the deeper overburden of dredged material which could result at a smaller site (relative to Mobile and Gulfport) could decrease the ability of benthic organisms to escape burial.

The potential for bioaccumulation of contaminants in infaunal, epifaunal, or planktonic organisms exposed to dredged materials is not known. No bioassay or bioaccumulation studies have been conducted using the dredged sediments.

ALTERNATIVE SITES

Previous dredged material disposal has not occurred at any of the Alternative Sites/Areas, with the exception of the Pensacola Nearshore Alternative Site. This site is a geographic extension of the Existing Site; therefore, the above discussion, where applicable, should apply.

(8) <u>INTERFERENCE WITH SHIPPING, FISHING, RECREATION, MINERAL EXTRACTION, DESALINATION, FISH AND SHELLFISH CULTURE, AREAS OF SPECIAL SCIENTIFIC IMPORTANCE, AND OTHER LEGITIMATE USES OF THE OCEAN</u> (40 CFR §228.6[a][8])

EXISTING AND NEARSHORE ALTERNATIVE SITES

Extensive commercial shipping, commercial and recreational fishing, recreational activities, and some scientific investigations occur throughout the nearshore region. The Existing and Alternative Sites are adjacent, and in the case of the Existing Sites, partially within the safety fairway of the major channel which serves their respective harbors. Hopper dredges must operate within shipping lanes when dredging and traveling to and from the disposal site; however, intermittent use of a site should not impede commercial shipping traffic within the shipping channels. Hazards to navigation are lessened by use of the U.S. Coast Guard's Area Vessel Traffic System, extra caution and awareness by the captains of hopper dredges, and the CE's public announcements to mariners of dredging schedules (J. Walker personal communication*).

Commercial and recreational fishing occurs, but is not geographically limited to the vicinity of the Existing and Alternative Sites. Major fisheries exist for menhaden and shrimp in the nearshore region off Gulfport and Mobile. Some interferences with menhaden (extends 3 nmi from shore) and white shrimp (extends out to 20m) fisheries may occur as a result of dredged material disposal. However, the disposal site represents only a small portion

---

* J. Walker U.S. Army Corps of Engineers, Mobile District, Alabama (1982)

of the total fishing area available. Offshore of Pensacola, commercial and sportfishing operations center primarily around hard-bottom, artificial reef, and wreck areas. The Pensacola Existing and Alternative Sites have predominantly sand bottoms; therefore, disposal activities should not greatly interfere with major fishing activities in the area.

Other recreational activities in the nearshore region include boating, scuba diving, and swimming. The Pensacola and Gulfport Existing Sites are near, but not within, the boundaries of the Gulf Islands National Seashore; the National Park Service has not noted any significant resource impacts from use of the Existing Sites (N. Guse, personal communication*). With the possible exception of a wreck in the Mobile Existing Site (reportedly at the southwestern boundary), the sites do not have unique features that would attract visitors. Intermittent use of the sites for disposal operations should not interfere with occasional recreational use of the areas.

No existing oil and gas structures are in the vicinity of the Existing and Alternative Sites. However, oil and gas development is proposed in the vicinity of the Mobile Existing Site. It is not known to what extent site use would interfere with potential future oil and gas exploration and development operations.

No mineral extraction, desalination projects, or fish and shellfish culture occur in the vicinity of the Existing and Alternative Sites. Intermittent use of the sites should not interfere with scientific investigations which may be conducted in the area; nor does dredged material disposal interfere with any other legitimate uses of the ocean.

MID-SHELF ALTERNATIVE SITE/AREA

As for the Existing Site, use of the Pensacola Mid-shelf Alternative Site would pose few interferences with other uses of the ocean. No oil and gas development is proposed in the area, and no mineral extraction, desalination

---

* N. Guse, Southeast Regional Director, National Park Service, U.S. Department of Interior, Atlanta, Georgia (1981)

projects, or fish and shellfish culture occur in the area. Some commercial and recreational fishing may occur in the area; therefore, some interference with fishing activities may result from site use. However, the site was selected from depths shallower than where the majority of the hard-bottom and reef areas which support the major fishery reportedly occur, and the disposal site represents only a small portion of the total fishing area available.

Similar to the Nearshore Existing and Alternative Sites, use of a site selected from the Mobile-Gulfport Mid-Shelf Alternative Area would cause few interferences with other uses of the ocean. Undeveloped oil and gas leases occur in the center of the area. However, a site could be selected so as to minimize interferences with potential future development. The Mid-Shelf Alternative Area is located within a larger area, which is fished intensively for shrimp and industrial bottomfish; thus, some interferences with fishing activities may result from site use.

DEEPWATER ALTERNATIVE AREA

Because of increased distance offshore, the potential hazard to navigation from hopper dredges traveling to and from the disposal site may be higher for a site selected from the Deepwater Alternative Area, than in the nearshore or mid-Shelf region. However, as for the other Alternative Sites, use of a deepwater site should not impede shipping traffic. No commercial or recreational activities occur in the Deepwater Alternative Area; therefore, no interferences with other uses of the ocean would occur from site use.

(9) <u>THE EXISTING WATER QUALITY AND ECOLOGY OF THE SITE, AS DETERMINED BY AVAILABLE DATA OR BY TREND ASSESSMENT OR BASELINE SURVEYS</u> (40 CFR §228.6[a][9])

EXISTING AND NEARSHORE ALTERNATIVE SITES

The existing water quality is primarily affected by discharges from coastal rivers and bays, and from anthropogenic inputs into nearshore waters. River discharges contribute appreciable quantities of suspended particulates (particularly near the Mississippi Delta) and, to a lesser extent, nutrients and trace pollutants to nearshore waters. Periodic storms influence the water quality and ecology of the area.

Phytoplankton and zooplankton studies have not been conducted at the Existing or Alternative Sites; however, diatoms reportedly dominate phytoplankton populations and copepods dominate zooplankton populations in nearshore Gulf waters. Plankton abundances are generally highest during spring and summer (Simmons and Thomas, 1962; Christmas, 1973).

Fish and shrimp dominate the epifaunal community of the Existing Sites, and are typical of those reported from northeastern Gulf coastal waters (Appendix A). Several of the species observed are common over sand and fine sediments, including shrimp, sea catfish, sand seatrout, flounder, and tongue-fish (Appendix A). Seasonal variations in abundances of nekton at the nearshore sites are expected to coincide with the migration patterns of dominant coastal species (Chittenden and McEachran, 1977).

The benthic community of the Existing Sites were generally dominated by deposit-feeding organisms (Appendix A). The infauna at the Mobile and Gulfport Existing Sites consisted primarily of spionid, magelonid, and capitellid polychaetes and the sipunculid Golfingia murinae bilobatae. Polychaetes were also numerically dominant at the Pensacola Existing Site; however, the cephalochordate Branchiostoma caribaeum (typical of clean sands) and various arthropods also were abundant. Differences in species composition, diversity, and abundances among the Existing Sites appears to be related to sediment type, and is consistent with distributional trends reported in the literature (Vittor, 1977). Generally, the Pensacola and Mobile Nearshore Alternative Sites would be expected to have a fauna similar to their respective Existing Site because of similar sediment type and geographic proximity. The fauna at the Gulfport Nearshore Alternative Site may be somewhat different from the Existing Site because of indicated differences in sediment type.

Site surveys by EPA/IEC (Appendix A) show that water quality and biological characteristics between areas within and adjacent to the Existing Sites were generally similar. Therefore, dredged material disposal at the Existing Sites does not appear to significantly alter existing water quality or ecology. Results of DMRP studies indicate that changes in water quality from dredged material disposal are temporary, lasting minutes to hours, depending on dilution, mixing characteristics, and parameter measured (Wright, 1978). Similarly, changes in the benthic community (the parameter most likely to be affected by dredged material disposal) was only temporarily affected in high-energy nearshore regions, with areas repopulated within months (Oliver et al., 1978; Hirsch et al., 1978).

MID-SHELF AND DEEPWATER ALTERNATIVE AREAS

Specific data for the Mid-Shelf and Deepwater Alternative Areas are sparse; however, available information indicates that the water quality of these areas is typical of clean open ocean water (i.e., with low concentrations of nutrients, suspended solids, and trace metals) (SUSIO, 1975: Slowey and Hood, 1969). Dredged material disposal should not adversely affect the existing water quality at deeper depths, primarily because of greater dilution and dispersion relative to shallow waters (Pequegnat et al., 1978; Brannon, 1978).

Diatoms dominate the phytoplankton community of the Mid-Shelf Alternative Area, although dinoflagellate diversity and abundance increase offshore (Steidinger, 1972). Coccolithophores generally dominate the deepwater phytoplankton communities of the Gulf (Hulbert and Corwin, 1972). As in the nearshore region, copepods dominate the zooplankton community in mid-Shelf and deepwater regions (SUSIO, 1975). Biomass of organisms generally decrease with depth, and polychaetes typically dominate the benthic community (Bault, 1969; SUSIO, 1975; Sokolova, 1959; Rowe and Menzel, 1971). The effects of dredged material disposal on mid-Shelf and deepwater environments are unknown; however, it has been suggested that recovery of benthic populations following disposal may be slower in more stable environments (e.g., deepwater areas), and where there is a difference between disposal site and dredged sediments (Hirsch et al., 1978; Wright, 1978). It may be possible to match grain size characteristics of the dredged material to sediments of the Mid-Shelf Alternative Area; however, it is less likely that dredged sediments, particularly from Pensacola and Mobile (primarily sand), would match deepwater sediments. Therefore, effects of dredged material disposal could be greater on deepwater benthos. However, in support of deepwater disposal of dredged material, Pequegnat et al. (1978) noted that the density of organisms in deepwater areas is much less than the density of organisms in shallow water.

(10) <u>POTENTIALITY FOR THE DEVELOPMENT OR RECRUITMENT OF NUISANCE SPECIES IN THE DISPOSAL SITE</u> (40 CFR §228.6[a][10])

EXISTING SITES

Surveys of the Existing Sites have not detected the development or recruitment of nuisance species. Organisms collected within the sites were similar to those collected in adjacent reference stations (Appendix A). Furthermore, the similarity of dredged material to extant sediments suggests that the development of nuisance species is unlikely.

ALTERNATIVE SITES/AREAS

There are no components in the dredged materials or consequences of their disposal that would attract nuisance species to alternative areas.

(11) <u>EXISTENCE AT OR IN CLOSE PROXIMITY TO THE SITE OF ANY SIGNIFICANT NATURAL OR CULTURAL FEATURES OF HISTORICAL IMPORTANCE</u> (40 CFR §228.6[a][11])

EXISTING SITES

No resources of historical importance occur within the Pensacola or Gulfport Existing Sites (J. Rankin, personal communication*; J. Palmer, personal communication†). However, there are shipwrecks and unidentified obstructions in the vicinity of the sites. For instance, the "Bride of Lorne"

* J. Rankin, Manager, New Orleans Outer Continental Shelf Office, U.S. Department of Interior, New Orleans, Louisiana (1981)

† J. Palmer, Archeologist II, Division of Archives, History and Records Management, Secretary of State, Tallahassee, Florida (1981)

(shipwreck) is located 0.7 nmi north of the Pensacola Existing Site; also the wreck "Massachusetts" is located about 1 nmi north of the Pensacola existing site; two unidentified obstructions occur at the southeastern and northeastern boundaries of the Gulfport Existing Site (western), and two unidentified shipwrecks occur within 1 nmi to the south and northeast of this site. A steel schooner "Tulsa" built in 1909, reportedly lies at the western boundary of the Mobile Existing Site. Proper management of disposal at the sites will ensure that impacts to these features will not occur.

ALTERNATIVE SITES

No resources of historical importance are known to occur in the Nearshore or Mid-Shelf Alternative Sites/Areas. Two schooners, the "Marion N. Cobb" and "Villa Y. Hermano," built in 1902 and 1891, respectively, occur in the Deepwater Alternative Area, (J. Palmer, personal communication†).

CONCLUSIONS

The existing Sites fulfill all criteria for site selection, based on evaluation of the EPA 11 site criteria and, in addition, because of historical use, are preferred over the Alternative Sites/Areas. In addition, recent EPA/IEC surveys (Appendix A) have detected no persistent or cumulative changes in physical, chemical, or biological characteristics of the sites which could be attributed to dredged material disposal. However, potential exists for some conflicts due to use of the Existing Sites, which could be alleviated by the following recommended modifications:

- The Pensacola Site is small (0.64 nmi^2) compared to other sites (e.g., Mobile and Gulfport Existing Sites) which receive similar volumes of dredged material; thus, initial overburdens after

---

* J. Rankin op. cit. pg. 2-36
† J. Palmer op. cit. pg. 2-36

disposal may be thick. The deeper overburden of dredged material that could result at a smaller site could decrease the ability of benthic organisms to escape burial. Recolonization rates by benthic fauna may be improved by enlarging the permissable dumping area. Enlargement of this site will also allow for more effective site management in that if monitoring at the site detects significant movement of the material toward beaches or other amenities measures can be taken to mitigate any impacts before the material reaches the site boundaries. Therefore, it is recommended that the Nearshore Alternative Site receive final designation.

It is also recommended that the Pensacola site receive only sand sized dredged material to illiminate impacts due to sediment texture change from disposal of finer grain materials.

- A shipwreck of possible historic importance reportedly lies at the western boundary of the Mobile Existing Site. Until final determination regarding the status of this wreck is made, it is recommended that dumping be restricted in the immediate vicinity of the wreck.

- The Gulfport Existing Sites (eastern and western) are located on either side of the dredging channel. Because of prevailing currents, material dumped in the northern portion of the eastern Existing Site could be transported back into the channel, thereby increasing dredging frequency and costs. In addition, shallow depths in the northern portion of the eastern and western Existing Sites may limit the area in which fully loaded hopper dredges are able to operate. Therefore, it is recommended that the use of the ODMDS be modified so that dumping is confined to the western Existing Site and southern portions of the eastern Existing Site, in depths greater than 8m (usable area of the ODMDS reduced from approximately 7.7 nmi^2 to 7.0nmi^2).

The following criteria of the Ocean Dumping Regulations are the most relevant in recommending the Existing Sites (with the above modifications) as the most favorable alternatives for receiving dredged material from Pensacola, Mobile, and Gulfport:

- The selected alternatives are located closer to the dredging channel and shore than the other Alternative Sites. Surveillance and monitoring will be facilitated by use of the Existing Sites (criteria 1 and 5).

- The Gulfport Existing ODMDS consists of two sites, one on either side of the dredging channel. Because of prevailing currents, sediments dumped in the northern portion of the eastern Existing Site could be transported back into the channel, thereby increasing the dredging frequency and costs (criterion 6).

- Dredged materials have been dumped at the selected alternatives, and no long-term or cumulative effects have been detected; impacts appear to be localized and short term. At the Pensacola Existing Site recolonization rates of benthic organisms after dredged material disposal may be improved by increasing the area of the site. No dumping has occurred at the other Alternative Sites (criterion 7).

- The water quality of the selected site is principally influenced by nearshore mixing processes, river discharges, and storms. The biotic communities are adapted to a high-energy environment, and are characteristic of nearshore northeastern Gulf waters. Results of DMRP studies indicate that effects of dredged material disposal are minimized at disposal sites in high-energy environments (Hirsch et al., 1978). Limited site-specific data are available for the other alternative sites; therefore, baseline studies may be necessary to provide required information. However, mid-Shelf and deepwater areas are typically more stable than nearshore areas, with better water quality and decreased biomass of benthic organisms. It has been suggested that recovery of benthic populations following disposal may be slower in more stable environments (Hirsch et al., 1978; Wright, 1978) (criterion 9).

- The steel schooner "Tulsa", built in 1909, reportedly lies on the western boundary of the Mobile Existing Site. It is not known whether the wreck represents a resource of historical importance (criterion 11).

RECOMMENDED USE OF THE SITES

All future uses of the sites for dredged material disposal must comply with the EPA Ocean Dumping Regulations—a requirement which brings prospective dumping into compliance with the MPRSA and the London Ocean Dumping Convention. The CE and EPA determine compliance with the Ocean Dumping Regulations on a case-by-case basis when applications for disposal permits and Federal project test results are evaluated. General guidelines for determining acceptability of dredged material proposed for release at a site are outlined below.

PERMISSIBLE MATERIAL LOADINGS

Material loadings at the Existing Sites have varied from year to year, depending on sedimentation rates, and have not always been conducted on an annual basis. Average volumes per dredging cycle include 740,[illegible] yd^3 (every 4 to 5 years) at Pensacola, 485,776 yd^3 (every 1 to 3 years) at Mobile, and 649,290 yd^3 (every 1 to 3 years) at Gulfport (Table 3-17). Therefore, it is difficult to assign an upper loading limit beyond which significant adverse impacts will occur. It is anticipated that continuation of [illegible] dredging volumes would have few, if any, significant adverse impacts. If dredged material volumes were significantly increased, the CE [illegible] should be intensified to identify and mitigate potential adverse effects.

MONITORING THE DISPOSAL SITES

Section 228.9 of the Ocean Dumping Regulations [illegible] of dumping in a disposal site and surrounding [illegible] ys of evaluated periodically for [illegible] types of [illegible] ducted make the dis[illegible] impac[illegible] may include [illegible] taken. Thus, "if [illegible] neces[illegible] Administra[illegible] ma[illegible] historica[illegible] a [illegible] plan by [illegible] e[illegible] National [illegible] (1981)

RECOMMENDED USE OF THE SITES

All future uses of the sites for dredged material disposal must comply with the EPA Ocean Dumping Regulations—a requirement which brings prospective dumping into compliance with the MPRSA and the London Ocean Dumping Convention. The CE and EPA determine compliance with the Ocean Dumping Regulations on a case-by-case basis when applications for disposal permits and Federal project test results are evaluated. General guidelines for determining acceptability of dredged material proposed for release at a site are outlined below.

PERMISSIBLE MATERIAL LOADINGS

Material loadings at the Existing Sites have varied from year to year, depending on sedimentation rates, and have not always been conducted on an annual basis. Average volumes per dredging cycle include 740,664 yd^3 (every 4 to 5 years) at Pensacola, 485,776 yd^3 (every 1 to 3 years) at Mobile, and 649,290 yd^3 (every 1 to 3 years) at Gulfport (Table 3-17). Therefore, it is difficult to assign an upper loading limit beyond which significant adverse impacts will occur. It is anticipated that continuation of historic dredging volumes would have few, if any, significant adverse impacts. If dredged material volumes were significantly increased, the CE monitoring effort should be intensified to identify and mitigate potential adverse effects.

MONITORING THE DISPOSAL SITES

Section 228.9 of the Ocean Dumping Regulations establishes that the impact of dumping in a disposal site and surrounding marine environment may be evaluated periodically for certain types of effects. The information used to make the disposal impact evaluation may include data from monitoring surveys. Thus, "if deemed necessary," the CE District Engineer (DE) and EPA Regional Administrator (RA) may establish a monitoring program to supplement the historical site data (40 CFR §228.9). The DE and RA develop the monitoring plan by determining appropriate monitoring parameters, frequency of sampling, and the areal extent of the survey. Factors considered in making the determination include frequency and volumes of disposal, physical and chemical nature of the dredged material, dynamics of the site physical processes, and life histories of the monitored species.

The primary purpose of the monitoring program is to determine whether disposal at the site is significantly affecting areas outside the site, and to detect significant long-term adverse effects. Consequently, monitoring efforts must survey the site and surrounding areas, including control sites and areas which are likely to be affected (as indicated by environmental factors, such as prevailing sediment transport). The results of adequate surveys will provide early indications of potential adverse effects outside the site.

GUIDELINES FOR THE MONITORING PLAN

The following sections outline the proposed monitoring requirements for disposal of dredged material at the Pensacola, Mobile, and Gulfport ODMDSs under §228.10 of the Ocean Dumping Regulations. As discussed above, the monitoring plan will be determined by the DE and RA. The monitoring plan will be reviewed when the sampling results and data analyses become available. Changes in the plan may be made after review.

The proposed elements for the monitoring plan at the selected sites can be determined by applying the six considerations outlined below.

(1) MOVEMENT OF MATERIALS INTO ESTUARIES OR MARINE SUNCTUARIES, OR ONTO OCEANFRONT BEACHES OR SHORELINES

Prevailing southwesterly to westerly bottom currents at the Pensacola and Gulfport Existing Sites should not transport materials northward towards shore, marine sanctuaries, or estuaries during most of the year. Currents offshore of Mobile are variable; however, the Existing Site is more than 4 nmi from shore, estuaries, or marine sanctuaries, which decreases the likelihood of dumped material being transported onto or into these areas. Therefore, monitoring the movement of dredged material towards shore, estuaries, or marine sanctuaries may not be necessary for the recommended sites. However, the National Marine Fisheries Service has expressed concern regarding the potential for dredged material dumped at the Gulfport ODMDS to accumulate and alter local current patterns, thus potentially affecting the movement of plankton and larvae between the Gulf and estuary (Mississippi Sound) (D. Ekberg, personal communication*). Buildup of dredged material could be detected by periodically conducting bathymetric surveys of the Gulfport ODMDS and adjacent area.

(2) MOVEMENT OF MATERIALS TOWARD PRODUCTIVE FISHERY OR SHELLFISHERY AREAS

The Pensacola and Gulfport ODMDSs represent small areas within larger nearshore regions fished for finfish and shellfish. The commercially important organisms of the Existing Sites and adjacent areas are mobile and are adapted to shifting sediments characteristic of a high-energy environment. The dredged material is physically similar to sediments in the disposal sites; thus, the dumped material will enter the natural transport cycle, and should present only minimal stress to indigenous fisheries species. Consequently, monitoring dredged sediment movement towards fisheries areas is not necessary.

The above discussion also applies to the Mobile ODMDS; however, there is an extensive fish haven approximately 1 nmi south of the site which represents an important fishery resource area. Dredged material appears to be similar in composition to Existing Site and adjacent area sediments (Davis, 1978; Appendix A); therefore, tracking the movement of dredged material may not be possible. However, higher lead concentrations were detected in sediments at a reference station south of the disposal site (in direction of fish haven) than in sediments within the disposal site or at other reference stations (Appendix A). Therefore, it is recommended that periodic bathymetric surveys of the site and adjacent areas extending in the southerly direction be conducted in order to detect any accumulation of dredged material near the fish haven.

* D. Ekberg, Chief, Environmental and Technical Services Division, National Marine Fisheries Service, Southeast Region, St. Petersburg, Florida (1981)

(3) ABSENCE FROM THE DISPOSAL SITE OF
POLLUTION-SENSITIVE BIOTA CHARACTERISTIC OF THE GENERAL AREA

Baseline surveys of the Existing Sites and adjacent areas have not detected significant differences in the fauna of the ODMDS and adjacent reference station(s) (Appendix A). However, bioassay and bioaccumulation studies of Pensacola, Mobile, and Gulfport dredged sediments have not been conducted. The monitoring plan should, therefore, include periodic bioassay and bioaccumulation tests on appropriate pollution-sensitive species (e.g., mollusks, crustaceans, polychaetes) to ensure that future dredged materials are nontoxic to biota. The plan should also include periodic sampling of the benthic community to document effects of dredged material disposal (see consideration 5, below).

(4) PROGRESSIVE, NONSEASONAL CHANGES IN
WATER QUALITY OR SEDIMENT COMPOSITION AT THE
DISPOSAL SITE ATTRIBUTABLE TO DREDGED MATERIAL

Results of elutriate analyses of Pensacola, Mobile, and Gulfport dredged sediments indicate that detectable amounts of ammonia and phosphorus may be released subsequent to dumping (Davis, 1978). Releases of trace metals and organics from dredged sediments were either minor or undetectable (ibid.). Differences in water quality between disposal site and reference stations were not detected during EPA/IEC surveys (Appendix A). Because released constituent concentrations decrease rapidly due to dilution and mixing (Brannon et al., 1978; Wright, 1978), monitoring the water quality is not recommended.

Dredged sediments from Pensacola and Mobile are similar in grain size composition to the disposal site sediments, and no effects on sediment texture from previous disposal were detected during EPA/IEC surveys (Appendix A). At Gulfport, dredged sediments are similar in composition to disposal site sediments, but were of finer grain size than the EPA/IEC reference station. Because finer-grained sediments naturally increase as the Mississippi Delta is approached from the east (Doyle and Sparks, 1980), it is not possible to conclude whether previous disposal at the Existing Site, or natural sediment distribution patterns, were responsible for the observed high percentages of fines in the disposal site sediments. Therefore, it is recommended that sediment grain size of the Gulfport ODMDS and adjacent area be monitored.

The chemical composition of disposal site sediments were generally similar to EPA/IEC reference station(s) (Appendix A). Exceptions included higher lead concentrations measured at the Gulfport Existing Site, and at a reference station south of the Mobile Existing Site. Therefore, it is recommended that trace metal concentrations in sediment of the Gulfport and Mobile ODMDS and adjacent areas be periodically monitored.

Monitoring sediment grain size at Gulfport, and concentrations of trace metals (Hg, Cd, Pb) at Mobile and Gulfport, should be conducted at the disposal sites and reference stations upcurrent and downcurrent from each site. Initially, sediment samples could be collected before and after (within 1 month) disposal to detect effects, and during each of the four seasons to detect natural seasonal variability.

(5) PROGRESSIVE, NONSEASONAL CHANGES IN
COMPOSITION OF NUMBERS OF DEMERSAL, OR BENTHIC BIOTA
AT OR NEAR THE DISPOSAL SITE ATTRIBUTABLE TO DREDGED MATERIAL

DMRP results indicate that motile demersal organisms are generally not affected by disposal operations (Wright, 1978). However, benthic infauna are more sensitive to dredged material disposal because of their sedentary habit, and thus, may provide an effective index for determining effects of dumping. Because the species composition of the benthic communities of the disposal sites and adjacent areas exhibited some seasonal and spatial variability during the EPA/IEC surveys (Appendix A), a sampling design accounting for these factors would be necessary for meaningful interpretation of results. Survey transects could be established to sample the disposal site and areas upcurrent and downcurrent of the site to detect spatial variability and possible effects of disposal. Samples could be collected before and after disposal operations--3 months after disposal allows for some recolonization (Oliver et al., 1977), and during each of the four seasons for at least the first year to detect natural seasonal variability.

(6) ACCUMULATION OF MATERIAL CONSTITUENTS (INCLUDING WITHOUT LIMITATIONS, HUMAN PATHOGENS), IN MARINE BIOTA AT OR NEAR THE SITE

No bioaccumulation studies have been conducted using dredged sediments from Pensacola, Mobile, or Gulfport. Therefore, these studies should be conducted using appropriate sensitive marine organisms prior to a determination of whether accumulation of material constituents in marine biota at or near the sites need monitoring. If it is determined that bioaccumulation analyses should be conducted, then commercial species of limited motility (to ensure effect is from dredged material) should be selected for testing. EPA/IEC surveys did not identify commercial species of limited motility that would be suitable for field studies. Another alternative may be to place an indicator organism, such as *Mytilus edulis*, into test cages within and adjacent to the disposal sites. The mussels could then be removed periodically for bioaccumulation analyses (EPA, 1982).

Chapter 3

AFFECTED ENVIRONMENT

Chapter 3 describes the environmental characteristics of the northeastern Gulf of Mexico, including the region where the Pensacola, Mobile, and Gulfport (PMG) Existing Sites and alternative disposal sites/areas are located. Nearshore waters overlying the PMG Existing Sites are influenced by river runoff and seasonal weather patterns. The waters of the Mid-Shelf and Deepwater Alternative Areas are influenced by the Loop Current. Sediments range from sand at the Pensacola Existing Site to silt and clay at the Gulfport Existing Site. Mid-Shelf Alternative Area sediments are sand and silt; Deepwater Alternative Area sediments are diverse, including rock, shell, sand, silt, and clay. The nearshore PMG Existing Sites are inhabited by diverse and seasonally variable benthic and nektonic organisms. Mid-Shelf Alternative Area communities are typically less diverse with lower biomass than nearshore communities. Relatively little is known about the indigeneous fauna of the Deepwater Alternative Area.

Environmental characteristics that may either affect or be affected by the proposed dredged material disposal operations are described in this chapter. Characteristics potentially affected by ocean disposal are generally categorized as either geological, chemical, or biological. Ancillary meteorological and oceanographic information are also presented in this chapter because natural physical processes influence the fate of released dredged material and the impacts of subsequent disposal. An historic background of dredging operations, and commercial and recreational resources which may be affected by dredged material disposal, are included in the discussion.

Regional and site-specific information (where available) regarding the Existing and Alternative Sites (see Figure 2-4) are summarized in this chapter. Site-specific surveys of the PMG Existing Sites were conducted by Environmental Protection Agency/Interstate Electronics Corporation (EPA/IEC) (discussed in Appendix A). Site-specific information for the Mobile-Gulfport Mid-Shelf Alternative Area are provided by the U.S. Department of Interior survey of the Mississippi, Alabama, Florida (MAFLA) outer Continental Shelf.

The Deepwater Alternative Area was considered as a potential area for OTEC development (Molinari et al., 1979); physical oceanographic data was collected at this area.

ENVIRONMENTAL CHARACTERISTICS

CLIMATE

Climatic parameters of interest at an ODMDS are air temperature, rainfall, wind statistics, storm occurrences, and fog. Air temperature interacts with surface waters and, particularly during warm periods, influences vertical stability of the water. Rainfall increases coastal freshwater runoff, thereby decreasing surface salinity and intensifying the vertical stratification of the water. Coastal runoff also might contribute suspended sediments and various chemical pollutants. Winds and storms can generate waves and currents, which stir up and transport dredged material. A high incidence of fog during particular seasons may affect navigational safety and limit disposal operations.

The climatic influence of the Gulf of Mexico results in warm humid summers and mild winters. The Bermuda High (a subtropical anticyclone) moves northwestward and strengthens during spring and summer, producing southeasterly winds in the eastern Gulf. During autumn the high-pressure system weakens and shifts to the southeast allowing penetration of continental and polar air masses. Significant frontal systems penetrating the Gulf each winter can number 15 to 20, resulting in strong northerly winds (often exceeding 33 kn) and rapid drops in temperature, occasionally below freezing (NOAA, 1972).

AIR TEMPERATURE

January is the coldest month and August is the warmest month in the northeastern Gulf (NOAA, 1972; CE, 1978a). During the period 1974 to 1977 the maximum and minimum temperatures recorded at Dauphin Island, Alabama were 35.2°C and -9°C, respectively (Figure 3-1).

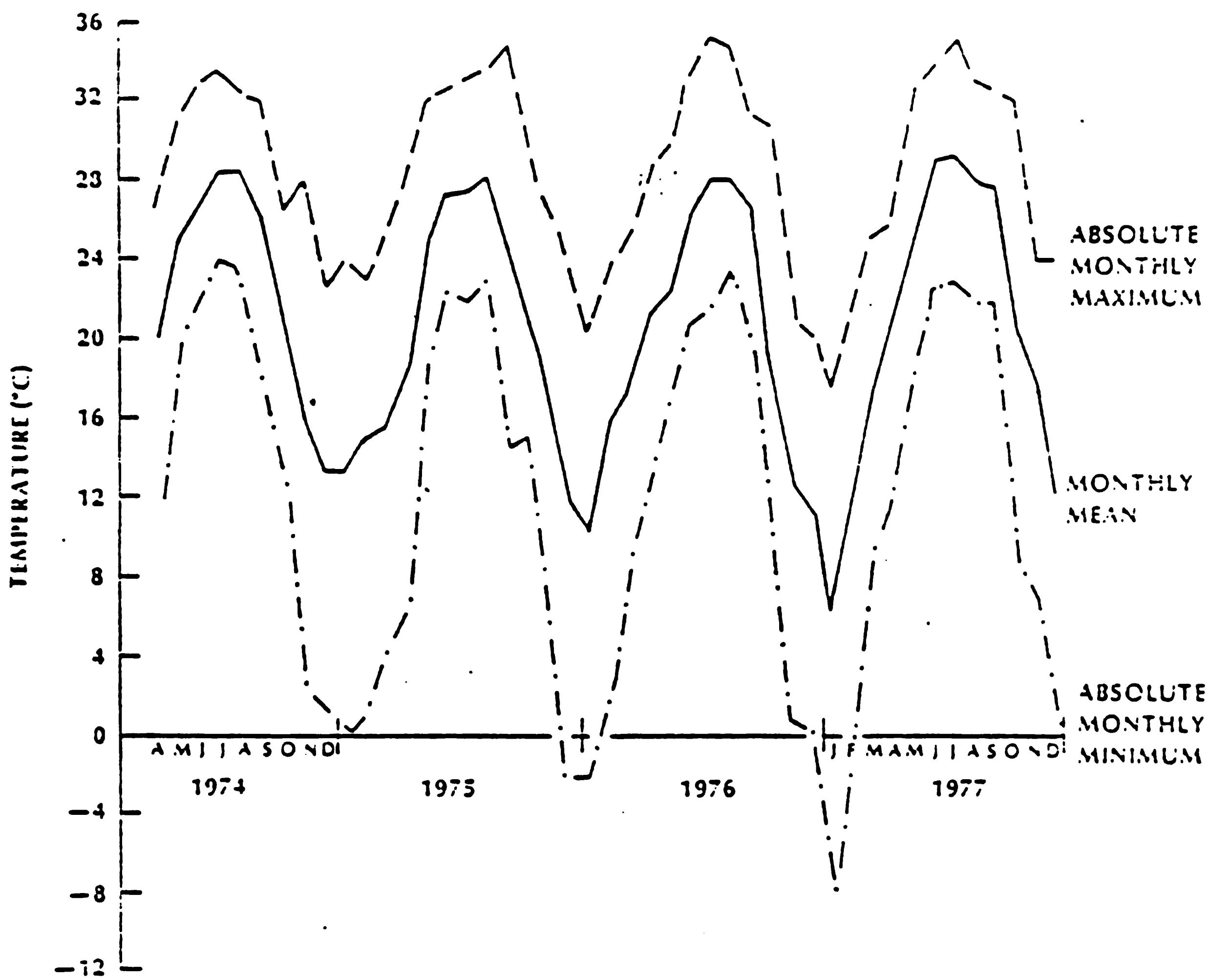


Figure 3-1. Monthly Minimum, Mean, and Maximum Air Temperatures (°C) at Dauphin Island, Alabama from 1974 to 1977
Source: Schroeder, 1977

Air temperatures over the open Gulf (Mid-Shelf Alternative Site/Area and Deepwater Alternative Area) exhibit smaller seasonal and daily ranges than the coastal area. Air temperatures near the coast and in offshore areas are similar except during winter, when temperatures are colder near the coast (CE, 1973). In the region of the Deepwater Alternative Area, temperatures ranged from 16°C in January, to 28°C in July and August (Molinari et al., 1979).

PRECIPITATION

Rain is the only significant source of precipitation over Gulf waters (NOAA, 1972). On the average, precipitation is evenly distributed throughout the year (Figure 3-2). However, minimum precipitation occurs during autumn and maximum rainfall occurs during the spring and summer thunderstorm season. Average yearly precipitation ranges from 150 cm at Biloxi, Mississippi to 173 cm at Mobile, Alabama and 160 cm at Pensacola, Florida (CE, 1978a,b; Christmas, 1973). Total annual rainfall at Mobile ranges from a minimum of 107 to a maximum of 231 cm (CE, 1978a).

WINDS

Prevailing nearshore surface winds are typically from the south from March through July, from the east in August and September, and from the north the

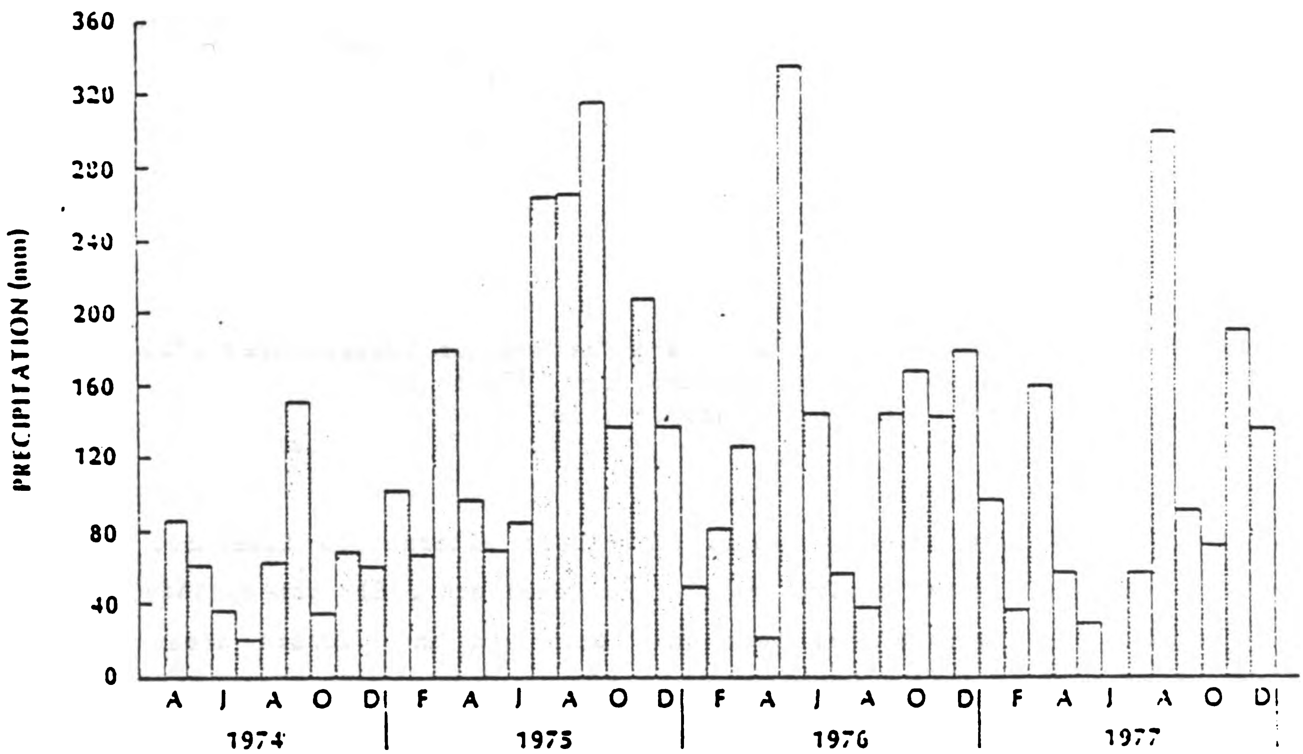


Figure 3-2. Monthly Precipitation at Dauphin Island, Alabama from 1974 to 1977
Source: Schroeder, 1977

remainder of the year (NOAA, 1972). Over 50% of the winds are in excess of 5 kn (Figure 3-3). In the region of the Deepwater Alternative Area, the average wind direction shifts from the northeast in January to southerly in July (Molinari et al., 1979). Average wind speeds in this offshore region vary from 8 kn in July to 15 kn in February.

STORMS

Thunderstorms, fronts, extratropical cyclones, and tropical cyclones are important climatic events in the northeastern Gulf of Mexico (NOAA, 1972). Thunderstorms may occur throughout the year (DOC, 1981); however, the highest frequency of storms is in June and July. There is a 40 to 80 $^{o}/oo$ daily probability of thunderstorm occurrence during summer, and a 20 to 30 $^{o}/oo$ daily probability during winter. Most thunderstorms occur within 120 nmi of the coast (DOC, 1981).

Frontal systems (northers) associated with polar air masses enter the northern Gulf from October through March (TerEco, 1978). Northers may persist up to 4 days, producing lowered air temperatures, high winds (up to 33 kn), and large waves (up to 7m) (TerEco, 1978; NOAA, 1972).

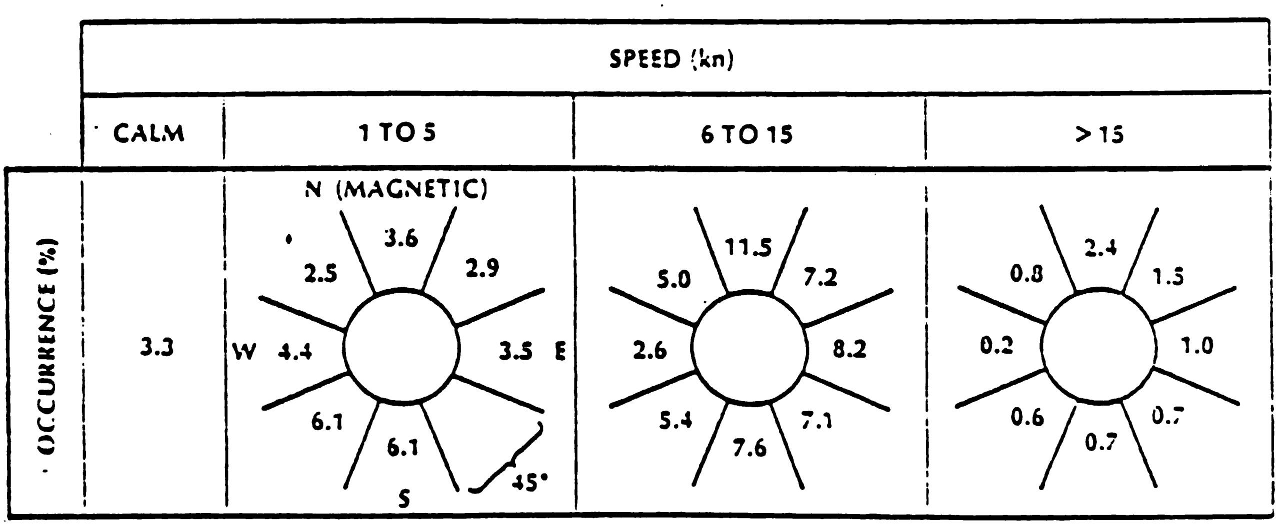


Figure 3-3. Annual Wind Roses at Dauphin Island, Alabama--
Averaged from 1974 to 1977 (32,235 Observations)
Source: Adapted from Schroeder, 1976

Extratropical cyclones (blue northers) exhibit a preferred track over the central Gulf in February. These storms develop primarily over the continent, but a few develop over the north coast or the open Gulf itself. Figure 3-4 shows the preferred tracks of these storms. Most are not particularly intense, although full gale force winds may develop in the presence of a sufficiently large pressure gradient (DOC, 1981).

The tropical cyclone season in the central and eastern Gulf lasts from May until December (DOC, 1981). September has the highest probability of tropical storm occurrence. Figure 3-5 shows the probability of cyclones along the coastal areas of Mississippi, Alabama, and Florida.

Hurricane Camille (1969) was probably the most intense and destructive hurricane to affect the northeastern Gulf of Mexico during this century. Maximum sustained winds were estimated at 175 kn; storm surge was observed to be about 7.6m (25 ft) (DOI, 1974). Ship Island, Mississippi (near Gulfport) was breached during hurricane Camille, leaving a 2.5-mi gap of shallows (1 to 2m) separating the remaining halves of the island.

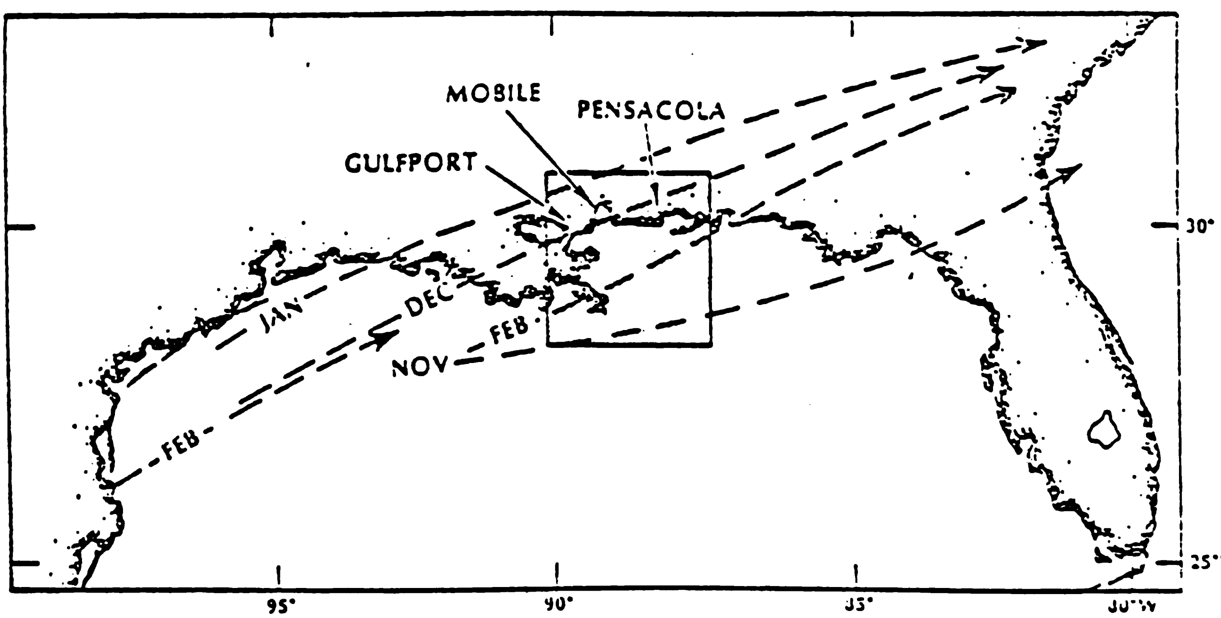


Figure 3-4. Preferred Tracks of Extratropical Cyclones in the Gulf of Mexico
Source: Jones et al., 1973 (after Klein, 1957)

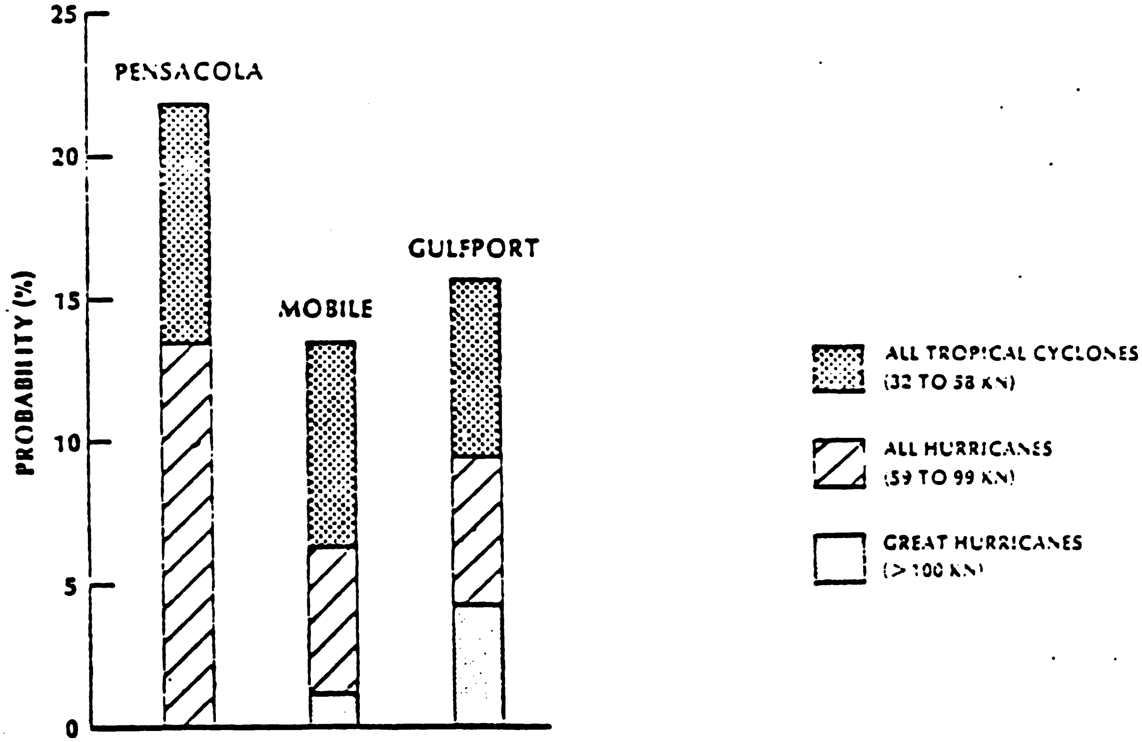


Figure 3-5. Probability of Tropical Cyclone, Hurricane, or Great Hurricane Occurring in Any Year at Pensacola, Mobile, and Gulfport
Source: Jones et al., 1973 (after Simpson and Lawrence, 1971)

FOG

On the average, fog occurs 37 days a year in the northeastern Gulf; the highest frequency of fog is from November to April (NOAA, 1972). Foggy conditions usually arise when warm Gulf air comes in contact with the relatively colder land, but also may result from the seaward drift of radiationally induced land fog (DOC, 1981). Normally the condition lasts for 3 to 4 hours, but may persist for several days (DOI, 1974).

PHYSICAL OCEANOGRAPHY

Physical oceanographic parameters determine the nature and extent of mixing zones, which influence sediment transport and the chemical environment at an ODMDS. Strong temperature or salinity gradients inhibit mixing of surface and bottom waters, whereas waves aid such mixing, resuspend bottom sediments, and affect water turbidity. Currents, especially bottom currents, determine the direction, and influence the extent of sediment transport into and out of the ODMDS. Tidal currents may contribute to the transport of dumped materials, but they usually do not add net directional effects.

WATER MASSES

Water masses in nearshore and mid-Shelf regions of the Gulf of Mexico are highly variable, and their distribution is subject to seasonal changes in the volumes of river discharge and the degree of intrusion of Loop Current Waters (Figure 3-6). Total river discharge into the western half of the northeastern Gulf is an estimated 124 billion m^3/yr (Schroeder, 1977). Freshwater discharge volumes are usually greatest from December through May (Crance, 1971). Plumes of low salinity Mississippi River water can extend 150 nmi east and south of the Mississippi Delta (Ichiye et al., 1973). These lenses of low-salinity water may become entrained in the Loop Current and eventually be transported eastward along the edge of the Continental Shelf (Schroeder, 1977). Freshwater plumes may create horizontal- or vertical-density gradients that induce secondary circulation patterns (Schroeder, 1977).

Loop Current Waters are characterized by salinities exceeding 36.7°/oo and surface temperatures ranging from 22 to 24°C (Gaul, 1967). Molinari et al. (1979) reported that variations in the strength of the Loop Current are not necessarily seasonal; therefore, the presence or absence of this distinctive water mass over the outer Shelf and Slope is not predictable. Detached Loop Current eddies may transport Loop Current Waters northward, as close as 4.3 nmi from the coast near Pensacola (Huh et al., 1981).

Molinari et al. (1979) described several identifiable water masses in the region of the Deepwater Alternative Area. The upper portion of the water column was occupied seasonally by Loop Current Water, Loop Transition Waters, or Mississippi River Discharge Plume Waters. The subsurface layer was composed of North Atlantic Central Water, characterized by temperatures of 10 to 15°C and a salinity range of 35.2 to 35.9°/oo. Antarctic Intermediate Water occurred in the lower water column, and is characterized by a temperature of 6.2°C and salinity of 34.9°/oo.

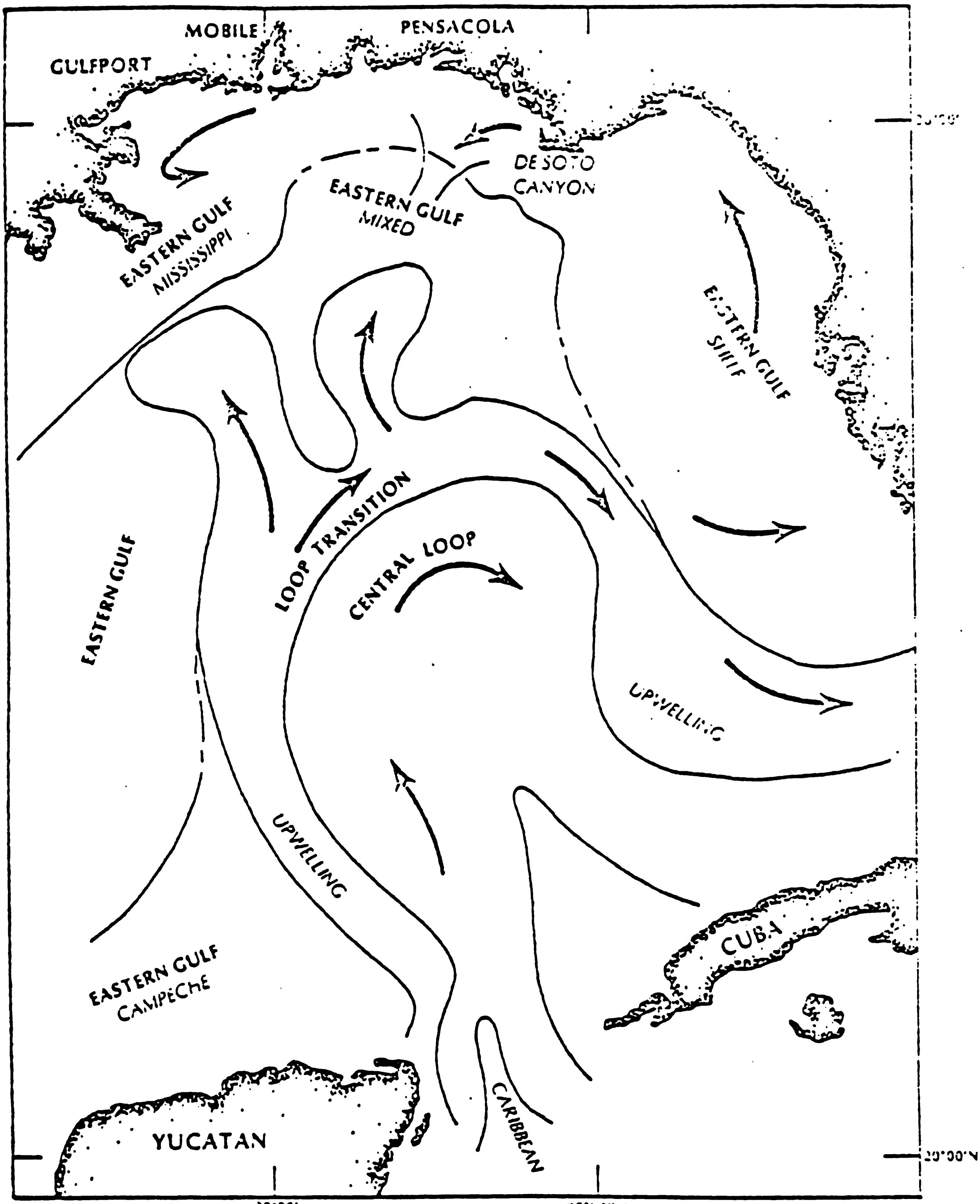


Figure 3-6. Water Masses and Currents in the Gulf of Mexico During May 1970
Source: Jones et al., 1973 (from Austin, 1971)

WATER TEMPERATURE

Surface water temperatures ranged from a low of 14.9 in January to a high of 29.5°C in June in the vicinity of the Mobile Existing Site, from 15.0 (January) to 26.5°C (June) in the vicinity of the Gulfport Existing Site, and from 16.0 (January) to 26.8°C (June) in the vicinity of the Pensacola Existing Site during the EPA/IEC surveys (see Appendix A). Bottom water temperatures during the surveys were lower than surface temperatures in June, and ranged from 15.0 (January) to 22.8°C (June) at Mobile, from 15.0 (January) to 22.9°C (June) at Gulfport, and from 15.8 (January) to 22.8°C (June) at Pensacola. Temperature measurements taken during the EPA/IEC surveys exhibited a smaller range of seasonal variation than temperatures previously reported. Franks et al. (1972) reported 12.3 in January to 30.3°C in July for surface, and 14.5 (January) to 29.5°C (July) for bottom temperatures offshore (9m) Gulfport (TerEco, 1978).

Warming of surface waters in summer results in a stratified water column in nearshore and mid-Shelf waters off Alabama, Mississippi, and Louisiana (Reitsema, 1980; SUSIO, 1977). Temperature differences of 5 to 6°C between surface and bottom waters have been reported (TerEco, 1978). Similar temperature differences (4.4 to 7.9°C) were observed in the vicinity of the Mobile Existing Site and, to a lesser extent, at the Gulfport (3.6 to 4.0°C) and Pensacola (3.3 to 4.0°C) Existing Sites during the June EPA/IEC surveys (see Appendix A).

Surface water temperatures in the region of the Deepwater Alternative Area ranged from 15.5°C in February and March, to 29.7°C in August 1978, and had a seasonally constant bottom water temperature of 5°C (Molinari et al., 1979). The mixed layer varies from the surface to less than 10m in summer to greater than 200m in winter. A strong seasonal thermocline develops in offshore waters during the summer, while the bottom of the permanent thermocline remains near 300m (Molinari et al., 1979).

SALINITY

Salinity is highly variable in nearshore and mid-Shelf waters of the western part of the northeastern Gulf of Mexico. Shelf water salinities are typically highest during late summer and fall, lowest during winter and spring, and are influenced by freshwater runoff from coastal rivers and intrusions of Loop Current Waters (CE, 1979a; Gaul, 1967; TerEco, 1978).

Surface water salinities ranged from a low of 31.95 in June to a high of 33.59°/oo in January in the vicinity of the Pensacola Existing Site, from 22.14 (June) to 34.02°/oo (January) in the vicinity of the Mobile Existing Site, and from 25.66 (June) to 28.97°/oo (January) in the vicinity of the Gulfport Existing Site during EPA/IEC surveys (see Appendix A). Lower surface salinity in June rather than January is consistent with historical data, and has been attributed to freshwater outflow from river discharges during the spring and summer rainy season (Thompson and Leming, 1978; TerEco, 1978). However, surface salinities offshore Pensacola are not as variable as those near Mobile or Gulfport, due to the diminished impact of river discharge (TerEco, 1978). Salinity increased with increasing depth; bottom water salinity generally exhibited less seasonal variation than surface waters during the EPA/IEC surveys, which is consistent with historical data (Thompson and Leming, 1978). Bottom water salinities ranged from a low of 33.97 in January to a high of 35.01°/oo in June in the vicinity of the Pensacola Existing Site, from 34.07 (January) to 35.87°/oo (June) in the vicinity of the Mobile Existing Site, and from 29.72 (January) to 34.71°/oo (June) in the vicinity of the Gulfport Existing Site (see Appendix A). Differences between surface and bottom water salinities were as high as 3.1°/oo at the Pensacola Existing Site, 13.1°/oo at the Mobile Existing Site, and 9.0°/oo at the Gulfport Existing Sites during the June EPA/IEC surveys; differences between surface and bottom salinities were typically less than 1.0°/oo at the Existing Sites during January. It has been reported that when low salinity surface waters override high salinity bottom waters (as in June surveys) a distinct density gradient is formed which limits vertical mixing (TerEco, 1978).

Surface salinities in mid-Shelf waters during January and May are shown in Figures 3-7 and 3-8. Surface salinities typically range from 28 to 32°/oo, while bottom water salinities range from 32 to 36°/oo, depending on the volume of river discharge (Thompson and Leming, 1978).

Surface salinity is generally less variable in the deep ocean than in nearshore regions (Pequegnat et al., 1978). However, lenses (<20m thick) of lower salinity water (33 to 35°/oo) were observed in the region of the Deepwater Alternative Area during February, June, and August of 1978, and were attributed to patches of Mississippi River discharge (Molinari et al., 1979).

CIRCULATION

Circulation on the Continental Shelf in the northeastern Gulf of Mexico results from a complex interaction between the Loop Current, and effects of winds, tides, and nearshore density gradients. In general, circulation in offshore areas of the Gulf is dominated by the Loop Current, whereas nearshore circulation is influenced to a greater extent by local conditions: tidal currents, winds, and density gradients (SUSIO, 1975).

The Loop Current is an extension of the Yucatan Current, which enters the Gulf of Mexico through the Straits of Yucatan and flows northward towards the Mississippi Delta. Approaching the Continental Margin the Loop Current turns eastward, flows parallel to the bottom contours, and eventually exits the Gulf through the Florida Straits. The strength of the Loop Current varies from 1 to 4 kn (Leipper, 1970).

Circulation in the vicinity of the nearshore Existing Sites and Mid-Shelf Alternative Area is influenced by tides, density gradients, bottom topography, wind, and occasionally by detached Loop Current eddies (TerEco, 1978). Tidal currents predominate in the immediate vicinity of tidal passes, reaching velocities of 1.4 and 1.5 kn during ebb and flood tides, respectively, at Mobile Point (Boone, 1973; TerEco, 1978). Current velocities up to 1.5 kn have been measured in Ship Island Pass (near Gulfport Existing Sites) (Water and Air Research Inc., 1975). The direction and relative magnitudes of tidal

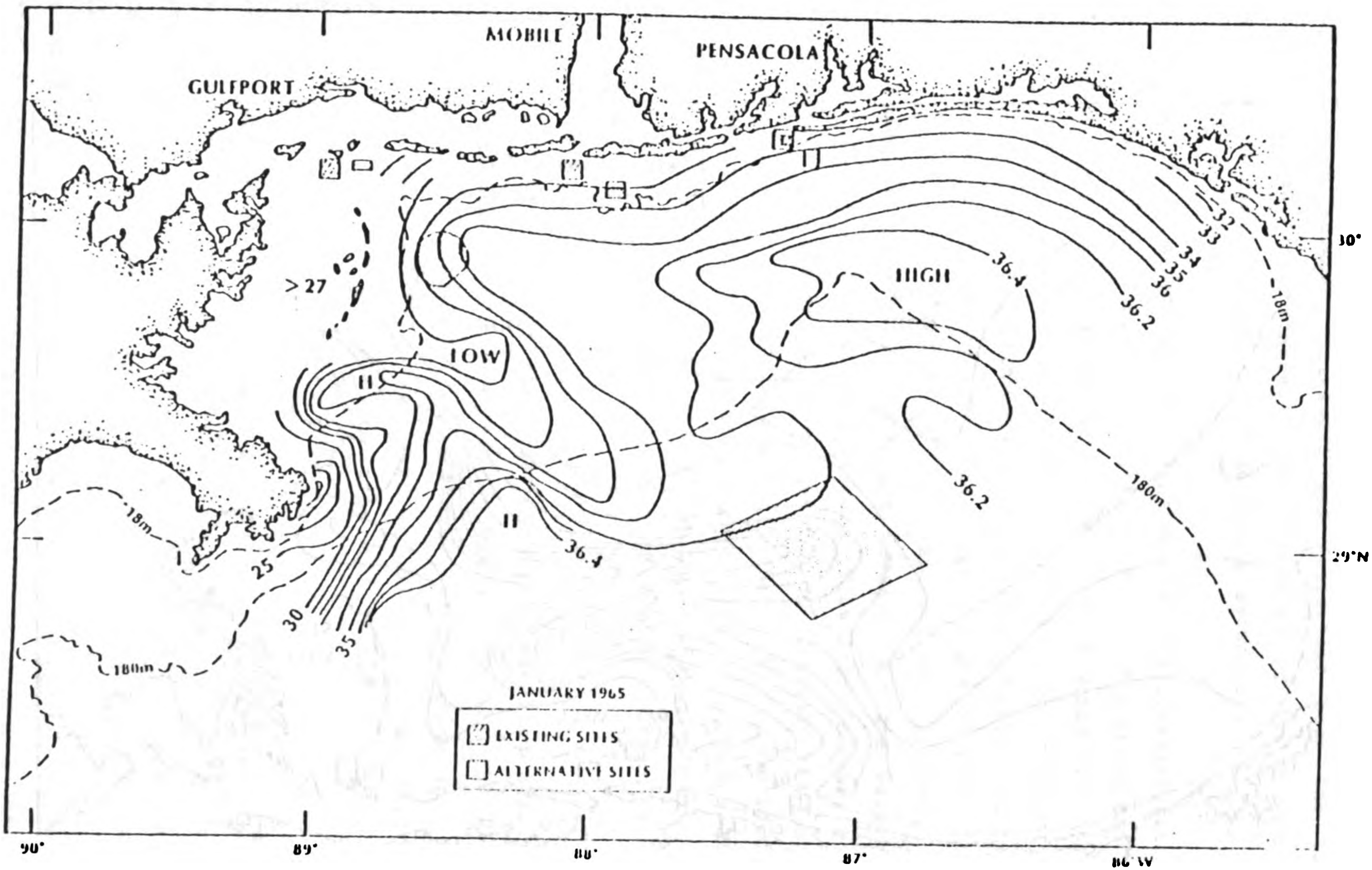


Figure 3-7. Surface Salinities in the Gulf of Mexico (January 1965)
Source: TerEco, 1978 (after Drennan, 1968)

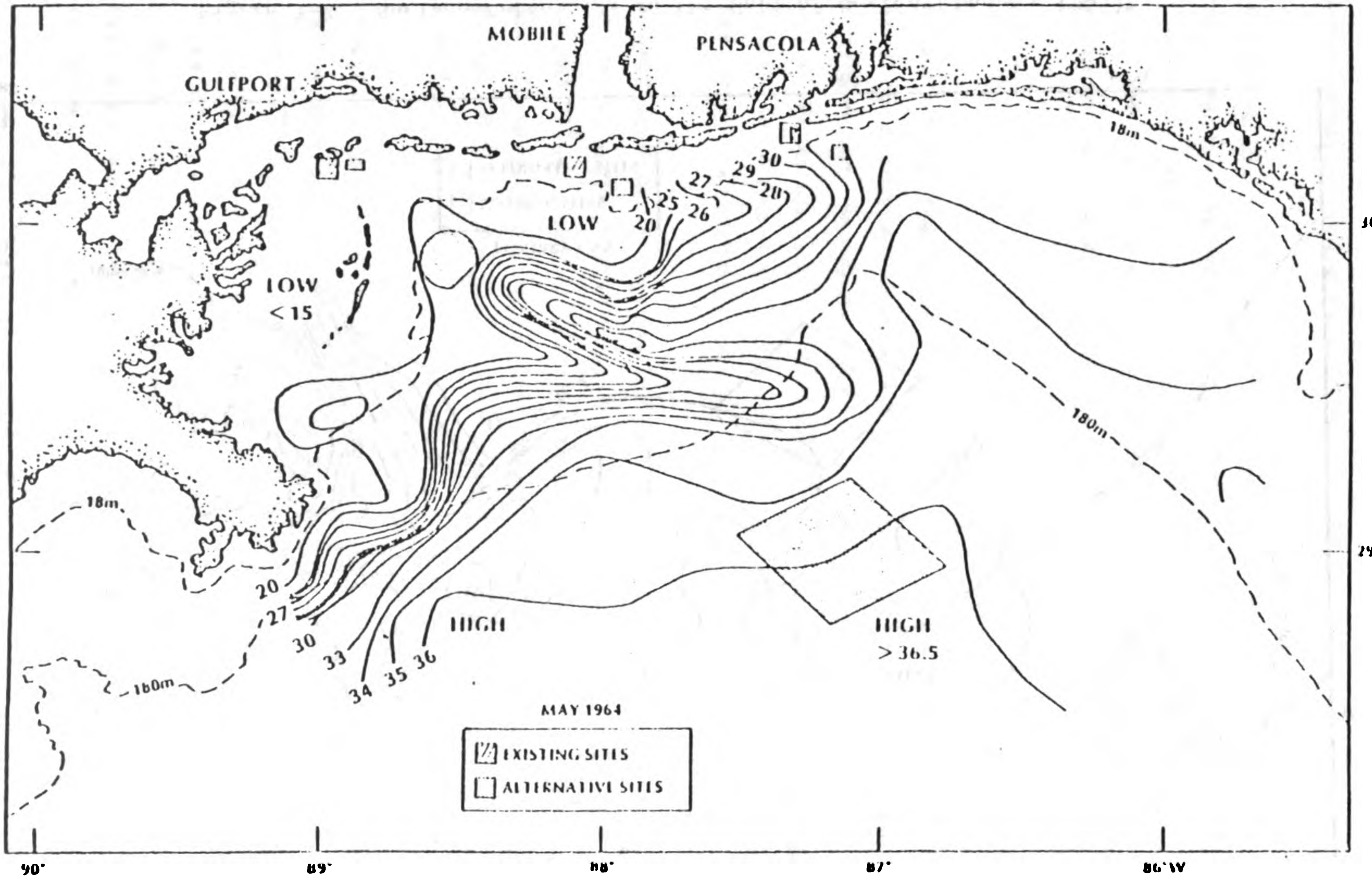


Figure 3-8. Surface Salinities in the Gulf of Mexico (May 1964)
Source: TerEco, 1978 (after Brennan, 1968)

currents in the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites are shown in Figure 3-9. Strong tidal currents in the respective passes may strongly influence sediment transport and deposition near the tidal bar, scouring of the entrance channels, and transport of larval and juvenile invertebrates and fish into and out of adjoining estuaries.

Sustained winds are a dominant force influencing the direction and velocity of nearshore and mid-Shelf currents (TerEco, 1978). Prevailing southerly or westerly winds produce a net easterly transport, while winds with northerly or easterly components typically result in westerly surface transport. During periods of southeasterly or northwesterly winds, the direction of net surface transport will be determined by the tidal stage, volume of river discharges, or other local conditions (TerEco, 1978). Nearshore wind patterns (discussed previously under "Climate") produce a net westerly surface water transport from September to April; however, the westerly flow from February to April is relatively weak. Net easterly flow occurs during June and July, and May and August are typically transitional periods (TerEco, 1978). Schroeder (1976) recorded near-bottom current velocities ranging from 0.4 to 0.9 kn approximately 14 nmi south of the east end of Dauphin Island, Alabama; flow was directed at right angles to the direction of the predominant wind (Figure 3-10).

No bottom current speeds at the Existing Sites have been measured during extreme weather conditions; however, Forristall et al. (1977) reported velocities for near-bottom Shelf currents of 3.9 kn during the passage of tropical storm Delia in 1973, and Murray (1970) recorded bottom current velocities of 3.1 kn in a nearshore area off Pensacola during hurricane Camille in 1969 (see Appendix B).

Surface currents in Shelf-break areas offshore the 200m depth contour are typically controlled by the Loop Current (Pequegnat et al., 1978; Gaul, 1967). Persistent winds, Loop Current intrusions, and internal waves may also affect surface and subsurface circulation in the region of the Deepwater Alternative Area (Pequegnat et al., 1978; Huh et al., 1981). Drift-bottle studies in the region of the Deepwater Alternative Area by Tolbert and Salsman (1964) indicated a net onshore movement of surface waters north of 29°N, and net

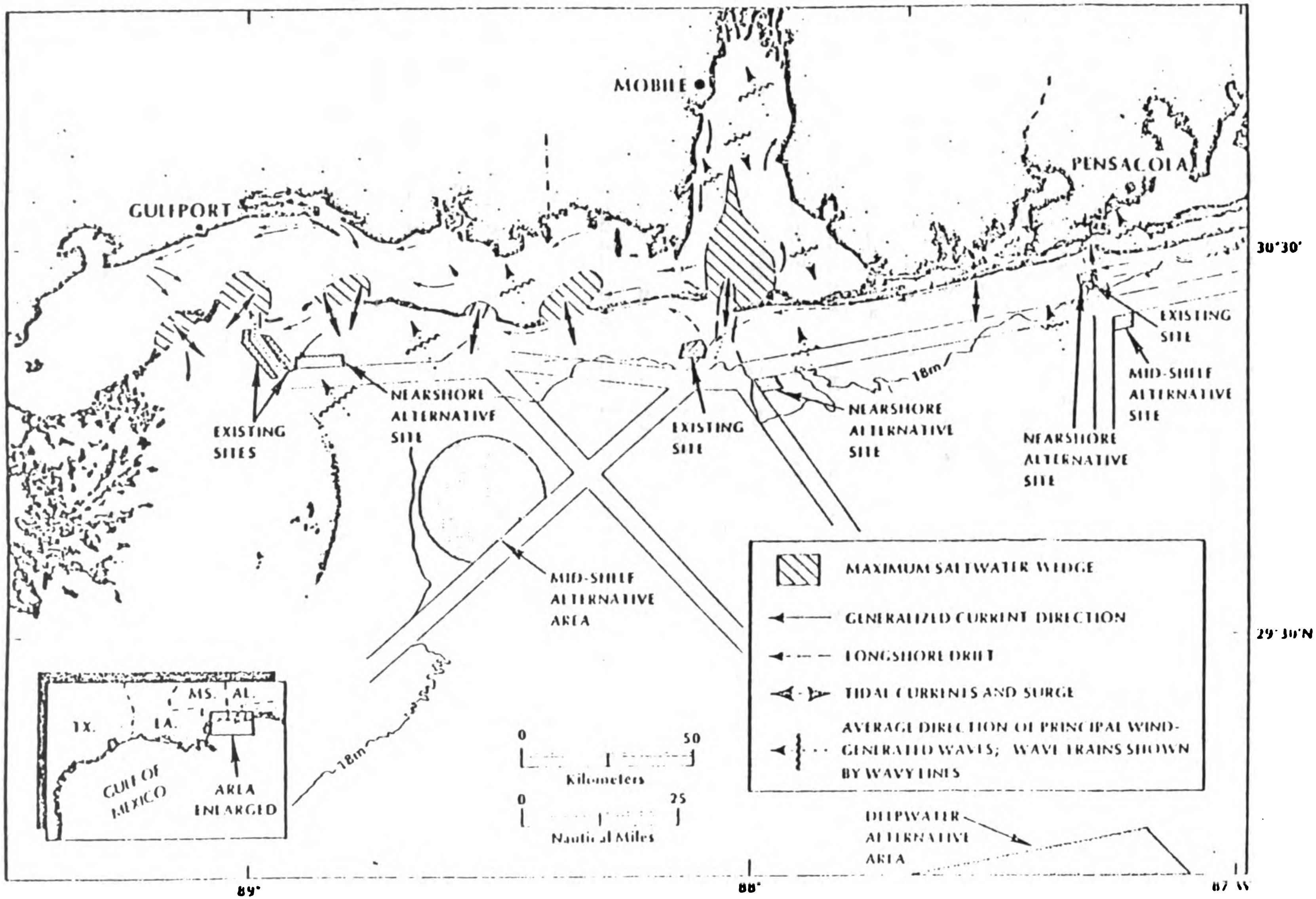


Figure 3-9. Generalized Circulation Patterns Occurring Near the Pensacola, Mobile, and Gulfport Existing Sites
Source: Boone, 1973

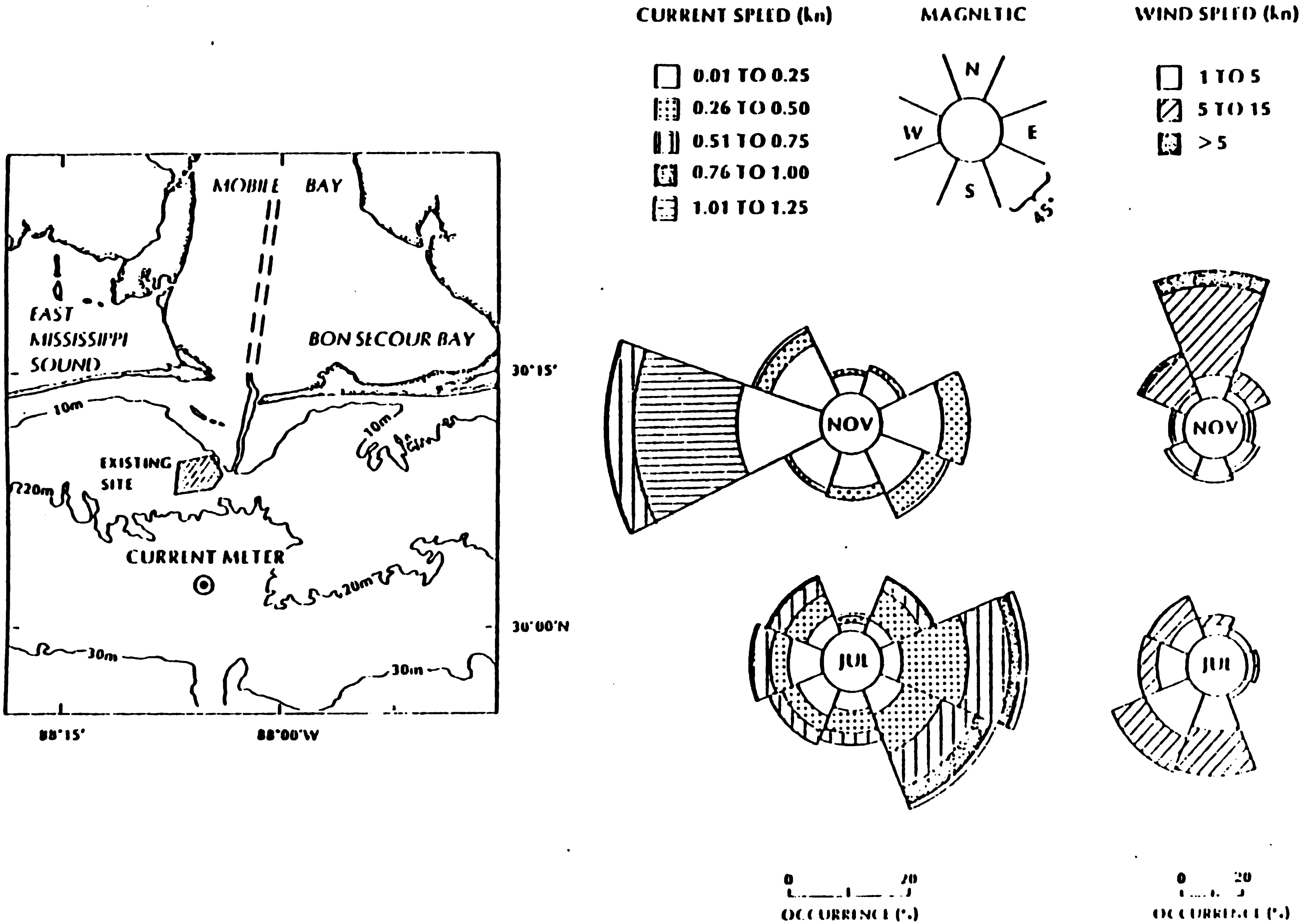


Figure 3-10. Wind Measured at Dauphin Island, Alabama and Near-Bottom Current Roses Measured 14 nmi South of Dauphin Island for July and November 1976
Source: Schroeder, 1976

offshore movement south of 29°N latitude from January to June. From August through November, net westward surface water movement was indicated. Molinari et al. (1979) reported bottom currents near the Deepwater Alternative Area oriented parallel to bottom contours with velocities ranging from 0.04 to 0.3 kn.

WAVES

In the northeastern Gulf greatest wave heights occur from October to March, with the smallest during spring and summer (NOAA, 1972). When wind speeds exceed 5 kn, 92% of the waves offshore have wave heights of 3 to 5 ft, and a period of 4.5 to 6 seconds (CE, 1973).

In the area north and east of the Mississippi Delta, waves normally are directed to the west with a northerly or southerly component, depending on the wind direction (Scruton, 1956). Boone (1973) reported that prevailing southerly and southeasterly winds produce waves directed in a northwestward direction along the seaward edges of the barrier islands. These waves result in westerly longshore current flow in depths less than 6m. The velocity of the longshore current is typically 1.0 to 2.5 kn, except during flood tide when velocities may approach 5.0 kn. Northeasterly winds during autumn produce waves directed towards the southwest. With the onset of "northers," wave directions shift toward the south or southeast. Waves during hurricanes are powerful enough to disturb bottom sediments over most of the Shelf (Scruton, 1956). The probability of wave heights reaching or exceeding 4m (12 ft) is 0.1% in late summer and 3.2% in February. Waves greater than 6m (20 ft) have a probability of occurrence of 0.5% in December (NOAA, 1972). Wave heights of 10m (31 ft) occur on an average of once every 5 years, and 14m (43 ft) waves are expected every 50 years (NOAA, 1972).

GEOLOGY

Geological information relevant to an ODMDS includes bathymetry, sediment characteristics, and dredged material characteristics. Bathymetric data provide information on bottom stability, persistence of sediment mounds, and shoaling. The type of bottom sediments strongly influences the composition of resident benthic biota. Differences in sediment types between natural CDMDS sediments and dumped material can sometimes be used as tracers to determine areas of bottom influenced by disposal of dredged material. Changes in CDMDS sediment type caused by disposal may produce significant changes in chemical characteristics and in the composition of benthic biota.

The northeastern Gulf of Mexico, from western Florida to the Mississippi Delta, is characterized by three major depositional systems: the Mississippi-Alabama Shelf system, the western Florida barrier spit and island system, and the Mississippi Sound barrier island system (Figure 3-11).

The Mississippi-Alabama Shelf extends from the Mississippi River Delta to the De Soto Canyon, and from the steep, narrow shoreface of the barrier island systems to the 200m contour. The Shelf is about 70 nmi wide at its western edge, narrowing to 30 nmi near the De Soto Canyon; it is a broad, nearly flat plain with a gradient varying from 0.6 m/km off Mobile Bay to 1.6 m/km off Pensacola Bay. The slope increases to 6 m/km near the 60m contour (Boone, 1973).

Sediment influx from the Mississippi River has resulted in a relatively smooth surface topography in the western portion of the Gulf; east of Mobile Point, however, the Shelf surface is highly irregular. As the sand sheet thins toward the east, the limestone karst topography of the West Florida Shelf predominates (Boone, 1973; Doyle and Sparks, 1980; Gould and Stewart, 1956). Offshore from Pensacola, sediment-free rock formations with coral and other invertebrate growth exist at depths of 25 to 30m (Moe, 1963); these become more numerous until the reef-interreef facies is reached. The Mississippi-Alabama reef-interreef facies occur along the Shelf edge (Figure 3-11). This zone consists of a series of well-cemented carbonate and terrigenous sand pinnacles about 1.6 km wide with an average relief of 9m, interspaced by an unconsolidated sand-silt-clay mixture (Boone, 1973). The Continental Slope from the Mississippi River Delta to the De Soto Canyon is a region of sediment instability and is marked by active mudflows, slumping, and erosional furrows and gullies (DOI, 1981). Evidence of recent slumping also exists in the bottom of the De Soto Canyon (Pequegnat, et al., 1978).

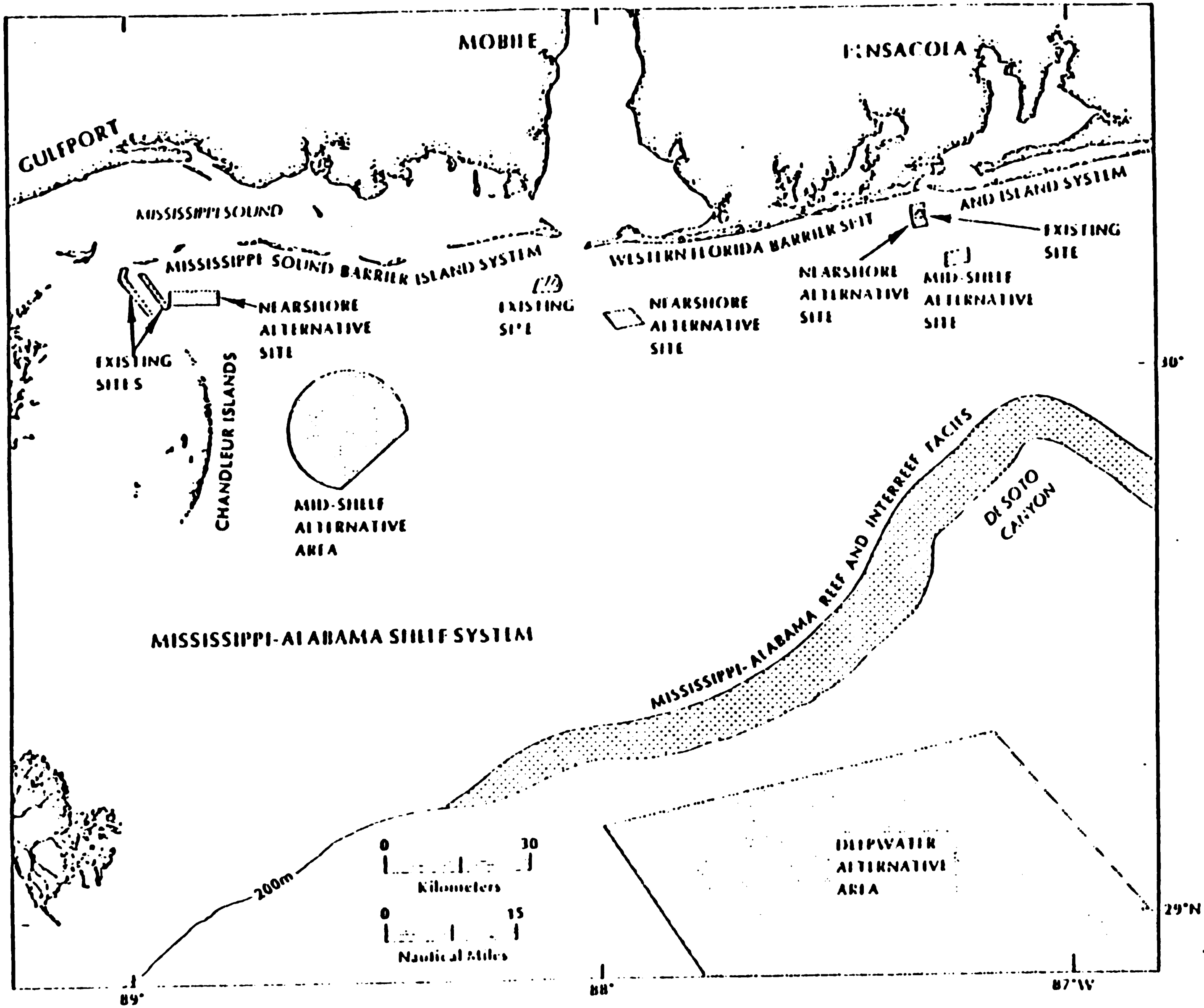


Figure 3-11. Major Geologic Features of the Mississippi, Alabama, and Western Florida Continental Shelf
Source: Adapted from Boone, 1973

The barrier island systems are composed of segmented chains of sandy islands broken by shallow passes having widths comparable to the lengths of the islands (Shepard, 1960). Barrier islands along the Mississippi, Alabama, and western Florida coast were formed during the submergence of dune beach ridges in the Holocene period (Hoyt, 1967; Shepard, 1960). The islands and spits consist of a broad beach backed by dunes on the Gulf side, intermittent beach and marsh areas in the interior, and another dune bank on the mainland side. The average width of the islands is less than 0.6 km, and dune height averages 3 to 6m, with a maximum of 12m (Boone, 1973). Their lengths range from less than 1 to over 30 nmi. The barrier island sand facies is usually less than 12m thick, although it can reach a maximum of about 20m. The shoreface of the barrier islands slopes abruptly to depths of 5 to 20m (Boone, 1973).

BATHYMETRY

The Existing Sites are situated on a gently sloping bottom, devoid of any prominent submarine features. The Existing Gulfport Sites, in 6 to 12m of water, have a bottom that slopes gently to the southeast with a relief of less than 1m (CE, 1979c). Only minor depth changes occurred in this nearshore region between 1917 and 1951, indicating that it has been a relatively stable area in the recent past (Henry and Shenton, 1955).

The Existing Mobile Site, in 12 to 16m of water, is south of the shoal area between Dauphin Island and Mobile Point. The bottom slopes gently to the southwest with no prominent outcrops. A gentle meter-high ridge with a northwest strike runs through the lower portion of the site (CE, 1979d). Depth profile measurements conducted south of Dauphin Island revealed shoaling of about 2m in the 10 to 15m depth range during the years 1851 to 1951 (Henry and Shenton, 1955). Therefore, the ridge in the Existing Mobile Site may represent a sandbar, or may be the result of dredged material disposal.

The Pensacola Existing Site, in 8 to 14m of water, slopes gently to the south-southwest. Sandbars are common throughout the area offshore from Pensacola (CE, 1973b). Considerable depth changes (up to 3m during the years 1920 to 1951 in some areas) occurred in the area (Henry and Shenton, 1955) probably as a result of sediment transport and sandbar migration.

The Mobile-Gulfport Mid-Shelf Alternative Area, in 23 to 29m of water, has a bottom that slopes gently to the southeast and has no prominent submarine features. The Deepwater Alternative Area, in 493 to 2,376m of water, covers, in part, the head of the De Soto Canyon. This is a region of considerable relief and steep gradients; in some areas the bottom slopes from 400 to 1,000m within a distance of about 5 nmi (DOC, 1980b).

SEDIMENT CHARACTERISTICS

Modern sediment sources to the area include the Mississippi, Pearl, Pascagoula, and Mobile Rivers. With the exception of the Mississippi, the major influx of silts and clays from river systems is limited to the region landward of the barrier island-spit systems. Barrier Island and Shelf sediments are primarily sand, and the large sand component extends well out toward the Shelf edge (Boone, 1973; Doyle and Sparks, 1980). Fine-grained sediments increase west of Mobile Bay as the Mississippi Delta is approached (Figure 3-12; Doyle and Sparks, 1980). The percentage of carbonates in the sediments is roughly correlated with sediment size distribution. Carbonates are low in regions having a large sand component and increase with increasing proportions of fine materials (Upshaw et al., 1966).

Sediment distributions at the Existing Sites conform to expected trends in sediment character between Pensacola and Gulfport (see Appendix A). The percentage of fines increased from east to the west. Sediments in the vicinity of the Pensacola Existing Site were approximately 99% sand. In the vicinity of the Mobile Existing Site, sediments varied from about 35 to 99% sand, and 1 to 64% silt and clay. In the vicinity of the Gulfport Existing Site, silt and clay percentages ranged from about 22 to 91%. The Mobile-Gulfport Mid-Shelf Alternative Area is located in a transition zone between the silty St. Bernard prodelta (the easternmost facies of the Mississippi Delta), and the predominantly sandy Shelf region. This results in a sediment distribution that grades from about 70 to 90% sand along the eastern edge, to about 5 to 15% sand to the west (Figure 3-13). The Deepwater Alternative Area is located over the De Soto Canyon and the surrounding Slope. The De Soto Canyon lies along the transition zone between the terrigenous sands of the Mississippi-Alabama Shelf and the primarily carbonaceous, sediment-poor

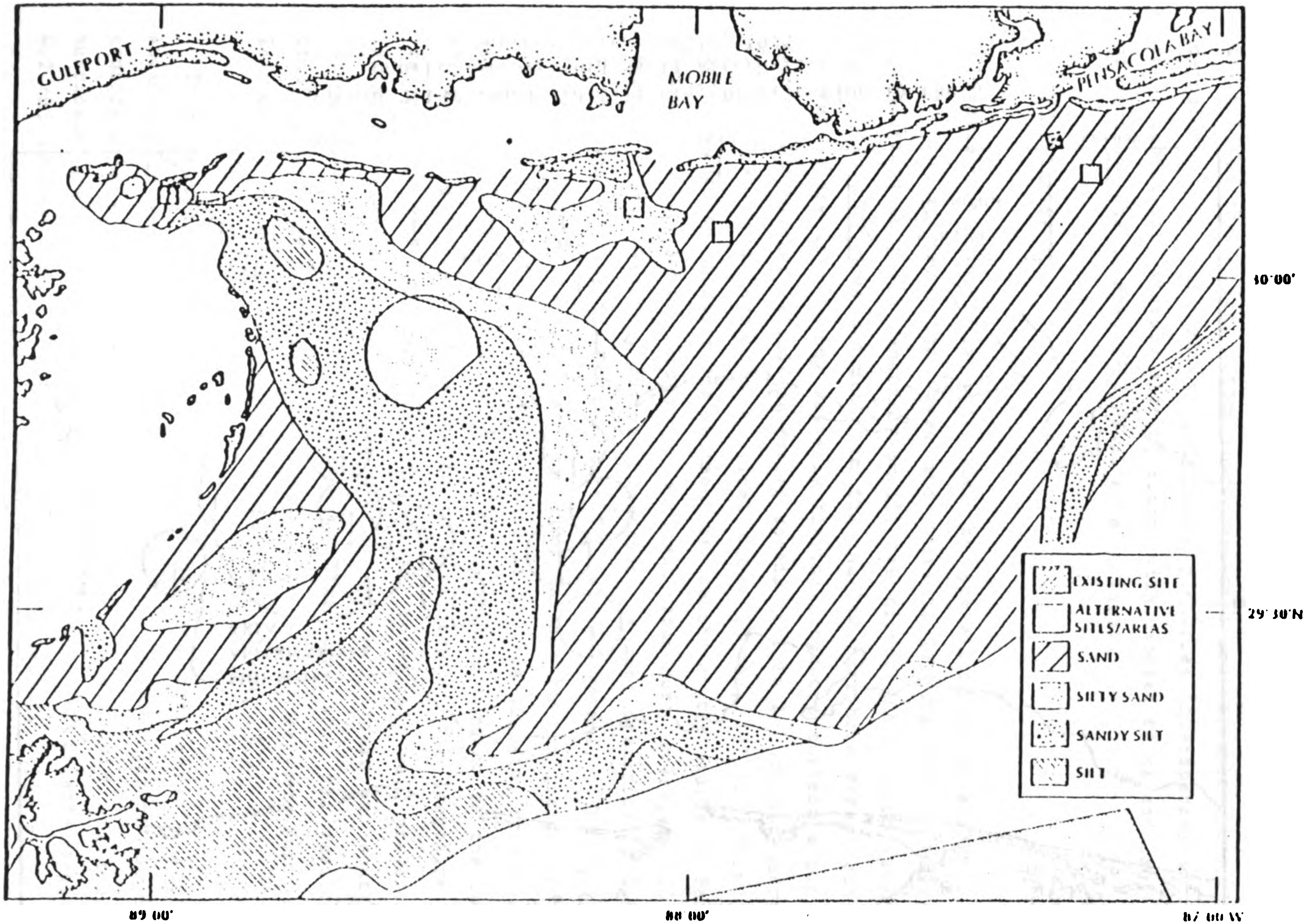


Figure 3-12. Sediment Distribution on the Mississippi, Alabama, and Western Florida Shelf
Source: CE, 1979a

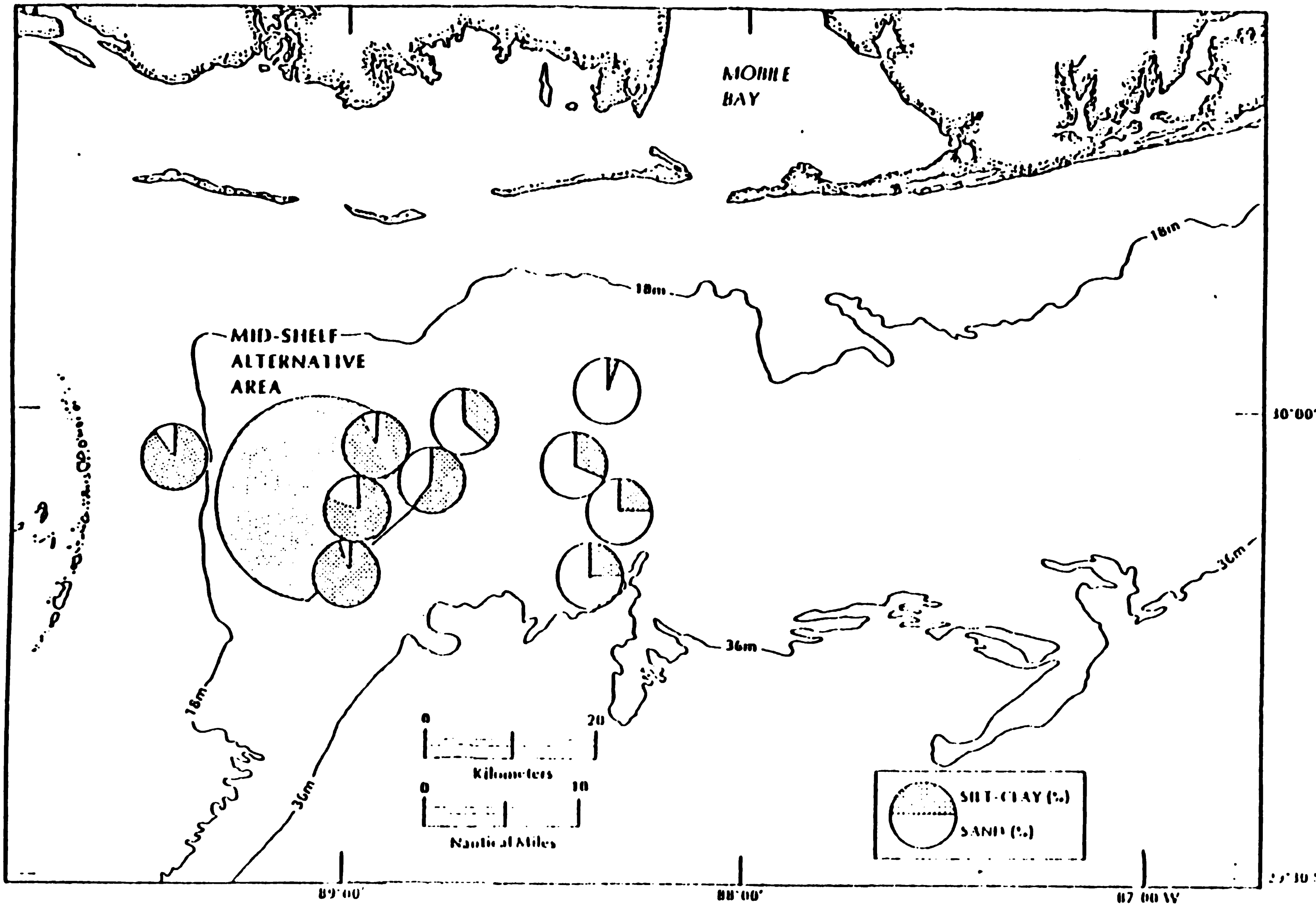


Figure 3-13. Sand and Silt-Clay Distribution in the Mobile-Gulfport Mid Shelf Alternative Area
Source: After SUSIO, 1975

West-Florida Shelf (Doyle and Sparks, 1980). Sediments in the De Soto Canyon range from silt and clay to sand (Doyle and Sparks, 1980; Moe, 1963). Near the head of the Canyon, bottom characteristics are variable and include thick deposits of clay and mud to calcareous pinnacles interspersed with mud and shell debris, and steeply sloping cliffs with exposed rocks and large deposits of sand and shell (Moe, 1963; Gaul et al., 1963).

SEDIMENT TRANSPORT

Sediment transport is controlled by prevailing wave energy, longshore drift, and storm-induced waves and currents (Figure 3-9). Waves in the northeastern Gulf are generally small; the direct energy from waves in this region can only move sediments in the shallow nearshore zone (Boone, 1973). However, there is a strong westerly flowing longshore current along the Gulf side of the barrier islands averaging speeds of 1 to 2.5 kn, and increasing to 2.5 to 5 kn when augmented by tidal flows (Boone, 1973). This longshore current produces considerable sediment transport; at the mouths of Perdido and Pensacola Bay, annual longshore sediment transport averages 130,000 yd^3 (Boone, 1973). Westward sediment transport is most dramatically illustrated in the westward drift of the barrier island systems. During the last 125 years Dauphin, Petit Bois, and Horn Islands have migrated from 2.5 to 7.0 nmi to the west (Boone, 1973). Ship Island has migrated to the south and west, indicating a general shift of the longshore current to the south near the Mississippi Delta. The change in direction of the longshore sediment transport to the south has left Cat Island relatively well protected; this island has experienced only minor erosion on the northern and southern tips (Boone, 1973). Sediment transport in this area also can result in the complete erosion of barrier islands. The shoals between Horn and Ship Islands, for example, are remnants of Dog Keys (Otvos, 1970).

Tropical storms and hurricanes can produce considerable shifting of sediments in short time periods (Appendix B). Dauphin Island has undergone considerable modification by storm activity. The island was breached by hurricane activity in the early 1900's, forming two islands separated by 4.2 nmi of open water. This opening filled gradually, only to be breached again in 1948. Since 1948 the separate islands have again rejoined to form the present shape of Dauphin Island (Sapp et al., 1975). Ship Island has undergone a similar sequence of breaching and filling several times in the last century (Otvos, 1970; Upshaw et al., 1966).

WATER COLUMN CHEMISTRY

The chemical parameters pertinent to evaluation of an ODMDS include suspended solids, nutrients important to phytoplankton growth (e.g., nitrate and phosphate), dissolved and particulate trace elements (e.g., Cd, Hg, and Pb), and hydrocarbons (e.g., PCB and DDT). Potential impacts depend on the concentrations of constituents released from dredged material, and physical factors such as mixing and dilution rates; however, because of the transient nature of water masses, changes in water chemistry are expected to be minor in most cases.

High levels of suspended solids may reduce light penetration through the water column, and thereby inhibit phytoplankton productivity, or clog respiratory structures of fishes and other organisms.

Nutrients are essential for growth and reproduction of phytoplankton; however, under certain conditions, and at elevated levels, nutrients may promote eutrophication with subsequent depletion of dissolved oxygen, or in the case of ammonia, may be toxic to organisms in the water column.

Several trace elements are necessary micronutrients in the life processes of organisms; however, many, such as mercury, lead, and cadmium, can be toxic if present in relatively high levels in water, or in food sources such as suspended particulates. Many chlorinated or petroleum hydrocarbons are toxic, and may be bioaccumulated by marine organisms if ingested in sufficient quantities.

DISSOLVED OXYGEN

Concentrations of dissolved oxygen for surface and near-bottom waters in the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites during the January and June EPA/IEC surveys are summarized in Table 3-1. Dissolved oxygen concentrations in surface waters in the vicinity of the Pensacola Existing Site ranged from a low of 4.97 in June to a high of 5.55 ml/liter in January, (>100% saturation); dissolved oxygen concentrations in near-bottom waters were slightly lower, ranging from 4.29 (June) to 5.22 ml/liter (January) (90 to 96% saturation). Rinkle and Jones (1973) have reported comparable surface and bottom dissolved oxygen concentrations (4.5 to 5.6 ml/liter, and 3.5 to 5.0 ml/liter respectively) in adjacent Escambia-Santa Rosa County coastal waters.

Surface dissolved oxygen concentrations in the vicinity of the Mobile Existing Site ranged from a low of 4.24 to a high of 5.96 ml/liter in June (96 to 130% saturation). January surface dissolved oxygen concentrations were within the range reported for June; saturation levels ranged from 90 to 96%.

TABLE 3-1
RANGE OF WATER COLUMN CHARACTERISTICS*
DURING JANUARY AND JUNE 1980 EPA/IEC SURVEYS

Parameter		Pensacola	Mobile	Gulfport
Dissolved Oxygen (ml/liter)		4.29 to 5.55	1.78 to 5.96	2.10 to 5.58
Turbidity (NTU)		0.30 to 0.88	0.50 to 5.10	1.00 to 7.30
TSS (mg/liter)		0.52 to 1.59	0.61 to 7.98	1.57 to 12.60
Trace Metals				
Particulate (µg/kg)	Hg	0.002 to 0.004	<0.0005 to 0.001	<0.0003 to 0.002
	Cd	0.004 to 0.038	0.016 to 0.094	0.003 to 0.022
	Pb	0.001 to 0.009	<0.005 to 0.039	0.002 to 0.095
Dissolved (µg/liter)	Hg	0.002 to 0.003	<0.003 to 0.016	<0.003 to 0.004
	Cd	0.036 to 0.104	<0.010 to 0.085	0.024 to 0.154
	Pb	0.030 to <0.20	<0.030 to <0.20	0.100 to <0.20
PCBs (ng/liter†)		ND to 0.002	ND to 0.003	ND to 0.001
Pesticides (ng/liter†)		ND to 10.81	ND to 6.42	ND to 7.59

ND - Not detectable

* Range of measurements (minimum to maximum) over all depths
† Values are for individual compounds, for further information see Appendix A

Near-bottom dissolved oxygen concentrations decreased from a high of 4.87 in January to a low of 1.78 ml/liter in June (85 to 36% saturation). Low dissolved oxygen concentrations have been observed in near-bottom Mobile Bay waters, particularly in summer. Depletion of oxygen in Bay waters was reportedly caused by oxygen demands of organic-rich bottom sediments, and biological respiration (May, 1973b). Bault (1972) reported lower dissolved oxygen concentrations in summer than winter, ranging from 10.1 to 2.2 ml/liter, but did not find lower concentrations in bottom waters relative to surface waters during his 1968-1969 survey of lower Mobile Bay (Station 5) waters. Data for Gulf of Mexico waters in the vicinity of the Existing Site were not available.

Surface dissolved oxygen concentrations in the vicinity of the Gulfport Existing Site were similar to those at Mobile, ranging from 4.21 to 5.53 ml/liter in June (90 to 117% saturation), and 4.94 to 5.33 ml/liter in January (86 to 94% saturation). Bottom water levels decreased from a high of 5.33 in January to a low of 2.10 ml/liter in June (94 to 44% saturation). Previously recorded dissolved oxygen concentrations in surface waters near Ship Island ranged from a low of 4.6 in August to a high of 9.8 ml/liter in February (Christmas, 1973).

Dissolved oxygen concentrations in surface and bottom waters in the vicinity of the Mid-Shelf Alternative Area have not been previously reported. Limited measurements in the region of the Deepwater Alternative Area indicated dissolved oxygen concentrations in excess of 5 ml/liter in near-surface (upper 50m) waters (Jones et al., 1973). Seasonal variations in dissolved oxygen concentrations in offshore waters consist mainly of a slight lowering of oxygen content in the upper 100m during the summer (ibid.).

NUTRIENTS

Little information is available to characterize the ranges or seasonal trends in dissolved nutrient concentrations in waters adjacent to the Pensacola, Mobile, and Gulfport Existing Sites. Eleuterius (1976) reported that nutrient levels in Mississippi Sound waters declined from east to west. There was an accompanying seaward decline of all nutrients, except nitrate, which increased with distance offshore. Mississippi Sound waters near the Gulfport Existing Site typically contained 0.4 to 3.0 µg-at/liter nitrate, 0.2 to 1.6 µg-at/liter inorganic phosphate, and 0.2 to 4.0 µg-at/liter total phosphate. Lower nutrient concentrations were reported (Rinkel and Jones, 1973) in surface waters adjacent to the Pensacola Existing Site; nitrate ranged from 0.01 to 0.09 µg-at/liter, inorganic phosphate from 0.0 to 0.34 µg-at/liter, and silicate from 2.0 to 20.0 µg-at/liter. Phosphate concentrations are typically higher during low river discharge conditions, while the converse is true for nitrate-nitrite (Eleuterius, 1976). No comparable data are available for the Mobile Existing Site waters. However, nitrate ranged from 0 to 53.38 µg-at/liter, orthophosphate from 0 to 25.68 µg-at/liter, and total phosphorus from 0 to 91.4 µg-at/liter in Mobile Bay waters (CE, 1973c).

Nutrient concentrations in mid-Shelf or open-Gulf waters are not well-defined. Fanning (1975) reported relatively low nutrient concentrations, 0.43 µg-at/liter nitrate, 0.08 µg-at/liter phosphate-arsenate, and 2.56 µg-at/liter silicate, in surface waters in the mid-Shelf MAFLA study area. Nutrient concentrations typically increased with depth; near-bottom waters contained 11.03 µg-at/liter nitrate, 0.29 µg-at/liter phosphate-arsenate, and 12.87 µg-at/liter silicate. These results are consistent with previous observations of open ocean waters, i.e., nutrient concentrations in surface waters are generally low and increase at greater depths (Raymont, 1963).

SUSPENDED SOLIDS

Total suspended solids (TSS) concentrations and turbidity (NTU) detected in the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites during the EPA/IEC surveys are summarized in Table 3-1. TSS and NTU values were highest at the Gulfport Existing Site and lowest at the Pensacola Existing Site. This trend is probably the result of decreasing inputs of suspended solids from rivers in the eastern direction (TerEco, 1978). No seasonal differences in turbidity were evident from the EPA/IEC survey data; and turbidity was generally higher in near-bottom than surface waters (see Appendix A).

Suspended solid concentrations of 0.1 to 0.2 mg/liter in mid-Shelf waters in the vicinity of the MAFLA study area were reported by Dames and Moore (1979). Levels of total suspended matter ranging from 0.12 to 0.25 mg/liter were reported for Shelf-break waters by Manheim et al. (1972). These levels are less than values measured at the Existing Sites during the EPA/IEC surveys, and are consistent with the frequently observed trend of deeper waters generally being less turbid than coastal waters.

TRACE METALS

Rinkel and Jones (1973) conducted an interdisciplinary synoptic study off Escambia-Santa Rosa counties in Florida (Pensacola Existing Site within area studied). They found that trace metal concentrations near the coast were approximately an order of magnitude greater than concentrations observed in open-ocean waters, indicating an enrichment of Shelf waters from inshore sources. Generally, trace metal concentrations were highest at the western edge of their study area (near Mobile Bay). Waters east of Mobile Bay intermittently contained high levels, indicating enrichment from Mobile Bay and/or the Mississippi River, and possibly from Escambia-Pensacola and Perdido Bays (Rinkel and Jones, 1973).

Concentrations of dissolved and particulate trace metals measured in the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites waters during the January and June EPA/IEC surveys are summarized in Table 3-1. No consistent spatial or seasonal trends were observed. Trace metal concentrations were similar to those reported by Rinkel and Jones, 1973 (e.g., cadmium ranged from 0.01 to 1.6 μg/liter, lead ranged from 0.04 to 4.25 μg/liter) and were below the EPA (1976) water quality criteria of 4.5 μg/liter for cadmium, and 0.025 μg/liter for mercury. No EPA criteria have been established for lead.

Trace metal concentrations generally decrease with increasing distance from shore, and inshore sources of enrichment (e.g., rivers, bays) (Rinkel and Jones, 1973). No reliable data are available to characterize trace metal concentrations in waters of the Mid-Shelf Alternative Area. In the vicinity of the Deepwater Alternative Area, Slowey and Hood (1969) reported copper, manganese, and zinc concentrations within the range (low end) reported by Rinkel and Jones (1973) for coastal waters.

HYDROCARBONS

Concentrations of dissolved chlorinated hydrocarbons (CHC) in the vicinity of the disposal site waters during the January and June EPA/IEC surveys are summarized in Table 3-1. Concentrations of pesticide and PCB compounds were generally below detection limits and less than 11 ng/liter, respectively, in all samples (see Appendix A). Concentrations reported for nearshore Gulf waters by Rinkel and Jones (1973) were similar to EPA/IEC values.

Data characterizing concentrations and types of hydrocarbon compounds in mid-Shelf and open Gulf waters are limited. However, concentrations of total dissolved heavy hydrocarbons (n/C_{14}) of less than 1 ug/liter, and concentrations of particulate hydrocarbons ranging from 0.01 to 0.3 ug/liter, have been reported from MAFLA stations (Dames and Moore, 1979).

SEDIMENT CHEMISTRY

A variety of trace contaminants, such as trace metals, petroleum, and CHCs, and other organic materials commonly expressed as total organic carbon (TOC), may accumulate in sediments. Elevated levels of marine sediment contaminants are generally caused by anthropogenic inputs, such as municipal and industrial waste, urban and agricultural runoff, atmospheric fallout from urban centers, and accidental spillage. Silty and clayey sediments exhibit greater absorptive capacities for trace contaminants, and have typically higher TOC levels than coarser materials because of the large surface area to volume ratios and charge densities.

Accumulation of trace elements, and chlorinated or petroleum hydrocarbons in sediments, may produce short- or long-term negative effects on marine organisms. Many benthic organisms are nonselective deposit feeders that ingest substantial quantities of suspended and bottom sediments. The potential for bioaccumulation of persistent trace contaminants (e.g., mercury, cadmium, lead, and some CHCs) by these organisms is of particular environmental concern.

High concentrations of organic materials in sediments can induce oxygen demands on sediments and overlying waters which, under certain circumstances, may lead to anoxic or hypoxic conditions and production of sulfides. Oxidation of these sulfides is responsible for much of the initial consumption of oxygen immediately following dredged material disposal. Significantly lowered oxygen levels in sediments or near-bottom waters may adversely affect marine organisms.

TRACE METALS

Trace metal concentrations in sediments are generally variable across the Continental Shelf off the Mississippi, Alabama, and Florida coast, with highest concentrations occurring near the Mississippi Delta and lower concentrations off the Florida coast (Dames and Moore, 1979). This trend correlates well with sediment characteristics; higher metal concentrations have generally been found in finer-grained, organic-rich sediments, such as those off the Delta (ibid.)

Concentrations of trace metals (weak acid leach) in sediments in the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites during the January and June EPA/IEC surveys are summarized in Table 3-2. Sediment metal concentrations were typically low at the Pensacola and Gulfport Existing Sites. Metal concentrations were more variable at the Mobile Existing Site, and significantly higher in June than January (see Appendix A). Sediment metal concentrations (weak acid leach) at the disposal sites were generally similar to concentrations reported for shallow (20 to 40m) mid-Shelf depths in the Gulf by Trefry et al. (1978), and summarized in Table 3-3. However, lead concentrations at one EPA/IEC station off Mobile (Station 7: seaward of the disposal site) were somewhat higher than values reported in Table 3-3; the reason for lead enrichment at this station cannot be determined from available information.

Trace metal concentrations (total dissolution) in sediments in the vicinity of the Pensacola Existing Site and the vicinity of the Mid-Shelf Alternative Area are listed in Table 3-4; as expected (due to the more rigorous total dissolution technique), maximum values are somewhat higher than the weak acid

TABLE 3-2
RANGE OF SEDIMENT CHARACTERISTICS
DURING JANUARY AND JUNE 1980 EPA/IEC SURVEYS

Parameter		Pensacola	Mobile	Gulfport
TOC (mg/g)		0.23 to 0.69	0.15 to 21.47	2.04 to 9.47
Oil and Grease (mg/g)		0.34 to 7.77	0.13 to 5.56	0.49 to 4.86
Trace Metals (weak acid leach; mg/kg)				
	Hg	0.001 to 0.298	<0.001 to 0.150	0.002 to 0.038
	Cd	0.001 to 0.003	<0.001 to 0.150	0.002 to 0.042
	Pb	0.069 to 0.238	0.012 to 19.14	<0.004 to 1.32
PCBs (ng/g)*		ND to 0.0001	ND	ND
Pesticides (ng/g)*		ND to 0.08	ND to 3.29	ND to 4.21

ND - Not detectable

* Values are for individual compounds; for further information see Appendix A

leach values presented in Table 3-3. Metals in sediments from the Deepwater Alternative Area have not been measured; however, concentrations at nearby MAFLA stations were within the range reported for shallower mid-Shelf stations (Table 3-4).

ORGANIC COMPOUNDS

The ranges of concentrations of total organic carbon (TOC), oil and grease, and pesticides in sediments from the Existing Sites during the January and June EPA/IEC surveys are summarized in Table 3-2. Historical information describing concentrations of total and trace organics in nearshore, mid-Shelf, and Shelf-break sediments are generally unavailable for comparisons with EPA/IEC data.

The concentration range for TOC in the vicinity of the Pensacola Existing Site was considerably smaller (0.23 to 0.69 mg/g) than the ranges detected in sediments the in vicinity of the Mobile and Gulfport Existing Sites (0.15 to

TABLE 3-3
RANGE OF TRACE METAL CONCENTRATIONS IN
SEDIMENTS FROM MAFLA STATIONS (20 TO 40M DEPTHS) IN THE
VICINITY OF PENSACOLA, MOBILE, AND GULFPORT EXISTING SITES
(mg/kg)

Cd	Cu	Cr	Fe	Ni	Pb
<0.01 to 0.16	0.27 to 5.5	1.6 to 13.0	860 to 9,670	<0.1 to 5.2	1.4 to 11.4

Notes: Metal range, n = 48; weak acid leach

Source: Trefry et al, 1978

21.47 mg/g, and 2.04 to 9.47 mg/g, respectively). Lower organic carbon concéntrations in sediments off Pensacola are consistent with the relatively low percentages of fines in the sediments. Oil and grease concentrations were similar in sediments from the vicinity of each of the Existing Sites, ranging from 0.13 to 5.56 mg/g at Mobile, 0.34 to 7.77 mg/g at Pensacola, and 0.49 to 4.86 mg/g at Gulfport.

Low concentrations (<5 ng/g) of pesticides and PCBs were detected in sediments in the vicinity of the Existing Sites during the EPA/IEC surveys (Table 3-2).

Data describing the presence of petroleum hydrocarbon in nearshore sediments in the vicinity of the Existing Sites has not been reported in the literature; however, studies of offshore areas (Dames and Moore, 1979; SUSIO, 1975; Gearing, et al., 1976) provide an indication of probable sources and trends for the region. The major sources for petroleum-derived hydrocarbons appear to be the Mississippi Delta Area (Dames and Moore, 1979; Gearing et al., 1976) and to a lesser degree, Mobile Bay. Hence, petroleum contamination of sediments decreases from (1) high concentrations adjacent to the Mississippi Delta in the west (vicinity of Gulfport Existing Site), to (2) moderate levels in the vicinity of Mobile Bay, to (3) low levels or absence on the Florida Shelf east of Pensacola (Gearing et al., 1976). Because of the complex nature of the analyses and classification schemes for hydrocarbons, more detailed discussion is beyond the scope of the EIS; the reader is referred to the above-cited studies for further information.

TABLE 3-4
RANGE OF HEAVY METAL CONCENTRATIONS IN SEDIMENTS IN THE VICINITY OF NEARSHORE PENSACOLA SITES, AND FROM MAFLA STATIONS NEAR MOBILE-GULFPORT MID-SHELF ALTERNATIVE AREA, AND DEEPWATER ALTERNATIVE AREA (mg/kg)

Sources	Cd	Cu	Cr	Fe	Ni	Pb
Rinkle and Jones, 1973*	ND to 1.0	ND to 3.0	1 to 6	183 to 482	ND to 12	ND to 8
Trefry et al., 1978†	0.01 to 1.7	0.33 to 7.4	2.4 to 38.5	420 to 22,700	0.5 to 13.3	1.1 to 16.2
SUSIO, 1975†	0.2 to 0.3	7 to 24	30 to 80	1.5 to 3.6††	11 to 45	5 to 22
SUSIO, 1975**	<0.5 to 0.15	5 to 14	14 to 72	0.92 to 1.40††	6 to 10	3 to 11

* Vicinity of Pensacola Existing and Nearshore Alternative Sites (Stations C31 to C36)
† Vicinity of Mid-Shelf Alternative Area (MAFLA Stations 1 to 6)
** Vicinity of Deepwater Alternative Area (MAFLA Stations 17 to 20)
†† Not measured in similar units (%)

TISSUES

Concentrations of trace metals and CHCs in tissues of epifauna collected in the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites during the EPA/IEC surveys were generally low (see Appendix A). Mercury concentrations were all less than 0.5 mg/kg, which is below the U.S. Food and Drug Administration (FDA) action level of 1.0 mg/kg for fish (FDA, 1980). Cadmium levels ranged from 0.02 mg/kg in *Etropus rimosus* to 0.47 mg/kg in *Callinectes similis*; whereas lead concentrations ranged from less than 0.02 to 0.88 mg/kg in the shrimp *Penaeus aztecus*. No FDA action levels or standards are available for cadmium or lead. However, comparable mean lead and cadmium concentrations of 0.1 mg/kg and 0.5 mg/kg in shrimp (species not reported), and 0.2 mg/kg and 4 mg/kg in crabs (species not reported), from the mid-Shelf MAFLA study area were measured by Dames and Moore (1979).

Concentrations of CHCs in tissues of epifauna collected during EPA/IEC surveys were below FDA action levels for fish and shellfish (Appendix A). Highest concentrations of CHCs included: pp'DDE-- 18.38 ng/g in *P. aztecus* and 23.13 ng/g in the crab Portunus gibbessi; 6.93 ng/g dieldrin, and 3.64 ng/g op'DDE, in P. gibbessi. Tissue concentrations of all other hydrocarbons were less than 1.0 ng/g. Hydrocarbons were typically undetectable in organisms sampled in the vicinity of the Mid-Shelf Alternative Area during the MAFLA study (Dames and Moore, 1979). No tissue data are available for Deepwater Alternative Area.

BIOLOGY

Biota in the water column and in benthic environments in the vicinity of the Existing Sites are described in this section. Water column biota include phytoplankton, zooplankton, and nekton; benthic biota include infaunal and epifaunal organisms and demersal fish. Benthic biota, especially the infauna, are often sedentary or sessile, and cannot readily emigrate from areas of disturbance. Infauna, therefore, are used as important indicators of environmental conditions. Dredged material disposal causes only short-term effects on planktonic communities because of the natural patchiness of the species and the transient nature of the water masses they inhabit. Nekton are highly mobile and normally are not affected by disposal of dredged material.

PHYTOPLANKTON

Over 900 species of 110 diatom genera and 400 species of 61 dinoflagellate genera have been reported from the Gulf of Mexico (DOI, 1974). Diatoms are typically the numerically dominant component of the phytoplankton, except during "red tide conditions," or in silicate-depleted waters when dinoflagellates may become locally abundant. The highest diversity of phytoplankton have been reported near river mouths where both riverine and coastal species occur (DOI, 1974). Seasonal peaks in abundance occur during spring and summer in estuarine and coastal waters and during winter in offshore waters (El-Sayed et al., 1972).

The types of species and seasonal abundances of phytoplankton at the Pensacola, Mobile, and Gulfport Existing Sites have not been previously investigated; however, the diatoms Nitzschia seriata, Thalassiothrix frauenfeldii, Thalassionema nitzschioides, Skeletonema costatum, Asterionella japonica, and Chaetoceros spp. have been reported in nearshore Gulf waters by Simmons and Thomas (1962), and are likely to occur at each of the nearshore Existing Sites. Species of Cyclotella, Melospira, and Navicula also may be present during periods of high freshwater discharge (ibid.). Dinoflagellates reported to have a widespread distribution in the Gulf, although not abundant include: Ceratium, Glenodinium, Goniodoma, Pyrocystis, Hypodinium, Gymnodinium, Gloedinium, Peridinium, Hemidinium, and Dinophysis (ibid.). Red tides caused by toxic dinoflagellate blooms have been reported only once (August-September, 1979) for coastal waters of Mississippi, although phytoplankton blooms causing discolored waters are a frequent occurrence during warmer months (Perry et al., 1979). Phytoplankton concentrations in the nearshore region east of the Mississippi Delta of 16 to 3781 cells/ml were recorded by Simmons and Thomas (1962).

SUSIO (1975) described the phytoplankton at stations near the Mobile-Gulfport Mid-Shelf Alternative Area. Three numerically dominant species (Table 3-5) listed with their abundances in cells/liter included the diatoms Nitzchia delicatissima (31,400), Thalassionema nitzschioides (1,920), and Leptocylindrus danicus (1,160). The diversity of dinoflagellates typically were higher in offshore waters; however, diatoms remained numerically dominant (Steidinger, 1972).

TABLE 3-5
CONCENTRATIONS OF DOMINANT
PHYTOPLANKTON FROM MAFLA STATIONS
IN VICINITY OF THE MID-SHELF ALTERNATIVE AREA

Species	Cells/liter
Nitzschia delicatissima	31,400
Thalassionema nitzschioides	1,920
Leptocylindrus danicus	1,160
Rhizosolenia fragilissima	940
Chaetoceros spp.	850
Rhizosolenia alata form gracillima	720
Thalassiothrix mediterranea	700
Nitzchia closterium	380

Source: SUSIO, 1975

Limited data are available to characterize the deep offshore waters of the Gulf; however, Hulbert and Corwin (1972) report that these nutrient poor waters are generally dominated by the coccolithophore Coccolithus huxleyi.

ZOOPLANKTON

Copepods are characteristically the dominant component of the zooplankton in neritic Gulf waters; Acartia tonsa is numerically dominant in nearshore and estuarine waters, whereas Euchaeta, Eucalanus, Candacea, and other calanoid copepods are abundant in offshore waters (DOI, 1974). Euphausiids, chaetognaths, ctenophores, and fish and shrimp larvae are also seasonally abundant in coastal waters.

The composition and seasonal abundances of zooplankton at the Pensacola, Mobile, or Gulfport ODMDSs have not been previously investigated. Christmas (1973) reported relatively high zooplankton abundances and diversity within the passes of the nearshore barrier islands off Mississippi. Zooplankton concentrations were highest during summer due to the presence of numerous meroplanktonic (e.g., larvae of invertebrates and fish) forms. SUSIO (1975) reported that copepods dominated the zooplankton community in the vicinity of the Mobile-Gulfport Mid-Shelf Alternative Area (Table 3-6).

NEKTON

Investigations, such as that conducted by Chittenden and McEachran (1977), of nekton in the northeastern Gulf of Mexico have focused on the commercially important species; consequently, a characterization of nearshore nekton assemblages has been biased towards species collected by fishing vessels. Some aspects of the life histories of common commercial and recreational species caught in nearshore regions are listed in Table 3-7. Chittenden and McEachran (1977) estimate that 96% of the fish caught shoreward of the 22m contour utilize coastal estuaries and bays during part of their life cycle. Coastal estuaries constitute productive nursery areas for these species, and the tidal passes and adjacent nearshore areas are pathways for migrating nekton. Movement of nekton into estuaries occurs mainly from January to June;

TABLE 3-6
CONCENTRATIONS OF DOMINANT
COPEPOD GENERA FROM MAFLA STATIONS
IN VICINITY OF THE MID-SHELF ALTERNATIVE AREA

Species	Number of Individual/m^3
Paracalanus	3036
Acartia	2170
Corycaeus	1699
Centropages	1320
Eucalanus	701
Oithona	388
Oncaea	367

Source: SUSIO, 1975

migration back into the Gulf typically occurs from August to December (Table 3-8). Seasonal variations in abundances of nekton at a nearshore ODMDS should coincide with the migration pattern of the dominant coastal species.

Members of the nektonic community (fish, shrimp, and squid) were sampled with otter trawls in the vicinity of the Existing Sites (see Appendix A). Fish captured in the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites are summarized in Table 3-9. Dominant species collected at the sites included: Pensacola—striped anchovy (400 individuals/4 otter trawls) in January, and Atlantic bumper (85 individuals/4 otter trawls) in June; Mobile—sea catfish (400 individuals/4 otter trawls), Atlantic moonfish (275 individuals/4 otter trawls), banded drum (179 individuals/4 otter trawls), sand seatrout (141 individuals/4 otter trawls), and Atlantic bumper (124 individuals/4 otter trawls) in January, and longspine porgy (265 individuals/4 otter trawls) in June; and, Gulfport—bay anchovy (245 individuals/4 otter trawls) and sea catfish (75 individuals/4 otter trawls) in January, and longspine porgy (13 individuals/4 otter trawls) in June. Greater number of species and higher abundance of fish were collected in the vicinity of the Existing Sites in January than June, which is consistent with reported migration patterns of coastal fishes. Some differences in species composition and abundance were observed between trawls taken within and outside the Existing Site, particularly at Mobile; however, no explanation for this trend

TABLE 3-7
LIFE HISTORY ASPECTS OF SOME COMMERCIAL AND RECREATIONAL SPECIES COMMONLY CAUGHT IN NEARSHORE REGIONS OF THE GULF

Species	Depth	Season of Abundance	Size	Spawning Area	Spawning Season	Average Life Span
Arius felis (sea catfish)	To 91m	Warm months	100 to 160 mm 75 to 291 mm (extreme)	Estuaries	Early May to mid-August	1 to 2 yr
Halieutichthys aculeatus (pancake batfish)	16 to 182m	Cold months	60 to 85 mm 51 to 92 mm (extreme)	—	—	1 yr
Serranus atrobranchus (blackear bass)	11m	Sep-Mar	60 to 130 mm 35 to 174 mm (extreme)	—	Fall and early winter	2 yr
Stenotomus caprinus (scup)	To 110m	All seasons	85 to 140 mm 67 to 156 mm (extreme)	—	Spring	1 to 2 yr
Cynoscion arenarius (sand seatrout)	To 20m (Sep) To 58m (Jan & Mar)	Jun-Sep Jan-Mar	70 to 250 mm 54 to 374 mm (extreme)	Estuaries	Early spring to late summer	1 to 2 yr
Cynoscion nothus (silver seatrout)	Nearshore Gulf	Winter	60 to 200 mm 50 to 230 mm (extreme)	—	Late spring to early fall	1 yr
Micropogon undulatus (Atlantic croaker)	Bayous, Channels, Offshore	Summer	100 to 210 mm 79 to 270 mm (extreme)	Estuaries	November	1 to 2 yr
Stellifer lanceolatus (star drum)	22m	Spring-Fall	40 to 130 mm 29 to 1553 mm (extreme)	Nearshore	April to mid-summer	1 yr
Upeneus parvus (dwarf goatfish)	—	—	90 to 145 mm 60 to 157 mm (extreme)	—	—	1 yr
Polydactylus octonemus (Atlantic threadfin)	Surf zone to 36m	Warm months	100 to 155 mm 84 to 171 mm (extreme)	Offshore	Late winter and early spring	1 yr
Trichiurus lepturus (cutlassfish)	To 75m (winter) To 35m (summer)	Warm months	140 to 660 mm 115 to 730 mm (extreme)	Offshore	Winter to early spring	1 to 2 yr
Peprilus burti (Gulf butterfish)	2 to 245m (To 29m, abundant)	Winter or warm months	85 to 120 mm 58 to 169 mm (extreme)	—	Year-round (primarily winter)	1 yr
Bellator militaris (horned searobin)	35 to 182m	Winter	65 to 110 mm 20 to 110 mm (extreme)	—	Winter to early summer	1 yr
Prionotus paralatus (Mexican searobin)	22 to 164m 64 to 109m (abundant)	Year-round (primarily cold months)	80 to 180 mm 70 to 198 mm (extreme)	—	Late winter	2 yr
Syacium gunteri (shoal flounder)	—	—	80 to 130 mm 55 to 159 mm (extreme)	—	—	1 yr
Brevoortia patronus (Gulf menhaden)	7 to 86m	Winter in Bays	—	Nearshore	Nov-Mar	2 yr

— No data

Sources: Chittenden and McEachran, 1976; Gunter, 1938; Tagatz and Wilkens, 1973; Chapoton, 1973

TABLE 3-8
MIGRATORY BEHAVIOR OF SOME COASTAL NEKTON COMMON TO THE GULF

	Species Moving into Estuaries (or nearshore zone)	Species Moving from Estuaries
January	Southern hake, red drum (peak)	Menhaden, spadefish
February	Stingray, brown shrimp (post-larvae), menhaden, spadefish	
March	Gulf killifish, spot, cutlass-fish, hogchoker, butterfish, rough silverside, flounder, tonguefish	Blue catfish, sheepshead minnow, longnose killifish.
April	Gafftopsail catfish, sea catfish bluefish, bumper, sand seatrout southern kingfish, skipjack, herring (in and out same month), adult croaker, black drum (peak) pinfish, Atlantic threadfin, toadfish, midshipman	Bighead searobin
May	Striped anchovy, lizardfish, sardine, Spanish mackerel, white shrimp (postlarvae)	Menhaden, southern hake
June	Needlefish, pompano, crevalle jack, leatherjacket, Atlantic moonfish	Butterfish
July	Ladyfish, lookdown	
August		Ladyfish, Atlantic threadfin

TABLE 3-8 (continued)

	Species Moving into Estuaries (or nearshore zone)	Species Moving from Estuaries
September		Adult croaker, rough silverside
October	Menhaden, sheepshead minnow, bighead searobin	Sardine, bluefish, leatherjacket, Atlantic moonfish, sand seatrout, cutlassfish, Spanish mackerel
November	Blue catfish, juvenile croaker	Striped anchovy, gafftopsail, catfish, needlefish, pompano, crevalle jack, bumper, lookdown, pinfish, tonguefish, toadfish, midshipman, white shrimp (juveniles)
December	Longnose killifish	Stingray, lizardfish, Gulf killifish, spot, southern kingfish, flounder, hogchoker

Source: After Christmas, 1973

can be concluded from the data. Squid occurred primarily at Pensacola and Mobile stations, and were found in highest numbers in June. Shrimp are discussed further in this chapter under "epifauna".

Shelf areas east of the Mississippi Delta having water depths less than 18m are considered the most productive region in the Gulf and account for approximately 30 to 40% of the total Gulf fishery production (Juhl, 1974 in Pequegnat et al., 1978). The productivity of nearshore nekton decreases with increasing depth and distance from the Mississippi River Delta (CE, 1979a).

The majority of the commercial fish catch is obtained from waters within a few miles of shore (Pequegnat et al., 1978), consequently, relatively little information is available to characterize the nekton occurring in the mid- and outer Shelf regions. The major bottom fish of commercial importance in depths

TABLE 3-9
FISH CAPTURED AT PENSACOLA, MOBILE, AND GULFPORT EXISTING SITES AND VICINITY DURING JANUARY AND JUNE 1980 EPA/IEC SURVEYS

Species	Common Name
Torpadinidae	
Narcine brasiliensis	Lesser electric ray
Rajidae	
Raja eglanteria	Clearnose skate
Dasyatidae	
Dasyatis americana	Southern stingray
Dasyatis sabinia	Atlantic stingray
Clupeidae	
Etremeus teres	Rock herring
Harengula pensacolae	Scaled sardine
Engraulidae	
Anchoa hepsetus	Striped anchovy
Anchoa mitchelli	Bay anchovy
Anchoviella perfasciata	Flat anchovy
Synodontidae	
Saurida brasiliensis	Large scaled lizardfish
Synodus foetens	Inshore lizardfish
Trachinocephalus myops	Snakefish
Ariidae	
Arius felis	Sea catfish
Batrachoididae	
Porichthys porosissima	Atlantic midshipman
Ogocephalidae	
Halieutichthys aculeatus	Pancake batfish
Ophichthidae	
Ophichtmus gomesi	Shrimp eel
Gadidae	
Urophycis floridanus	Southern hake
Urophycis regius	Spotted hake
Ophidiidae	
Ophidion grayi	Blotched cusk-eel
Ophidion welshi	Crested cusk-eel

TABLE 3-9 (continued)

Species	Common Name
Syngnathidae	
Syngnathus springeri	Bull pipefish
Serranidae	
Centropristis philadelphia	Rock sea bass
Diplectrum bivittatum	Dwarf sand perch
Diplectrum formosum	Sand perch
Carangidae	
Caranx crysos	Blue runner
Chloroscombrus chrysurus	Atlantic bumper
Decapterus punctatus	Round scad
Vomer setapinnis	Atlantic moonfish
Pomadasyidae	
Orthopristis chrysoptera	Pigfish
Sparidae	
Stenotomus caprinus	Longspine porgy
Sciaenidae	
Cynoscion arenarius	Sand seatrout
Larimus fasciatus	Banded drum
Leiostomus xanthurus	Spot
Menticirrhus americanus	Southern kingfish
Menticirrhus cf. americanus	Southern kingfish
Menticirrhus littoralis	Gulf kingfish
Menticirrhus saxatilus	Northern kingfish
Micropogon undulatus	Croaker
Ephippidae	
Chaetodipterus faber	Atlantic spadefish
Scombridae	
Scomberomorus maculatus	Spanish mackerel
Trichiuridae	
Trichiurus lepturus	Atlantic cutlassfish

TABLE 3-9 (continued)

Species	Common Name
Stromateidae	
Peprilus burti	Pacific pompano
Peprilus paru	Butterfish
Triglidae	
Prionotus roseus	Bluespotted searobin
Prionotus rubio	Blackfin searobin
Prionotus tribulus	Bighead searobin
Bothidae	
Citharichthys macrops	Spotted whiff
Etropus crossotus	Fringed flounder
Etropus rumosus	Gray flounder
Paralichthys albigutta	Gulf flounder
Cynoglossidae	
Symphurus civitatus	Offshore tonguefish
Symphurus plagiusa	Blackcheek tonguefish
Symphurus sp.	Tonguefish
Tetraodontidae	
Sphoeroides parvus	Least puffer

of 18 to 183m are snappers, groupers, and sea bass. For example, red snapper (*Lutjanus campechanus*) may be locally abundant in the vicinity of reefs and hard bottoms on the outer Shelf, especially along the western edge of upper De Soto Canyon and near rocky outcrops off Pensacola (Jones et al., 1973; Moe, 1963).

Limited data are available describing deepwater nekton beyond the northern Gulf Shelf break. Pequegnat et al. (1978) noted reports of large schools of round herring (*Etrumeus teres*) and rough scad (*Trachurus lathami*) in deep waters over the Continental Slope, and the occurrence of schools of tuna

(*Euthynnus pelamis*, *Thunnus albacares*, *T. atlanticus*, and *T. thynnus*) in waters overlying the 183m to 1,830m depth contours. A diverse assemblage of midwater and bottom nekton were observed in De Soto Canyon; abundant species included squid, snake mackerel, eels, hatchet and lantern fish, cyclothonids, and scorpaenids (Gaul et al., 1968). Several unique species of shark (*Etmopterus* spp.), an endemic grenadier, and a skate (*Springeria folirostris*), have also been reported from the Continental Slope in the northern Gulf (Jones et al., 1973).

BENTHOS

Infauna

Data describing the benthic infauna and their distributional patterns in the northeastern Gulf of Mexico are limited. The MAFLA study (SUSIO, 1975; Dames and Moore, 1979) represents one of the few reports describing infaunal distributions in the Gulf; MAFLA stations on the Mississippi-Alabama Shelf were located in depths from approximately 14 to 335m. Vittor (1977; in Dames and Moore, 1979) summarized the following distributional trends from the MAFLA studies: (1) benthic macroinfaunal abundance and diversity increases with increased distance from the Mississippi River and Mobile Bay, which is the result of coarser sediments supporting more numerous benthic animals, and (2) deepwater habitats (>100m) support a less abundant and less diverse polychaete fauna (than shallower habitats), regardless of geographic location. Further data on nearshore macroinfauna communities, species composition, abundance, biomass, and productivity are currently being collected under the direction of the U.S. Army Corps of Engineers (CE); however, the results of these studies are not scheduled to be available until 1984 (D. Barrineau, personal communication*).

Common macrofauna collected at the Existing Sites during EPA/IEC surveys are presented in Table 3-10. Similar species compositions have been reported

* D. Barrineau, U.S. Army Corps of Engineers, Mobile District, Alabama (1981)

TABLE 3-10
COMMON MACROINFAUNA COLLECTED DURING
EPA/IEC SURVEYS IN JANUARY AND JUNE 1980

Pensacola
Branchiostoma caribaeum
Paraprionospio pinnata
Spiophanes bombyx
Armandia maculata
Mobile
Golfingia murinae bilobatae
Armandia maculata
Magelona cf. phyllisae
Spiophanes bombyx
Diopatra cuprea
Paraprionospio pinnata
Gulfport
Golfingia murinae bilobatae
Apoprionospio pygmaea
Magelona cf. phyllisae
Mediomastus californiensis
Spiophanes bombyx

by Vittor (1977). The trophic structure of the infauna in the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites were generally dominated by deposit-feeding organisms; relatively lower percentages of deposit feeders were present at Pensacola, probably due to the larger median grain size of bottom sediments. The infauna at the Mobile and Gulfport Existing Sites consisted primarily of spionid, magelonid, and capitellid polychaetes, and the sipunculid Golfingia murinae bilobatae. Polychaetes were also numerically dominant at the Pensacola Existing Site; however, the cephalochordate Branchiostoma caribaeum (typical of clean sands) and various arthropods also were abundant. Fewer species were collected at the Gulfport Existing Site than the Mobile Existing Site, which is consistent with distributional trends reported by Vittor (1977). In contrast, fewer species (total of all replicates) were collected at the Pensacola Existing Site than at Mobile, which is not consistent with what would be expected from sediment type alone (generally, coarser sediments at Pensacola). However, more samples were collected at Mobile than Pensacola, which may account for this discrepancy.

Seasonal and spatial variation in the densities of the dominant infaunal species were noted at the Pensacola, Mobile, and Gulfport Existing Sites during the EPA/IEC surveys (see Appendix A). Spatial variability may be due to slight changes in substrate composition, while seasonal increases in infaunal density may be related to recruitment into the population, rather than effects of dredged material disposal.

Bault (1969) studied the distribution of polychaetes in the northeastern Gulf of Mexico and found that abundance decreased with increasing depth (transects from 7 to 180m). In the vicinity of the Mid-Shelf Alternative Area, the diversity and abundance of infaunal species were low (SUSIO, 1975). Polychaetes were numerically dominant at all sampling stations and represented by the maldanids Asychis carolinae and Clymenella torquata, the lumbrinerid Ninoe nigripes, and the nereid Ceratonereis tridentata. A list of the dominant polychaete species is presented in Table 3-11.

The benthic infauna in the vicinity of the Deepwater Alternative Area have not been described. However, benthic infauna present in the deepwater areas of the northern Gulf typically consist of deposit feeders, suspension feeders, and carnivores, which comprise 55%, 25%, and 20%, respectively, of the infaunal assemblage (Sokolova, 1959). The biomass of the deepwater infauna is relatively low, (Rowe and Menzel, 1971).

TABLE 3-11
DOMINANT POLYCHAETE TAXA
FOUND IN MOBILE-GULFPORT
MID-SHELF ALTERNATIVE AREA AND VICINITY

Paraprionospio pinnata
Asychis carolinae
Algaophamus verrilli
Clymenella torquata
Ceratonereis tridentata
Lumbrineris parvipedata
Ceratonereis irritabilis
Ninoe nigripes
Diopatra cuprea
Cirrophorus lyriformis
Notomastus latericeus
Cossura sp. A
Magelona pettiboneae

Note: Dominant species represent at least 50% of total individuals per station.

Source: SUSIO, 1975

Epifauna

Primary factors affecting the distributions of epifaunal species include sediment composition and water depth (Defenbaugh, 1976). Epifaunal organisms present in nearshore waters of the northeastern Gulf of Mexico have been characterized by Defenbaugh (1976) as a "pro-delta sound assemblage" (Mississippi Sound seaward to Chandeleur Islands, and eastward to Pensacola, Florida) consisting of species belonging typically to the Carolinian, and to a lesser extent, Caribbean zoogeographical provinces (Table 3-12). A similar species composition was found during the EPA/IEC surveys (Appendix A). A total of 45 invertebrates and 57 chordate species were collected at the Existing Sites during both surveys. Dominant species included the shrimps *Penaeus aztecus*, *Trachypenaeus* spp., and *Acetes americanus*, mantis shrimp *Squilla empusa*, and swimming crabs *Callinectes* spp., and *Portunus gibbessi*.

TABLE 3-12
DOMINANT EPIFAUNA OF
THE NEARSHORE CONTINENTAL SHELF
(4 to 20m)

Cnidaria

Renilla mulleri

Gastropoda

Sinum perspectivum

Cantharus cancellarius

Pelecypoda

Noetia ponderosa

Chione clenchi

Crustacea

Penaeus aztecus

Sicyonia brevirostris

Sicyonia dorsalis

Trachypenaeus similis

Pagurus pollicaris

Persephona squilonaris

Persephona crinata

Calappa sulcata

Hepatus epheliticus

Callinectes similis

Portunus gibbessi

Portunus spinimanus

Podochela sidneyi

Squilla chydaea

Squilla empusa

Echinodermata

Luidia clathrata

Ophiolepis elegans

Mellita quinquiesperforata

Source: Defenbaugh, 1976

Epifaunal assemblages were generally similar at each of the Existing Sites, although the number of species and species abundances were higher at Mobile relative to either of the other two disposal sites.

Several of the dominant epifaunal species (e.g., Penaeus aztecus and Callinectes sapidus) present within the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites represent major fisheries resources in nearshore Gulf waters (see "Fisheries Resources" sections). Brown shrimp (P. aztecus) were collected primarily at Mobile and were generally absent from collections in the vicinity of the Pensacola Existing Site, which is consistent with distributional patterns reported by Defenbaugh (1976). Brown shrimp are common from the Mississippi Delta to Mobile, over silty bottom sediments, and are less abundant over sandy substrate areas (Defenbaugh, 1976). Blue crabs (C. sapidus) are common in coastal bays, estuaries, and nearshore waters throughout the northern Gulf region; gravid females are typically present in the open Gulf from March through August (Lindall et al., 1972). Blue crabs were present in relatively low numbers at the Pensacola Existing Site during June, and absent from all Existing Sites in January. Both brown shrimp and blue crabs migrate into coastal estuaries during early stages of their life cycle.

Representative epifaunal species present on the mid-Shelf of the northeastern Gulf are listed in Table 3-13. This mid-Shelf assemblage is represented by several molluscan and crustacean species, including some that were also abundant in nearshore waters. The abundance and diversity of epifaunal on the mid-Shelf are lower than those nearshore, and exhibit a relatively small seasonal variability (SUSIO, 1975). Several commercially important epifaunal species, including the brown shrimp Penaeus aztecus and calico scallop Argopectin gibbus, occur in the mid-Shelf region. Calico scallops have been reported offshore Mobile and Pensacola in water depths of 18 to 36m (Defenbaugh, 1976).

The number of epifaunal species decreases in deeper Shelf areas (Table 3-14), and little faunal overlap exists with the mid-Shelf assemblage described above. However, little information is available to assess the relative abundances of deepwater epifauna. Royal red shrimp (Hymenopenaeus

TABLE 3-13
DOMINANT EPIFAUNA OF
THE MIDDEPTH CONTINENTAL SHELF
(30 to 90m)

Gastropoda

Conus austini

Polystira albida

Pelecypoda

Anadara floridana

Argopecten gibbus

Crustacea

Parapenaeus longirostris

Penaeus aztecus

Sicyonia brevirostris

Trachypenaeus similis

Porcellana sayana

Petrochirus diogenes

Raninoides lousianensis

Calappa sulcata

Callinectes similis

Portunus spinicarpus

Portunus spinimanus

Anasimus latus

Podochela sidneyi

Squilla chydaea

Squilla empusa

Echinodermata

Luidia clathrata

Astropecten duplicatus

Ophiolepis elegans

Source: Defenbaugh, 1976

TABLE 3-14
DOMINANT EPIFAUNA OF
THE DEEP CONTINENTAL SHELF
(90 to 200M)

Polychaeta	
	Protula tubularia
Gastropoda	
	Polystira albida
Crustacea	
	Raninoides louisianensis
	Calappa sulcata
	Portunus spinicarpus
	Anasimus latus
Echinodermata	
	Anthenoides piercei
	Echinocardium fulvescens

Source: Defenbaugh, 1976

robustus) occur at depths of 255 to 545m on the Continental Slope. This species has potential commercial value, although their present utilization is limited (Pequegnat et al., 1978).

MARINE MAMMALS

The Gulf of Mexico supports a seasonal and resident marine mammal population of cetaceans (whales, dolphins, and porpoises) and sirenians (manatees) (Table 3-15). The Gulf serves as summer mating and calving grounds, and winter feeding grounds for 16 species of whales and 8 species of dolphins and porpoises. Common dolphins and whales include the bottlenose dolphin (Tursiops truncatus), Atlantic spotted dolphin (Stenella plagiodon), and short-finned pilot whale (Globicephala macrorhyncus). Most whales occur

TABLE 3-15
SPECIES OF MARINE MAMMALS IN THE GULF OF MEXICO

Species	Seasonal Occurrence and Diet
Cetaceans	
Minke whale (Balaenoptera acutorostrata)	Possible winter resident; feed on euphausiids and small fish
Bryde's whale (Balaenoptera edeni)	Possibly year-round; feed on small schooling fishes, some euphausiids, and other crustaceans
Sei whale* (Balaenoptera borealis)	Possible winter resident; winter calving and mating; feed on copepods, euphausiids, and various small fishes
Finback whale* (Balaenoptera physalus)	Possible winter resident; mating and calving in winter; feed mostly on euphausiids
Blue whale* (Balaenoptera musculus)	Uncommon; feed on euphausiids
Humpback whale* (Megaptera novaeangliae)	Possible winter resident; feed on euphausiids
Black right whale* (Eubalaena glacialis)	Possible winter resident; winter mating and calving; feed on copepods
Rough-toothed dolphin (Steno bredanensis)	Rare; feed on fish and squid
Bottlenose dolphin (Tursiops truncatus)	Common year-round; feed mostly on fish; breed year-round
Spinner dolphin (Stenella longirostris)	Possibly year-round; probably feed on fish and squid
Spotted dolphin (Stenella frontalis)	Uncommon; feed on fish and squid
Atlantic spotted dolphin (Stenella plagiodon)	Common; year-round; feed primarily on squid
Striped dolphin (Stenella coeruleoalba)	Uncommon; feed on fish, squid, and crustaceans
Common dolphin (Delphinis delphis)	Maybe year-round, near Shelf edge; feed on fish and copepods
Risso's dolphin (Grampus griseus)	Uncommon; feed on cephalopods

TABLE 3-15 (continued)

Species	Seasonal Occurrence and Diet
Pygmy killer whale (*Feresa attenuata*)	Rare; little known
False killer whale (*Pseudorca crassidens*)	Uncommon; feed on fish
Short-finned pilot whale (*Globicephala macrorhyncus*)	Year-round in deep water; probably feed on squid and fish
Killer whale (*Orcinus orca*)	Uncommon; feed on fish, cephalopods, and other cetaceans
Sperm whale* (*Physeter catodon*)	Winter resident or possibly year-round; calving in summer; feed on cephalopods and some fish
Pygmy sperm whale (*Kogia breviceps*)	Year-round; feed on squid and pelagic crustaceans, such as shrimp
Dwarf sperm whale (*Kogia simus*)	Uncommon; possibly year-round; feed on squid and pelagic crustaceans, such as shrimp
Goose-beaked whale (*Ziphius cavirostris*)	Rare; feed on squid and deepwater fishes
Gervais beaked whale (*Mesoplodon europaeus*)	Rare; little known
	Sirenians
West Indian manatee* (*Trichechus manatus*)	Presently not found west of Aucilla and Port St. Joe Rivers, Florida; feed on aquatic vegetation

* Threatened and endangered species, DOI, 1979b

Source: DOI, 1978a

well offshore in deep waters beyond the Continental Shelf (e.g., in vicinity of Deepwater Alternative Area), while dolphins and porpoises are present in shallow, as well as, deep waters (e.g., all Existing and Alternative Sites) (DOI, 1978a).

The west Indian manatee Trichechus manatus, is the only species of manatee found in the Gulf. Manatees generally inhabit inland waterways, usually less than 3m deep, seldom venturing offshore. Their principle source of nutrition is aquatic vegetation growing in shallow coastal and bay waters. Thus, they would not be expected to occur in the vicinity of the Existing or Alternative Sites/Areas.

THREATENED AND ENDANGERED SPECIES

Threatened and endangered marine mammals, birds, and reptiles previously reported in nearshore Gulf waters are listed, along with the frequency of occurrence in Table 3-16. The endangered whales reported to occur off the Florida, Alabama, and Mississippi coasts are seldom seen inshore and generally occur in deep oceanic waters (e.g., Deepwater Alternative Area) (DOI, 1981). The manatee has not been reported to occur in the vicinity of any of the Existing Sites.

Endangered birds, with the exception of the brown pelican, feed and nest on beaches and in marshes. The brown pelican occurs along the Gulf coast in the vicinity of the Existing Sites (CE, 1979a). The only known breeding ground of the brown pelican in the northern Gulf is located on Grand Terre Island, Louisiana, west of the Mississippi Delta, which is far removed from the Existing or Alternative Sites (DOI, 1978a).

Endangered turtles have been found in the Gulf, south of the barrier islands (CE, 1979a). Few data are available on the frequency of occurrences of sea turtles; however, the loggerhead turtle has been observed to nest on Horn and Chandeleur Islands (Gulfport Existing Sites in vicinity) (DOI, 1978a).

SITE HISTORY

The existing dimensions of the entrance channels to Pensacola, Mobile, and Gulfport were authorized by the River and Harbor Acts of October 1962, September 1954, and June 1948, respectively. Maintenance dredging has

TABLE 3-16
THREATENED AND ENDANGERED SPECIES OF THE FLORIDA, MISSISSIPPI, AND ALABAMA GULF COAST

Species	Florida Status	Alabama Status	Mississippi Status	DOI Status	Occurrence
Balaenoptera physalus (finback whale)				Endangered	Offshore oceanic species
Megatera novaeangliae (humpback whale)				Endangered	Offshore oceanic species
Physeter catodon (sperm whale)				Endangered	Offshore oceanic species
Grus canadensis pulla (Mississippi sandhill crane)	Threatened		Endangered	Endangered	Resident of coastal marshes
Pelecanus occidentalis (brown pelican)	Endangered	Endangered	Endangered	Endangered	Increasing abundance, particularly in summer
Anas fulvigula (mottled duck)		Threatened			Permanent resident, nesting on mainland and islands
Charadrius alexandrinus (snowy plover)		Endangered			Resident of outer beaches
Alligator mississippiensis (American alligator)	Threatened	Threatened	Endangered	Endangered	Increasing abundance in coastal marshes
Lepidochelys kempii (Atlantic ridley turtle)	Endangered	Endangered	Endangered	Endangered	Occasional visitor
Eretmochelys imbricata (Atlantic hawksbill turtle)	Endangered	Endangered	Endangered	Endangered	Occasional visitor
Dermochelys coriacea (leatherback sea turtle)	Endangered	Threatened	Endangered	Endangered	Occasional visitor
Caretta caretta (Atlantic loggerhead sea turtle)	Threatened	Endangered	Endangered	Threatened	Occasional visitor, historical use of beaches for nesting
Chelonia mydas (green sea turtle)		Endangered	Endangered		Occasional visitor
Trichechus manatus (west Indian manatee)	Endangered				Presently not found west of Aucilla and Port St. Joe Rivers, Florida (east of Pensacola ODMDS)

Sources: CE, 1979a; CE, 1978a; DOI, 1979b

occurred at Mobile and Gulfport since 1931, and at Pensacola since 1933 (Davis, 1978). It is not known, however, when the Existing Sites acquired their present dimensions, or were first used for the disposal of dredged material from the respective entrance channels. Records documenting dredging and disposal activities at any of the sites prior to the late 1960's are unavailable. Although the locations at which dredged materials were dumped prior to 1970 are unknown, it may be reasonable to assume that the present sites were delineated based on previous dumping (J. Walker, personal commmunication*).

Volumes of dredged material dumped at the existing ODMDSs during the period 1970 through 1981 are listed in Table 3-17. Each of the three entrance channels is dredged on an as-needed basis (every 1 to 5 years) due to sediment transport by longshore currents and deposition of riverine sediments. "However, the Pensacola Entrance Channel was not dredged from 1975 to 1980 as water quality concerns and later certification requirements under the Clean Water Act together with the position of the State of beach nourishment resulted in an inability to perform maintenance dredging. Since that time the Corps of Engineers and the State reached agreement, a 5-year dredging permit was issued and dredging was performed in 1981."

DREDGED MATERIAL CHARACTERISTICS

PENSACOLA

Dredged materials from the Pensacola Entrance Channel comprise an average of 93% sand, 3% silt, and 4% clay. Sediment samples collected from the entrance channel beyond the bay mouth bar were described by Davis (1978) as "grey silty sand." Results of chemical analyses of the Pensacola dredged sediments are presented in Table 3-18. Total organic carbon (TOC) levels were less than 1% (10 mg/g), and concentrations of trace metals with the exception of zinc and chromium were generally low (<5 ppm). Pesticide and PCB concentrations in dredged sediment were generally undetectable, with the exception of 0.486 ng/g diazinon and 14.152 ng/g Arochlor 1254 (PCB). Elutriate test results are presented in Table 3-19. Slight increases in the concentration of TOC, phosphorus, and zinc were measured, but changes in other trace metal concentrations were not detected. Dredged sediments have not been analyzed using bioassay tests (J. Walker, personal communication*).

* J. Walker, U.S. Army Corps of Engineers, Mobile District, Alabama (1981)

TABLE 3-17
DREDGED MATERIAL VOLUMES DISPOSED AT PENSACOLA, MOBILE, AND GULFPORT EXISTING SITES FROM 1970 TO 1981
(yd^3)

Fiscal Year	Gulfport Ship Island Bar Channel	Mobile Entrance Channel	Pensacola Entrance Channel
Maintenance Dredging by Hopper Dredges			
81	831,438	-	646,924
80	-	190,300	-
79	-	707,142	-
78	470,440	-	-
77	1,751,500	261,775	-
76	136,116	725,086	-
75	123,253	550,255	343,481
74	-	-	-
73	-	-	-
72	232,503	262,450	-
71	370,089	827,388	1,732,615
70	1,278,981	361,815	239,637
Average Volume Per Dredging Cycle (years in which dredging occurred)			
	649,290	485,776	740,664

- Channel not dredged

Source: J. Walker, U.S. Army Corps of Engineers, Mobile District, Alabama, personal communication (1981)

MOBILE

Dredged materials from the Mobile Bar Channel comprise an average of 86% sand, 9% silt, and 5% clay. Samples collected from the entrance channel shoreward of the pass consisted of soft grey silty ooze with some sand; whereas, sand and silt were collected near the seaward end of the bay mouth bar, and sand seaward of the bar (Davis, 1978). Results of bulk chemical

TABLE 3-18
ANALYSES OF ENTRANCE CHANNEL SEDIMENT
SAMPLES COLLECTED FROM PENSACOLA HARBOR, FLORIDA

Sample Number	TOC (mg/g)	Total Phosphate (mg/kg P)	Ammonia Nitrogen (mg/kg N)	Oil and Grease (mg/g)	Trace Metals (mg/kg)								
					Hg	As	Cu	Zn	Cd	Pb	Ni	Cr	Fe††
PB-1	1.66	67.00	9.0	0.41	0.12	0.5	4.9	128.4	<0.1	<0.5	<0.5	43.5	<0.3
PB-2	0.36	7.00	27.4	0.36	0.10	0.5	<0.3	1.0	<0.1	<0.5	<0.5	1.0	<0.3
PB-3	1.44	11.25	75.0	0.31	0.18	1.1	<0.3	32.4	<0.1	<0.5	4.3	5.9	<0.3

Note: Stations located from inner portion of channel near Santa Rosa Island (PB-3) to outer portion (seaward) of channel (PB-1); mg/kg = ppm

Source: Davis, 1978

analyses of the Mobile dredged sediments are presented in Table 3-20. Levels of TOC were less than 1% (10 mg/g); concentrations of chromium, zinc, copper, and nickel generally exceeded 4 ppm whereas, other trace metal concentrations were generally low (<2 ppm). Pesticides and PCBs were not detected in dredged materials. Elutriate test results showed slight increases in ammonia and phosphorus concentrations; no significant releases of trace metals were apparent (Table 3-21). Dredged materials have not been analyzed using bioassay tests (J. Walker, personal communication*).

GULFPORT

Dredged materials from the Gulfport Ship Island Bar Channel comprise an average of 6% sand, 46% silt, and 48% clay. Sediment samples collected from the channel north of the barrier islands contain soft black and brown silty ooze, and soft brown sandy silt. Adjacent to Ship Island, sediment is sand and shell with some clumps of clay, whereas south of the Island sediments are predominantly soft silt and clay with some minor sand fractions (Davis, 1978). Results of bulk chemical analyses of sediments dredged from nine stations in the Gulfport Ship Island Bar Channel, from 1.5 nmi north to 7 nmi south of Ship Island, are presented in Table 3-22. Concentrations of TOC, ammonia

* op. cit. page 3-58

TABLE 3-19
ELUTRIATE ANALYSES OF SEDIMENT AND
WATER SAMPLES FOR CHEMICAL AND HEAVY METALS
CONSTITUENTS COLLECTED FROM PENSACOLA HARBOR, FLORIDA

Parameter	Dilution Water	Standard Elutriate
Total organic carbon (ppm)	11.2	20.6
Ammonia nitrogen (ppm)	1.08	0.21
Phosphorus (ppm)	0.025	0.123
pH	8.28	8.13
Mercury (ppb)	<0.3	<0.3
Arsenic (ppb)	21.0	21.0
Copper (ppb)	<0.2	<0.2
Zinc (ppb)	32.0	40.0
Cadmium (ppb)	0.2	<0.2
Lead (ppb)	<0.5	<0.5
Nickel (ppb)	<0.5	<0.5
Chromium (ppb)	<0.5	<0.5
Iron (ppb)	<10.0	<10.0

ppm = mg/liter
ppb = µg/liter

Note: Sediment sample number: PB-2; Water sample number: PB-2; Collected: 21 August 1974

Source: Davis, 1978

nitrogen, phosphate, and several trace metals, including As, Cu, Cd, Pb, and Ni were usually higher than concentrations measured in dredged material at either the Mobile or Pensacola. Concentrations of zinc and chromium were generally higher than other trace metal concentrations. DDT (7.1 ppb) was the only pesticide detected in the dredged material. Elutriate analysis results showed increases in ammonia and phosphorus, similar to elutriate test results for Pensacola and Mobile dredged sediments. A slight increase in arsenic was

TABLE 3-20
ANALYSES OF ENTRANCE CHANNEL SEDIMENT
SAMPLES COLLECTED FROM MOBILE HARBOR, ALABAMA

Sample Number	TOC (mg/g)	Total Phosphate (mg/kg P)	Ammonia Nitrogen (mg/kg N)	Oil and Grease (mg/g)	Trace Metals (mg/kg)								
					Hg	As	Cu	Zn	Cd	Pb	Ni	Cr	Fe††
MB-1	0.76	18.25	39.8	0.44	0.24	0.8	4.5	14.2	<0.1	<0.5	5.4	4.5	1.0
MB-2	1.18	60.00	33.6	0.51	1.11	1.3	2.6	1.1	<0.1	<0.5	5.3	22.7	<0.3
MB-3	8.61	34.50	44.8	0.74	0.31	1.8	7.0	5.57	<0.1	<0.5	4.0	17.0	0.8

Note: Stations located from inner portion of channel within Mobile Bay (MB-3) to outer portion (seaward) of channel (MB-1); mg/kg = ppm

Source: Davis, 1978

detected; however, releases of other trace metals were generally not observed (Table 3-23). Bioassay tests have not been performed using dredged sediments (J. Walker, personal communication*).

OTHER RESOURCES

FISHERIES

COMMERCIAL

Major commercial marine fisheries of Mississippi, Alabama, and northwest Florida include shrimp, menhaden, oysters, and hard blue crabs in order of value for the 1979 catch (DOI, 1981). The red snapper is one of the most sought after and most numerous fish in the catch of sport and commercial vessels, and is fished in offshore areas with significant bottom relief (Moe, 1963).

* op. cit. page 3-58

TABLE 3-21
ELUTRIATE ANALYSES OF SEDIMENT AND
WATER SAMPLES FOR CHEMICAL AND HEAVY METALS
CONSTITUENTS COLLECTED FROM MOBILE HARBOR, ALABAMA

Parameter	Dilution Water	Standard Elutriate
Total organic carbon (ppm)	7.2	16.5
Ammonia nitrogen (ppm)	0.04	1.05
Phosphorus (ppm)	0.085	0.340
pH	7.50	7.82
Mercury (ppb)	<0.3	<0.3
Arsenic (ppb)	<10.0	10.0
Copper (ppb)	0.9	1.0
Zinc (ppb)	25.1	22.4
Cadmium (ppb)	0.2	0.2
Lead (ppb)	2.9	2.3
Nickel (ppb)	2.8	3.1
Chromium (ppb)	<0.5	<0.5
Iron (ppb)	22.0	22.0

ppm = mg/liter
ppb = µg/liter

Note: Sediment sample number: MB-2; water sample number: MB-2; collected 28 July 1974

Source: Davis, 1978

Shrimp trawling is most productive close to the Mississippi Delta and is reduced almost completely immediately west of Pensacola (GMFMC, 1980b). The average commercial catch from 1959 to 1975 between Gulfport and Mobile was 7.8 million pounds (tails) for brown shrimp and 1.8 million pounds (tails) for white shrimp. From Mobile to Pensacola the average was 0.6 million pounds (tails) for brown shrimp and 0.2 million pounds (tails) white shrimp (GMFMC, 1980b). In 1976 pink shrimp production from the Mississippi Delta to Pensacola was 223,000 pounds of tails, or 5% of the total catch in that area. Of the total shrimp harvest of all three species, 60 to 70% is taken from shallow (<9.1m) nearshore and estuarine areas (GMFMC, 1980b).

TABLE 3-22
ANALYSES OF SHIP CHANNEL SEDIMENT
SAMPLES COLLECTED FROM GULFPORT HARBOR, MISSISSIPPI

Sample Number	TOC (mg/g)	Phosphate (mg/kg P)	Ammonia Nitrogen (mg/kg N)	Oil and Grease (mg/g)	Trace Metals (mg/kg)								
					Hg	As	Cu	Zn	Cd	Pb	Ni	Cr	Fe††
GP-12	23.94	65.50	80.1	0.40	0.43	5.0	12.3	95.8	0.53	19.6	12.7	44.5	<0.3
GP-13	26.73	57.50	51.5	0.16	0.36	4.5	3.7	46.8	0.42	10.8	6.4	23.3	<0.3
GP-14	9.00	43.25	106.4	0.17	<0.03	1.4	<0.3	2.8	<0.1	3.0	1.7	0.6	<0.3
GP-15	1.61	48.25	33.6	0.35	<0.03	4.1	11.0	49.8	0.33	18.9	17.9	23.5	<0.3
GP-16	9.73	45.75	83.4	0.34	0.30	6.3	14.3	84.5	0.60	26.9	15.1	47.1	<0.3
GP-17	11.75	57.50	101.9	0.45	0.61	7.0	12.2	83.9	0.48	28.5	12.9	40.4	<0.3
GP-18	8.73	62.50	125.4	0.52	0.51	4.0	13.4	87.9	0.53	32.7	16.9	39.8	<0.3
GP-19	15.27	51.25	41.4	0.71	0.32	2.6	22.8	55.9	0.57	21.0	4.8	19.7	<0.3
GP-20	8.82	51.25	70.6	0.47	0.68	4.5	10.6	73.7	<0.1	20.1	16.6	29.6	<0.3
GP-17*					<0.02								

* Sediment sample recollected and analyzed for mercury only

Note: Stations located from inner portion of Ship Island Channel near Ship Island (GP-12) to outer portion (seaward) of channel (GP-20); mg/kg = ppm

Source: Davis, 1978

Menhaden is the most valuable, as well as the volume leader of all finfish fisheries in the Gulf of Mexico (Roithmayr, 1965). In the eastern Gulf the fishery is centered between eastern Louisiana and northwestern Florida. Fish are caught with a purse seine from May to November within 3 nmi of shore. In 1975 Mississippi landed 180.2 million pounds, equal to 14% of the total volume taken from the Gulf of Mexico. Most (99%) menhaden are processed into fish meal, oil, and fish solubles; the remaining 1% is used for bait (Jones et al., 1973).

There are several important fisheries that occur almost entirely in estuarine areas. Oysters cannot tolerate salinities greater than $30^{o}/oo$ due to inhibition of growth and reproduction and susceptibility to predators. Hard blue crabs are important in all Gulf states, with production centered on the west coast of Florida. Most crabs are taken in crab traps from inside waters (bays and sounds), but during early spring, shrimp trawls capture a significant quantity from nearshore Gulf waters. Mullet is fished almost exclusively in Alabama inland waters, with a production peak in the fall, when they concentrate nearshore on the way to offshore spawning grounds (Swingle, 1977). Abundance is greatest at Pensacola and areas to the east, where they are caught in gill nets (Jones et al., 1973).

TABLE 3-23
ELUTRIATE ANALYSES OF SEDIMENT AND
WATER SAMPLES FOR CHEMICAL AND HEAVY METALS
CONSTITUENTS COLLECTED FROM GULFPORT HARBOR, MISSISSIPPI

Parameter	Dilution Water	Standard Elutriate
Total organic carbon (ppm)	11.1	15.8
Ammonia nitrogen (ppm)	0.04	0.32
Phosphorus (ppm)	0.002	0.417
pH	7.95	7.92
Mercury (ppb)	<0.2*	<0.2*
Arsenic (ppb)	17.0	21.0
Copper (ppb)	7.4	7.0
Zinc (ppb)	<0.2	<0.2
Cadmium (ppb)	0.3	0.6
Lead (ppb)	2.3	1.0
Nickel (ppb)	1.5	1.8
Chromium (ppb)	1.0	0.8
Iron (ppb)	<10.0	10.0

ppm = mg/liter
ppb = μg/liter
*Sample collected 21 January 1976

Note: Sediment sample number: GP-17; water sample number: GP-17; collected 17 July 1974

Source: Davis, 1978

The eastern Gulf of Mexico industrial bottomfish fishery operates from the Mississippi Delta to eastern Alabama out to 64m water depth (partially shown on Figure 3-14). This area comprises 5,500 nmi^2 of relatively flat mud and sand bottom suitable for trawling (Roithmayr, 1965). Catches consist mainly of croaker (56%), spot (11%), sand and silver seatrout (8%), and over 173 other fish species averaging less than 0.25 kg each (25%) (Roithmayr, 1965). Trawling operations are conducted with the same gear and methods as the shrimp fishery. Processing yields canned pet food, frozen fish for mink farms, fish meal, and crab bait.

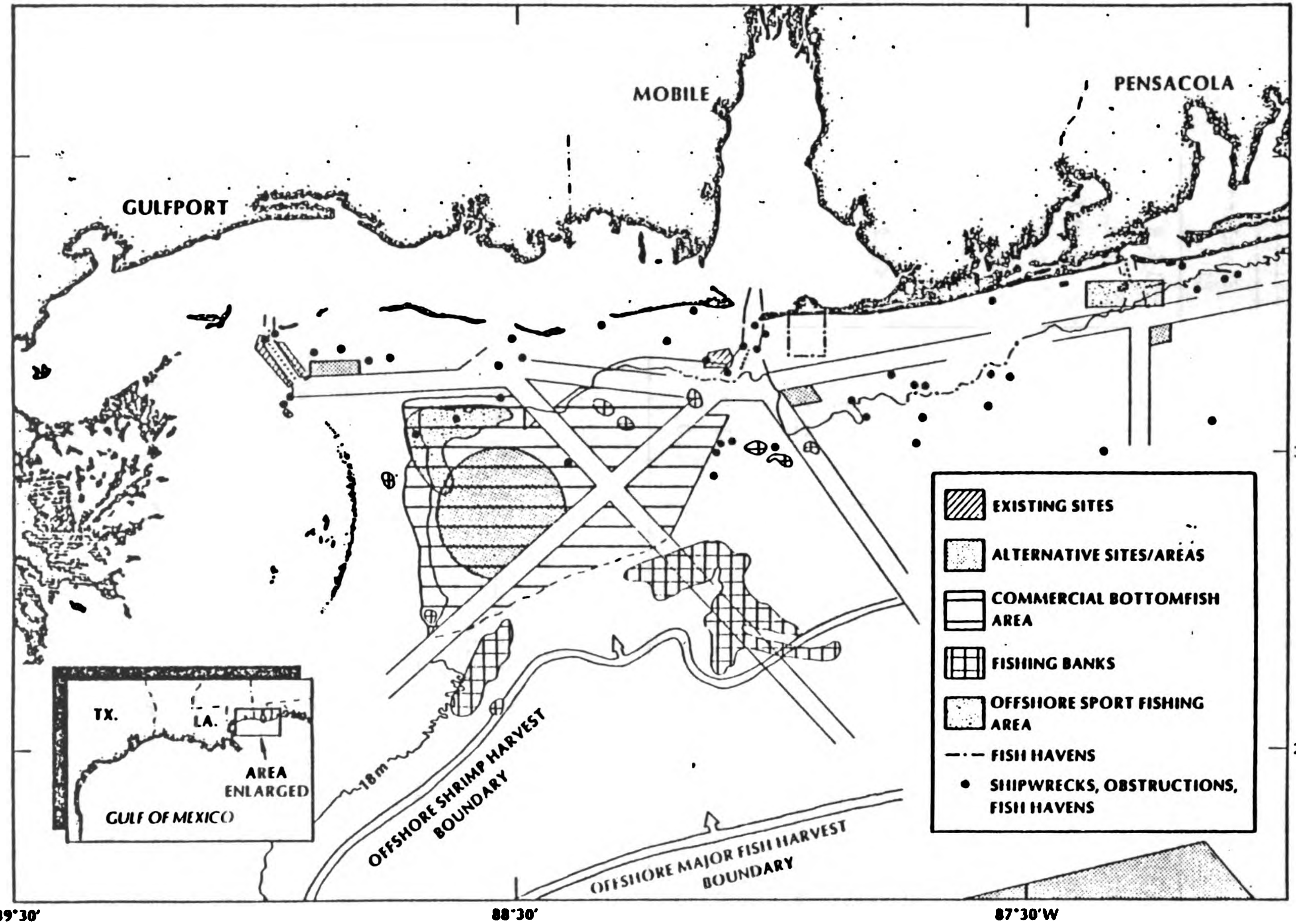


Figure 3-14. Offshore Fishing and Use Areas at the Existing Sites and Vicinity
Source: TerEco, 1978; Moe, 1963; DOI, 1978a

One of the most valuable finfish resource in the Gulf of Mexico is the red snapper. Snappers were the first bottomfish to be actively sought in the Gulf of Mexico (GMFMC, 1980a). Along with other reef fish (snappers and groupers), they are found in areas of rocky bottom and limestone outcrops where handlines are the traditional and most effective method of capture. Areas of abundance are off Louisiana, west Florida, De Soto Canyon, and artificial fishing reefs. Small unmarketable red snapper are also caught in shrimp trawls on mud and sand bottoms (10 to 35m depth) (Swingle, 1977). Depletion of stocks has resulted in a Fishery Management Plan by the Gulf Fishery Management Council (GMFMC, 1980a).

The Mid-Shelf Alternative Area is located within a broader area used for shrimping and bottomfish trawling, and is within the major harvest area for finfish (Figure 3-14). The Deepwater Alternative Area is located outside the principal economic fisheries regions, including the royal red shrimp grounds and pelagic fisheries (Pequegnat et al., 1978).

RECREATIONAL

Saltwater sportfishing is an important industry in offshore and inshore waters of Mississippi, Alabama, and northwest Florida. Fishing is conducted from charter boats, private boats, piers, banks, and beaches. Some sportfishing areas, fish havens, artificial reefs, and banks where recreational fishing occurs are shown on Figure 3-14. Important recreational fishery species for Florida include red snapper, grouper, warsaw, cobia, king mackerel, dolphin, barracuda, sailfish, and marlin (Jones et al., 1973). For Alabama the same source lists tarpon, king mackerel, red snapper, mullet, shrimp, crab, and oysters as important; for Mississippi--speckled trout, Spanish mackerel, tarpon, redfish, king mackerel, pompano, ladyfish, and bonito are considered important.

National Marine Fisheries Service conducted a recreational fishery statistical survey in 1979 (DOC, 1980a). The intercept survey results showed that 53% of the fishermen were not fishing for any particular fish species, 17% sought spotted seatrout, 4% wanted king mackerel, 3% were after red snapper, 2% fished for groupers, and 2% for mullet. The estimated total number of fish caught in Mississippi revealed that Atlantic croaker was the fish caught most often (over 1 million), followed by sand and speckled trout (1 million combined), sea catfish (0.4 million) and mullet (0.25 million). For Alabama, kingfish was first (0.68 million), followed by Atlantic croaker (0.55 million), herrings (0.42 million), sea catfish (0.3 million), and Spanish mackerel (0.27 million).

Wade (1977) reported that a 1975 marine recreational fishery survey in Alabama showed the fishery to be dominated by the private boat fishermen (86% of landings by weight). The most abundant fishes by weight were king mackerel, Spanish mackerel, and bluefish. In offshore areas, 80 to 90% of fishing is conducted by trolling with artificial bait.

South of Pensacola there are several areas that are heavily fished during the summer season for snapper and grouper. The closest to shore is "the wreck", an old Russian freighter on a hard sand bottom. It is located at 30°12'N and 87°13'W, about 6 nmi southeast of the Pensacola Existing Site, in 24m of water (Moe, 1963). In depths greater than 26m in the vicinity of rock outcrops, red snapper, vermillion snapper, red grouper, and black grouper are abundant in the catch (Moe, 1963). Sport fishermen of Pensacola are ideally located to take advantage of seasonal concentrations of two desirable pelagic gamefish, cobia, and sailfish. Cobia move close to shore as they migrate westward to spawn off the Mississippi River during spring. Sailfish concentrate within 3 nmi offshore of Navarre, Florida during September (Hopkins, 1973).

The Mid-Shelf Alternative Area is located within a broader recreational fishing region. The location of the Mid-Shelf Alternative Area was selected to minimize potential conflicts with fishery resources, by avoiding the hard-bottom and reef areas offshore Pensacola, and artificial reefs, havens, and fishing banks offshore Mississippi and Alabama (Figure 3-14). The Deepwater Alternative Area is located outside the principal sportfisheries regions (Pequegnat et al., 1978).

SHIPPING

The Gulfport Existing Sites are located adjacent and partially within the shipping fairway serving Gulfport, which passes between Cat and Ship Islands. The eastern borders of both the Mobile and Pensacola Existing Sites are located within the shipping fairways that serve their respective ports. The Mid-Shelf and Deepwater Alternative Areas are located outside the important shipping fairways that serve the northeastern Gulf.

Mobile, Alabama is one of the most important ports in the Gulf of Mexico. The shipping volume has grown from 23.83 million short tons in 1970 to 36.26 million short tons in 1978 (CE, 1978d). Internal barge traffic has contributed most to the observed increase (CE, 1980b). Traffic from deep draft vessels decreased during the period 1966 to 1975, while commerce increased. This trend indicates the use of larger ships to transport deep draft cargo (CE, 1980b). Some of the larger vessels that visit the port are only partially loaded due to depth limitations of the channel (CE, 1980b).

Internal domestic receipts of coal, petroleum products, sand, gravel, and marine shells, as well as shipments of coal, iron ore, and petroleum products comprise nearly half (48%) the total traffic in Mobile Harbor (CE, 1978d). Foreign imports of iron and aluminum ores and coal are the major items that account for 29.4% of the total traffic; exports of coal, soybeans, and grains contribute 14.3%.

Gulfport, Mississippi does not figure as prominently as Mobile in volumes of trade or vessel traffic; however, the shipping volume has expanded from 0.70 million short tons in 1970 to 1.1 million short tons in 1978 (CE, 1978d). Vessels calling at the port have lengths up to 635 ft (192m) and widths to 90 ft (27m), registering maximum drafts up to 36 ft (11m) (CE, 1976). The present 30-ft channel will only accommodate vessels drawing up to 26 ft (7.9m); thus, vessels often must call on the port with only partial loads (CE, 1976).

Foreign imports including fresh (bananas) and prepared fruits accounted for 51.6% of total freight traffic in Gulfport Harbor. Paper products, rice, meat, timber, and fertilizer accounted for 31.3% of the export trade. The remaining freight traffic consisted of domestic receipts of marine shells, fuel, and iron products and shipments of cotton, corn, rice, and grain mill products (CE, 1978d).

Pensacola, Florida is similar to Mobile and Gulfport in that the larger vessels calling on the port are limited by channel depth (CE, 1978b). Approximately 87% of the ship and barge traffic had drafts of less than 19 ft. There are fewer vessel trips at Pensacola than at Gulfport; however, despite having only 32% as many vessels using the harbor, commerce volume is twice as great.

Volume of trade at Pensacola has increased from 0.99 million short tons in 1970 to 3.1 million short tons in 1978 (CE, 1978d). Domestic receipts and shipments accounted for approximately 70% of the total vessel traffic; shipments of liquid sulphur, fuel oil, and crude petroleum were about equal in volume to receipts of petroleum products, marine shells, sand, gravel, and chemicals (CE, 1978d). Foreign imports of crude petroleum, phosphate rock, and lumber contributed 14.3%, and exports of grain products and fertilizer made up 15.1% of vessel loadings.

MARINE RECREATION

Important recreational facilities are associated with the barrier islands that separate the mainland and estuarine areas from the open Gulf of Mexico. Of the islands in the Mississippi section of the National Seashore, only western Ship Island is accessible to the general public by excursion boats (no cars). Private boats can dock near Fort Massachusetts (on western Ship Island) year-round, and are the only means of access to the other islands (DOI, 1980). Western Ship Island is a day use facility offering opportunities for beach activities (swimming, etc.), picnicking, and hiking. Dauphin Island's (offshore Mobile, Alabama) attractions include 250 campsites at Fort Gaines, Casino Pier (500 to 600 ft long) which accommodates 200 fishermen, and public beaches (CE, 1978a). The island is also a primary landfall for migratory birds, ideally located for "birding." The other islands allow overnight primitive camping and are maintained as wilderness areas. Fishing is allowed anywhere, and no license is required. Boating is popular throughout the northeastern Gulf of Mexico.

Gulf State Park, located midway between Mobile and Pensacola bays, occupies 6,160 acres and provides campgrounds, motels and cabins, picnic areas, recreational fields, fishing piers, and swimming areas (CE, 1978a). The Florida section of the National Seashore offers a 160-site campground (year-round), marine aquaria, historic sites, and picnic areas, as well as the beach-related attractions. Swimming and scuba diving are allowed except near the entrance channel to Pensacola Bay. Fishing is available at both surf and offshore locations (boat charters). Hiking on the nature trails through the dune areas is also popular (DOI, 1980).

Boating and fishing may occur anywhere in the Gulf; however, there are no specific recreational attractions in the Mid-Shelf or Deepwater Alternative Areas.

MILITARY ACTIVITIES

The potential for conflict between military activities and ocean disposal in the northeastern Gulf of Mexico is low. There are no large naval ship facilities along the Mississippi, Alabama, and western Florida coasts. Military air bases that are located near the coast are unlikely to affect disposal operations.

Military installations of importance are Eglin Air Force Base to the east of Pensacola, Pensacola Naval Air Station on Pensacola Bay, and the Naval Construction Battalion Center at Gulfport, Mississippi. National Ocean Survey Chart No. 11360 identifies restricted areas, and also a missile test area at least 20 nmi east of Pensacola Bay entrance channel (DOC, 1980b); important military air exercises are conducted in that area. Table 3-24 lists military facilities in the Mississippi, Alabama, and western Florida Gulf coast areas.

TABLE 3-24
MILITARY INSTALLATIONS
IN NORTHEASTERN GULF OF MEXICO

Mississippi Gulf Coast Area

Keesler Air Force Base

Naval Construction Battalion Center

Alabama Gulf Coast Area

Dauphin Island Air Force Defense Control Station

Mobile Harbor Coast Guard Station

Florida Panhandle Gulf Coast Area

Pensacola Naval Air Station

Saufley Naval Air Station

Whiting Naval Air Station

Ellyson Naval Air Station

Chevalier Naval Air Station

Pensacola Navy Gunnery Range

Eglin Air Force Base

Live Oaks Naval Reservation

Tyndall Air Force Base

Naval Mine Defense Laboratory

Source: DOI, 1975

Two training ships are homeported at Pensacola Naval Air Station: one destroyer and the aircraft carrier LEXINGTON. These ships leave port during the year in accordance with training schedules (CE, 1978b). The Marine Corps also conducts reserve training from the Seabee Base at Gulfport during January, May, June, and September. Twelve LVTP-7's are used to cross

Mississippi Sound (3-hr crossing) and make amphibious landings on the northside of Cat Island (Major Williams, personal communication*).

OIL AND GAS EXPLORATION AND DEVELOPMENT

The northeastern Gulf of Mexico has not been subjected to the intense exploration and development of energy resources that has occurred in the northwestern and central Gulf of Mexico. However, that condition may be changing in the near future. Exploratory wells are being drilled in Mobile Bay, and BLM has 30 OCS tracts offered for leasing from 3 to 20 nmi off Alabama and Mississippi (Figure 3-15).

No active or proposed oil and gas lease tracts occur in the vicinity of the Pensacola and Gulfport Existing Sites. Oil and gas development is, however, proposed in the vicinity of the Mobile Existing Site. Lease Tract No. 132, owned by Shell Oil Co., is located adjacent to the eastern boundary of the Mobile Existing Site; Shell plans to use a submersible rig to drill directional holes. Exxon plans to use a jackup rig to drill on Lease Tract No. 112, which overlaps the northern one-third of the Mobile Existing Site. The first exploratory rig will be in the west central portion of the tract, probably outside of the boundaries of the Mobile Existing Site (OGJ, 1981). Mobil Oil Corporation has applied for permits through the Mobile District Corps of Engineers to drill four appraisal wells. The area of exploration is from 4 to 6 nmi NNE of the Existing Site between Dauphin Island and Mobile Point and inside Mobile Bay (CE, 1980a).

Proposed OCS Oil and Gas Lease Sale Nos. 67 and 69, tentatively scheduled for March and August 1982, respectively, call for 30 tracts to be leased 3 to 20 nmi south of eastern Mississippi and Alabama; 21 of these tracts are located 3 to 9 nmi south of the Barrier Islands (Figure 3-15). Bureau of Land Management (BLM) estimates that 20 exploration and delineation wells could be drilled and 3 to 5 production platforms built on the 21 lease tracts (DOI, 1981).

* Major Williams USMC, Amphibious Marine Detachment, Seabee Base, Gulfport, Mississippi (1981)

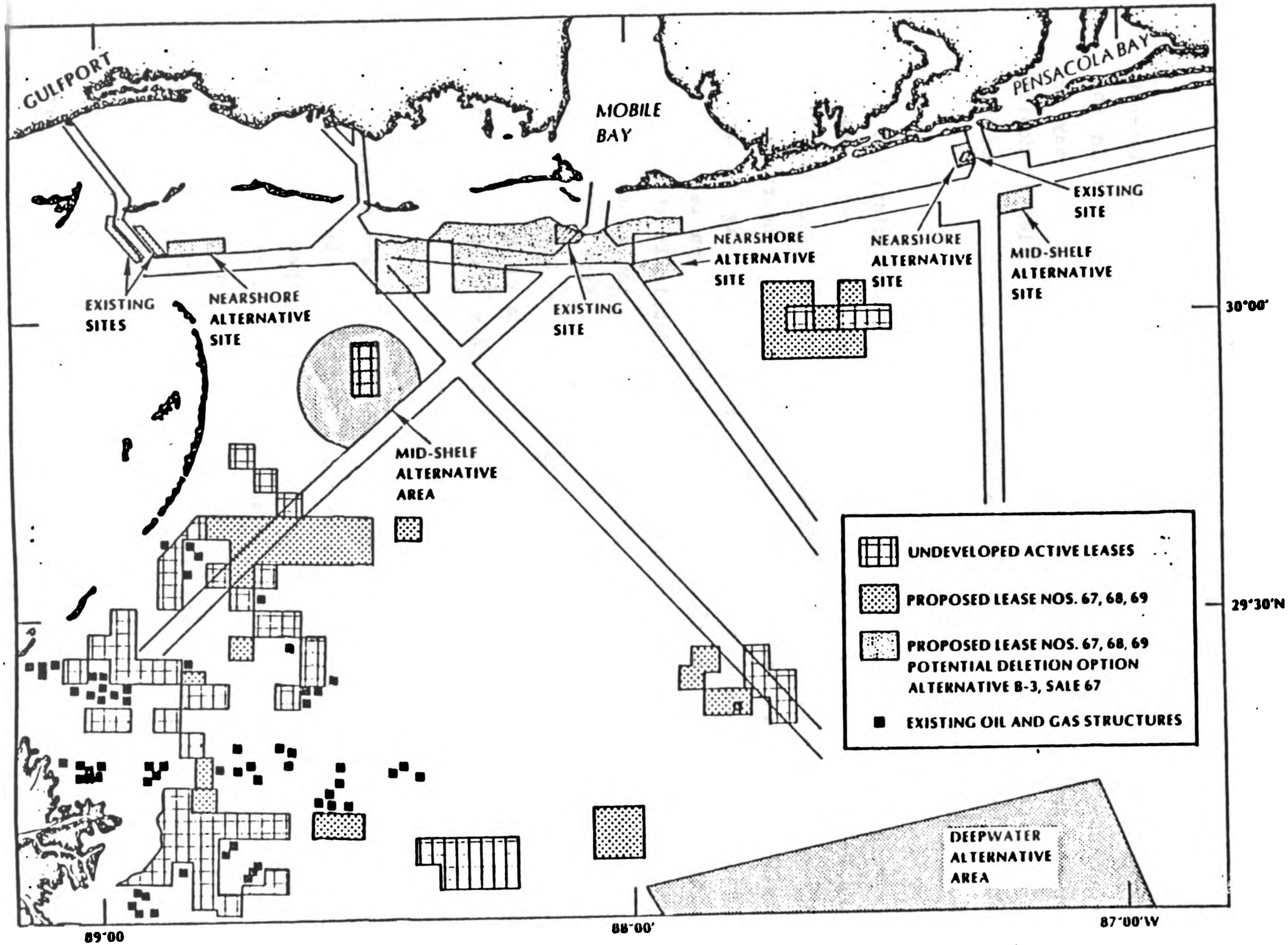


Figure 3-15. Existing, Proposed, and Developed Oil and Gas Leases at the Existing and Alternative Sites and Vicinity
Sources: DOI, 1981, 1979a, 1978b

The Mid-Shelf Alternative Area was studied as part of the MAFLA program sponsored by the BLM. The intent of this program was to determine ongoing or potential impacts on the outer Continental Shelf from oil and gas development (Dames and Moore, 1979). The Mid-Shelf Alternative Area is in the vicinity of undeveloped active oil and gas leases (Figure 3-15). No active or proposed lease tracts are in the region of the Deepwater Alternative Area, with the exception of proposed leases near the northwestern border.

CULTURAL RESOURCES

The northeastern Gulf of Mexico may have many potential historic and prehistoric sites. In addition, historic sites of significance include military fortifications dating from the 18th and 19th centuries (CE, 1978b). Dredged material has been used on occasion to protect cultural resources such as Fort Massachusetts on Ship Island. Sand has been placed around the Fort to replenish eroded areas and prevent crumbling of the walls (CE, 1976).

In the open Gulf important cultural resources may include prehistoric sites, which existed at lower stands of sea level, and shipwrecks. Actual evidence of buried prehistoric sites usually cannot be identified by current survey methods; however, areas of high prehistoric site potential can be located by interpreting relict geomorphology (DOI, 1981). Similarly, historically significant shipwrecks may be difficult to locate, and may either be undetected on a 100% magnetometer survey, or magnetic signatures may fail to indicate the difference between a shipwreck and an area of modern ferromagnetic debris (DOE, 1981).

Several shipwrecks and obstructions located in the vicinity of the Existing and Alternative Sites have been reported (Table 3-25). In addition to the locations provided by BLM, National Ocean survey chart Nos. 11360, 11373, 11376, 11382, and 11383 indicate other obstructions and fish havens at distances less than 2 nmi from the Existing and Alternative Sites (DOC 1979a,b,c; 1980b,c). No reported resources of cultural importance occur within the Pensacola Existing, Nearshore Alternative, or Mid-Shelf Alternative Sites. The nearest shipwreck "Bride of Lorne", is located 0.7 nmi north of the Existing Site. Fish havens are located at distances greater than 4 nmi to

TABLE 3-25
WRECKS AND OBSTRUCTIONS AT EXISTING AND ALTERNATIVE SITES/AREAS AND VICINITY

Type of Obstruction	Latitude	Longitude	Date of Loss	Remarks	Source/Report	Approximate Distance from Site/Area
Pensacola Existing Site						
Ship—BRIDE OF LORNE	30°17'30"N	87°18'42"W	Apr 1887	—	"Encylopedia of American Shipwrecks"	1 nmi north
Ship—EASTERN LIGHT	30°18'54"N	87°19'30"W	23 Dec 1890	Sail	"Guide to Southern Ships in American Waters"	2 nmi north
Ship—MASSACHUSETTS	30°17'48"N	87°18'42"W	1921	Warship	U.S. Hydrographic Office	1 nmi north
Mobile Existing Site						
Ship—TULSA	30°09'N	88°08'W	10 Mar 1943	Steel schooner sail, 607 tons, built 1909	"Encyclopedia of American Shipwrecks"	Western border of site
Unidentified	30°07'36"N	88°04'07"W	—	Depth—50 ft	Date of information: 8/2/75	1 nmi southeast
Unidentified	30°08'18"N	88°05'07"W	—	Depth—41 ft	Date of information: 8/2/75	0.25 nmi south of southeastern border of site
Ship—TERRY LEE	30°10'54"N	88°03'26"W	—	Depth—12 ft	Date of information: 10/3/57	1 nmi northeast
Ship—MAGNOLIA CG	30°12'48"N	88°02'10"W	Aug 1975	U.S. gunboat	—	3 nmi northeast
Gulfport Existing Sites						
Unidentified	30°11'15"N	89°06'00"W	—	—	—	4 nmi west
Mobile-Gulfport Mid-Shelf Alternative Area						
Ship—MARION D.	29°45'00"N	88°36'00"W	—	Fishing boat	Date of information: 7/15/67	5 nmi southwest
Deepwater Alternative Area						
Ship—RHODA B. TAYLOR	28°40'N	86°30'W or 86°15'W	1 Dec 1878	—	Wreck reports LSU, Baton Rouge	10 nmi southeast
Ship—MARION N. COBB	28°50'N	87°30'W	28 Nov 1925	Schooner sail, 459 tons, built 1902	"Encyclopedia of American Shipwrecks"	Within area
Ship—VILA Y. HERMANO	29°00'N	87°00'W	5 Oct 1905	Schooner sail, 327 tons, built 1891	"Encyclopedia of American Shipwrecks"	Within area
Unidentified	29°22'31"N	87°51'05"W	—	—	Date of information: 5/4/74	1 nmi north

— No information available

Source: Melanie Stright, Bureau of Land Management, New Orleans OCS Office, Louisiana, personal communication (1981) the east, northeast, and northwest. A steel schooner "Tulsa", built in 1909, is located on the western boundary of the Mobile Existing Site. Two unidentified obstructions occur within 1 nmi of the southeastern boundary of the site. Obstructions and fish havens also occur at distances greater than 1 nmi to the south, southeast, and northeast. No resources of cultural importance have been reported in the vicinity of the Mobile Nearshore Alternative site. No resources of cultural importance are reported to occur at the Gulfport Existing or Nearshore Alternative Sites; however, an unidentified obstruction occurs at the southeastern and northeastern borders of the western Existing Site, and two unidentified shipwrecks occur at distances within 1 nmi to the south and northeast of this site. In addition, unidentified obstructions and shipwrecks occur at distances greater than 1 nmi to the south and north of the western Existing Site, and east of the eastern Existing Site.

No cultural resources have been reported at the Mid-Shelf Alternative Area; unidentified shipwrecks, obstructions, and fish havens occur at distances greater than 1 nmi to the south, east, north and northwest of the Mid-Shelf Alternative Area. Two schooners, "Marion N. Cobb" and "Vila Y. Hermano," built in 1902 and 1891, respectively, occur within the Deepwater Alternative Area; other shipwrecks and obstructions occur at distances greater than 1 nmi from the Deepwater Alternative Area.

MARINE SANCTUARIES

The western end of Santa Rosa Island, part of the Gulf Islands National Seashore, and the waters surrounding it are designated as the Fort Pickens State Park Aquatic Preserve. "Aquatic Preserve" is the designation given to an exceptional area of submerged lands and its associated waters, which are being maintained essentially in their natural or existing conditions. The Fort Pickens State Park Aquatic Preserve is 2.5 nmi NNE of the Pensacola Existing Site. No other marine sanctuaries occur in the vicinity of the Existing or Alternative Sites.

ACTIVE OCEAN DISPOSAL SITES

The northeast Gulf of Mexico has several ocean sites for the disposal of dredged materials. There is a small (0.26 nmi^2) disposal site located 1 nmi offshore from the entrance to St. Andrew Bay, which leads to Panama City, Florida. The disposal area is 82 nmi east of the Pensacola Existing Site. No sites are located between Pensacola and Mobile. Between Mobile and Gulfport occurs the Pascagoula ODMDS, which is located 2 nmi southwest of Petit Bois Island and covers an area of 1.19 nmi^2. The Mobile Existing Site is 21 nmi to the east, and Gulfport Existing Sites are 17 nmi to the west. Mississippi River/Breton Sound and Bar Channel (Gulf Outlet Existing Site) Existing Site is located in Louisiana, 38 nmi due south of the Gulfport Existing Sites, and covers an area of 6.6 nmi^2.

PRESENT AND FUTURE STUDIES

The northeastern Gulf of Mexico has not been extensively studied in the past. Previous activities work have tended to concentrate on the estuaries, Mississippi Sound, and areas considered for offshore oil and gas development. Therefore, a comprehensive data base does not exist for the dredged material disposal sites. Surveys conducted by IEC, under contract to EPA, have provided data on chemical, biological, geological, and physical conditions present at the Existing Sites during January and June 1980. The results of these surveys are presented in Appendix A.

At the present time the Mobile District of the U.S. Army Corps of Engineers is directing the "Mississippi Sound and Adjacent Areas Study" of dredged material disposal. This comprehensive study will (1) provide information to fill identified data gaps, (2) be used to develop mathematical models to aid in understanding the ecosystem, and (3) enable prediction of future conditions. Table 3-6 indicates the subjects which are being covered during this study; the results are scheduled for public release in 1984 (D. Barrineau, personal communication*).

* D. Barrineau, U.S. Army Corps of Engineers, Mobile District, Alabama (1981)

If the disposal sites are designated, periodic monitoring may provide useful information which can be used for disposal impact assessments. The decision to conduct monitoring surveys will be made by the Corps of Engineers District Engineer and the EPA Regional Administrator. A recommended monitoring plan for the recommended Pensacola, Mobile, and Gulfport ODMDSs is presented in Chapter 2 of this EIS.

TABLE 3-26
MISSISSIPPI SOUND AND ADJACENT AREAS STUDY PARAMETERS

PHYSICAL

Tide elevations
Meteorology
Bottom pressure
Currents
Conductivity
Temperature
Bathymetry
Waves
Suspended sediments

MODELING

1. Gulf Tide Model (tidal fluctuations)

2. WES Implicit Flooding Model (long-term wave behavior)

3. Wave Hindcast Model (relation of wave height to wind field and wave frequency)

TABLE 3-26. (continued)

4. <u>ARAP Sediment Transport Model</u>

   a. Currents
   b. Sediment dispersion
   c. Estimate suspended sediment levels
   d. Changes in bottom topography
   e. Changes in water direction

<u>BIOLOGY</u>

1. <u>Benthic Macroinfauna</u>

   a. Major taxonomic groups
   b. Species identification
   c. Biomass size
   d. Abundance

2. <u>Trophic Characterization</u> (literature reviews)

   a. Food preferences (demersal fish)
   b. Feeding habits (demersal fish)
   c. Community structure (macrobenthic invertebrates)
   d. Productivity (macrobenthic invertebrates)
   e. Fish gut analyses
   f. Fish trawl records

3. <u>Finfish and Shellfish Mapping</u> (literature search)

   a. Nursery areas
   b. Spawning areas
   c. Migratory Routes

Source: CE, 1981

Chapter 4

ENVIRONMENTAL CONSEQUENCES

Short-term impacts associated with disposal activities at the Pensacola, Mobile, and Gulfport ODMDSs may include temporary mounding, burial of some infaunal organisms, formation of turbidity plumes, and releases of dissolved nutrients and some trace metals. No long-term or persistent adverse impacts have been identified, and none are expected. Potential impacts occurring at Mid-Shelf or Deepwater Alternative Areas would depend on the amount of dilution and mixing, and the similarity between dredged materials and disposal site sediments.

Effects of dredged material disposal described in this chapter are classified under two broad categories: (1) public health and safety, and (2) ecosystem. The public health and safety section discusses potential contamination of edible fish, development of nuisance species, and effects on navigation and aesthetics. The ecosystem section describes the environmental effects of dredged material disposal on water and sediment quality, the biota, and fisheries. Unavoidable adverse environmental effects and mitigating measures, short-term use versus long-term productivity, and irreversible and irretrievable commitments of resources also are discussed. This chapter provides the scientific and analytical bases for evaluation and comparisons of the alternatives described in Chapter 2.

EFFECTS ON PUBLIC HEALTH AND SAFETY

The potential for bioaccumulation of contaminants associated with dredged material into seafood consumed by humans is unknown. Specific bioaccumulation tests of Pensacola, Mobile, and Gulfport dredged sediments, using representative marine organisms, have not been performed. Although trace metal and chlorinated hydrocarbon concentrations (CHC) in epifauna collected during EPA/IEC surveys were low and below U.S. Food and Drug Administration (FDA) action levels for fish and shellfish (where applicable), the potential for elevated levels of contaminants to accumulate in infaunal or epifaunal organisms exposed to dredged materials dumped in nearshore, mid-Shelf, or deepwater environments remains problematic. Elutriate test results (Chapter 3) indicate that significant resolubilization of metals from dredged sediments is unlikely. In addition, results of Dredged Material Research Program (DMRP) studies (Hirsch et al., 1978) suggest that the bioavailability of sediment-sorbed metals and organics is low. It is unlikely that transient fish and shrimp species captured and consumed by humans could obtain sufficient quantities of contaminants from food items found within the disposal site to render them toxic or unpalatable; however, subsequent bioaccumulation tests would be necessary for verification.

Surveys of the Pensacola, Mobile, and Gulfport Existing Sites by EPA/IEC (Appendix A) did not detect any nuisance species within or adjacent to site boundaries. Infaunal and epifaunal species collected were similar to those described for comparable regions of the northeastern Gulf of Mexico. No elevated total or fecal coliforms were detected in sediments or shellfish collected from either the Pensacola or Gulfport Existing Sites. Low counts of total coliforms were present in sediments and shellfish from the Mobile Existing Site. There are no components in the dredged materials that would be likely to promote development of nuisance species in the Mid-Shelf or Deepwater Alternative Areas.

The disposal of dredged materials could present two potential problems to navigation: (1) mounding of sediments within the disposal site and (2) interference of the hopper dredge with shipping traffic during transit to and from the disposal site.

Circulation in the vicinity of the Pensacola, Mobile, and Gulfport Existing Sites is influenced by tides, density gradients, bottom topography, wind, and occasionally by detached Loop Current eddies (TerEco, 1978). Sediment dispersion and transport in nearshore areas off Pensacola is controlled by a westward-flowing longshore current. For instance, longshore drift of 130,000 yds^3 per year has been reported at the mouth of Perdido and Pensacola Bays by the CE (Boone, 1973). Sediment dispersion and transport off Mobile is speculative; currents are highly variable and flows are directed primarily at right angles to the direction of the predominant wind (with a strong east-west component) (Shroeder, 1976). A southwestward-flowing current is indicated in the vicinity of the Gulfport Existing Site; Ship Island has generally migrated to the south and west (Boone, 1973). In addition, tidal currents probably exert a strong influence on the circulation patterns in the vicinity of the Site because of the proximity of the site to Ship Island Pass (tidal pass). Besides the normal circulation patterns in the vicinity of the Existing Sites, intense wave action associated with hurricanes reworks the sediments on the Shelf about once every 2 years (Boone, 1973). Dredged material is similar in composition to Existing Site sediments; therefore, the dumped material should enter natural transport cycles. Fine-grained fractions should be winnowed away as the mounds are dispersed by the predominant currents. Sediments unaffected by prevailing currents may be resuspended and mixed with adjacent sediments during storm passage. As a result, mounds of dredged sediments eventually decrease in size, and may completely disperse during the storm season.

Hopper dredges used in maintaining the entrance channels to Pensacola, Mobile, and Gulfport harbors are not as hazardous to navigation as pipeline or bucket dredges because hopper dredges do not utilize anchor lines, pipelines, or barges. Intermittent hopper dredge movement from the dredging to disposal sites should not appreciably congest shipping traffic within the navigation channels. Hazards to navigation are lessened by use of the U.S. Coast Guard's Area Vessel Traffic System, extra caution and awareness by captains of hopper dredges, and public announcements of dredging schedules to mariners by the CE (J. Walker, personal communication*). Because of increased distance offshore, the potential hazard to navigation from hopper dredges traveling to and from the disposal site may be higher for a site selected from the Mid-Shelf or Deepwater Alternative Areas. Temporary mounding of deposited sediments in deeper water areas will not create navigational hazards.

* J. Walker, U.S. Army Corps of Engineers, Mobile District, Alabama (1982)

EFFECTS ON AESTHETICS

Dredged material disposal at Pensacola, Mobile, and Gulfport Existing Sites will create temporary and localized turbidity plumes within site waters. The plumes will be dispersed by nearshore currents and cause only minor increases in suspended sediment concentrations and water discoloration. Plumes at the Gulfport Existing Site may be visable from Ship Island (0.7 to 1.2 nmi from site); however, they should not be visable from shore for the Pensacola and Mobile Existing Sites (2.3 and 4.2 nmi from shore, respectively) and nearshore Alternative Sites (about 2 to 7 nmi from shore).

Dredged material disposal at the Mid-Shelf and Deepwater Alternative Areas (located at least 15 and 50 nmi from shore, respectively) would not degrade the aesthetic quality of northern Gulf waters.

EFFECTS ON THE MARINE ECOSYSTEM

The effects of dredged material disposal on the ecosystems of the Existing Sites have been examined by EPA/IEC (Appendix A). The results of the DMRP Aquatic Field Investigation Studies provide further insight regarding the effects of dredged material disposal; however, they must be applied carefully when predicting impacts because local conditions affect the fate and effects of dredged material (Wright, 1978). The nature and extent of impacts may vary from site to site, depending on the composition of the dredged materials, and the physical and biological characteristics of the disposal site. Adverse impacts from dumping are minimized when the following factors occur singularly or in concert: (1) dredged sediments are similar in composition to disposal site sediments; and (2) sites are situated in high-energy, dynamic environments (e.g., coastal areas) and/or areas having relatively low biological productivity (e.g., deepwaters of the Gulf).

WATER QUALITY

Disposal of dredged material should not appreciably degrade the water quality in regions adjacent to the Pensacola, Mobile, and Gulfport ODMDSs. In general, changes in water quality associated with dumping are localized and relatively short-term; conditions return to normal within a period of minutes to hours (Wright, 1978). Results of several long-term studies conducted at other nearshore locations are summarized by Brannon (1978), indicating that dredged materials have limited chronic impacts on the water quality of the disposal site.

TURBIDITY

The specific effects of dumping on turbidity levels in waters overlying the Existing Sites have not been investigated. However, Water and Air Research, Inc. (1975) measured changes in turbidity and suspended sediments before, during, and after dredging the Gulfport Ship Channel in Mississippi Sound. The authors concluded (p. VI-25) "Dredging had no significant or lasting effect on the levels of turbidity and suspended solids in the water column. The effects of dredging on the background levels are insignificant when compared to [the effects of] shrimping and the natural events of weather." Similar results were observed by May (1973a) in a study of the effects of dredging and disposal in Mobile Bay. Wright (1978; p. 48) concluded that at most dredged material disposal sites, increases in turbidity persisted for only a few hours and, in addition, "...storms, river discharge and other natural phenomena resulted in turbidity increases of much greater magnitude than those associated with disposal." In support of the observations reported by Water and Air Research, Inc. (1975) and May (1973a), total suspended solids and turbidity values were similar between disposal site and reference station(s) waters during EPA/IEC surveys (Appendix A).

The duration of turbidity plumes depend on the particle settling rates and intensity of mixing processes (Wright, 1978). Consequently, turbidity plumes at a Gulfport ODMDS consisting of suspended fine-grained particles may persist for longer periods than plumes at a Pensacola or Mobile ODMDS, where dredged materials consist of coarser-grained particles.

Concentrations of suspended sediments are lower in offshore waters of the Mid-Shelf and Deepwater Alternative Areas (Chapter 3). Thus, dumping may produce temporary suspended sediment concentrations appreciably higher than background levels.

NUTRIENTS

Resolubilization of nutrients commonly occurs during disposal of polluted and nonpolluted sediments dredged from coastal areas (Schubel et al., 1978; Heaton, 1978; Windom, 1976). Results of elutriate tests performed on dredged materials from Pensacola, Mobile, and Gulfport entrance channels (summarized in Chapter 3) indicated that detectable quantities of micronutrients may be released from sediments during disposal. Consistent releases of dissolved phosphorus and organic carbon, and sporadic releases of dissolved nitrogen, were measured in elutriate samples of Pensacola, Mobile, and Gulfport dredged sediments (Davis, 1978).

Localized increases in phosphorus concentrations following dumping are typically of short duration due to rapid precipitation or adsorption onto suspended particulate matter, particularly clay particles (Heaton, 1978; Wright, 1978; Windom, 1975).

Releases of soluble nitrogen, especially ammonia, from dredged sediments are common (Heaton, 1978; Windom, 1975). Nitrogen is the limiting nutrient for nearshore primary productivity since coastal waters characteristically have a low nitrogen content (Ryther and Dunstan, 1971). Therefore, localized releases of nitrogen may temporarily stimulate phytoplankton productivity (Windom, 1975). Conversely, excessive concentrations of nitrogenous compounds (e.g., ammonia) can be toxic to marine life. Releases of ammonia that are sufficient to cause toxicity to either pelagic or sessile organisms inhabiting the disposal site or adjacent areas are unlikely (Brannon, 1978). Increased ammonia concentrations in the water column are ephemeral due to rapid dilution and mixing (Wright, 1978). Chronic water quality problems resulting from long-term leaching of nutrients from dredged sediments are not expected (Brannon et al., 1978). Similarly, no significant degradation of water quality would be expected from short-term nutrient releases at the Mid-Shelf or Deepwater Alternative Areas.

DISSOLVED OXYGEN

The short- and long-term effects of dredged material disposal on dissolved oxygen concentrations taken at the Existing Sites are unknown. Slight decreases in oxygen concentrations following disposal of dredged materials in Mobile Bay were limited to an area immediately surrounding the point of discharge (May, 1973a). Anoxic or reducing conditions were not detected in bottom waters overlying the disposal site (ibid.). During the June EPA/IEC surveys (Appendix A) bottom waters near the Mobile and Gulfport Existing Sites were undersaturated (36 to 47% saturation) in dissolved oxygen, but were not hypoxic or anoxic. Depressed oxygen concentrations in nearshore bottom waters during summer have been reported previously for the Mobile and Gulfport areas by Rinkel and Jones (1973) and Christmas (1973), respectively. Such conditions result from restricted vertical mixing, biological respiration, and oxidation of organic matter in surficial sediments (May, 1973b), and not necessarily from dredged material disposal.

Although the effects of dumping on oxygen concentrations in bottom waters at the Mid-Shelf and Deepwater Alternative Areas are unknown, significant reductions in oxygen concentrations due to dumping are unlikely in the open ocean (Pequegnat et al., 1978). Furthermore, the Deepwater Alternative Area is outside the impingement area of the bottom oxygen minimum layer (ibid.); therefore, the development of anoxic conditions is improbable.

TRACE METALS

Nearshore sediments are a major sink for riverine and anthropogenic trace metals (Trefry, 1977). Thus, sediments dredged from river mouths and coastal navigation channels may contain levels of trace metals which are elevated relative to crustal abundances (e.g., Holmes, 1973). However, releases of trace metals from dredged sediments to the water column during disposal cannot be predicted solely on the basis of bulk chemical analyses of the dredged material (Windom, 1973; Brannon et al., 1978). Furthermore, results of the DMRP (Brannon, 1978) and studies by Windom (1975, 1976) and Schubel et al.

(1978) demonstrate that following dumping the concentrations of certain dissolved metals (i.e., Zn, Cu, Cd, and Pb) in disposal site waters may be reduced by adsorption onto insoluble iron and manganese hydroxides.

In an effort to evaluate the impact of trace metal releases to disposal site waters, the CE (Davis, 1978) performed elutriate tests on the Pensacola, Mobile, and Gulfport dredged sediments. No significant desorption of trace metals from dredged sediments was detected; the results are discussed in Chapter 3. Elutriate tests of sediments within and adjacent to the Existing Sites were performed as part of the EPA/IEC surveys (discussed in Appendix A). Releases of cadmium, mercury, and lead from sediments at the Existing Pensacola and Gulfport Sites were either small or undetectable; slightly higher releases of trace metals from the Mobile Existing Site sediments were detected relative to the reference sediments. During EPA/IEC surveys no significant differences in dissolved trace metal concentrations between disposal site and adjacent waters were observed. However, dilution and mixing processes would obscure any long-term releases of metals (Heaton, 1978; Schubel et al., 1978; Brannon et al., 1978).

Releases of trace metals at either the Mid-Shelf or Deepwater Alternative Areas would be similar to those at the Existing Sites. Consequently, no significant degradation of disposal site waters is expected.

CHLORINATED HYDROCARBONS (CHC)

Concentrations of pesticides and PCBs in waters of the Pensacola, Mobile, and Gulfport Existing Sites immediately following the disposal of dredged materials have not been investigated. The low, but variable, CHCs detected in the waters or the Existing Sites during EPA/IEC surveys were similar to previously reported concentration ranges in nearshore waters (e.g., Rinkel and Jones, 1973). The similarities indicate that long-term or chronic accumulations of hydrocarbons in ODMDS waters have not occurred. These results are consistent with the findings of the DMRP (Burks and Engler, 1978), which reported insignificant releases of CHCs from dredged materials due to their insolubility and characteristic rapid sorption onto suspended particles. Similarly, chronic releases or accumulations of hydrocarbons in waters overlying the Mid-Shelf or Deepwater Alternative Areas are not expected.

SEDIMENT QUALITY

The physical and chemical composition of sediments within the Pensacola, Mobile, and Gulfport Existing Sites were investigated during EPA/IEC surveys (Appendix A). Grain size characteristics of the Pensacola and Mobile dredged sediments were similar to those of sediments from the respective disposal sites and adjacent areas. Therefore, appreciable changes in sediment grain size within the Pensacola and Mobile disposal sites due to dumping are not expected. Dredged sediments dumped at the Gulfport Existing Site were similar to existing disposal site sediments, but dissimilar to the EPA/IEC reference sediments (i.e., from the EPA/IEC reference Station 14, located approximately 2 nmi east of the eastern site). It is not possible to conclude from these data whether previous disposal at the Gulfport Existing Site or natural sediment distribution patterns are responsible for the observed high percentages of fines in the disposal site sediments. Fine-grained sediments increase west of Mobile Bay as the Mississippi Delta is approached (Doyle and Sparks, 1980).

In general, Pensacola and Mobile dredged sediments contained concentrations of total organic carbon (TOC), oil and grease, cadmium (Cd), mercury (Hg), and lead (Pb), similar to those in sediments of the respective disposal site and reference station. Dredged sediments from Gulfport contained higher concentrations of Hg, Cd, and Pb than the ODMDS and reference station sediments. Significant changes in the concentrations of trace metals due to dredged material disposal would not be expected at either Pensacola or Mobile ODMDSs, whereas increases in total sediment metal concentrations may occur at a Gulfport ODMDS. However, during EPA/IEC surveys, only lead concentrations were significantly higher in Gulfport Existing Site sediments relative to concentrations in reference station sediments. Furthermore, the metals and TOC levels in sediments at the Existing Sites were within the respective concentration ranges reported in nearshore sediments off Pensacola (Rinkel and

Jones, 1973), and shallow mid-Shelf sediments of the northeastern Gulf (Trefry, 1978). Trace metal concentrations in dredged sediments are generally similar to those reported for sediments in the vicinity of the Mid-Shelf Alternative Area (see Chapter 3). Trace metal concentrations in sediments of the Deepwater Alternative Area have not been measured; however, concentrations at nearby MAFLA stations are generally similar to those in dredged sediments (see Chapter 3). Therefore, metal enrichment of sediments in Mid-Shelf or Deepwater Alternative Areas should not result from disposal of material dredged from the nearshore Pensacola, Mobile, or Gulfport entrance channels.

Concentrations of pesticides and PCBs in disposal site sediments were either low or undetectable during EPA/IEC surveys. Significant changes in Existing Site sediment quality with respect to hydrocarbons were not evident. Similar results were obtained during DMRP studies. Wright (1978; p. 49) concluded "Disposal did not appear to have any lasting effect on the sediment chemistry. There were some small changes in dissolved oxygen, metals, and nutrients but these did not appear to be large enough to have a significant impact on the benthic community."

The composition of the Pensacola, Mobile, and Gulfport dredged sediments vary from predominantly sand at Pensacola to primarily silt and clay at Gulfport. Sediments in the Mid-Shelf Alternative Area contain from 70 to 90% sand in the eastern portion, and from 5 to 15% sand in the western portion. Similarly, the composition of the substrate in the Deepwater Alternative Area varies with location. Sediments of the Deepwater Alternative Area consist primarily of silt and clay; however, sand sized sediments occur in some areas of De Soto Canyon. Theoretically, if sufficient information was available to map the areal distribution of specific sediment types, then grain size characteristics of the dredged materials perhaps could be matched to similar sediments within the Mid-Shelf, and to a lesser extent, the Deepwater Alternative Areas. Short- and long-term impacts to sediment quality would be minimized by dumping in areas where disposal site and dredged sediment characteristics were similar.

BIOTA

In general, the disposal of dredged material presents four potential problems to aquatic organisms: (1) temporary increases in turbidity, (2) changes in the physical and chemical characteristics of the habitat, (3) smothering by burial, and (4) possible introduction of pollutants (Hirsch et al., 1978). The magnitude of adverse impacts on the existing fauna depend on the similarity of dredged materials to existing sediments, frequency of dumping, thickness of the overburden, types of organisms present, and the physical characteristics of the habitat (Pequegnat, et al., 1978). It is often difficult to distinguish adverse effects caused by sediment dispopsal from changes due to natural variability in species abundances. The paucity of site-specific data limits conclusions concerning the impacts of dumping at the Existing Sites.

PLANKTON

Effects of dredged material disposal on phytoplankton and zooplankton are difficult to assess because of the naturally high variability of populations. The influences of tidal and river discharges, as well as diel changes in zooplankton abundances, increase the difficulty of measuring disposal effects. Sullivan and Hancock (1977) concluded that for most oceanic areas natural plankton fluctuations are so large that field surveys would not be useful for detecting the impacts of dredged material disposal.

Disposal of dredged material creates a temporary turbidity plume consisting of fine-grained silts and clays. Entrainment of phytoplankton, zooplankton, and ichthyoplankton within a turbidity plume has a potential for localized plankton mortality due to physical injury, exposures to suspended particulates and released contaminants, and decreased light transmittance (Wright, 1978). Elevated concentrations of suspended sediment within the disposal plume may inhibit filter-feeding zooplankton, although the extent of this impact is unknown. Existing (background) concentrations of suspended sediment are high near shore and dumping may cause negligible increases in these concentrations (e.g., May, 1973a). Furthermore, Hirsch et al. (1978, p.2) concluded that "Most organisms are not seriously affected by suspended sediment conditions created in the water column by dredging and disposal operations." Results of elutriate tests (Davis, 1978) indicated that releases of contaminant metals from dredged materials are, in most cases, negligible. Furthermore, changes in water quality due to increased concentrations of dissolved nutrients, trace metals, and suspended sediments resulting from disposal activities are temporary. Thus, long-term adverse impacts to planktonic organisms are considered minimal. However, bioassay and bioaccumulation tests of Pensacola, Mobile, or Gulfport dredged sediments, using representative planktonic species, have not been conducted to substantiate these predictions.

The potential effects of dumping on mid-Shelf and deepwater plankton would be similar to those discussed for the nearshore Existing Sites. Impacts from dumping on plankton probably are short-term, although some potential exists for bioaccumulation of contaminants in zooplankton (Pequegnat et al., 1978).

NEKTON

Sufficient data to describe the effects of previous dumping on nekton at the Existing Sites are unavailable. Results from the DMRP (Wright, 1978) suggest that fish usually are not directly affected by dredged material disposal. The motility of nektonic organisms generally precludes adverse effects, such as sediment inundation or gill-clogging. However, tests have not been performed to specifically assess the response of representative nekton species to the dumping of Pensacola, Mobile, and Gulfport dredged sediments.

Localized burial of benthic infauna may result in decreases in fish prey items and cause temporary changes in finfish abundance and species composition at the disposal site. Results of the DMRP studies assessing the effects of dredging and disposal on demersal fish were ambiguous. Wright (1978) reported that in some cases relatively higher numbers of fish occurred at an ODMDS after disposal. In other cases, short-term avoidance of turbidity plumes at disposal sites by finfish were observed after dumping. Wright (1978; p. 50) concluded "Some question exists as to whether this behavior represented avoidance of the [dredged] material or was the result of normal seasonality and the sampling techniques that were used."

The effects of dredged material disposal on marine mammals and reptiles have not been investigated. Because of the relatively large size and motility of most species, dumping should result in no significant direct impacts. In addition, the disposal sites represent only a small portion of the total habitat range of the mammal and reptile species occurring in the northeastern Gulf.

The effects on nekton from dumping dredged materials at a site selected in the Mid-Shelf or Deepwater Alternative Areas should be similar to those potentially occurring at the Existing Sites.

BENTHOS

Benthic organisms at the Pensacola, Mobile, and Gulfport ODMDSs will be exposed to increased suspended sediment concentration, temporary changes in water quality, and burial due to dredged material disposal. The short-term (acute) effects of dumping at the Existing Sites have not been investigated. The following discussion of potential impacts on the benthos are based on the results of the DMRP summarized by Wright (1978) and Hirsch et al. (1978), and site-specific infaunal data collected during EPA/IEC surveys (Appendix A). No bioassay or bioaccumulation tests have been performed on representative benthic organisms using the Pensacola, Mobile, or Gulfport dredged sediments.

Results of the DMRP (Hirsch et al., 1978) suggest that no significant adverse impacts to marine organisms are expected from uncontaminated or lightly contaminated suspended particulates. As mentioned previously, concentrations of suspended sediments at the Pensacola, Mobile, and Gulfport Existing Sites are naturally high, and the increases in concentrations which occur following dumping are temporary.

No significant adverse impacts to benthic organisms due to changes in water quality were detected during the DMRP (Hirsch et al., 1978). Water quality changes at Pensacola, Mobile, and Gulfport ODMDSs are expected to be short-term. No persistant alterations of water quality at the Existing Sites or adjacent waters were detected during EPA/IEC surveys (Appendix A).

Direct effects of dumping are burial and smothering of some benthic organisms (Hirsch et al., 1978). Previous investigations of the effects of burial of benthic infauna demonstrated that adverse impacts are typically restricted to species of limited motility, such as some tube-dwelling polychaetes (Richardson et al., 1977). Some motile or active organisms (e.g., bivalves) are capable of burrowing through deposited dredged materials of up to 32 cm in thickness (Maurer et al., 1978). Nevertheless, dredged material disposal at Pensacola, Mobile, and Gulfport ODMDSs will smother some organisms. As a result, densities of benthic organisms may temporarily decline.

Recently deposited sediment may be recolonized by motile infaunal organisms burrowing up through the overburden, or migrating horizontally from adjacent undisturbed areas (Hirsch et al., 1978). Specific recolonization patterns are greatly influenced by the composition of benthic communities in adjacent areas (Oliver et al., 1977). Several of the dominant species collected from the Existing Sites and reference stations during EPA/IEC surveys have been reported as being opportunistic (e.g., small-bodied deposit feeders, such as spionid and capitellid polychaetes), and were considered representative of typical nearshore silt/sand bottom communities in the northeastern Gulf (Appendix A). Opportunistic species are adapted for life in an unpredictable habitat and are capable of rapid population growth in response to naturally (e.g., waves, storms) disturbed conditions (Grassle and Grassle, 1974). Results of DMRP studies indicate that effects of dredged material disposal are minimized at disposal sites in naturally unstable (high-energy) environments; many of the animals of disturbed areas are opportunistic and, therefore, capable of quickly recolonizing newly disposited sediment derived from disposal activities (Hirsch et al., 1978; Oliver et al., 1977).

Recolonization typically occurs within several months, although these rates are dependent upon the nature of the dredged sediment (Oliver et al., 1977). Rates are faster in naturally variable environments (e.g., Pensacola, Mobile, and Gulfport Existing Sites) and when the dredged sediments are similar to the existing sediments (Hirsch et al., 1978). Dredged material disposal occurred in February and March, between the two EPA/IEC survey periods of January and June at the Mobile Existing Site; no dumping occurred between surveys at the

Pensacola or Gulfport Existing Sites (J. Walker, personal communication*). Species composition and abundance were similar between the disposal site and reference stations at Mobile, in June, indicating that recolonization occurred within at least 3 months. The effect of dredging on the benthic fauna of the Gulfport Ship Channel (within Mississippi Sound) was studied by comparing pre- and post-dredging species composition, abundance, and diversity (Water and Air Research Inc., 1975). It was found that repopulation of the benthic community in the dredged areas was rapid, and no discernible effects were noted 6 weeks after the end of the dredging operations (ibid.). Although, recolonization has not been investigated at the Pensacola Existing Site, rates may be slower because of the deeper overburden (compared to Mobile and Gulfport Existing Sites), which would result from disposal at the relatively small site.

Tolerances of deepwater macrofauna for dredged material are generally unknown (Pequegnat et al., 1978). It has been suggested that recovery of benthic populations following disposal may be slower in more stable environments (e.g., mid-Shelf and deepwater areas), and where there is a difference between disposal site and dredged sediments (Hirsch et al., 1978; Wright, 1978). The environment of the Mid-Shelf Alternative Sites is influenced by many of the same physical factors which account for variability in the nearshore area, but to a lesser degree; thus, recovery of benthic populations following dredged material disposal could be slower at sites in the mid-Shelf than in the nearshore region. It may be possible to match grain size characteristics of the dredged material to sediments of the Mid-Shelf Alternative Area; therefore, recovery rates may not be hampered by differences of sediment type. The effects of dredged material disposal on benthic populations at a site selected from the Deepwater Alternative Area may be greater than at sites from either the mid-Shelf or nearshore region because of greater environmental stability at deeper depths. In addition, it is less likely that dredged sediments, particularly from Pensacola and Mobile (primarily sand), would match deepwater sediments. However, in support of deepwater disposal of dredged material, Pequegnat et al. (1978) noted that the density of organisms in deepwater areas is much less than in shallow water.

* J. Walker, U.S. Army Corps of Engineers, Mobile District, Mobile, Alabama (1982)

THREATENDED AND ENDANGERED SPECIES

Several species of endangered whales and turtles move through the northeastern Gulf and offshore water. Infrequent and localized ocean dumping at the Existing or Alternative Sites should have no significant impacts on the food source or passage routes of these animals for the following reasons:

- threatened and endangered species are highly mobile and therefore, could avoid an area in which disposal operations were taking place;
- dredged material disposal has been occurring in these areas for the past 50 years with no detectable adverse effects to threatened and endangered species;
- the feeding ranges of such species are sufficiently large so that the infrequent dumping activities should not significantly affect their feeding activities; and
- site size is small compared to the total feeding area available to such species.

FISHERIES

Shelf waters out to the 90m contour from Pensacola to the Mississippi River Delta comprise some of the most productive fishing grounds in the Gulf of Mexico (Gutherz et al., 1975). Several commercial species may be present within the Pensacola, Mobile, and Gulfport Existing Sites on a seasonal basis (Appendix A). Commercial and recreational fishing activities occur throughout the nearshore region; consequently, some interferences to fishing and fisheries resources may result from dredged material disposal at nearshore Existing and Alternative Sites.

Moe (1963) identified a nearshore area, including the Pensacola Existing Site, as an offshore sportfishing ground. A "heavy fishing effort" occurs within this area during summer for king mackerel, Spanish mackerel, bluefish, and cobia (ibid.). Burial of exposed relief features (e.g., outcrops) with dredged materials may decrease the productivity of these fishing grounds.

The Mobile Existing Site is located in a nearshore area which is utilized on a seasonal basis by several commercial species for spawning, feeding, and breeding activities. The effects of dumping on these activities have not been studied; however, the disposal site represents only a small portion of the total fishing grounds; thus, the relative impact of dumping at the Existing Site on bottomfish resources is probably negligible.

An artificial fish haven is lcoated approximately 1 nmi south of the Mobile Existing Site. Bottom currents may periodically transport dumped sediment toward this fishery area (e.g., during storms). A shipwreck located in the extreme western portion of the Existing Site may represent a recreational fishery area for snappers and groupers. The effect of previous dumping at the Existing Site on this potential resource is unknown.

The Gulfport Existing Site is also within the productive fishing region (Gutherz et al., 1975), and is utilized for spawning, feeding, and breeding by migrating finfish and shellfish. Similar to the Mobile Existing Site, the Gulfport disposal site represents only a small portion of the nearshore fishing grounds. Therefore, localized and intermittent disposal should have a negligible impact on commercial and recreational fisheries.

Dredged material disposal in Mid-Shelf and Deepwater Alternative Areas should have little potential for adversely affecting fisheries resources in the northeastern Gulf. The Mid-Shelf Alternative Area is within the productive fishing region (Gutherz et al., 1975); however, intermittent and localized dumping probably would impact only a small portion of the total breeding, feeding, or spawning areas available to commercially important species. Fishing for pelagic and demersal species does not occur in waters overlying the Deepwater Alternative Area (Pequegnat et al., 1978).

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS AND MITIGATING MEASURES

In general, few significant adverse impacts result from dredged material disposal (Wright, 1978). Short-term effects which would occur at both nearshore and offshore disposal sites include temporary increases in turbidity, releases of dissolved nutrients or trace metals, mounding, and reductions in infaunal abundances and diversity. Results of the DMRP (Hirsch et al., 1978) indicate that impacts within a site are minimized when dumping occurs in variable, high-energy environments (e.g., nearshore Existing and Alternative Sites). Impacts associated with dumping dredged material at a deepwater site would be lessened by the diluting capacity of the receiving waters, the small biomass or organisms that could be affected, and the present limited use of the deep ocean by man (Pequegnat et al., 1978). Therefore, mitigating measures to protect the environment of the ODMDSs may be unnecessary.

Dumping at nearshore ODMDSs may cause some interference with the productive nearshore fisheries. For instance, the Existing Sites are located within passage areas, through which various life stages of nekton seasonally migrate. Migrations into the estuaries primarily occur from January to June and migrations back into the Gulf primarily occur from August to December; therefore, it may not be possible to schedule dumping to avoid migrating populations. Because the ODMDS represents only a small portion of the total nearshore fishing grounds, mitigating measures to reduce interferences with commercial or recreational fishing may not be warranted. Monitoring and periodic bioassay and bioaccumulation tests are recommended; these studies would (1) ensure that the dredged materials do not case toxic effects to marine organisms, (2) facilitate early identification of potential environmental problems, and (3) ensure decisionmaking ability with respect to mitigating measures, if the need arose.

RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Disposal operations at the Existing or Alternative Sites would not jeopardize the long-term productivity of marine resources. Commercial fishing and sportfishing at and near the nearshore Existing or Alternative Sites or Mid-Shelf Alternative Area should not be significantly affected because the sites constitute only a small portion of the total fishing grounds. The Deep-water Alternative Area is offshore of the principal economic and sportfisheries region of the northeastern Gulf. Thus, it is not anticipated that short-term impacts at any of the Alternative Sites would significantly affect long-term productivity.

The principal adverse effect on biota is a temporary reduction in abundances of benthic organisms following dumping. This short-term impact is minor relative to the economic benefits accrued by maintaining the entrance channels to the respective harbors.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible or irretrievable resources committed to the proposed action are:

- Loss of energy (as fuel required by the hopper dredge)
- Loss of economic resources due to costs associated with ocean disposal
- Loss of dredged material for use as landfill or beach nourishment

CHAPTER 5

COORDINATION

This Final EIS was prepared by the Environmental Protection Agency's Ocean Dumping EIS Task Force. It is based on the Draft EIS issued for public review on January 21, 1983, and on the comments received as a result of the public review.

PREPARATION OF THE DRAFT EIS

The Draft EIS was based on a Preliminary EIS prepared by Interstate Electronics Corporation under contract to the EPA. Principal preparer of the Draft was Christopher S. Zarba. Reviews and support were provided by members of the Task Force:

William C. Shilling, Chief
Frank G. Csulak
Michael S. Moyer
Edith R. Young

Reviews and support were also provided by:

Department of the Army
Corps of Engineers
  Water Resources Support Center
  Waterways Experiment Station

PREPARATION OF THE FINAL EIS

The comments received on the Draft EIS and the EPA's responses to those comments are contained in pages 5-4 through 5-37. Where appropriate, revisions were made to the Draft EIS and are included in the Final EIS. In addition the Florida Department of Environmental Regulation was forwarded a preliminary copy of the Final EIS. EPA responses to their comments are contained in pages 5-38 through 5-44. Further comments were received from the State of Florida before the publication of the Final EIS. Those comments and EPA responses are contained in pages 5-46 through 5-55.

Principal preparers of the Final EIS were Christopher S. Zarba and Christopher A. Provost. Reviews and support were provided by members of the Ocean Dumping EIS Task Force.

William C. Shilling, Chief
John M. Hill
Edith R. Young

SECTION 7 COORDINATION

During the studies leading to the preparation of the Draft EIS, contacts were made with various agencies regarding any possible effects on endangered and/or threatened species. The information resulting from these contacts was evaluated and the evaluations included in the Draft EIS. However, it was apparent from the Fish and Wildlife Service comment on the Draft EIS that the Services did not consider the previous contacts sufficient to fulfill the coordination requirements of Section 7 of the Endangered Species Act of 1973. In view of the foregoing, EPA wrote the Fish and Wildlife Service and the National Marine Fisheries service initiating formal consultation.

The EPA wrote the Fish and Wildlife Service on June 17, 1983, initiating formal consultation. The Fish and Wildlife Service replied on July 25, 1983, stating that it was their belief that there are no federally listed Endangered or Threatened species under the jurisdiction of the Fish and Wildlife Service in the immediate vicinity of the impact area of the project nor will any such species be affected by the project (Figure 5-1).

The EPA wrote the National Marine Fisheries Service on September 16, 1983, initiating formal consultation. The National Marine Fisheries Service replied on September 20, 1983, concurring with the EPA's determination that endangered/threatened species under their purview would not be adversely affected by the proposed action (Figure 5-2).

COASTAL ZONE MANAGEMENT PLANS CONSISTENCY DETERMINATIONS

The EPA has reviewed the Coastal Zone Management Plans of the States of Alabama, Florida, and Mississippi. Based on the review and subsequent evaluations, the EPA has determined that the proposed action is consistent with the CMZ Plans of these states.

(Figure 5-1)

ADDRESS ONLY THE DIRECTOR
FISH AND WILDLIFE SERVICE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
WASHINGTON, D.C. 20240

In Reply Refer To:
FWS/OES

JUL 25 1983

Mr. Christopher S. Zarba
Criteria and Standards Division (WH-585)
Office of Water
U.S. Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Zarba:

We have reviewed the Draft Environmental Impact Statement (DEIS) for the Pensacola, Florida; Mobile, Alabama; and Gulfport, Mississippi, Dredged Material Disposal Site Designation, as requested by letter of June 17, 1983.

Based on our records, it is our belief that there are no federally listed Endangered or Threatened species under the jurisdiction of the Fish and Wildlife Service in the immediate vicinity of the impact area of the project nor will any such listed species be affected by the project. In view of this, the Service believes your Section 7 requirements under the Endangered Species Act of 1973, as amended (Act), have been satisfied. However, obligations under Section 7 of the Act must be reconsidered if (1) new information reveals impacts of this identified action that may affect listed species or Critical Habitat in a manner not previously considered, (2) this action is subsequently modified in a manner which was not considered in this review, or (3) a new species is listed or Critical Habitat determined that may be affected by the identified action.

We appreciate the opportunity to review your proposed action. If you have any questions concerning the consultation process, please contact Brian Cole, Chief, Branch of Management Operations, 235-2760.

Sincerely yours,

John L. Spinks, Jr.
Chief, Office of Endangered Species

(Figure 5-2)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Region
9450 Koger Boulevard
St. Petersburg, FL 33702

September 20, 1983 F/SER23:AM:cf

Mr. William C. Shilling, Chief
Ocean Dumping EIS Task Force
U.S. Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Shilling:

This responds to your September 16, 1983, letter regarding the proposed Pensacola, Florida; Mobile, Alabama; and Gulfport, Mississippi dredged material disposal site designation in the Gulf of Mexico. A biological assessment (BA) was transmitted pursuant to Section 7 of the Endangered Species Act of 1973 (ESA).

We have reviewed the BA and concur with your determination that populations of endangered/threatened species under our purview would not be adversely affected by the proposed action.

This concludes consultation responsibilities under Section 7 of the ESA. However, consultation should be reinitiated if new information reveals impacts of the identified activity that may affect listed species or their critical habitat, a new species is listed, the identified activity is subsequently modified or critical habitat determined that may be affected by the proposed activity.

Sincerely yours,

Charles A. Oravetz, Chief
Protected Species Management Branch

COMMENTS ON THE DRAFT EIS AND COMMENT RESPONSES

National Oceanic and Atmospheric Administration
Washington, D.C. 20230

OFFICE OF THE ADMINISTRATOR

March 14, 1983

Mr. Christopher S. Zarba
Criteria and Standards Division (WH-585)
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Zarba:

This is in reference to your draft environmental impact statement entitled "Pensacola, FL, Mobile, AL, and Gulfport, MS, Dredged Material
1-1 Disposal Site Designation." Enclosed are additional comments from the National Oceanic and Atmospheric Administration.

Thank you for giving us an opportunity to provide these comments.

Sincerely,

Joyce M. Wood

Joyce M. Wood
Chief, Ecology and
Conservation Division

Enclosure

National Oceanic and Atmospheric Administration
Washington, D.C. 20230

OFFICE OF THE ADMINISTRATOR

February 28, 1983

Mr. Christopher S. Zarba
Criteria and Standards Division (WH-585)
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Zarba:

This is in reference to your draft environmental impact statement
entitled "Pensacola, FL, Mobile, AL, and Gulfport, MS, Dredged Material
1-1 Disposal Site Designation." Enclosed are comments from the National
Oceanic and Atmospheric Administration.

The Maritime Administration is now part of the Department of Transportation; therefore these comments do not include any review by the Maritime Administration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving four copies of the final environmental impact statement.

Sincerely,

Thomas E. Bigford for

Joyce M. Wood
Chief, Ecology and
Conservation Division

Enclosures

National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Region
9450 Koger Boulevard
St. Petersburg, FL 33702

February 25, 1983

F/SER11/WNL
(313)893-3503

Mr. Christopher S. Zarba
Criteria and Standards Division (WH-585)
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Zarba:

The National Marine Fisheries Service has reviewed the Draft Environmental Impact Statement for the Pensacola, Florida, Mobile, Alabama, and Gulfport, Mississippi, Dredged Material Disposal Site Designation.

Based on the information provided we can identify no significant problems with respect to adverse impacts on fishery resources. However, this Region's Protected Species Management Branch has identified some deficiencies regarding whales and sea turtles (enclosure 1).

Should new or additional data become available, we would appreciate an opportunity to review the information and provide comments.

Sincerely yours,

Richard J. Hoogland, Chief
Environmental Assessment Branch

Enclosure

National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Region
9450 Koger Boulevard
St. Petersburg, FL 33702

February 15, 1983

TO: F/SER11 - Richard J. Hoogland

FROM: F/SER23 - Andreas Mager, Jr.

SUBJECT: Review of DEIS 8301.11 - Pensacola, FL, Mobile, AL, and Gulfport, MS, Dredged Material Disposal Site Designation

The Protected Species Management Branch has received the subject DEIS for review and comment. The following comments are provided for transmittal to PP/EC.

General Comments

The section pertaining to endangered species is entirely
inadequate and statements are made regarding whales that apparently
are based on information that does not exist. The specifics are
1-2 detailed later. Also, project impacts on endangered and threatened
sea turtles in the water are not even discussed. Furthermore, the
DEIS should list and discuss impacts to each endangered and threatened
species that was considered in the document. This should be in the
form of a biological assessment conducted as described in Attachment 1.

We are also very concerned that no Section 7 Consultation,
required by the Endangered Species Act of 1973 (ESA), was conducted
on the subject activity with the National Marine Fisheries Service.
This potentially places EPA in violation of the ESA, particularly
1-3 if the Agency action occurs and it is later determined that
EPA's actions have resulted in the deaths of endangered or threatened
species. The procedures involved in the Section 7 Consultation
process are provided by Attachment 2. We urge EPA to initiate
consultation on this and other dump site designations to avoid time
delays and future problems.

Specific Comments

Page 4-16, Paragraph 1 - THREATENED AND ENDANGERED SPECIES

Five species of endangered whales, including four baleen whales
1-4 and one toothed whale are believed to occur in the Gulf of Mexico
(see attachment 3).

ENCLOSURE 1

For none of these whales in the Gulf of Mexico are life history paramenters, population sizes, or movements known.[1] Therefore, the basis for the statement that, " . . . ocean dumping at the Existing or Alternative Sites should have no significant impacts on the food source or passage routes of these animals," should be provided, particularly since migration routes for whales in the Gulf of Mexico are unknown. Feeding habits are also poorly known.

1-5 This section also does not discuss project impacts on endangered/threatened sea turtles (Attachment 3) in the water. Since sea turtles may occur in the dump areas, the DEIS must also address potential project impacts to these animals while in the water.

Page 5-1, CHAPTER 5 - COORDINATION

This section should include the results of the Section 7 ESA Consultation when completed.

Attachments

1-6

[1]Schmidly, David J. 1981. Marine mammals of the Southeastern United States coast and the Gulf of Mexico. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-80/41, 163 pp.

ATTACHMENT 1

Guidelines for Conducting a Biological Assessment

(1) Conduct a scientifically sound on-site inspection of the area affected by the action. Unless otherwise directed by the Service, include a detailed survey of the area to determine if listed or proposed species are present or occur seasonally and whether suitable habitat exists within the area for either expanding the existing population or reintroducing a new population.

(2) Interview recognized experts on the species listed, including those within the Fish and Wildlife Service, the National Marine Fisheries Service, state conservation agencies, universities and others who may have data not yet found in scientific literature.

(3) Review literature and other scientific data to determine the species distribution, habitat needs, and other biological requirements.

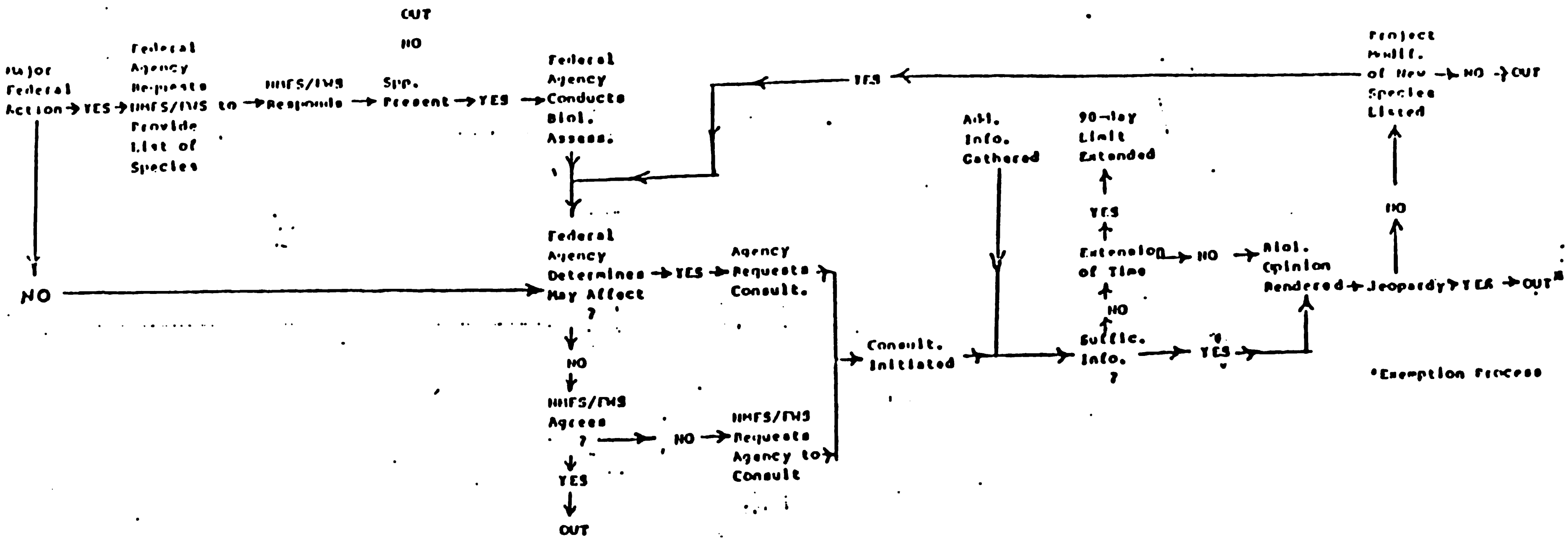
(4) Review and analyze the effects of the action on the species, in terms of individuals and population, including consideration of the cumulative effects of the action on the species and habitat.

(5) Analyze alternative actions that may provide conservation measures.

(6) Conduct any studies necessary to fulfill the requirements of (1) through (5) above.

(7) Review any other information.

INTERAGENCY CONSULTATION FLOW CHART



Endangered and Threatened Species and Critical Habitats Under NMFS Jurisdiction

Gulf of Mexico

LISTED SPECIES	SCIENTIFIC NAME	STATUS	DATE LISTE
Finback Whale	Balaenoptera physalus	E	12/2/
Humpback Whale	Megaptera novaeangliae	E	12/2/
Right Whale	Eubaleana glacialis	E	12/2/
Sei Whale	Balaenoptera borealis	E	12/2/
Sperm Whale	Physter catodon	E	12/2,
Green Sea Turtle	Chelonia mydas	E	7/28
Hawksbill Sea Turtle	Eretmochelys imbricata	E	6/2/
Kemp's (Atlantic) Ridley Sea Turtle	Lepidochelys kempi	E	12/2/
Leatherback Sea Turtle	Dermochelys coriacea	E	6/2/
Loggerhead Sea Turtle	Caretta caretta	Th	7/2

SPECIES PROPOSED FOR LISTING
None

CRITICAL HABITAT
None

CRITICAL HABITAT PROPOSED FOR LISTING
None

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
XXXXXXXXXXXXXXXX NATIONAL OCEAN SERVICE
Rockville, Md. 20852

March 2, 1983

N/OMS3:MD

TO: N/MB - Robert B. Rollins

FROM: N/OMS - Wesley V. Hull /s/

SUBJECT: DEIS 8301.11, Pensacola, FL, Mobile, Alabama, and Gulfport, MS, Dredged Material Disposal Site Designation

This DEIS represents, for the most part, a routine designation of long-used and demonstrably necessary dredged material disposal sites. The one significant change is the enlarging of the relatively small Pensacola site from 0.64 n mi^2 to 2.48 n mi^2. This larger area reflects historical usage and is also intended in ensure that sediment overburden at the site stays well below the 25 cm level, where vertical migration of benthic organisms might be affected. Overall, these sites have been used satisfactorily for at least 12 years, and as far as is known, represent no significant threat to human health or the marine environment.

There is, however, some reason to continue with a meaningful research and monitoring program at the sites. As the DEIS says on p. 4-1 "the potential for bioaccumulation ... is unknown. Specific tests ... have not been performed." These statements do not warrant exclusion of the site, but do warrant continued research and testing to determine the disposal procedures which have least impact on the marine environment. Such a program should also include investigating for the presence of pathogenic bacteria, amoebae, and viruses in the material. Such pathogens can exist in viable form even where coliform counts are negative.

As we have commented before, a significant continuing program of monitoring and research should be included in DEIS's of this type, and should reflect coordination among the various U.S. Army Corps of Engineers districts to ensure consistency of approval and comparability of results. An appropriate monitoring program should include quantitative measures of remobilization and bioavailability of contaminants. Only in this way can rational limits on allowable amounts of material and rate of dumping; as functions of material constituents, disposal location, regional dynamics, and biological population; be derived.

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
Atlanta GA 30333
(404) 452-4095

February 28, 1983

Mr. Christopher S. Zarba
Criteria and Standards Division (WH-585)
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Zarba:

We have reviewed the Draft Environmental Impact Statement (EIS) for the Pensacola,
Florida, Mobile, Alabama, and Gulfport, Mississippi, Ocean Dredged Material Dis-
2-1 posal Site (ODMDS) Designation. We are responding on behalf of the U.S Public
Health Service and are offering the following comments for your consideration in
preparing the final document.

According to the EIS, the potential for bioaccumulation of contaminants associated
with dredged material into the food chain and into seafood consumed by humans is
unknown for the Pensacola, Mobile, and Gulfport dredged sediments. We believe this
2-2 information should be made available for Gulfport Harbor and Pensacola because of
the location of the site in near-shore waters and the moderately elevated levels
of arsenic, zinc, and chromium at Gulfport and zinc and chromium at Pensacola.
While ". . . it is unlikely that transient fish and shrimp species captured and
consumed by humans could obtain sufficient quantities of contaminants from food
items found within the disposal site to render them toxic or unpalatable . . .,"
". . . subsequent bioaccumulation tests would be necessary for verification."

While the discharge of dredged material ". . .should not appreciably degrade the
2-3 water quality in regions adjacent to the Pensacola, Mobile, and Gulfport ODMDS's,"
will these discharges meet the limiting permissible concentration (LPC) pursuant
to 40 CFR Part 227.27 of the Marine, Protection, Research and Sanctuaries Act of
1972?

We appreciate the opportunity to review this Draft EIS. Please send us a copy of the final document when it becomes available. Should you have any questions about our comments, please contact Mr. Robert Kay or me at FTS 236-6649 or 236-4096, respectively.

Sincerely yours,

Frank S. Lisella, Ph.D.
Chief, Environmental Affairs Group
Environmental Health Services Division
Center for Environmental Health

DEPARTMENT OF THE ARMY
WATER RESOURCES SUPPORT CENTER, CORPS OF ENGINEERS
KINGMAN BUILDING
FORT BELVOIR, VIRGINIA 22060

REPLY TO
ATTENTION OF:

7 [illegible]

WRSC-D

Mr. Chris Zarba
Criteria and Standards Division (WH-585)
U. S. Environmental Protection Agency
401 M Street, S. W.
Washington, D. C. 20460

Dear Mr. Zarba:

The Corps of Engineers has reviewed the EPA Draft Environmental Impact Statement for the Pensacola, Mobile and Gulfport Ocean Dredged
1 Material Disposal Site Designation. Enclosed are our general and specific review comments on the subject document.

We concur with the document conclusions that the EPA interim designated ocean disposal sites at Mobile, Gulfport, and Pensacola are acceptable locations for the ocean disposal of dredged material and should receive final EPA designation for continuing use.

Sincerely,

William R. Murden

William R. Murden, P. E.
Chief, Dredging Division

Enclosures

Copies Furnished:

Mobile District (SAMPD-EE)
SADPD-R

US Army Corps of Engineers
Comments on Draft EIS
Pensacola, Mobile, Gulfport
Ocean Dredged Material Disposal Sites Designation

General Comments.

1. The second full paragraph on Page 1-4 states that the sites "would be
·2 designated for the disposal of dredged material." Other sections of the Draft
EIS could lead the reader to believe that only maintenance material from the
out bar channels of the existing Federal projects could be discharged at the
sites. This point of possible confusion should be clarified in the Final EIS.

2. Maximum flexibility should be maintained in determining the need for and
·3 design of any monitoring plan. The proposed elements for a monitoring plan
presented in the Draft EIS should form the basis for development of a practical
and scientifically meaningful monitoring plan. However, the need for any
actual development of a monitoring plan will be determined by the District
Engineer or the Regional Administrator.

3. The Alabama, Florida, and Mississippi State Historic Preservation Officers
·4 should be contacted and their comments obtained on the potential effects to
cultural resources by the proposed action.

4. A more extensive review should be conducted to assess the potential for
·5 submerged cultural resources within the alternate disposal areas.

5. Recommend that the annual dredging volumes used in the Draft EIS be rounded
·6 to the nearest thousand cubic yards.

6. Request references cited "J. Walker, Personal Communication" and
·7 "Mr. D. Barrineau, Personal Communication" be changed to "US Army Corps of
Engineers" with Mr. Walker and Mr. Barrineau listed as references, if
necessary.

7. The location of the disposal sites relative to artificial fishing reefs
·8 should be presented and potential impacts discussed in the Final EIS.

Specific Comments.

1. Page viii - The Mississippi State Historic Preservation Officer (Department
·9 of Archives and History) should be included in the list of state agencies
contacted for comments on the Draft EIS.

·10 2. Page xi - February 1983 date should be corrected.

·11 3. Page xx - The statement "Nearshore waters are characteristically turbid"
should be qualified (e.g. seasonality due to flood runoff, storm events, etc.)
since data presented in Appendix A do not indicate high turbidity.

4. Page xxii - The words "(in separate volume)" should be deleted from the
·12 last paragraph.

3-13 5. Page 2-2 - February 1983 date should be corrected.

6. Page 2-39 - The word "sites" should be substituted for "alternatives" in
3-14 the first line of paragraph 3.

7. Pages 3-3 and 3-4 - The date on references in Figures 3-1 and 3-2 should be
3-15 checked since data on the graphs are a later date.

8. Page 3-73 - Last paragraph is out of date and needs to be updated.
3-16

9. Page 3-80 - Delete Section 4. ARAP Sediment Transport Model since the model
3-17 was not developed. Line 1.a. should read "Major Community Groups." Line 1.d. should read "Abundance, diversity" and line 1.e. should be added to read "Correlation with physical chemical factors." Delete line 2.f. and add a line 3.d. to read "Life history requirements."

10. Page 4-11 - May's work was in estuaries. Suggest changing the wording in
3-18 last paragraph from "near shore to "inshore."

United States Department of the Interior
OFFICE OF ENVIRONMENTAL PROJECT REVIEW
Southeast Region / Suite 1384
Richard B. Russell Federal Building
75 Spring Street, S.W. / Atlanta, Ga. 30303

MAR 1 1 1983

ER-83/67

Mr. Christopher S. Zarba
Criteria and Standards Division (WH-585)
U.S. Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Zarba:

4-1 The Department of the Interior has reviewed the draft environmental impact statement (EIS) for the Pensacola, Florida; Mobile, Alabama; and Gulfport, Mississippi; Ocean Dredged Material Disposal Site Designation and we offer the following comments:

General Comments

4-2 We find that the draft EIS adequately describes the proposed action and most of the generic impacts that will probably result from the action. We do not believe that the draft EIS adequately describes the specific areas that are proposed for site designation or the potential for conflicting uses of the sites.

4-3 The Report of Field Survey (Appendix A) describes the biological, chemical, geological, and physical aspects of the existing disposal sites. The sampling grid for the soft-bottom Mobile site is adequate. However, the use of only two samples at the Gulfport and Pennsacola sites seriously limits the value of any conclusions drawn from the survey.

4-4 Geophysical surveys such as side-scan sonar and subbottom profiling should have been performed to determine the presence of natural hard-bottom areas, shipwrecks, and other areas of relief which are valuable areas for fisheries. Surveys of this type are required of oil and gas operators by the Minerals Management Service (MMS) to determine the presence of live-bottom communities prior to drilling operations. The data relied upon in this EIS is inadequate to determine if hard-bottom areas exist in the alternative disposal sites. Further, the EIS seems to overlook the biological significance of the shipwrecks serving as hard-bottom substrate supporting benthic communities important to commercial and sports fisheries. Faunal surveys are needed to determine the productivity of benthic communities on shipwrecks located in or near the proposed sites.

4-5 Generally, the EIS relies too much on assumptions regarding conditions at nearshore and deeper water alternative sites and not on observations.

Specific Comments

Pages 2-9, 2-32, 3-73, 3-74, and 3-75. Information regarding oil and gas
leasing and operations in the areas considered in the EIS is incomplete or
erroneous in some cases. Blocks in the Deepwater Alternative Area are
6 proposed for leasing, and there are active leases in the Midshelf Alternative
Area and the Mobile Existing Area. We recommend full coordination with MMS's
Gulf of Mexico Outer Continental Shelf office in Metairie, Louisiana, to
correct these discussions.

Page 2-30, paragraph 3. If indeed there is no available information on the
potential for bioaccumulation of containments in infaunal, epifaunal, and
planktonic organisms exposed to dredged material, then this should have been
-7 addressed as part of the contract studies performed for the U.S. Environmental
Protection Agency (EPA) for this EIS.

Page 2-32, paragraph 4. The EIS does not address potential conflicts with the
development of marine nonenergy minerals such as sand, sulfur, phosphate, and
-8 heavy minerals. This discussion should consider these resources and any
adverse impacts the proposed action may have upon their development.

Page 2-34, paragraph 2. Information on phytoplankton and zooplankton in
existing or alternative sites is lacking or dated. Same comment as for
-9 page 2-32.

Page 3-19, paragraph 4 and page 3-22, paragraph 1. The EIS notes recently
slumping and active mudflows associated with the steep slopes of the Deepwater
-10 Alternative Area. Dumping spoil materials at this site will add to the
sediment instability of these slopes. This poses an engineering constraint or
hazard to potential oil and gas operations in this area and has not been
considered in the EIS.

Page 3-25, paragraph 2 and page 4-19, paragraph 2. The EIS discusses sediment
transport and erosion in the Mississippi barrier islands area but does not
-11 assess what effects the proposed action may have on these islands. We are
concerned that disposal of material dredged from the Ship Island Bar Channel
outside of the active littoral drift zone will adversely impact beach
nourishment at Ship Island. In addition, disposal of the dredged material in
the Gulfport Nearshore Alternative Site may cover available sources of sand
for beach nourishment or result in disposed fine sediments being driven
onshore at Ship Island due to to prevailing wind driven wave action over this
shallow disposal area.

Page 4-12 and 4-13. The discussion on nekton states that "sufficient data to
describe the effects of previous dumping on nekton at the existing sites are
unavailable," and concludes that effects on nekton from dumping at "the Mid-
-12 Shelf or Deepwater Alternative Areas should be similar to those potentially
occurring at the existing sites." This is internally contradictory and
reflects the paucity of information on fishery resources discussed in the EIS.
Same comment as for page 2-32.

Page 5-1. We believe that early coordination with the U.S. Fish and Wildlife Service and MMS in this Department and with the National Marine Fisheries
4-13 Service would have provided EPA with some information currently missing from this EIS. We recommend full coordination with these and other Federal Agencies responsible for resources affected by these projects.

Thank you for the opportunity to comments on this EIS.

Sincerely,

James H. Lee

James H. Lee
Regional Environmental Officer

STATE OF FLORIDA

Office of the Governor

THE CAPITOL

TALLAHASSEE 32301

BOB GRAHAM
GOVERNOR

March 29, 1983

Mr. Christopher S. Zarba
Criteria and Standards Division (WH-585)
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Zarba:

5-2 Pursuant to your request and in accordance with Florida Statutes, Chapter 23 and as provided by the Council on Environmental Guidelines, we reviewed your Draft Environmental Impact Statement (DEIS) for the Pensacola, Fla., Mobile, Ala., Gulfport, Miss., Dredge Material Disposal Site Designation. This document describes a proposed action designating disposal sites off the coast of three Gulf states. Although there are proposed sites off the States of Mississippi and Alabama that may have a direct impact on Florida, our principal concern during this review was focused on the Pensacola designations The Deepwater Alternative site 61 miles from Perdido Key was also considered.

5-3 The three proposed Pensacola sites are 1.5, 2.3 and 7.2 miles from Perdido Key and are within the territorial waters of Florida. The material to be dumped at the Pensacola site principally will be from dredged material obtained from the Pensacola Harbor Entrance Channel and other adjacent channels.

5-4 During the past several years, a relatively small amount of material was dumped at the existing disposal site although a large amount was dumped in 1971. Your agency's analysis shows that this material taken from the entrance channel was 93 percent sand.

5-5 The State of Florida has consistently held the position that suitable sand material taken from Florida inlets be placed on or near adjacent beaches. To waste such a resource in the face of a continuous beach erosion problem is inexcusable. Therefore, we will continue to recommend that suitable sand not be dumped in the Gulf but placed on a beach or at least in the littoral zone.

The Department of Natural Resources (DNR) is currently reviewing this document and plans to furnish comments shortly. When DNR's review is complete, comments will be forwarded to your agency. The Department of Environmental Regulation (DER) has completed an indepth review of this
5-6 document and its comments are attached. The DER concludes that this DEIS overall lacks site specific data on which to base a decision. However based on the information presented, DER finds that mid-shelf disposal is totally unacceptable and near shore disposal has the potential to negatively effect (amenity areas) and fisheries. For these reasons and the lack of information concerning the Deepwater alternative site, DER suggests that the preferred alternative be the "no active alternative." They further suggest that acceptable material be examined for disposal on suitable land sites.

Clearly the DEIS lacks specific environmental and economic data. Considering these omissions, we concur with DER's findings and suggest that a more extensive analysis of
5-7 the environmental and economic impacts of ocean dumping be done before any site designation process.

As previously indicated, the three Pensacola sites are within the territorial waters of the State of Florida (Florida's territory extends three leagues into the Gulf
5-8 of Mexico); therefore, in accordance with Chapter 253, Florida Statutes, your agency, prior to designating a site, must obtain permission from the Board of Trustees of the Internal Improvement Fund. In this regard we suggest that you contact the Division of State Lands in the Department of Natural Resources to obtain the necessary state easements or leases.

The draft statement does not include a federal consistency determination. Such a determination is required by the
5-9 Coastal Zone Management Act and we request that your agency submit its consistency findings if you intend to proceed with this proposal. This determination should be submitted to:

Mr. David Worley, Administrator
Florida Office of Coastal Management
Department of Environmental Regulation
2600 Blair Stone Road
Twin Towers Office Building
Tallahassee, Florida 32301

Thank you for giving us the opportunity to review and comment on this draft statement. We look forward to your response to our letters and those that may be submitted later by DNR.

Sincerely,

Walt O. Kolb

Walter O. Kolb
Sr. Governmental Analyst

WOK/bq

Attachment

cc: Mr. John Outland
Mr. Art Wilde
Mr. George Percy

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

February 7, 1983

Mr. Walt Kolb
Senior Governmental Analyst
Office of Planning and Budgeting
Office of the Governor
415 Carlton Building
Tallahassee, Florida 32301

Dear Walt:

Re: Draft Environmental Impact Statement for Pensacola, FL, Mobile, AL, and Gulfport, MS, Dredged Material Disposal Site Designation SAI No. FL8301200640

6-1 The Department of Environmental Regulation reviewed the referenced document and offers the following comments. The information provided on the Alabama and Mississippi sites was not reviewed in detail; however the general inadequacies discussed pertaining to the Pensacola, Florida site are also applicable to these other sites.

6-2 The proposed action for Pensacola is the selection of an enlarged version of the existing (interim) nearshore site as the designated area to receive dredged materials from maintenance dredging of Pensacola Harbor Entrance Channel. DER's Office of Coastal Zone Management is completing a rule that addresses the problem of maintenance dredging spoil disposal at Pensacola. We recommend that the Corps of Engineers coordinate more closely with that office.

6-3 Upland disposal methods were inappropriately eliminated as possible alternatives. These methods were considered by the CE to be less than desirable than ocean disposal due to a lack of appropriate equipment and increased cost of transporting dredge material. Interestingly, deepwater disposal is one of the discussed alternatives, requiring a transportation distance of 60 miles or more. No economic analysis or cost comparison is provided to determine if the elimination of upland disposal as an alternative based on economic concerns is warranted. The description of the dredged material provided in the document indicates that it may be excellent material for beach renourishment projects or resale. Oceanic disposal of such materials is a waste of a valuable resource for which many taxpayers dollars are spent. Adequate tests should be conducted on the dredged material to determine its suitability for beach renourishment.

6-4 Page 1-7 of the DEIS states "(t)his document has been prepared to provide the public and decision makers with relevant information to assess the impacts associated with the final designation..." No intelligent decisions can be based on the impoverished information included in this DEIS. The study conducted in Pensacola (EPA/IEC) was minimal, simplistic, and in an inappropriate time frame to provide sufficient information. No bathymetric surveys have been conducted at the Pensacola site nor have currents been measured. Based on these inadequacies it is not surprising that "no long-term or cumulative effects have been detected" (p. xiii); no work has been done which would detect them. Additionally, no studies have been done at the sites to investigate short term effects. Deficiencies in the EPA/IEC study include:

1) Sampling dates -

Samples were collected twice, January and June 1980. No material had been disposed since 1975. (table 3-17). At least one major hurricane had impacted the area in that time period redistributing existing dredged material.

2) Stations -

Only one station at the existing site and one outside were sampled. No data was collected on the nearshore alternative site (existing site extension). This limited sampling did not generate enough data to characterize the sites. No samples were taken at the mid-shelf or deepwater sites.

3) Numerical variability of organisms -

Two collections cannot provide information on impacts to the collected organisms' life histories and population patterns. Seasonal collections taken one year minimum are needed to merely understand background variability.

4) Chemistry data -

Why were Cd, Hg, & Pb the only metals analyzed? No analysis was conducted for mid-shelf or deepwater alternatives. What are the locations of the water quality stations in Table 3-1? What were the depths? Averaging over depth and time is inappropriate treatment of water quality data.

Alternative Selection

6-5 1. No action: p. vii states this alternative would require the CE to (1) justify an acceptable alternative disposal method such as land based (see 2. below), (2) develop information sufficient to select an acceptable oceanic disposal site or (3) modify or cancel proposed dredging projects.

Based on the lack of information provided in the DEIS we cannot recommend any of the alternative sites therefore the CE should proceed with one of the actions listed above.

6-6 2. Non-oceanic disposal: As discussed above this alternative should be investigated. The final EIS should provide a complete economic analysis including long-term environmental and monetary benefits from reuse of appropriate materials. This alternative, if the materials are suitable, would be our preference for dredged material disposal.

6-7 3. Near shore alternative: This is the CE preferred alternative. "The CE has indicated that the coordinates initially furnished to the Environmental Protection Agency (EPA) for this disposal area represented more of a target area than the actual area of use." The CE has requested the disposal area be enlarged to reflect the area used in the past. This statement by the CE raises grave concerns about potential area extent of impacts of DMD. The selection of the near shore alternative has the potential to impact amenity areas and recreational/commercial fisheries. Tidal currents, surge, and wave action all move toward Pensacola Inlet (fig 3-9). This potential is not discussed in the document.

6-8 Repeated reference is made relative to the excellent fisheries in the nearshore area. The possibility of habitat and economic loss is discounted and not discussed. Increasing the area of disposal will increase the area that becomes unsuitable for these fisheries. No documentation was provided to substantiate the supposition that recolonization would be improved.

6-9 No information was provided on how this area was surveyed to determine habitat characteristics. Adequate investigations should be conducted and documented to provide important decision-making information.

6-10 4. Mid shore alternative. This alternative should be immediately dropped from consideration due to the prime habitat value of the hard-bottom and rocky outcrops (p. 2-12, 2-20).

6-11 5. Deepwater alternative. No surveys have been conducted on this area to define habitats, biota, currents, water/sediment chemistry, etc. Until such information is obtained, no decision can be made on using this site. The statement that deepwater areas, due to their relative stability, may suffer more deleterious impacts than a high energy area is purely conjectural and unsubstantiated. If future investigations determine that the deepwater site has acceptable characteristics to receive DMD, it would be our preferred oceanic disposal. Again, as mentioned earlier, cost comparison should be made between this alternative and land disposal.

Mr. Walt Kolb
Page Four
February 7, 1983

6-12 In summary, there is a total lack of site specific data on which to base a decision. Most justifications provided in the document were conjectural. Mid shelf disposal is totally unacceptable and nearshore disposal has the potential to negatively effect amenity areas and fisheries. No site specific information was provided on the deepwater site. For these reasons our preferred alternative is the "No Action" alternative. We recommend investigation of suitable land based disposal unless the material is deemed unacceptable.

6-13 The DEIS did not include a federal consistency determination as required by the Coastal Zone Management Act. Both the site designation and dumping permitting processes require this scrutiny, as explained in 15 CFR Part 930, Subpart C. We request that the EPA submit their consistency findings to the state as soon as possible. The collective comments provided for the DEIS should comprise the substance of the determination.

We appreciate the opportunity to comment on this draft EIS.

Sincerely,

John B. Outland
for Patricia J. Dugan
Environmental Specialist
Intergovermental Programs
Review Section

PJD/jb

cc: Robert Kriegel
Marvin Collins
Joe Ryan

EPA RESPONSES TO COMMENTS ON DRAFT EIS

1-1 EPA thanks the Department of Commerce (Office of the Administrator, National Marine Fisheries Service and National Ocean Service) for reviewing the Draft EIS.

1-2 As a result of the comment, the section on endangered species in Chapter 4 has been rewritten to provide clarification of EPA's evaluations (page 4-16). The section 7, Endangered Species Act Coordination has been completed. F&WS and NMFS responses are included on page 5-3a and 5-3b.

1-3 Contacts were made with a number of agencies during the studies leading to the preparation of the Draft EIS. The information resulting from these contacts was evaluated and used in the preparation of the Draft EIS. However, it appears from the comment that these contacts were not vviewed by the National Marine Fisheries Service as fulfilling the consultation requirements of Section 7 of the Endangered Species Act of 1973. The Section 7 consultations with the National Marine Fisheries Service have now been completed (See Chapter 5)

1-4 The statement was correct as presented. However, the section on page 4-16 has been revised (see response 1-2). The endangered whales shown in attachment 3 are listed on pages 3-54 and 3-55 and noted as being endangered by an *.

1-5 See comment response 1-3, and 1-4.

1-6 See comment response 1-3, and 1-4.

1-7 EPA agrees with this comment.

1-8 EPA agrees with this statement. The proposed guidelines for a monitoring program can be found on page 2-40 to 2-45. It should be noted page 2-45 covers accumulation in biota.

1-9 See comment response 1-8.

2-1 EPA thanks the Department of Health and Human Services for reviewing the Draft EIS.

2-2 As stated on pages 3-35 and 3-36 of the Draft EIS, concentrations of trace metals and CHC's were either low or below FDA action levels. The Draft EIS also identifies bioaccumulation of contaminants in marine biota as one of the priority items to be addressed by a monitoring program. (see pages 2-40 to 2-45).

2-3 As stated on page 4-4, "Disposal of dredged material should not appreciably degrade the water quality in regions adjacent to the Pensacola, Mobile, and Gulfport ODMDSs." As stated on page 2-28 "---EPA/IEC surveys did not detect significant adverse nor cumulative effects from previous dredged material disposal---. Water column and sediment parameters measured at the Existing Sites were typically similar in value to measurements taken at the reference stations---." Dredged materials considered for future disposal at the sites must meet the requirements of §227.13., ODR. These evaluations are made in connection with each Federal project and permit application. As stated on page 1-20 "---U.S. Ocean Dumping Criteria are based on the provisions of the London Dumping Convention (LDC)---."

3-1 EPA thanks the U.S. Army Corps of Engineers for reviewing the Draft EIS. It is noted that the COE concurs with the proposed action.

3-2 The proposed action is the designation of an ocean dredged material disposal site. This does not limit disposals to only materials resulting from operation and maintenance dredging. The determination of what dredged materials will be for disposal at a given site will be made by the EPA Regional Administrator and COE District Engineers. In order to avoid confusion, reference to only operation and maintenance dredging in subsequent sections have been changed to reflect the designation as proposed on page 1-4.

3-3 EPA agrees there should be flexibility in the design of the monitoring plan. Thus, the monitoring elements are presented as proposed rather than fixed requirements. However, EPA does not agree there is any flexibility in the need for monitoring or the development of a monitoring plan by the District Engineer and/or the Regional Administrator.

3-4 During the early development of the EIS, contacts were made with a number of agencies regarding cultural resources. The results of these contacts are reported on pages 2-36 and 2-37, with appropriate footnotes as to the sources of the information. The location and appraisal of off-shore cultural resources is a continuing effort. Any new information that is developed will be considered in the management of the sites.

3-5 See comment response 3-4.

3-6 EPA can see no advantage to making the suggested change.

3-7 These gentlemen are identified in the footnotes as being with the CE.

3-8 No artificial reefs are located within the site. Any reefs near the site will be subject to additional study.

3-9 The Draft EIS was sent to the Mississippi Office of the Governor for distribution to the appropriate State agencies.

3-10 The date has been changed to January 1985.

3-11 Paragraph 2 sentence 2 has been changed to read "Nearshore waters turbidity levels fluctuate frequently as a result of storm activity, flood runoff and similar events."

3-12 The suggested change has been made to the text. Appendix A, B, C, and D are a part of the Final EIS..

3-13 See comment response 3-10.

3-14 The suggested change has been made to the text.

3-15 The correct date is 1977.

3-16 The data given is accurate for the given date.

3-17 EPA appreciates the receipt of this updated information, however, the outline presented is correct in reference to the source and date.

3-18 The statement is correct as stated.

4-1 EPA thanks the Department of Interior for reviewing the Draft EIS.

4-2 It is EPA's opinion that the Draft EIS adequately addresses these issues. Location of the sites is given in Chapter 1; Appraisals using the 11 specific criteria of the ODR are contained in Chapter 2; and adverse impacts are evaluated in Chapter 4.

4-3 As stated in Appendix A, Report of Field Survey, "A major consideration of survey design was to determine whether any adverse effects identified within the ODMDS were detectable outside site boundaries." The Pensacola, Mobile, and Gulfport sites are located in similar ocean areas. The sampling points at the central site (Mobile) were designed to not only provide information on the ocean area but also to measure possible effects in four directions from an ODMDS located in the ocean area. The Pensacola and Gulfport sampling points were designed to measure possible effects in the critical prevailing down current direction. The conclusions in the EIS are based on the historical data and information on the sites and ocean area and the results of the two surveys.

As part of EPA's continuing ocean survey program and to establish an additional specific base for future monitoring, EPA recently conducted a survey of the Pensacola site. The initial results of this survey are presented in Appendix D.

4-4 See comment response 4-3. Since the interim designated sites are proposed for final designation, data concerning the presense of hard bottoms at the alternative sites is not essential. Information pertaining to the botton features of the existing sites is presented on page 2-19.

4-5 EPA does not agree with the comment. Available historic data and information and the results of surveys were used to make informed judgements not assumptions.

4-6 See comment response 3-16.

4-7 Tissue analysis was done by EPA and IEC at the time of the survey. This information can be found on page 3-35 - 3-36 of the EIS. Also bioaccumulation is identified as an area of concern to be covered by a monitoring program.

4-8 As stated on page 2-32 of the EIS, it is not believed that the proposed action will have an adverse effect on these activities. The sites have been in use for a number of years without any apparent effect on proposals for such other uses.

4-9 As indicated on page 2-34, EPA did not make specific studies of water column pytoplankton and zooplankton. Historical data on the phytoplankton and zooplankton is presented on pages 3-36 through 3-38. The water column phytoplankton and zooplankton are only affected temporarily, if at all, during the disposal operations. Information on the more germane bottom organisms is presented in more detail in chapters 2 and 3, and in the Survey Report.

4-10 The deep water alternative site is not proposed for designation. It is agreed the engineering problems mentioned would need to be evaluated if a deep water site is considered for designation in the future.

4-11 The potential for adverse effects on amenity areas are addressed on pages 2-21 and 2-22. In reference to possible beach nourishment, it is not believed the movement of material from the channel to a nearby area alters the availability of the material for beach nourishment.

4-12 The section on nekton (Page 4-12 & 4-13) is accurate as stated. Since as indicated, nekton are highly mobile, measurement of past effects would have to have been made during past disposals. Since effects on nekton, if any, would result from the descending plume, the effects at a mid-shelf or deepwater site would be similar to those at the existing sites.

4-13 Contacts were made with a number of agencies during the studies leading to the preparation of the Draft EIS. The information resulting from these contacts was evaluated and used in the preparation of the Draft EIS. However, it appears from the comment that these contacts were not viewed by the Fish and Wildlife Service as fulfilling the coordination requirements of Section 7 of the Endangered Species Act of 1973. The Section 7 Coordination with the Fish and Wildlife Service has now been completed. (see Chapter 5).

5-1 EPA thanks the State of Florida Office of the Governor for commenting on the Draft EIS.

5-2 EPA notes this comment.

5-3 EPA notes this comment.

5-4 EPA notes this comment.

5-5 The existing Pensacola ODMDS was determined to be environmentally acceptable for the disposal of dredged material. It was found that the interim designation coordinates contained in the ODR do not reflect the actual area of historical usage. Thus, the area of past use (revised coordinates) is proposed for final designation. The final designation of the site, or continuation of the interim designation, does not preclude the use of the dredged material for beneficial purposes. Use of the site will be based on evaluation of each Federal project or permit application. Alternative disposal methods, including land based sites and beach nourishment, can be considered in these evaluations. A summary of possible alternatives is presented in Appendix C of the Final EIS.

The EPA shares the State of Florida's desire that dredged material be put to beneficial uses. However, the use of the dredged material for beach nourishment must meet the requirements of P.L. 94-587. Section 145 of P.L. 94-587 states: "Sec. 145. The Secretary of the Army, acting through the Chief of Engineers, is authorized upon request of the State, to place on the beaches of such State beach-quality sand which has been dredged in constructing or maintaining navigation inlets and channels adjacent to such beaches, if the Secretary deems such action to be in the public interest and upon payment of the increased cost thereof above the cost required for alternative methods of disposing of such sand."

5-6 See comment response 5-5. The existing ODMDS has been found to be environmentally acceptable for disposal of dredged material. Thus, it is believed the no-action alternative is not acceptable.

5-7 EPA believes that the information presented in this EIS is adequate for the evaluation of an ocean dredged material disposal site.

5-8 The Division of State Lands in the Department of Natural Resources has been contacted concerning this matter and it has been determined that no lease or easement is necessary.

5-9 Actions on Consistency Determination will be completed in connection with the site designation rule making process.

6-1 EPA thanks the Department of Environmental Regulation for commenting on the Draft EIS.

6-2 The comment has been noted.

6-3 See comment response 5-5. Also see Appendix C included in this Final EIS.

6-4 The same scientific rigor in sampling and analysis was used at all sites. The difference lies in the number of sampling points at each site. During the development of the survey plan (some five years ago) it was determined that the generic approach suggested by a number of knowledgeable individuals could be utilized. The survey plan developed by the contractor was approved by the EPA in consultation with CE. The survey was not intended to be a research endeavor. It was intended to provide more recent site specific information to be utilized in conjunction with the historical data and information to reach a site selection decision. It is believed the survey results fulfilled that requirement.

Since completion and issuance of the Draft EIS, the EPA has completed an additional survey of the Pensacola Site area. While the purpose of this survey was to establish a base for future monitoring, the results of the survey support and confirm the determinations based on the two previous surveys. The results of this latest survey are included as Appendix D.

6-5 See comment response 5-5 and 5-6.

6-6 Non-ocean disposal alternatives were evaluated in previous Corps of Engineers Studies (CE, 1980b; 1978b; 1976). It was determined from these studies that ocean disposals sites are needed. This does not mean that land-based disposal or any other feasible alternatives mentioned in the Environmental Protection Agency's (EPA) Ocean Dumping Regulations and Criteria (40 CFR §227.15) are being permanently set aside in favor of ocean disposal. The need for ocean disposal must be evaluated for each Federal project or permit application. These evaluations include considerations of the availability and environmental acceptability of other feasible alternatives. Designation of an ocean disposal site presents one option for the disposal of dredged material.

6-7 It was determined the coordinates stipulated in the ODR did not accurately reflect the boundaries of the historically used site; thus the coordinates were revised. The revision of the coordinates does not result in an increase in the area to be used for dredged material disposal from that which has been used in the past. It does establish the accurate boundaries of the historically used site.

6-8 See response 6-7. The revised boundaries reflect the area that has been historically used for dredged material disposal. These past disposals do not appear to have adversely affected the fisheries in the area. See pages 2-8 through 2-30 for discussion of the effects of past disposals.

6-9 The EPA/IEC survey and historical data were used to determine habitat characteristics. This information can be found throughout the EIS and in Appendix A.

6-10 This document considers the Mid-Shelf Alternative Site as a potential disposal site. After evaluating this site it was determined that the site is not the preferred disposal site and therefore not recommended for use. We find no reason to remove this information from the document.

6-11 The data concerning the Deepwater site was acquired from a variety of sources and is referenced in the text.

6-12 See comment response 6-4.

6-13 See comment response 5-9.

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

September 25, 1984

Mr. Patrick Tobin, Director
U.S. Environmental Protection Agency
Criteria and Standards Division
Washington, D.C. 20460

Dear Pat:

Re: Pensacola Ocean Dump Site Permanent Designation

At your request, our staffs have had further discussions regarding the potential conflicts between the proposed action and state regulations. Apparently, there is still some misunderstanding between them over what we are to review and submit. I hope this letter answers most of your concerns.

The issues of this designation were explained in detail in our previous comments on the draft Environmental Impact Statement and the federal consistency review under the Coastal Zone Management Act. Both of these reviews resulted in the state's objection to the EPA's permanent designation of an enlarged ocean dump site near Pensacola Inlet. (See enclosed correspondence.)

The NEPA review pointed out technical inadequacies in the DEIS. My staff reviewed the advance copy of the final EIS you provided and found that their comments and concerns about the draft document were not substantively addressed in the final. Although no other state agencies have had an opportunity to read the FEIS, we have enclosed specific comments readdressing the DER's concerns.

In spite of the EPA's submission of a negative determination under the federal consistency provisions of the CZMA, the state completed the required review. The state disagreed with the consistency of the proposed action with statutory particularity and suggested an alternative which would better accommodate the spoil disposal needs of the Port of Pensacola. To date, no response has been received regarding our conclusions and recommendations, nor has a consistency determination been submitted for the state's consideration as required by 15 CFR part 930.

As you recall, we recommended that the maintenance dredging and disposal needs of the Port be considered through the state's 25-year permit system, which was specifically designed to resolve the problems addressed in our previous reviews. These problems are ones we face regularly with all deepwater ports. We believe the difficulty inherent in balancing ports planning, operation and maintenance with environmental quality can be reduced through a regulatory mechanism which fosters appropriate spoil disposal methodologies. Ocean dumping is only one alternative considered through this process.

The 25-year permit process was designed to assess all options. The pursuit of the necessary coordination and permits under this system is a preferable approach to spoil disposal decisionmaking. A permanent offshore disposal site might turn out to be appropriate. However, we reiterate the point made in our consistency response that permanent designation of an enlarged disposal site needs to be reviewed in the context of our statutory mandates.

We have prepared a summary and provided enclosures which will explain the 25-year disposal permits system more thoroughly. We request that the final EIS give full consideration to this alternative as an appropriate approach to spoil management on both environmental and economic bases. Further, we request that the state's comments on the DEIS, as well as those attached, be addressed substantively in the FEIS. Finally, the EPA is required to prepare and submit a consistency determination for the proposed action for the state's review. My staff provided quidance materials for this to supplement the general directions found in 15 CFR 930, Subpart C, and will be pleased to offer further assistance as necessary.

We appreciate the opportunity to review the advance copy of the FEIS. We hope we can assist the EPA in selecting an appropriate alternative. To do so, we might want to bring in other state agencies at this time to obtain a comprehensive review.

Sincerely,

Steve

Stephen J. Fox, Director
Division of Environmental
Permitting

SJF/lgb
Enclosures
cc: Elton Gissendanner
Walt Kolb
Dave Worley
John DeGrove
Bob Kriegel

Comments on Final EIS

p. v

7-1 While the draft EIS proposed the permanent designation of the proposed dump site to accommodate the disposal of material dredged to maintain the Pensacola Harbor entrance channel, the FEIS now proposes the dumping of material dredged from the Pensacola area. The section of the FEIS which presents the "Detailed Consideration of the Alternative Sites" includes a subsection entitled "Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any." (p. 2-23). This analysis then proceeds to discuss the disposal of the Pensacola entrance channel maintenance spoils, judging the dumping to be environmentally benign because it is 93% sand. It is deceptive to base the site approval on an environmental impacts evaluation of the effects of dumping clean material when the approval would allow lower quality spoils to be dumped. We believe that if a dump site is designated in nearshore, shallow Outstanding Florida Waters, it should be highly restricted to the receipt of only completely clean material with a rapid settling rate, essentially only sand.

p. xi

7-2 The purpose and need for the action here is stipulated to be the maintenance of the entrance channel. This is another contradition to the description of the proposed action presented on p. v.

p. xiii-xvii

7-3 The data sources for the water quality characterizations of the alternative sites (Criterion 9) should be referenced.

p. 2-21

7-4 In part (3), under "Existing Sites", it should be recognized that the waters of the Gulf Islands National Seashore and the Ft. Pickens Aquatic Preserve are specially designated as Outstanding Florida Waters under Section 17-3.041, Florida Administrative Code. The proposed site is in these waters, not 2.3-2.5 nmi from them. Also, we understand that the wreck of the "Massachusetts" is in this area and is a much-used recreational site. It should be disscussed in this section.

7-5 Prevailing southwesterly currents are not the only consideration in determining the direction in which disposed materials might be transported. As Figure 3-9 illustrates, tidal surges are perpendicular to the coast and could influence movement toward beaches and Pensacola Inlet. Considering that the proposed dump site would extend to 1.5 mi from Perdido Key, hydrographic disturbances and transport effects should be given a more in depth treatment than one sentence.

p. 2-24

7-6 The last paragraph of section (4) implies that the Corps intends to continue its traditional practice of discharging spoils while the dredge vessel is underway. This method would be expected to result in the same inaccurate deposition beyond the site boundaries as has happened with the present site.

p. 2-25

7-7 The discussion in part (6) should be amplified to allow an estimation of the fate of the sediment mound after dumping. For a given volume of material, the direction, distance and areal extent of coverage which results from local current and tide forces should be shown. These should be near-term estimates rather than observations made years after dumping has occurred.

p. 2-29

7-8 Does the general statement that turbidity effects will be minimal because high background turbidity levels exist apply to the Pensacola site? On what is this based? The analysis on p. A-15 does not reflect a turbid environment.

p. 2-32

7-9 As mentioned above, the location of the wreck of the "Massachusetts" should be identified in the EIS. This section also fails to recognize that the proposed site is within Outstanding Florida Waters.

p. 5-3

7-10 As we advised the EPA in our comments responding to their negative federal consistency determination, a determination as described in 15 CFR 930, subpart C, is required and should be submitted to the state as soon as possible. If it is not to be included in this section, it should accompany the FEIS.

p. 5-34, response 5-5

7-11 The first three sentences of this response are irrelevant to the point of the comment. The designation is an automatic incentive not to employ alternative disposal options. The second paragraph of this response makes this very clear. The stated conditions are inherently prejudiced against beach nourishment since it can never be cheaper than sidecasting in an open water area.

p. 5-34, 5-35, responses

7-12 5-6 and 5-7 - We believe our in depth review comments on the DEIS deserve substantive responses rather than simple statements of disagreement.

p. 5-35, response 5-8

7-13 The Department of Natural Resources has advised the EPA that site designati will require a submerged lands lease.

p. 5-35, response 5-9

7-14 The State of Florida has already determined that this project is inconsistent with its Coastal Management Program. When the EPA prepares its consistency determination, the state's suggested alternative to the proposed action should be fully considered.

p. 5-35, response 6-4

7-15 Our comment was that there was no "scientific rigor."

p. 5-36, response 6-6

7-16 The EPA avoids all responsibility for environmental protection in rendering these remarks. The designation is a direct incentive to ocean dump and implicitly approves the disposal method. Otherwise, there is no reason to guadruple the area of the designation: it is assumed it will be used.

p. 5-36, response 6-7

7-17 This rationalization does nothing more than legitimize the Corps' previous mistakes. Coordinates are not established around a "target" area under the MPRSA. The revision does result in an increase in the area previously approved for use. There is no response in this item to our concerns for current/tidal movement toward Pensacola Inlet.

Alternatives Analysis

7-18 The alternatives analysis provides an economic evaluation of several alternatives. The inclusion of bay open water spoiling as an alternative is illegitimate. It is acknowledged as totally unacceptable to all state, federal and local interests, but is included "to identify the most economical plan." (p. 8.) This is absurd. Since such an option will not be pursued, its costs are irrelevant to the discussion. The only effect of including alternative B in the comparison is to exaggerate the costs of more environmentally acceptable options.

The paragraph devoted to the relative environmental merit of each alternative plainly states that beach nourishment would enhance the acceptability of the preferrable alternatives. (p. 15.) The alternatives don't really consider beach nourishment as an alternative, although it is listed as an option for Alternative A. We believe beach nourishment should receive genuine treatment for both environmental and economic benefits.

7-1 The need for the Pensacola Ocean Dumping Site has been demonstrated in past Federal dredging projects. The majority of this material has come from maintenance of the entrance channel. Since information is available concerning the quantities and types of materials coming from the entrance channel it is included in the EIS. It is anticipated that future disposal at the Pensacola site will involve disposal of dredged materials similar to those disposed at the site in the past. However, EPA will not restrict the use of the site to entrance channel materials only. The site is restricted to disposal of dredged material which is predominantly composed of sand (see page xxi). It is not clear what is meant by "lower quality spoils" as all material disposed of at the site will meet the acceptability requirements given in the Ocean Dumping Regulations.

7-2 See comment response 7-1.

7-3 This information was gained from the IEC surveys done for EPA in 1980. The reference has been added on page xvii.

7-4 Comment noted. The distances have been removed from the text. The wreck of the "Massachusetts" is mentioned on page 3-76 but will now appear in the text on page 2-37 within the review criteria (number 11-"Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.").

7-5 An in depth treatment of prevailing currents is given in pages 2-25 through 2-28.

7-6 EPA does not agree that inaccurate deposition is directly attributed to the fact that the vessel is underway during disposal. Inaccurate deposition is more likely caused by inaccurate navigation.

7-7 Estimates have been made as to sediment accumulation at the site if the dredged material is evenly distributed (page 2-6). It is impractical if not impossible to try to determine the short term fate of a given volume of material in light of the many variables contributing to sediment dispersion in the transient weather-driven current regime. It is expected, based on past experiences with ocean dumping operations, that the majority of the material will rapidly sink to the bottom of the site. Effective site monitoring will detect any movement of significant quanities of the dredged material toward amenity areas.

7-8 Considering the restriction to sand-sized dredged material disposal at the Pensacola site, turbidity is not a significant issue. The turbidity associated with the disposal of sand is not greater that that caused by storm events or beach nourishment projects.

7-9 See comment response 7-4.

7-10 A consistency statement has been issued and is currently being reviewed.

7-11 EPA does not agree that a site designation is an automatic incentive not to employ alternative disposal options. This EIS specifically addresses designation of an ocean disposal site. Disposal options including beach nourishment, upland disopsal, and ocean disposal are evaluated in the planning stages for each dredging project. That evaluation is not part of this EIS. In designating ocean disposal sites, EPA is merely providing an acceptable location in the event ocean disposal is the preferred disposal option for a particular dredging project. Sites are designated in areas where a need for an ocean disposal site has been indicated based on past dredging projects, but in no way does the site designation preclude the consideration of other disposal options for a particular project.

7-12 Comment noted. However EPA does support designation of the site based on the information contained in the EIS.

7-13 See comment response 5-8.

7-14 See comment response 7-10.

7-15 Comment noted.

7-16 See comment response 7-11.

7-17 Interim boundaries were established at existing sites based on the areas of historical use. The interim Pensacola site did not reflect the area of historical use. It is agreed that this was a mistake. Therefore the proposed site is larger than the existing site as it more accurately represents the area of historical use. Other reasons to designate the larger area are given on page 2-6. The general current pattern depicted in figure 3-9 does show that currents could move toward the Pensacola inlet. However these water mass movements are highly varible and are subject to seasonal changes in the volumes of river discharges and the degree of intrusion of the Loop Currents. Specific current patterns cannot be predicted with the existing information. However significant movement of the disposed material will be detected during monitoring surveys at the site.

7-18 An alternative analysis would be incomplete without considering all available practical alternatives and their associated costs, benefits, and environmental impacts regardless of their implications. The non-oceanic alternatives are not considered relevant to ocean disposal site designations and are provided as background information only.

STATE OF FLORIDA

Office of the Governor

THE CAPITOL

TALLAHASSEE 32301

BOB GRAHAM
GOVERNOR

September 26, 1986

Mr. Chris Provost
Environmental Engineer
U.S. Environmental Protection
Agency, Region IV
Marine Protection Section
345 Courtland Street
Atlanta, Georgia 30365

RE: Draft Final Environmental Impact Statement (DFEIS), Pensacola Ocean Dredged Material Disposal Site Designation

Dear Mr. Provost:

A-1 At your request and pursuant to verbal agreement with the Florida Department of Environmental Regulation, the state of Florida has completed a preliminary review of the above referenced document. The Departments of Community Affairs, Environmental Regulation and Natural Resources have reviewed and commented on the DFEIS. Their comments are attached for your use in preparing the FEIS. These preliminary comments should not be considered to be the state's official or final position. When the FEIS is received by the state, we will circulate it to the appropriate state agencies for review in accordance with NEPA.

-2 The state position on the consistency of the proposed site designation is based on comparison of the activity to state laws and rules included in the NOAA approved Florida Coastal Management Program (August, 1981). Each state agency responsible for those laws and rules determines the consistency of the activity with their statutory authority. This office reviews the agency comments and formulates a state position on NEPA and federal consistency. The Department of Environmental Regulation, as the lead state agency, communicates the federal consistency position to the federal agency.

-3 The Department of Community Affairs has no negative comments. They urge that you coordinate site designation with the West Florida Regional Planning Council and their Resource Planning and Management Committee staff in Tallahassee.

-4 The Department of Natural Resources (DNR) indicates two generic problems with the draft document (DNR letter, 9/2/86) regarding the need for a complete disposal plan and the use of beach grade material for beach nourishment. They also indicated (personal communication, Casey Fitzgerald and Rick Smith) that a submerged lands lease for the site will be required from the Trustees of the Internal Improvement Trust Fund. This is in contradiction to the comment response in the DFEIS on pages 5-35 that DNR, Division of State Lands, had been contacted and determined that no lease or easement would be necessary. Their initial comments remain in effect. (DNR letter, Dr. E. J. Gissendanner, 11/21/83, attached).

A-5 The Department of Environmental Regulation is concerned about use of the proposed site for unacceptable material (fine sediments) and the quadrupling in size of the interim designated site. They list the conditions that, if adopted by EPA, would resolve the Department's concerns. (DER letter, 9/9/86).

Our previously stated position (EOG letter, 3/29/83, attached) regarding the use of suitable dredged material for beach renourishment is a continuing concern. If you have questions about Florida's position regarding the site designation, or need further information please contact me at (904) 488-5551.

If you have questions or want to arrange a meeting regarding federal consistency to resolve any remaining differences, please contact Clare Gary, Attorney, at (904) 488-8114.

Sincerely,

Walt O Kolb

Walt O. Kolb
Senior Government Analyst
Natural Resources Policy Unit

WOK/rsm
Enclosures
cc: Ms. Victoria Tschinkel
Dr. Elton J. Gissendanner
Ms. Pamela Davis
Ms. Mary Smallwood

STATE OF FLORIDA
DEPARTMENT OF COMMUNITY AFFAIRS

2571 EXECUTIVE CENTER CIRCLE, EAST • TALLAHASSEE, FLORIDA 32301

September 5, 1986

BOB GRAHAM
Governor

TOM LEWIS, JR.
Secretary

M E M O R A N D U M

TO: Rick Smith, Governor's Office of Planning and Budgeting, Natural Resources Policy Unit

FROM: Pamela Jo Davis, Assistant Secretary

SUBJECT: Draft Final Environmental Impact Statement - Pensacola Dredged Material Disposal Site Designation, US EPA

A-6 As per your request, staff of the Department of Community Affairs has reviewed the draft final environmental impact statement (EIS) prepared by the US Environmental Protection Agency (EPA) for ocean dredged material disposal sites designation in the Pensacola area. The Department does not have any specific comments on the EIS at this time. The summary review conducted by staff showed that the Department's concerns expressed in the June 30, 1986, review of the Pensacola ocean dredged material site designation consistency statement (SAI #FL8605261376C) have been addressed in the EIS.

It is important to note that the Escambia/Santa Rosa Coast Resource Planning and Management Committee, established by the Governor in February 1985 pursuant to Section 380.045, Florida Statutes, has developed a resource management plan for the coastal areas of Escambia and Santa Rosa Counties that contains recommendations related to dredging and spoil disposal. Two recommendations in particular, one dealing with the development of a bay area resource inventory program and the other dealing with the development of a comprehensive regional maintenance dredging and spoil disposal program, should be considered in any federal or state activities involving assessment or designation of spoil disposal sites in the Pensacola region. It is suggested that the EPA contact the West Florida Regional Planning Council, which is serving as the administrative agency for both programs, to obtain information on the recent activities that have been initiated under the two programs. The EPA also may wish to contact the Department of Community Affairs, which administers the resource planning and management committee process, to obtain information on the committee process and the historical development of the two programs mentioned above.

Thank you for the opportunity to comment on the draft final EIS. If you have any questions, please contact David Hawley of the Bureau of State Resource Planning at 8-9210.

PJD/dhi

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

September 9, 1986

Mr. Walt Kolb
Senior Governmental Analyst
State Planning and Budgeting
Office of the Governor
404 Carlton Building
Tallahassee, Florida 32301

Dear Walt:

Re: Pensacola Ocean Dredged Material Disposal Site Designation

On August 6, 1986, EPA supplied the data and information to support its assertions that the referenced designation is consistent with the Florida Coastal Management Program. We have completed a review of these materials and offer the following comments and recommendations.

A-7 In its amendments to the final Environmental Impact Statement, EPA proposes to limit the use of the site to predominantly sand dredged material. However, the designation makes the site available for the disposal of material dredged from the Pensacola area rather than only the entrance channel. On page xxi, it is stated that ". . .the majority of sediments in the Pensacola area consist of sand sized particles." This characterization is too general and does not recognize the wide distribution of fine sediments in the Pensacola Bay system. We agree that material from the entrance channel between the Gulf and Pensacola inlet is clean, coarse-grained material, but much of the material dredged from areas inside the inlet would not be acceptable for disposal in this site.

A-8 The proposed boundaries of the site extend those of the existing, interim-designated site to the north and south. This expansion quadruples the size of the existing site and brings its northern boundary within 1.5 miles of Perdido Key. In the past, we have expressed strong concern for this expansion since the need for such a great increase in capacity is not clear now that the Corps has become willing to use the entrance channel dredged material for beach nourishment. The latest reason proffered by EPA for the expansion is that it will provide a buffer zone around the main area of disturbance and insure containment of the materials within the site's boundaries.

The disposal management program is not described in the EIS other than the mention on page 2-24 that dumping will occur while the vessel is underway. This practice raises concern for the precision of dumping and the ability to effectively monitor impacts. We believe the EIS should provide assurances that dumping procedures will be controlled, occur at specified, Loran-verified locations and be monitored for impacts. Although the general outline of the monitoring program is presented in the EIS, the final program should be developed in consultation with the state.

A-9 We are willing to concur with this designation if the EPA provides clarification and assurances regarding the following items:

1) The designation will only allow the disposal of dredged material which is predominantly sand as defined by a median grain size of > .125mm and a composition of < 10% fines;

2) A description of the method of disposal and that the designation will specify the positioning requirements and other relevant features of disposal management;

3) The state will be a participant in the development of a monitoring program;

4) The monitoring program will stipulate the contingency measures which will be implemented if material moves offsite or if unacceptable adverse impacts to marine biota are detected.

Satisfactory responses to these requests should resolve the central concerns of DER's consistency evaluation.

Sincerely,

Mary F. Smallwood

Mary F. Smallwood, Director
Division of Environmental
Permitting

MFS/lgb

cc: Dave Worley
Randy Armstrong
Elton Gissendanner
George Henderson

State of Florida
DEPARTMENT OF NATURAL RESOURCES

DR. ELTON J. GISSENDANNER
Executive Director
Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard, Tallahassee, Florida 32303

REPLY TO

Bureau of Marine Research
100 Eighth Avenue, S.E.
St. Petersburg, Florida 33701-5095

Phone: (813) 896-8626
Suncom: 523-1266

M E M O R A N D U M

September 2, 1986

TO : Rick Smith
Office of The Governor

FROM : George Henderson GEH
Bureau of Marine Research

SUBJ : Pensacola Dredged Material Ocean Disposal Site Designation

I have reviewed this document with particular emphasis on portions where changes have been made.

A-10 The principle problems continue to be generic to the process and not specific to the Pensacola site. The generic problems are two. The EPA disposal plans are narrowly drawn, this plan only for offshore of Pensacola. What is needed is a complete disposal plan such as ports must develop for a 25 year permit. This is especially the case for Pensacola because it is proposed only sand material be allowed and if fines or silts are encountered a new site designated. This slow and inefficient procedure should be avoided by proper planning and designation upfront.

A-11 The second generic problem is the separation of the federal agencies involved from joint responsibilities in complimentary activities and conflicting mandates which impede cooperation. The obvious example in this case is sand grade beach renourishment material being transported offshore instead of being deposited on eroding beaches. Furthermore, this site is so close to shore, especially given that the proposed expansion is largely landward, that special monitoring is proposed to assure no beach impacts occur. This sand is state property and disposal is proposed on state land. Why not put it on the state lands that need it.

A-12 Biologically, disposal at this site should have limited impacts as it is an area of seasonally shifting sands with communities adapted to these regimes.

Please let me know if I can provide further input.

GEH:pab
cc: Charles Futch
Charles McCoy
Jack Woodward

Responses to Comments A-1 through A-12

A-1 EPA thanks the State of Florida for its comments.

A-2 Comment noted.

A-3 Specific responses to individual Department comments follow.

A-4 See comment response A-3. Although an ocean disposal site designation by EPA identifies an area determined to be environmentally suitable for ocean disposal of dredged materials, the designation does not in itself authorize any disposal or other use of the ocean waters or ocean floor at the site. Disposal of dredged materials there may legally occur only if a disposal project is subsequently permitted by the Corps of Engineers as required under Section 103 of MPRSA and/or Section 404 of the Clean Water Act (or, in the case of a federal project, if all permitting requirements are met).

Because the act of site designation by EPA neither involves nor authorizes any activity at the site, EPA does not consider state requirements for leases or easements for activitiesa using state waters relevant to site designation. Consideration of such property law requirements should be made in the context of specific dumping proposals affecting state waters. EPA has been informed by the South Atlantic Division of the Corps of Engineers that the Corps considers Florida's requirements for leases or easements in state waters during its permitting procedures for dredged material disposal projects.

A-5 See comment response A-3.

A-6 EPA thanks the Department of Community Affairs for its comments. We feel ocean disposal site designations are independent of specific bay or harbor dredging and disposal plans. The action discussed in this EIS will provide an environmentally acceptable area for ocean disposal but does not suggest, recommend, or authorize any disposal activities.

A-7 The designation of this site will include the restriction that only predominantly sand dredged materials be disposed of at the site. Predominantly sand will be defined as the majority of samples tested having median grain sizes of greater than 0.125 mm and a composition of less than 10% fines. No restriction will be placed on which area of the Pensacola Bay system these sediments are dredged from.

A-8 Site management will include requirements that specify which area of the site is to be used for disposal. These requirements will be part of the project review process. The monitoring program will be developed according to the use of the site and will be coordinated with the State.

A-9 We will incorporate the definition of sand sized materials in the final designation (see comment response A-7). The description of disposal methods and locations will be part of the review process authorizing actual disposal projects (see comment response A-9). The State will be included in the development of the monitoring program. Contingency measures will include altering the dumping procedures (times, rates, locations, etc.) or terminating use of the site. Actual measures taken will depend on the type of impact detected and the resource impacted.

A-10 Comment noted. See comment response A-6.

A-11 Comment noted. Specific disposal plans undergo a separate review process (part 227 of the Ocean Dumping Regulations) and are not a part of the site designation procedures (Part 228 of the Ocean Dumping Regulations).

A-12 Comment noted.

Chapter 6

GLOSSARY, ABBREVIATIONS, AND REFERENCES

GLOSSARY

ABUNDANCE	The number of individuals of a species inhabiting a given area. Normally, a community of several component species will inhabit an area. Measuring the abundance of each species is one way of estimating the comparative importance of each component species.
ADSORB	To adhere in an extremely thin layer of molecules to the surface of a solid or liquid.
ALKALINITY	The number of milliequivalents of hydrogen ions neutralized by 1 liter of seawater at 20°C. Alkalinity of water is often taken as an indicator of its carbonate, bicarbonate, and hydroxide content.
AMBIENT	Pertaining to the undisturbed or unaffected conditions of an environment.
AMPHIPODA	An order of crustaceans (primarily marine) with laterally compressed bodies, which generally appear similar to shrimp. The order consists primarily of three groups: hyperiideans, which inhabit open ocean areas; gammarideans, which are primarily bottom dwellers; and caprellideans, common fouling organisms.
ANOXIC	Absence of oxygen.
ANTHROPOGENIC	Relating to the effects or impacts of man on nature. Construction wastes, garbage, and sewage sludge are examples of anthropogenic materials.
APPROPRIATE BENTHIC MARINE ORGANISMS	Pertaining to bioassay samples required for ocean-sensitive dumping permits, "at least one species each representing filter-feeding, deposit-feeding, and burrowing species chosen from among the most sensitive species accepted by EPA as being reliable test organisms to determine the anticipated impact on the site" (CFR 40 227.27).
APPROPRIATE MARINE ORGANISMS	Pertaining to bioassay samples required for ocean-sensitive dumping permits, "at least one species each representative of phytoplankton or zooplankton, crustacean or mollusk, and fish species chosen from among the most sensitive species documented in the scientific literature or accepted by EPA as being reliable test organisms to determine the anticipated impact of the wastes on the ecosystem at the disposal site" (CFR 40 227.27).

ASSEMBLAGE	A group of organisms sharing a common habitat.
BACKGROUND LEVEL	The naturally occurring concentration of a substance within an environment that has not been affected by unnatural additions of that substance.
BASELINE CONDITIONS	The characteristics of an environment before the onset of an action which can alter that environment; any data serving as a basis for measurement of other data.
BASELINE SURVEYS AND BASELINE DATA	Surveys and the data collected prior to the initiation of actions that may alter an existing environment.
BENTHOS	All marine organisms (plant or animal) living on or in the bottom of the sea.
BIOACCUMULATION	The uptake and assimilation of materials (e.g., heavy metals) leading to elevated concentrations of the substances within organic tissue, blood, or body fluid.
BIOASSAY	A method for determining the toxicity of a substance by the effect of varying concentrations on growth or survival of suitable plants, animals or micro-organisms; the concentration which is lethal to 50% of the test organisms or causes a defined effect in 50% of the test organisms, often expressed in terms of lethal concentration (LC_{50}) or effective concentration (EC_{50}), respectively.
BIOMASS	The quantity (wet weight) of living organisms inhabiting a given area or volume at any time; often used as a means of measuring the productivity of an ecosystem.
BIOTA	Animals and plants inhabiting a given region.
BIOTIC GROUPS	Assemblages of organisms which are ecologically, structurally, or taxonomically similar.
BLOOM	A relatively high concentration of phytoplankton in a body of water resulting from rapid proliferation during a time of favorable growing conditions generated by nutrient and sunlight availability.
BOD	Biochemical Oxygen Demand or Biological Oxygen Demand; the amount of dissolved oxygen required by aerobic micro-organisms to degrade organic matter in a sample of water usually held in the dark at 20°C for 5 days; used to assess the potential rate of substrate degradation and oxygen utilization in aquatic ecosystems.
CARCINOGEN	A substance or agent producing a cancer or other type of malignancy.

CEPHALOPODS	Exclusively marine animals constituting the most highly evolved class of the phylum Mollusca (e.g., squid, octopus, and *Nautilus*).
CHAETOGNATHA	A phylum of small planktonic, transparent, worm-like invertebrates known as arrow-worms; they are often used as water mass tracers.
CHLOROPHYLL *a*	A specific chlorophyll pigment characteristic of higher plants and algae; frequently used as a measure of phytoplankton biomass.
COCCOLITHOPHORIDS	Microscopic, planktonic unicellular, golden-brown algae characterized by an envelope of interlocking calcareous plates.
COELENTERATA	A large diverse phylum of primarily marine animals, members possessing two cell layers and an incomplete digestive system, the opening of which is usually surrounded by tentacles. This group includes hydroids, jellyfish, corals, and anemones.
COLIFORMS	Bacteria residing in the colons of mammals; generally used as indicators of fecal pollution.
CONTINENTAL MARGIN	A zone separating the emergent continents from the deep-sea bottom; generally consists of the Continental Slope, Continental Shelf, and Continental Rise.
CONTINENTAL SHELF	That part of the Continental Margin adjacent to a continent extending from the low water line to a depth, generally 200m, where the Continental Shelf and the Continental Slope join.
CONTINENTAL SLOPE	That part of the Continental Margin consisting of the declivity from the edge of the Continental Shelf down to the Continental Rise.
CONTOUR LINE	A line on a chart connecting points of equal elevation above or below a reference plane, usually mean sea level.
CONTROLLING DEPTH	The least depth in the approach or channel to an area, such as a port, governing the maximal draft of vessels which can enter.
COPEPODS	A large diverse group of small planktonic crustaceans representing an important link in oceanic food chains.
COST/BENEFIT RATIO	A comparison of the price, disadvantages, and liabilities of any project versus profit and advantages.

CRUSTACEA — A class of arthropods consisting of animals with jointed appendages and segmented exoskeletons composed of chitin. This class includes barnacles, crabs, shrimps, and lobsters.

CTENOPHORA — An animal phylum, superficially resembling jellyfish, ranging in size from less than 2 cm to about 1m in length. Commonly known as "sea walnuts" or "comb jellies", these animals prey heavily on planktonic organisms, particularly crustaceans and fish larvae.

CUMACEANS — Small motile crustaceans which usually inhabit the surface layers of sediment, although some species exhibit diurnal vertical migrations in the water column; their presence is often indicative of unstable sediment conditions.

DECAPODA — The largest order of crustaceans; members have five sets of locomotor appendages, each joined to a segment of the thorax; includes crabs, lobsters, and shrimps.

DEMERSAL — Living at or near the bottom of the sea.

DENSITY — The mass per unit volume of a substance, usually expressed in grams per cubic centimeter (1g water in reference to a volume of 1 cc @ 4°C).

DETRITIVORES — Animals which feed on detritus; also called deposit feeders.

DETRITUS — Product of decomposition or disintegration; dead organisms and fecal material.

DIATOMS — Microscopic phytoplankton characterized by a cell wall of overlapping silica plates. Sediment and water column populations vary widely in response to changes in environmental conditions.

DINOFLAGELLATES — A large diverse group of flagellated phytoplankton with or without a rigid outer shell, some of which feed on particulate matter. Some members of this group are responsible for toxic red tides.

DISCHARGE PLUME — The region of water affected by a discharge of waste that can be distinguished from the surrounding water.

DISPERSION — The dissemination of discharged matter over large areas by natural processes (e.g., currents).

DISSOLVED OXYGEN — The quantity of oxygen (expressed in mg/liter, ml/liter, or parts per million) dissolved in a unit volume of water. Dissolved oxygen (DO) is a key parameter in the assessment of water quality.

DIVERSITY (Species)	A statistical concept that generally combines the measure of the total number of species in a given environment and the number of individuals of each species. Species diversity is high when it is difficult to predict the species or the importance of a randomly chosen individual organism, and low when an accurate prediction can be made.
DOMINANT SPECIES	A species or group of species which, because of their abundance, size, or control of the energy flow, strongly affect a community.
DRY WEIGHT	The weight of a sample of material or organisms after all water has been removed; a measure of biomass when applied to organisms.
EBB CURRENT, TIDE	Tidal current moving away from land or down a tidal ebb stream.
ECHINODERMS	Exclusively marine animals which are distinguished by radial symmetry, internal skeletons of calcareous plates, and water-vascular systems which serve the needs of locomotion, respiration, nutrition, or perception; includes starfishes, sea urchins, sea cucumbers, and sand dollars.
ECOSYSTEM	The organisms in a community together with their physical and chemical environments.
EDDY	A circular mass of water within a larger water mass which is usually formed where currents pass obstructions, either between two adjacent currents flowing counter to each other, or along the edge of a permanent current. An eddy has a certain integrity and life history, circulating and drawing energy from a flow of larger scale.
EFFLUENT	Liquid waste of sewage or industrial processing.
ENDEMIC	Restricted or peculiar to a locality or region.
ENTRAIN	To draw in and transport by the flow of a fluid.
EPIFAUNA	Animals that live on or near the bottom of the sea.
ESTUARY	A semienclosed coastal body of water which has a free connection to the sea, commonly the lower end of a river, and within which the mixing of saline and fresh water occurs.
EUPHAUSIIDS	Shrimp-like, planktonic crustaceans which are widely distributed in oceanic and coastal waters, especially in cold waters. These organisms, also known as krill, are an important link in the oceanic food chain.
EURYHALINE	Able to live in waters of a wide range of salinity.

FACIES	The makeup or appearance of a community or species population; the visible characteristics of a rock or stratigraphic unit (e.g., general appearance or composition).
FAUNA	The animal life of any location, region, or period.
FINFISH	Term used to distinguish "normal" fish (e.g., with fins and capable of swimming) from shellfish. Usually in reference to the commercially important species.
FLOCCULATION	The process of aggregating a number of small, suspended particles into larger masses.
FLOOD TIDE, FLOOD CURRENT	Tidal current moving toward land or up a tidal stream.
FORAMINIFERA	Benthic or planktonic single-celled marine organisms possessing a shell (usually of calcium carbonate) enclosing an ameboid body.
GASTROPODS	Molluscs which possess a distinct head (generally with eyes and tentacles), a broad, flat foot, and usually a spiral shell (e.g., snails).
GYRE	A closed circulation system, usually larger than an eddy.
HEAVY METALS ELEMENTS	Metals with specific gravities of 5.0 or greater (e.g., 5 times the density of water).
HERBIVORES	Animals that feed chiefly on plants.
HOLOCENE	Recent
HOLOTHURIAN	An echinoderm of the class Holothuroidea, characterized by a cylindrical body, smooth, leathery skin, and feeding tentacles; includes the sea cucumbers.
HOPPER DREDGE	A self-propelled vessel with capabilities to dredge, store, transport, and dispose of dredged materials.
HYDROGRAPHY	That science which deals with the measurement of the physical features of waters and their marginal land areas, with special reference to the factors which affect safe navigation, and the publication of such information in a form suitable for use by navigators.
HYPOXIC	Low dissolved oxygen concentration (e.g. less than 2.0 ppm).
ICHTHYOPLANKTON	That portion of the planktonic mass composed of fish eggs and weakly motile fish larvae.

INDICATOR SPECIES	An organism so strictly associated with particular environmental conditions that its presence is indicative of the existence of such conditions.
INDIGENOUS	Having originated in, being produced, growing, or living naturally in a particular region or environment; native.
INFAUNA	Aquatic animals which live in the bottom sediment.
INITIAL MIXING	Dispersion or diffusion of liquid, suspended particulate, and solid phases of a waste material which occurs within 4 hours after dumping.
IN SITU	(Latin) in the original or natural setting (in the environment).
INTERIM DISPOSAL SITES	Ocean disposal sites tentatively approved for use by the EPA.
INVERTEBRATES	Animals lacking a backbone or internal skeleton.
ISOBATH	A line on a chart connecting points of equal depth below mean sea level.
ISOPODS	Small crustaceans with flattened bodies and reduced heads and abdomens. They are an important intermediate link in marine food chains.
ISOTHERMAL	Approximate equality of temperature throughout a geographical area.
LARVA	A young and immature form of an organism that must usually undergo one or more form and size change(s) before assuming characteristic features of the adult.
LIMITING PERMISSIBLE CONCENTRATION	A concentration of a waste material which, after initial mixing, does not exceed marine water quality criteria, or cause acute or chronic toxicity, or other sublethal (LPC) adverse effects.
LITHOGENIC	Of or derived from rock.
LITTORAL	Of or pertaining to the seashore, especially the regions between tide lines.
LONGSHORE CURRENT	A current which flows in a direction parallel to a coast-line.
LORAN-C	LOng Range Aid to Navigation, type C; Low frequency radio navigation system having a range of approximately 1,500 mi radius.
MAIN SHIP CHANNEL	The designated shipping corridor leading into a harbor.

MAINTENANCE DREDGING	Periodic dredging of a waterway, necessary for continued use of the waterway.
MICRONUTRIENTS	Microelements, trace elements, or substances required in minute amounts; essential for normal growth and development of an organism.
MIOCENE	A geologic epoch of the Tertiary period, extending from the end of the Oligocene to the beginning of the Pliocene; 7 to 26 million years ago.
MIXED LAYER	The upper layer of the ocean which is well-mixed by wind and wave activity.
MODEL	A mathematical or physical system, obeying certain specified conditions, whose behavior is used to understand an analogous physical, biological, or social system.
MOLLUSCA	A phylum of unsegmented animals, most of which possess a calcareous shell; includes snails, mussels, clams, and squid.
MONITORING	As used herein, observation of environmental effects of disposal operations through biological and chemical data collection and analyses.
MUTAGEN	A substance which increases the frequency or extent of mutations (changes in hereditary material).
NEKTON	Free-swimming aquatic animals which move independently of water currents.
NERITIC	Pertaining to the region of shallow water adjoining the seacoast, and extending from the low-tide mark to a depth of about 200m.
NUISANCE SPECIES	Organisms of no commercial value, which, because of predation or competition, may be harmful to commercially important organisms.
OMNIVOROUS	Pertaining to animals that feed on animal and plant matter.
ORGANOHALOGEN PESTICIDES	Pesticides whose chemical constitution includes the elements carbon and hydrogen, plus a common element of the halogen family: bromine, chlorine, fluorine, or iodine.
ORGANOPHOSPHATE PESTICIDES	Phosphorus-containing organic pesticides (e.g., malathion or parathion).
ORTHOPHOSPHATE	One of the salts of orthophosphoric acid; an essential nutrient for plant growth.

OSTRACODA	A subclass of the class, crustacea, inclusive of small benthic forms with bodies completely enclosed within a round bivalve carapace; also called "seed shrimps."
OXIDE	A binary chemical compound in which oxygen is combined with another element, metal, nonmetal, gas, or radical.
PARAMETER	Values or physical properties that describe the characteristics or behavior of a set of variables.
PATHOGEN	An entity producing or capable of producing disease.
PCB(s)	Polychlorinated biphenyl(s); any of several chlorinated compounds having various industrial applications. PCB's are highly toxic pollutants that tend to accumulate in the environment.
PELAGIC	Pertaining to water of the open ocean beyond the Continental Shelf and above the abyssal zone.
PERCENT DRY WEIGHT	An expression of the concentration of a constituent in relation to its contribution (in percent) to the total weight of dried sample material.
PERTURBATION	A disturbance of a natural or regular system; any departures from an assumed steady state of a system.
pH	The acidity or alkalinity of a solution, determined by the negative logarithm of the hydrogen ion concentration (in gram-atoms per liter), ranging from 0 to 14 (lower than 7 is acid, higher than 7 is alkaline).
PHOTIC ZONE	The layer of a body of water which receives sufficient sunlight for photosynthesis.
PHYTOPLANKTON	Minute passively floating plant life in a body of water; the base of the food chain in the sea.
PLANKTON	The passively floating or weakly swimming, usually minute animal and plant life in a body of water.
PLEISTOCENE	The earlier epoch of the Quaternary, 1 to 11 million years before present.
PLUME	A patch of turbid water, caused by the suspension of fine particles following a disposal operation.
POLYCHAETA	The largest class of the phylum Annelida (segmented worms); benthic marine worms distinguished by paired, lateral, fleshy appendages provided with bristles (setae) on most segments.
PRECIPITATE	A solid that separates from a solution or suspension by chemical or physical change.

PRIMARY PRODUCTIVITY	The amount of organic matter synthesized by producer organisms (primarily plants) from inorganic substances per unit time and volume of water. Plant respiration may or may not be subtracted (net or gross productivity, respectively).
PYCNOCLINE	A vertical density gradient in a body of water, positive with respect to depth, and much greater than the gradients above and below it.
QUALITATIVE	Pertaining to the non-numerical assessment of a parameter.
QUANTITATIVE	Pertaining to the numerical measurement of a parameter.
RADIATION FOG	A major type of land fog produced when radiational cooling reduces the air temperature to or below its dew point; strictly a nighttime occurrence, although the fog may begin to form by evening, and often does not dissipate until after sunrise.
RADIONUCLIDES	Species of atoms which exhibit radioactivity.
RECOLONIZATION	Repopulation of an area after a perturbation (e.g., dredged material disposal); process is accomplished by larval settlement and immigration.
RECRUITMENT	Addition to a population of organisms by reproduction or immigration of new individuals.
RELEASE ZONE	An area defined by the locus of points 100m from a vessel engaged in dumping activities; will never exceed the total surface area of the dumpsite.
RUNOFF	That portion of precipitation upon land which ultimately reaches streams, rivers, lakes, and oceans.
SALINITY	The amount of salts dissolved in water; expressed in parts per thousand ($^{o}/oo$, or ppt).
SHELF WATER	Water which originates in, or can be traced to the Continental Shelf, differentiated by characteristic temperature and salinity.
SHELLFISH	Any invertebrate, usually of commercial importance, having a rigid outer covering, such as a shell or exoskeleton; includes some molluscs and arthropods; term is the counterpart of finfish.
SHORT DUMPING	The premature discharge of waste from a vessel anywhere outside designated disposal sites. This may occur legally under emergency circumstances, or illegally to avoid hauling to a designated site.

SIGNIFICANT WAVE HEIGHT	The average height of the one-third highest waves of a given wave group.
SIPHONOPHORA	An order of planktonic, colonial, marine coelenterates; includes jellyfish and the Portugese man-of-war.
SLOPE WATER	Water which orginates from, occurs at, or can be traced to, the Continental Slope, differentiated by characteristic temperature and salinity.
SPECIES	A group of morpholcgically similar organisms capable of interbreeding and producing fertile offspring.
STANDARD ELUTRIATE ANALYSIS	A test used to determine the types and amounts of constituents that can be extracted from a known volume of sediment by mixing with a known volume of water.
STANDING STOCK	The biomass or abundance of living material per unit volume of water, or area of sea bottom.
SUBSTRATE	The solid material upon which an organism lives, or to which it is attached (e.g., rocks, sand).
SURVEILLANCE	Systematic observation of an area by visual, electronic, photographic, or other means for the purpose of ensuring compliance with applicable laws, regulations, permits, and safety.
SUSPENDED SOLIDS	Finely divided particles of a solid temporarily suspended in a liquid (e.g., soil particles in water).
TEMPORAL DISTRIBUTION	The distribution of a parameter over a period of time.
TERRIGENOUS SEDIMENTS	Sedimentary deposits composed of eroded terrestrial material.
THERMOCLINE	A vertical temperature gradient in some layer of a body of water, which is appreciably greater than the gradients above or below it; a layer in which such a gradient occurs.
TOTAL SEDIMENT ANALYSIS	A test wherein sediment samples are digested over heat with concentrated acid, and the resultant solution analyzed for inorganic constituents of interest (generally trace metals).
TRACE METAL OR ELEMENT	An element found in the environment in extremely small quantities; usually includes metals constituting 0.1% (1,000 ppm) or less, by weight, in the earth's crust.
TREND ASSESSMENT SURVEYS	Surveys conducted over long periods to detect shifts in environmental conditions within a region.

TROPHIC LEVELS — Discrete steps along a food chain in which energy is transferred from the primary producers (plants) to herbivores, and finally to carnivores and decomposers.

TURBIDITY — Cloudy or hazy appearance in a naturally clear liquid caused by a suspension of colloidal liquid droplets, fine solids, or small organisms.

TURNOVER RATE — The time necessary to replace the entire standing stock of a population; generation time.

UPWELLING — The rising of water toward the surface from subsurface layers of a body of water. Upwelled water is cooler and rich in nutrients; regions of upwelling are generally areas of rich fisheries.

WATER MASS — A body of water, identified by its temperature-salinity values, or chemical composition, consisting of a mixture of two or more water types.

WATER TYPE — Ocean water of a specified temperature and salinity; defined as a single point on a temperature-salinity diagram.

ZOOPLANKTON — Weakly swimming animals whose distribution in the ocean is ultimately determined by current movements.

ABBREVIATIONS

BLM	Bureau of Land Management
C	carbon
°C	degrees centigrade
CE	U.S. Army Corps of Engineers
CFR	Code of Federal Regulations
DA	District Administrator (CE)
DMRP	Dredged Material Research Program
DMDS	Dredged Material Disposal Site
DO	dissolved oxygen
DOC	U.S. Department of Commerce
DOI	U.S. Department of the Interior
E	east
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FDA	Food and Drug Administration
FWPCA	Federal Water Pollution Control Act
FWPCAA	Federal Water Pollution Control Act Amendments
g	gram(s)
GMFMC	Gulf of Mexico Fishery Management Council
hr	hour
IMCO	Inter-Governmental Maritime Consultative Organization
k	kilogram
kHz	kilohertz
km	kilometer(s)
kn	knot(s)
m	meter(s)
m^2	square meter
mg	milligram(s)
mm	millimeter(s)
MPRSA	Marine Protection, Research, and Sanctuaries Act
N	north
ng	nanogram
NEPA	National Environmental Policy Act

nmi	nautical mile(s)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center
NOO	Naval Oceanographic Office
NOS	National Ocean Survey
NTU	nephelometric turbidity units
OCS	Outer Continental Shelf
ODMDS	Ocean Dredged Material Disposal Site
OGJ	Oil and Gas Journal
PL	Public Law
PMG	Pensacola, Mobile and Gulfport
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand = $^{o}/oo$
$^{o}/oo$	parts per thousand
%	percent
RA	Regional Administrator (EPA)
s	second(s)
S	south
SUSIO	State University System Florida Institute of Oceanography
TOC	total organic carbon
TSS	total suspended solids
μ	micron
μg	microgram
μmole	micromole
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
W	west
wt	weight
yd^3	cubic yard(s)
yr	year(s)

REFERENCES

Bault, E.I. 1972. Hydrology of Alabama estuarine areas - Cooperative Gulf of Mexico Estuarine Inventory. Alabama Marine Resources Bulletin #7. Alabama Dept. of Conservation and Natural Resources. 36 pp.

Bault, E.I. 1969. A study of the distribution and the zoogeography of the polychaetous annelids of the Continental Shelf in the northeastern Gulf of Mexico. Masters thesis, Florida State University. 113 pp.

Boone, P.A. 1973. Depositional systems of the Alabama, Mississippi and Western Florida Coastal Zone. Transactions - Gulf Coast Association of Geological Studies. Vol. XXIII. pp. 266-277.

Brannon, J.M. 1978. Evaluation of dredged material pollution potential. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS. Tech. Rpt. DS-78-6. 39 pp.

Brannon, J.M., R.H. Plumb, Jr., and I. Smith. 1978. Long-term release of contaminants from dredged material. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS. Tech. Rpt. D-78-49. 87 pp.

Burks, S.A., and R.M. Engler. 1978. Water quality impacts of aquatic dredged material disposal (laboratory investigations). U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS. Tech. Rpt. DS-78-4. 45 pp.

CE. See U.S. Army Corps of Engineers.

Chapoton, R. 1973. Biological considerations and the Gulf of Mexico menhaden fishery. Proc. Gulf and Caribbean Fisheries Inst. 26th annual session. pp. 15-23.

Chittenden, M.E., Jr., and J.D. McEachran. 1976. Composition, ecology and dynamics of demersal fish communities on the northwestern Gulf of Mexico Continental Shelf, with a similar synopsis for the entire Gulf. Dept. of Wildlife and Fisheries Sciences. Texas A&M Univ., College Station, TX. 104 pp.

Christmas, J.Y. (ed.). 1973. Cooperative Gulf of Mexico Estuarine Inventory and Study, Miss. Gulf Coast Research Lab., Ocean Springs, MS. 434 pp.

Crance, J.H. 1971. Description of Alabama Estuarine Areas - Cooperative Gulf of Mexico Estuarine Inventory. In: Alabama Marine Resources Bulletin. Number 6. Dauphin Island, AL. 85 pp.

Dames and Moore. 1979. The Mississippi, Alabama, Florida, Outer Continental Shelf Baseline Environmental Survey, MAFLA 1977/1978. Prepared for Bureau of Land Management, Washington, DC. Contract No AA550-CT7-34. 3 Vol.

Davis, R.W. 1978. Dredged material disposal sites (ocean). U.S. Army Corps of Engineers, Mobile District, Mobile, AL.

Defenbaugh, R.E. 1976. A study of the benthic macroinvertebrates of the Continental Shelf of the northern Gulf of Mexico. Ph.D. Dissertation. Texas A&M Univ. 476 pp.

DOC. See U.S. Department of Commerce.

DOI. See U.S. Department of Interior.

Doyle, L.J. and T.N. Sparks. 1980. Sediments of the Mississippi, Alabama, and Florida (MAFLA) Continental Shelf. J. Sed. Petrol. 50(3):0905-0916.

EPA. See U.S. Environmental Protection Agency.

Eleuterius, C.K. 1976. Mississippi Sound: temporal and spacial distribution of nutrients, Mississippi-Alabama Sea Grant Consortium, MASGP-76-024. 48 pp.

El-Sayed, S.Z., W.M. Sackett, L.M. Jeffrey, A.D. Fredericks, R.P. Saunders, P.S. Conger, G.A. Fryxell, K.A. Steidinger, and S.A. Earle. 1972. Chemistry, primary productivity, and benthic algae of the Gulf of Mexico. Ser. Atlas Mar. Environ, Folio 22, Amer. Geog. Soc., NY. 29 pp.

Fanning, K.A. 1975. Nutrient analysis. In: SUSIO, 1975, Baseline Environmental Survey of the MAFLA Lease Areas CY 1974. Vol. II.

FDA. See U.S. Department of Health, Education and Welfare, Food and Drug Administration.

Forristall, G.Z., R.C. Hamilton, and V.J. Cardone. 1977. Continental Shelf currents in tropical storm Delia. Jour. of Phys. Oceanog. 7(4):552-546.

Gaul, D. 1967. Circulation over the Continental Margin of the northeast Gulf of Mexico. Ph.D. Dissertation. Texas A&M Univ. 156 pp.

Gearing, P., J.N. Gearing, T.F. Lytle, and J.S. Lytle. 1976. Hydrocarbons in 60 northeast Gulf of Mexico Shelf sediments: a preliminary survey. Geochimica et Cosmochimica Acta. 40:1005-1017.

Gould, H..R. and R.H. Stewart. 1956. Continental terrace sediments in the northeastern Gulf of Mexico. In: Hough, J.L. and H.W. Menard (eds.). Finding ancient shorelines. Society of Economic Paleontologists and mineralogists. Special Publ. 3, Tulsa, OK.

Grassle, J.F. and J.P. Grassle. 1974. Oportunistic life histories and genetic systems in marine benthic polychaetes. J. Mar. Res. 32(2):253-284.

Gulf of Mexico Fishery Management Council (GMFMC). 1980a. Draft environmental impact statement for the reef fish fishery of the Gulf of Mexico. 175 pp.

______ 1980b. Shrimp fishery of the Gulf of Mexico, proposed rules. Federal Register. 45(218) Friday, Nov. 7, 1980.

Gunter, G. 1938. Seasonal variation in abundance of certain estuarine and marine fishes in Louisiana, with particular reference to life histories. Ecol. Monogr. 8(3):314-346.

Gutherz, E.J., G.M. Russell, A.F. Serra, and B.A. Rohr. 1975. Synopsis of the northern Gulf of Mexico industrial and foodfish industries. Mar. Fish. Rev. 37:1-11.

Heaton, M.G. 1978. Chemical aspects of hydraulic dredging and open-water pipeline disposal in estuaries. M.S. Thesis, Marine Sciences Research Center, State Univ. of New York, Stony Brook, NY. 186 pp.

Henry, V.J. and E.H. Shenton. 1955. Literature survey of Lake Charles, LA, Gulfport, MS, Mobile, AL, and Pensacola, FL and their approaches. Vol. I Geological Oceanography. Texas A&M Univ., College Station, TX.

Hirsch, N.D., L.H. DiSalvo, and R. Peddicord. 1978. Effects of dredging and disposal on aquatic organisms. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS. Tech. Rpt. DS-78-5. 41 pp.

Holliday, B.H. 1978. Processes affecting the fate of dredged material. U.S. Army Waterways Experiment Station, Vicksburg, MS. Tech. Rpt. DS-78-2. 30 pp.

Holmes, C.W. 1973. Distribution of selected elements in surficial marine sediments of the northern Gulf of Mexico Continental Shelf and Slope. U.S. Geological Survey Professional Paper No. 814. 7 pp.

Hopkins, T.S. 1973. Marine ecology in Escarosa. Coastal Coordinating Council. State of Florida, Department of Natural Resources. 100 pp.

Hoyt, J.H. 1967. Barrier island formation. Geol. Soc. Am. Bull. 78:1125-1136, 8 figs.

Huh, O.K., W.J. Wiseman, Jr., and L.J. Rouse, Jr. 1981. Intrusion of Loop Current waters onto the west Florida Continental Shelf. J. Geophys. Res. 86(C5):4186-4192.

Hulbert, E.M. and N. Corwin. 1972. A note on the phytoplankton distribution in the offshore water of the eastern and central Gulf of Mexico. Caribbean J. of Sci. 12(1-2):29-38.

Ichiye, T., H.H. Kuo, and M.R. Carnes. 1973. Assessment of currents and hydrography of the eastern Gulf of Mexico. Contrib. 601, Texas A&M Univ.

Jones, J.I., R.E. Ring, H.O. Rinkel, and R.E. Smith (eds.). 1973. A summary of knowledge of the eastern Gulf of Mexico. Coordinated by St. Univ. Syst. of FL. Inst. of Oceanogr. (SUSIO), St. Petersburg, FL. 577 pp.

Leipper, D.F. 1970. A sequence of current patterns in the Gulf of Mexico. J. Geophys. Res. 75(3):637-657.

Lindall, W.N., Jr., J.R. Hall, J.R. Sykes, and E.L. Arnold, Jr. 1972. Louisiana coastal zone: analysis of resources and resource development needs of connection with estuarine ecology.

Manheim, F.T., J.C. Hathaway, and E. Uchupi. 1972. Suspended matter in surface waters in the northern Gulf of Mexico. Limn. and Oceanogr. 17(1):17-27.

Maurer, D.L., R.J. Keck, J.C. Tinsman, W.A. Leathem, C.A. Wethe, M. Huntzinger, and J.M. Church. 1978. Vertical migrations of benthos in simulated dredged material overburdens. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS. Tech. Rpt. D-78-35. 97 pp.

May, E.B. 1973a. Environmental effects of hydraulic dredging in estuaries. Alabama Marine Resources Bulletin. No. 9. Alabama Department of Conservation and Natural Resources, Dauphin Island, AL.

_____ 1973b. Extensive oxygen depletion in Mobile Bay, Alabama. Limn. and Oceanogr. 18(3):353-366.

Moe, M.A., Jr. 1963. A survey of offshore fishing in Florida. Professional Papers Series. No. 4. Florida State Board of Conservation. 115 pp.

Molinari, R.L., D. Mayer, and F. Chew. 1979. Physical oceanographic conditions at a potential OTEC site in the Gulf of Mexico. 88°W, 29°N. NOAA Technical Memorandum ERL AOML-41 Atlantic Oceanographic and Meteorological Laboratories, Miami, FL. 105 pp.

Murray, S.P. 1970. Bottom currents near the coast during hurricane Camille. J. Geophys. Res. 75(24):4579-4582.

National Oceanic and Atmospheric Administration (NOAA). 1972. Environmental guide for the U.S. Gulf Coast, Environmental Data Service. National Climatic Center, Asherville, NC. 177 pp.

Oil and Gas Journal (OGJ). 1981. Mobile Bay wildcat drilling programs outlined. O.G.J. pp. 80-81.

Oliver, J.S., P.N. Slattery, L.W. Hulberg, and J.W. Nybakken. 1977. Patterns of succession in benthic infaunal communities following dredging and dredged material disposal in Monterey Bay. Moss Landing Marine Laboratories. Prepared for: U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. Tech. Rpt. D-77-27. 186 pp.

Otvos, E.G., Jr. 1970. Development and migration of barrier islands, northern Gulf of Mexico. Geol. Soc. Am. Bull. 81:241-246, 3 figs.

Parker, R.H. 1960. Ecology and distributional patterns of marine macro-invertebrates, northern Gulf of Mexico. In: Recent Sediments, Northwest Gulf of Mexico. Shepard (ed.). Am. Assoc. of Petrol. Geol. pp. 302-337.

Pequegnat, W.E., D.D. Smith, R.M. Darnell, B.J. Presley, and R.O. Reid. 1978. An assessment of the potential impact of dredged material disposal in the open ocean. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. Tech. Rpt. D-78-2. 642 pp.

Perry, H.M., K.G. Stuck, and H.D. Howse. 1979. First record of a bloom of Gonyaulax monilata in coastal waters of Mississippi. Gulf Res. Rpts. 6(3):313-316.

Raymont, J.E.G. 1963. Plankton and productivity in the oceans. The MacMillan Company, NY. 600 pp.

Reitsema, L.A. 1980. Determine seasonal abundance, distribution and community composition of zooplankton. Vol. II. In: Jackson, W.B. and G.M. Faw (eds.). Biological/chemical survey of Texoma and Capline sector salt dome brine disposal sites off Louisiana, 1978-1979. NOAA Technical Memorandum NMFS-SEFC-26. 133 pp. Available from: NTIS, Springfield, VA.

Richardson, M.D., A.G. Carey, Jr., and W.A. Colgate. 1977. Aquatic disposal field investigations, Columbia River disposal site, Oregon; Appendix C: The effects of dredged material disposal on benthic assemblages. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. Tech. Rpt. D-77-30. 411 pp.

Rinkel, M.O. and J.I. Jones (eds.). 1973. Escarosa 1: An oceanographic survey of the Florida Territorial Sea of Escambia and Santa Rosa counties. State of Florida, Department of Natural Resources Coastal Coordinating Council. 366 pp.

Roithmayr, C.M. 1965. Industrial bottomfish fishery of the northern Gulf of Mexico, 1959-63. United States Fish and Wildlife Service. Special Scientific Report - Fisheries No. 518. 23 pp.

Rowe, G.T. and D.W. Menzel. 1971. Quantitative benthic samples from the deep Gulf of Mexico with some comments. Bull. Mar. Sci. 21(2):557-566.

Ryther, J.H. and W.M. Dunstan. 1971. Nitrogen, phosphorus and eutrophication in the coastal marine environment. Science 171:1008-1013.

Sapp, C.D., J.G. Emplaincourt, and J.D. Harding. 1975. Remote sensing of shoreline dynamics, Mobile Bay area, 1900-1975. Gulf Coast Assoc. Geol. Soc. Trans. 25:153-165.

Schroeder, W.W. 1977. The impact of the 1973 flooding of the Mobile River System on the hydrography of Mobile Bay and east Mississippi Sound. Northeast Gulf Sci. 1(2):68-76.

______ 1976. Physical environment atlas of coastal Alabama. Mississippi-Alabama Sea Grant Program. MASGP-76-034.

Schubel, J.R., H.H. Carter, R.E. Wilson, W.M. Wise, M.G. Heaton, and M.G. Gross. 1978. Field investigations of the nature, degree, and extent of turbidity generated by open-water pipeline disposal operations. Tech. Rep. D-78-30, office Chief of Engineers, U.S. Army Corps of Engineers, Washington, DC. 245 pp.

Scruton, P.C. 1956. Oceanography of Mississippi Delta sedimentary environments. Bull. Am. Assoc. Petrol. Geol. 40(12):2864-2952.

Shepard, F.P. 1960. Mississippi Delta: Marginal environments, sediments and growth. pp. 56-81. In: F.P. Shepard, F.B. Phleger and T.H. van Andel (eds.). Recent Sediments, Northwest Gulf of Mexico, A Symposium 1951-1958. AAPG Tulsa, OK. 394 pp.

Simmons, E.G. and W.H. Thomas. 1962. Phytoplankton of the eastern Mississippi Delta. Publ. Inst. Mar. Sci. 8:269-298.

Slowey, J.F. and D.W. Hood. 1969. Copper, manganese, and zinc concentrations in the Gulf of Mexico Water. Geochimica et Cosmochimica Acta. 3S:121-138.

Sokolova, M.N. 1959. On the distribution of deep-water bottom animals in relations to their feeding habits and the character of sedimentation. Deep Sea Res. 6:1-4.

Steidinger, K.A. 1972. Dinoflagellate distribution in the Gulf of Mexico. In: El-Sayed et al., chemistry, primary productivity, and benthic algae of the Gulf of Mexico. Ser. Atlas Mar. Environ., Folio 22, Amer. Geog. Soc., NY.

State University System Florida Institute of Oceanography (SUSIO). 1977. Baseline monitoring studies, Mississippi, Alabama, Florida outer Continental Shelf, 1975-1976. A report to the Bureau of Land Management, Washington, DC., Contract No. 08550-CT5-30. State University System Florida Institute of Oceanography. St. Petersburg, FL. 782 pp.

______ 1975. Final report on the baseline environmental survey of the MAFLA lease areas CY 1974. A report to the Bureau of Land Management, Washington, DC., Contract No. 08550-CT4-11. State University System Florida Institute of Oceanogrpahy. St. Petersburg, FL. 5 Volumes.

Sullivan, B. and D. Hancock. 1977. Zooplankton and dredging research perspectives from a critical review. Water Resources Bull. 13:461-467.

Swingle, H.A. 1977. Coastal fisheries resources of Alabama. In: Alabama Mar. Resources Bull. No. 12. Department of Conservation and National Resources. pp. 31-58.

Tagatz, M.E. and E.P.H. Wilkens. 1973. Seasonal occurrence of young Gulf menhaden and other fishes in a northwestern Florida estuary. NOAA Technical Report NMFS SSRF-672. U.S. Department of Commerce, National Marine Fisheries Service. 14 pp.

Tereco. 1978. Literature review of Mississippi Sound and adjacent area. A Report to Dept. of the Army, Mobile District Corps of Engineers, Mobile, AL. 251 pp.

Thompson Engineering Testing. December 1984. A report of the collection and Analysis of sediment, water, and elutriate samples. Pensacola Bay Entrance Channel. Dept. of the Navy, Contract No. N62467-83-C-2067.

Thompson, P.S., Jr. and T.D. Leming. 1978. Seasonal description of winds and Surface and bottom salinities and temperatures in the northern Gulf of Mexico, October 1972 to January 1976. NOAA Technical Report NMFS SSRF-719. U.S. Department of Commerce, National Marine Fisheries Service. 44pp.

Tolbert, W.H. and G.G. Salsman. 1964. Surface circulation of the eastern Gulf of Mexico as determined by drift bottle studies. J. Geophys. Re. 69(2):223:230.

Trefry, J.H., III, A.D. Fredericks, S.R. Fay, and M.L. Byington. 1978. Final report for BLM MAFLA OCS Study - heavy metal analysis of bottom sediment. TerEco Corporation, College Station, TX. 29 pp.

Trefry, J.H., III. 1977. The transport of heavy metals by the Mississippi River and their fate in the Gulf of Mexico. Unpublished PhD. Theseis. Texas A&M University. 223 pp.

Upshaw, G.F., W.B. Creath, and F.L. Brooks. 1966. Sediments and microfauna off the coasts of Mississippi and adjacent states. Mississippi Geol. Survey Bull. 1-6:127 pp.

U.S. Army Corps of Engineers (CE). 1981. Mississippi Sound and adjacent areas public information fact sheet. U.S. Army Corps of Engineers, Mobile District, Mobile, AL.

_____1980a. Final environmental impact statement for four exploratory/ appraisal hydrocarbon wells. Mobile Bay, Alabama. U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 443 pp.

_____1980b. Survey report on Mobile Harbor, Alabama. Vol. 2. U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 443 pp.

_____1979a. Mississippi Sound and adjacent areas reconnaissance report and appendices. 6 Vol. U.S. Army Corps of Engineers, Mobile District, Mobile, AL.

_____1979b. Final environmental impact statement and appendices proposed pipeline and wastewater outfall in Mobile Bay, Alabama from the Theodore Industrial Park. U.S. Army Corps of Engineers, Mobile District, Mobile, AL.

_____1979c. Bathymetry Chart D-13-3-2 - Gulfport Harbor, Mississippi Ship Island Bar Channel disposal areas. U.S. Army Corps of Engineers, Mobile District, Mobile, AL.

_____1979d. Bathymetry Chart D-13-3-16 - Mobile Harbor, Alabama Inner-Outer Bar Channel disposal area. U.S. Army Corps of Engineers, Mobile District, Mobile, AL.

______1978e. Dredged material evaluation Pensacola Harbor maintenance dredging of entrance channel and navy channel. U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 13 pp.

______1978f. Dredged material evaluation Mobile Harbor maintenance dredging-Bar Channel. U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 4 pp.

______1978a. Mobile County, Alabama (including Dauphin Island) Feasibility report for beach erosion control and hurricane protection. U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 141 pp.

______1978b. Pensacola Harbor, Florida. Stage 2 study documentation (Milestone 03) and revised plan of study. U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 52 pp.

______1978c. Draft report on Mobile Harbor, Alabama, appendices. U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 419 pp.

______1978d. Waterborne commerce of the United States. Calendar Year 1978. Part 2 - Waterways and Harbors Gulf Coast, Mississippi River System and Antilles. U.S. Army Corps of Engineers. Fort Belvoir, VA. 185 pp.

______1976. Feasibility Report - Gulfport Harbor Gulfport, Mississippi. channel deepening for navigation. U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 59 pp.

______1973. Reports on Gulf coast deep water port facilities Texas, Louisiana, Mississippi, Alabama, and Florida. Appendix F. Environmental Assessment, Eastern Gulf. 202 pp.

U.S. Department of Commerce (DOC). 1981. Proceedings of a symposium on environmental research needs in the Gulf of Mexico (GOMEX), Key Biscayne, Florida, 30 September-5 October 1978. Vol. II.

______1980a. Marine recreational fishery statistics survey, Atlantic and Gulf Coasts, 1979. U.S. Department of Commerce, National Marine Fisheries Service. 139 pp.

______1980b. Cape St. George to Mississippi Passes. National Ocean Surveys Chart No. 11360. National Oceanic and Atmospheric Administration.

______1980c. Pensacola Bay. National Ocean Survey Chart No. 11383. National Oceanic and Atmospheric Administration.

______1979a. Mississippi Sound and approaches. National Ocean Survey Chart No. 11373. National Oceanic and Atmospheric Administration.

______1979b. Mobile Bay. National Ocean Survey Chart No. 11376. National Oceanic and Atmospheric Administration.

______1979c. Pensacola Bay and approaches. National Ocean Survey Chart No. 11382. National Oceanic and Atmospheric Administration.

U.S. Department of Health, Education and Welfare, Food and Drug Administration (FDA). 1980. Action levels for poisonous and deleterious substances in human and animal feed. Food and Drug Administration. Washington, DC.

U.S. Environmental Protection Agency (EPA). 1982. Draft environmental impact statement (EIS) for New York dredged material disposal site designation. EPA, criteria and standards division, Washington DC.

_____ 1977. Ocean Dumping: final revision of regulations and criteria. Federal Register. 42(70)2461-2490.

_____ 1976. Quality criteria for water. U.S. Government Printing Office. EPA-44019-76-023. Washington, D.C. 256 pp.

U.S. Department of Interior (DOI). 1981. Draft environmental impact statement outer Continental Shelf oil and gas lease sales 67 and 69, offshore Gulf of Mexico. Bureau of Land Management. 417 pp.

_____ 1980. Gulf Islands - visitor information map. National Park Service.

_____ 1979a. Draft environmental impact statement for the proposed outer Continental Shelf oil and gas lease sale 58, western and central Gulf of Mexico. Bureau of Land Management. 168 pp.

_____ 1979b. List of endangered and threatened wildlife and plants, republication. Federal Register. 44(12):3636-3654.

_____ 1978a. Draft environmental impact statement outer Continental Shelf oil and gas lease sale 51, offshore west and central Gulf of Mexico. Bureau of Land Management. 2 vols.

_____ 1978b. Final environmental impact statement proposed 1977 outer Continental Shelf oil and gas lease sale 47, Gulf of Mexico. Bureau of Land Management.

_____ 1975. Compilation and summation of historical and existing physical oceanographic data from the eastern Gulf of Mexico in support of the creation of a MAFLA sampling program. Bureau of Land Management.

_____ 1974. Final environmental impact statement outer Continental Shelf oil and gas lease sale 36. Bureau of Land Management. 3 vols.

Vittor, B.A. 1978. Review of literature pertaining to the effects of dredging within the Mississippi Sound and adjacent study areas. Barry A. Vittor & Associates, Inc., Dauphin Island, AL. 63 pp.

Vittor, B.A. 1977. Characterization of benthic habitats on the Misssissippi - Alabama Shelf, adjacent to Mobile Bay, Alabama. Prepared for U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 19 pp.

Wade, C.W. 1977. Survey of the Alabama marine recreational fishery. Alabama Mar. Resources Bull. 12:1-22.

Water and Air Research Inc. 1975. A study on the effects of maintenance dredging on selected ecological parameters in the Gulfport Ship Channel Gulfport, MS. U.S. Army Corps of Engineers, Mobile District, Mobile, AL. 203 pp.

Windom, H.L. 1976. Environmental aspects of dredging in the coastal zone. CRC Critical Reviews in Environmental Control. pp. 91-109.

_____1975. Water quality aspects of dredging and dredge-spoil disposal in estuarine environments. Pages 559-571 in: L.E. Cronin (ed.) Estuarine Research Volume II: Geology and Engineering. Academic Press. NY.

_____1973. Processes responsible for water quality changes during pipeline dredging in marine environments. Proc. Fifth World Dredging Conference, Hamburg, Germany, June 1973.

Wright, T.D. 1978. Aquatic dredged material disposal impacts. U.S. Army Engineers waterways Experiment Station Vicksburg, MS. Tech. Rpt. DS-78-1. 57 pp.

Appendix A

REPORT OF FIELD SURVEY

Field surveys at the Pensacola, Mobile, and Gulfport interimly-designated Ocean Dredged Material Disposal Sites (ODMDS) were conducted during 18 to 21 January and 27 to 29 June 1980 by Interstate Electronics Corporation (IEC) under contract to the Environmental Protection Agency (EPA) (Contract Number 68-01-4610). Biological, chemical, geological, and physical oceanographic data were collected to assess the effects of dredged material disposal on the marine environment and to augment historical information from the area. A major consideration of survey design was to determine whether any adverse effects identified within the ODMDSs were detectable outside site boundaries.

Methods of data collection, results, and interpretations of the survey data are presented in the following sections. The data are compared briefly with historical information; however, more comprehensive treatment is given in Chapter 3 of this EIS.

A.1 METHODS

All survey operations were conducted using the Ocean Survey Vessel ANTELOPE. Loran-C or radar range and bearing positioning were used for navigation, providing accuracy within 0.25 nmi.

Stations 1 to 4 were located inside the Mobile ODMDS, and control Stations 5 to 10 were positioned in predominant upcurrent-downcurrent directions from the site (Figure A-1). Station locations were designed to determine whether transport of dredged material was occurring outside the site boundaries. Stations 11 and 13 were located within the Pensacola (Figure A-2) and Gulfport ODMDSs (Figure A-3), respectively. Control Station 12 was located northwest of the site at Pensacola and control Station 14 at Gulfport was positioned northeast of the eastern disposal site. Samples collected, coordinates, and water depths for all stations are presented in Table A-1.

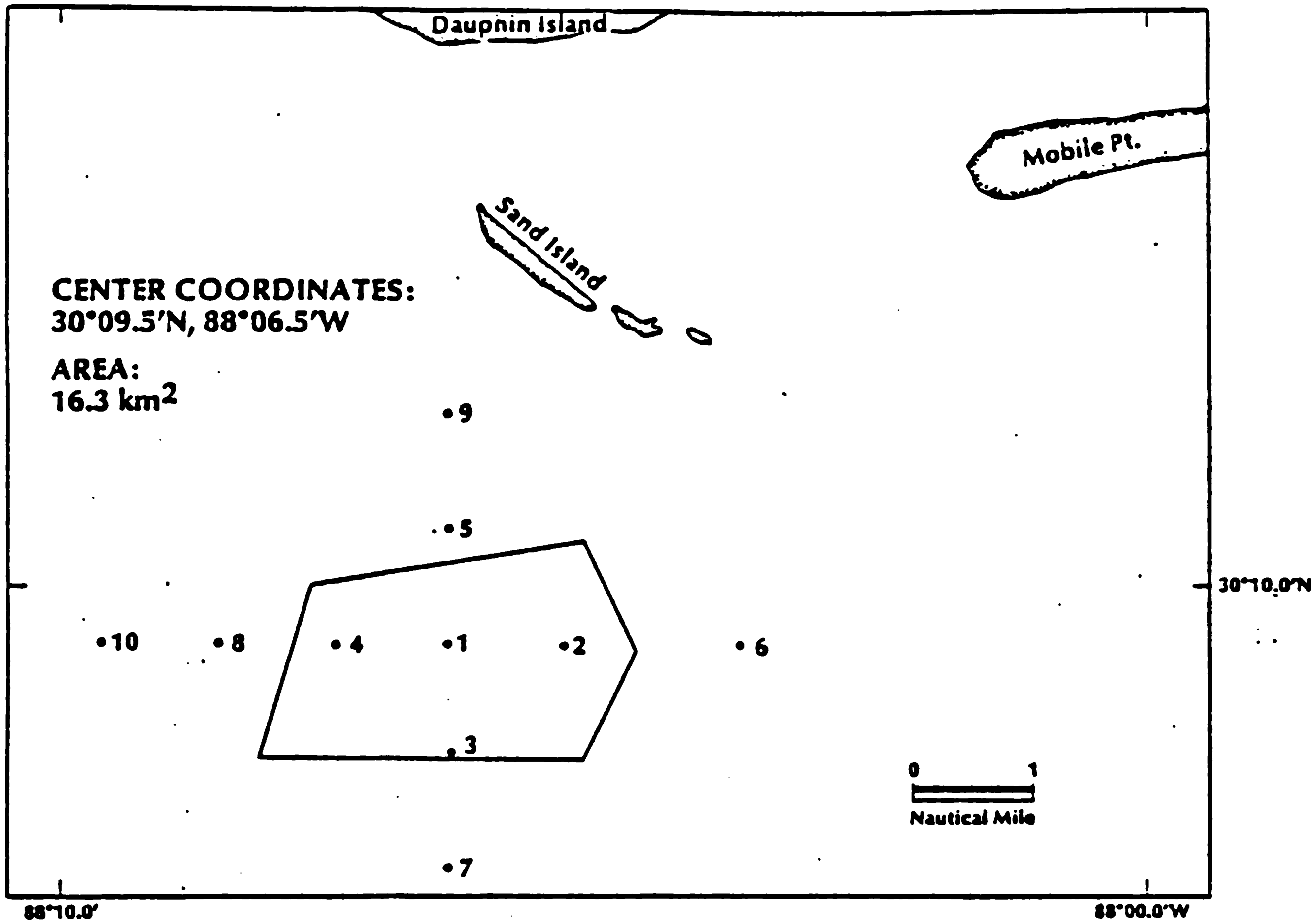


Figure A-1. Station Locations, EPA/IEC Survey of Mobile ODMDS (January and June 1980)

Microbiological analyses of sediments and tissues, and several physical and chemical oceanographic measurements were performed aboard the ANTELOPE; all other detailed chemical, geological, and biological analyses were performed at shore-based laboratories listed in Table A-2.

Sampling equipment, procedures, and preservation methods were in accordance with the "Oceanographic Sampling and Analytical Procedures Manual" (IEC, 1980). A summary of these methods is presented in the following sections.

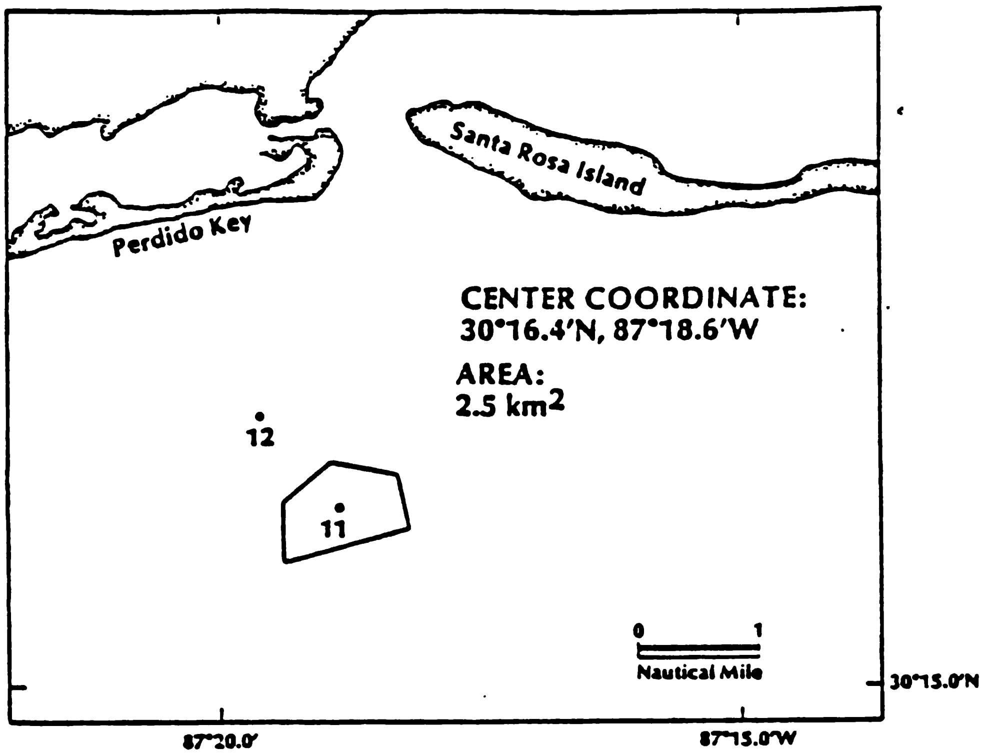


Figure A-2. Station Locations, EPA/IEC Survey of Pensacola ODMDS (January and June 1980)

A.1.1 WATER COLUMN MEASUREMENTS

Shipboard Procedures

A rosette sampler equipped with 30-liter Go-Flo bottles was used to collect surface and near-bottom samples for suspended solids, dissolved oxygen, salinity, and temperature; middepth samples were collected for analysis of dissolved and particulate trace metals and dissolved chlorinated hydrocarbons (CHC). Salinity samples were analyzed with a Beckman salinometer. Surface and bottom water temperatures were measured using reversing or bucket thermometers. Turbidity was measured with a Hach laboratory turbidimeter, and pH with a Beckman pH meter. Dissolved oxygen was determined using a modified Winkler method (Strickland and Parsons, 1972). Water samples for total suspended solids (TSS) and trace metals (particulate and dissolved) analyses were transferred from Go-Flo bottles to 2-liter pressure filtration bottles, then filtered through Nucleopore filters. The filtrate was collected for

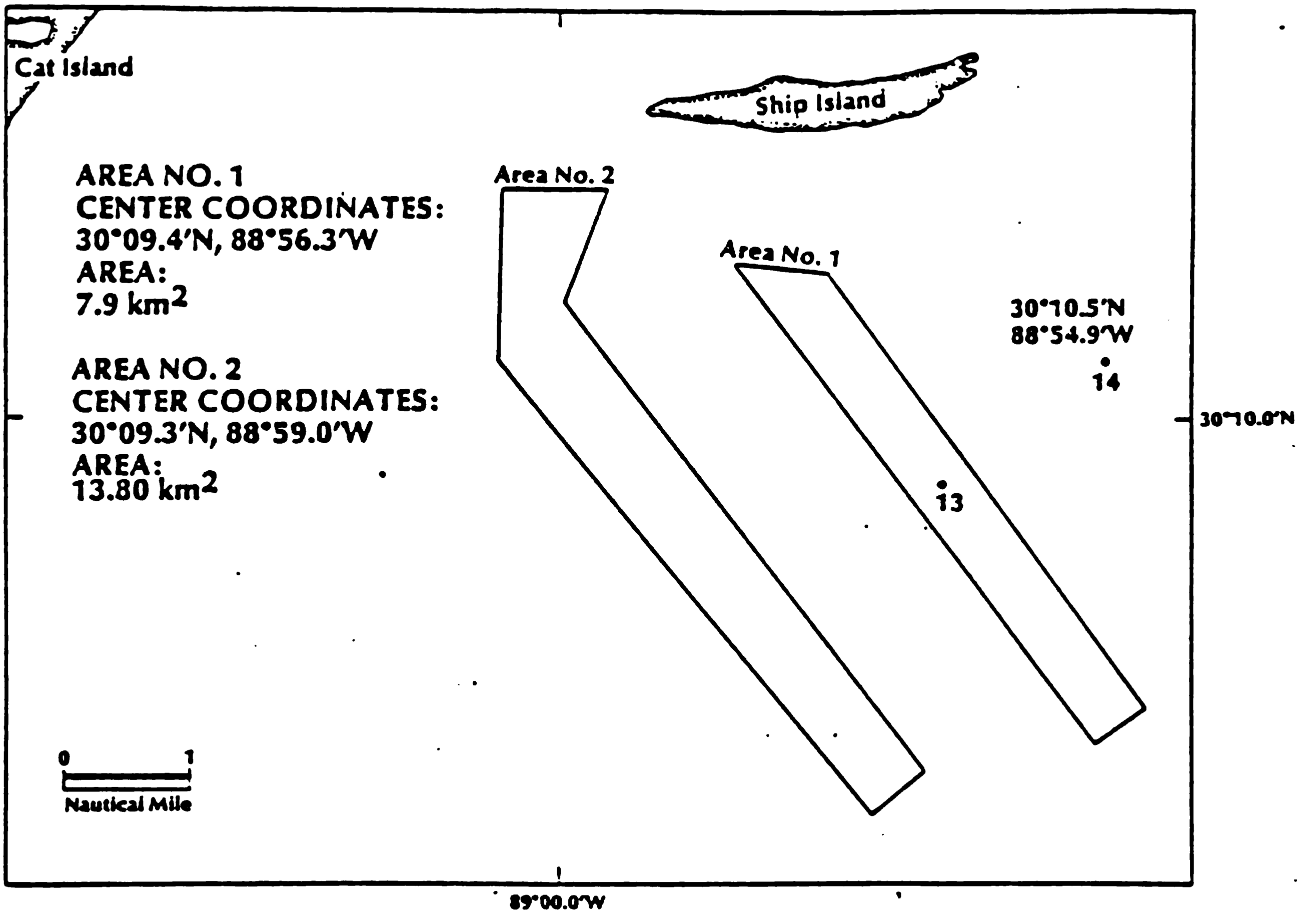


Figure A-3. Station Locations, EPA/IEC Survey of Gulfport ODMDS (January and June 1980)

dissolved trace metals analysis in precleaned bottles acidified with Ultrex nitric acid. Measured water volumes were pressure-fed directly from Go-Flo bottles through an Amberlite XAD resin column for extraction of CHCs (Osterroht, 1977). Filters for particulate trace metals and suspended solids, and resin columns for CHCs were processed in a positive pressure clean hood and frozen prior to analysis.

Laboratory Methods

Total suspended solids were determined gravimetrically on an electrobalance (Meade et al., 1975). Filters containing particulate trace metal samples were

TABLE A-1
SAMPLING REQUIREMENTS FOR PENSACOLA, MOBILE, AND GULFPORT ODMDSs AND VICINITIES

		WATER COLUMN								SEDIMENT							BIOTA			
			WATER SAMPLING ROSETTE							BOX CORER, 7 DROPS							DREDGE/TRAWL			
		INSTRUMENT ARRAY 1 PROFILE/ STATION	GO-FLOW 2 SAMPLES: SURFACE AND BOTTOM/STATION				GO-FLOW TEFLON LINED 1 SAMPLE/ STATION MIDWATER			2 CORES/STATION					ONE CORE PER STA	BIOLOGICAL 5 CORES/ STATION	EPIFAUNA & MACROINFAUNA TISSUES 2 TRAWLS/SITE			
	STATION NUMBER	PROFILES OF SALINITY, pH, TEMPERATURE	CALIBRATION SAMPLES: SALINITY, TURBIDITY, pH, & TEMPERATURE	SUSPENDED SOLIDS	DISSOLVED OXYGEN	DISSOLVED TRACE METALS	PARTICULATE TRACE METALS	CHLORINATED HYDROCARBON SCAN	GRAINSIZE, ARTIFACTS	TOTAL ORGANIC CARBON	TRACE METALS	CHLORINATED HYDROCARBON SCAN (a)	OIL & GREASE	ELUTRIATE SAMPLE	GRAIN SIZE & ARTIFACTS	MACROINFAUNA, TAXONOMY	TRACE METALS (b)	CHLORINATED HYDROCARBON SCAN (b)	TOTAL & FECAL COLIFORMS (b)	MACROFAUNA, TAXONOMY
MOBILE	1	●	●	●	●	QC	QC	QC	QC	QC	QC	QC	●	●	●	●	QC	QC	●	●
	2								●	●	●		●		●	●				
	3								●	●	●		●		●	●				
	4								●	●	●		●		●	●				
	5								●	●	●		●		●	●				
	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	7	●	●	●	●				●	●	●		●		●	●				
	8	●	●	●	●				●	●	●		●		●	●				
	9	●	●	●	●				●	●	●		●		●	●				
	10								●	●	●		●		●	●				
PENSACOLA	11	●	●	●	●	●	●	●	●	QC	QC	●	●	●	●	●	●	●	●	●
	12	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
GULFPORT	13	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	14	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

STATIONS

NUMBER	1	2	3	4	5	6	7	8	9
LATITUDE	30°09.5'N	30°09.5'N	30°08.6'N	30°09.5'N	30°10.4'N	30°09.5'N	30°07.6'N	30°09.5'N	30°11.4'N
LONGITUDE	88°06.5'W	88°05.4'W	88°06.5'W	88°07.5'W	88°06.5'W	88°03.7'W	88°06.5'W	88°08.6'W	88°06.5'W
DEPTH *	13m	12m	14m	15m	12m	8m	16m	15m	11m
NUMBER	10	11	12	13	14				
LATITUDE	30°09.5'N	30°16.4'N	30°17.2'N	30°09.4'N	30°10.5'N				
LONGITUDE	88°09.6'W	87°18.8'W	87°19.8'W	88°56.3'W	88°55.0'W				
DEPTH *	15m	11m	10m	8m	8m				

QC = one quality control sample will be analyzed in addition to samples being collected at the designated site.

(a) = Composite sample from both box cores at each designated station.

(b) = Composite samples from all dredges and trawls, plus samples of opportunity from geology-chemistry boxcores; species identified on board before analyses or preservation.

* = Mean depth among replicates

TABLE A-2
LABORATORIES PERFORMING ANALYSIS OF SAMPLES
FROM PENSACOLA, MOBILE, AND GULFPORT ODMDSs

Biology	Chemistry	Geology
Barry A. Vittor and Associates Mobile, Alabama	Science Applications Inc. San Diego, California	Science Applications Inc. San Diego, California
La Mer* San Pedro, CA	LFE Environmental Analysis Laboratories* Richmond, California	------

* Denotes quality control laboratory

leached for 2 hours with 1N Ultrex nitric acid. Leachates were analyzed for cadmium (Cd) and lead (Pb) by graphite furnace atomic absorption spectrophotometry (AAS), and for mercury (Hg) by cold-vapor AAS (EPA, 1979).

Dissolved Hg was analyzed by cold vapor AAS following an acid-permanganate digestion and reduction with hydroxylamine and stannous sulfates (EPA, 1979). Dissolved Cd and Pb were concentrated using a chelation-solvent extraction method (Sturgeon et al., 1980), and analyzed by graphite furnace AAS.

CHCs were eluted from resin columns with acetonitrile. The eluate was extracted three times with hexane, evaporated to near dryness, fractionated on a florisil column, and analyzed by electron-capture gas chromatography (Osterroht, 1977). The chromatogram was scanned for presence of polychlorinated biphenyls (PCB) mixtures (Arochlors 1016, 1221, 1232, 1242, 1248, 1254, 1260 and 1262), and various pesticides and derivatives (aldrin, dieldrin, endrin, heptachlor, β-BHC, DDT, DDD, DDE, heptachlor epoxide).

A.1.2 GEOCHEMISTRY AND GRAIN SIZE ANALYSIS

Shipboard Procedures

Fifty grams of sediment were removed from each of seven 0.065 m^2 box cores per station, and frozen for grain size analysis. Sediment samples for geochemical analyses (trace metals, oil and grease, total organic carbon [TOC], and CHCs) were collected from the surface 2 cm of two cores per station, stored in acid-cleaned Teflon jars, and frozen.

Total and fecal coliforms in sediments were determined from two box core samples. Approximately 30g of sediment from the surface 1 cm of each sample was collected aseptically; analyses was initiated within 6 hours after collection. Coliforms were determined using a modified Most Probable Number (MPN) technique (APHA, 1975).

Laboratory Methods

Sediment grain size was determined by washing sediment samples through 2,000- and 62-um mesh sieves to separate gravel, sand, and silt/clay fractions following a procedure described by Folk (1978). Sand/gravel fractions were separated with 1 phi (Ø) interval sieves, dried, and weighed. The silt/clay fractions were analyzed using a pipette method (Rittenhouse, 1933).

Trace metals (Cd and Pb) were leached from 5 to 10g of sediment for 2 hours with 25 ml of 1N nitric acid, and analyzed by graphite furnace AAS. Mercury was leached from 5 to 10g of sediment at 95°C with aqua regia and potassium permanganate, reduced using hydroxylamine sulfate and stannous sulfate, and analyzed by cold-vapor AAS (EPA, 1979).

Oil and grease were extracted from 100g sediment samples with an acetone-hexane mixture, dried and quantified gravimetrically according to the method of APHA (1975). TOC in sediments was measured with a Perkin-Elmer Model 240 Elemental Analyzer (Gibbs, 1977).

CHCs were soxhlet extracted from sediment samples using a 1:1 acetone-hexane solvent. The extract was evaporated, cleaned on a florisil column, fractionated on a silicic acid column, and analyzed by electron capture gas chromatography (EPA, 1974). An additional acid cleanup step was required for analysis of PCBs. Chromatograms were scanned for compounds listed above in Section A.1.1.

Elutriate analyses were performed in accordance with the specifications of EPA/CE (1977). Sediments and unfiltered disposal site water were mixed at a 1:4 ratio by mechanical- and air-agitation for 30 minutes. After a 1-hour settling period, test water was filtered, acidified with Ultrex hydrochloric acid, and analyzed for dissolved trace metals using techniques described above.

A.1.3 BIOLOGICAL MEASUREMENTS (Including Tissue Chemistry and Coliform)

Shipboard Procedures

Five macrofaunal samples were collected at each station using a 0.065 m^2 box core and washed through a 0.5 mm screen; organisms were preserved in 10% formalin in seawater prior to analysis. Two 10.2 cm diameter subcores were taken from one box core at each station for the first survey, and preserved for enumeration of all macrofauna.

Trawls were conducted inside and outside of each site using a 7.6m Otter trawl to collect epifauna for analysis of tissue concentrations of CHCs, trace metals, and total and fecal coliforms. In additon, information from the catch was used to further characterize the benthic and nektonic communities.

Epifauna from the trawls were sorted in stainless steel trays and enumerated. Tissue was combined from at least three individuals of each of the commercially important species captured, aseptically homogenized in a blender, and cultured within 6 hours for total and fecal coliforms using a modified most probable number (MPN) technique (APHA, 1975; IEC, 1980). Other specimens were transferred from the trays to acid-rinsed plastic buckets, and then into clean plastic bags and frozen for trace metal analyses. Additional specimens were transferred to stainless steel buckets with stainless steel forceps, wrapped in aluminum foil, placed in polyethylene bags, and frozen for CHC analysis.

Total and fecal coliforms were determined in sediments during the June survey only. Approximately 30g of sediment from the surface 1 cm of each sample were collected aseptically; analysis was iniated within 6 hours after collection. Coliforms were determined using a modified MPN technique (APHA, 1975).

Laboratory Methods

Six dominant macrofaunal species were selected by Interstate biologists for enumeration in all samples. Selection of species was based on the inspection of initial laboratory data from analyses of subcores and considered abundance, feeding types, and known association with environmental conditions, particularly substrates. Each of the six dominant species were enumerated in all five station replicates, and mean species abundances were calculated for each station. All samples were transferred to 70% alcohol for storage.

Analysis of Cd and Pb concentrations in tissues followed techniques described by EPA (1977). Approximately 5 to 10g of homogenized tissue were digested with nitric acid and hydrogen peroxide while heated. The digests were then evaporated, diluted to volume with deionized water, and analyzed with flame or flameless AAS. Analysis of Hg concentrations in tissues required digestion of an 8 to 10g sample with concentrated nitric and sulfuric acids and potassium permanganate, reduction of the ionized mercury with hydroxylamine and stannous sulfate, and analysis with cold-vapor AAS (EPA, 1979).

Tissue analyses for CHCs required homogenization of 50g of tissue with sodium sulfate, extraction with hexane, cleanup, fractionation, and analysis with electron capture gas chromatography (EPA, 1974).

A.1.4 COMPUTER DATA ENTRY AND ANALYSIS

All data were entered into the Interstate computerized Oceanic Data and Environmental Evaluation Program data base (ODEEP). Statistical analyses included calculation of means, standard deviations, and analysis of variance.

A.2 RESULTS AND DISCUSSION

A.2.1 Water Column Characteristics

Water column temperature, salinity, dissolved oxygen concentrations, pH, turbidity, and total suspended solids (TSS) concentrations were measured at one station inside and four stations outside the Mobile ODMDS, and at one station inside and one outside each of the Pensacola and Gulfport ODMDSs. Data are summarized in Table A-3. Concentrations of particulate and dissolved trace metals (mercury, cadmium, lead), PCBs, pesticides, and derivatives were measured at one station inside and one station outside each ODMDS; these values are reported in Tables A-4 and A-5, respectively.

MOBILE

Surface (2m depth) and bottom (6-15m depth) water temperatures in the vicinity of the Mobile ODMDS showed little horizontal and vertical variability during January, ranging from 14.9 to 16.2°C. June temperatures were higher and decreased with depth; surface temperatures ranged from 25.9 to 29.5°C and bottom temperatures ranged from 20.2 to 22.8°C.

Salinity consistently increased with depth during both Mobile surveys. Greater vertical differences in salinity (up to 13^{o}/oo) were observed during June, with the greatest changes occurring within the upper 5 to 8 meters. Surface salinites ranged from 27.82 to 34.02^{o}/oo in January and from 22.14 to 30.85^{o}/oo in June. Lower surface salinity in June relative to January is consistent with historical data, and has been attributed to freshwater outflow from rivers during the spring and summer rainy season (Thompson and Leming, 1978; TerEco, 1978). Bottom waters showed less seasonal variability but salinities were higher in June than January; bottom water salinities ranged from 34.07 to 34.56^{o}/oo in January and from 35.19 to 35.87^{o}/oo in June. No clear inshore-offshore trends were evident.

The water column in the vicinity of the Mobile ODMDS was well oxygenated during January with surface dissolved oxygen concentrations ranging from 5.11 to 5.37 ml/l and saturation levels ranging from 90 to 96%; bottom dissolved oxygen concentrations ranged from 4.31 to 4.87 ml/l with saturation levels ranging from 77 to 87%. During June, surface dissolved oxygen concentrations ranged from 4.24 to 5.96 ml/l (96 to 130% saturation); bottom dissolved oxygen concentrations ranged from 1.78 to 2.32 ml/l (36 to 47% saturation). The dissolved oxygen concentrations for surface waters in January and June and for bottom waters in January are similar to those reported for the region by Rinkel and Jones (1973). The dissolved oxygen concentrations for bottom

TABLE A-3
WATER COLUMN PHYSICAL AND CHEMICAL PARAMETERS AT MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES

Station	Sample Depth (m)	Temperature (°C)		Salinity (°/oo)		Dissolved Oxygen* (ml/liter)		pH		Turbidity (NTU)		Total Suspended Solids (mg/liter)	
		Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun
Mobile 1	2	16.2	27.5	32.43	29.93	5.11 (93)	5.96 (130)	8.2	8.2	1.70	1.00	2.43	2.05
	5			32.42	30.40			8.2	8.2	1.80	1.00	2.59	2.61
	10-11	16.0	21.2	34.07	35.79	4.64 (85)	2.32 (47)	8.2	7.9	4.00	2.30	2.08	4.27
Mobile 6	2	15.7	29.5	34.02	30.85	5.15 (96)	4.24 (96)	8.2	8.1	0.52	3.10	0.61	5.83
	4-5			33.52	32.20			8.2	8.0	0.75	2.80	0.63	5.05
	6-9	15.7	21.6	34.21	35.64	4.77 (87)	1.78 (36)	8.2	8.0	0.78	3.10	1.11	2.78
Mobile 7	2	15.9	26.2	29.74	25.67	5.26 (94)	4.66 (97)	8.2	8.0	1.50	1.90	1.98	3.29
	7-8			34.26	35.22			8.2	7.9	1.20	2.00	1.55	4.73
	14-15	15.3	21.6	34.56	35.64	4.87 (85)	1.83 (37)	8.2	7.8	2.40	3.30	3.93	5.43
Mobile 8	2	14.9	25.9	27.82	29.36	5.24 (90)	5.52 (117)	8.2	8.2	3.60	0.50	5.24	1.07
	6-8			33.72	34.00			8.2	8.0	1.80	1.50	2.50	3.13
	12-13	15.0	20.2	34.34	35.87	4.31 (78)	1.97 (39)	8.2	7.9	4.40	2.60	6.79	4.43
Mobile 9	2	15.9	27.2	30.06	22.14	5.37 (96)	5.18 (107)	8.1	8.2	1.80	1.50	2.14	2.12
	5			34.07	35.19			8.2	8.1	4.20	2.10	6.23	4.31
	9-10	15.8	22.8	34.49	35.19	4.31 (77)	1.83 (38)	8.2	7.9	5.10	4.40	7.39	7.98
Pensacola 11	2	16.2	26.8	33.59	31.95	5.55 (102)	4.97 (108)	8.2	8.2	0.50	0.44	0.90	0.78
	5			33.91	32.46			8.2	8.2	0.30	0.68	0.63	0.55
	9	15.8	22.8	33.97	35.01	5.22 (95)	4.29 (90)	8.2	8.1	0.30	0.73	1.59	0.97
Pensacola 12	2	16.0	26.1	33.33	32.67	5.28 (96)	5.13 (111)	8.3	8.2	0.40	0.37	0.76	0.94
	4			34.35	33.92			8.3	8.2	0.30	0.43	0.67	0.52
	8	15.9	22.8	34.51	34.99	5.22 (96)	4.30 (90)	8.3	8.1	0.40	0.88	0.72	1.27
Gulfport 13	2	15.7	26.5	28.97	25.66	5.33 (94)	5.58 (117)	8.2	8.1	3.00	1.50	5.19	4.69
	3-4			29.63	27.74			7.7	8.1	3.70	1.60	5.76	3.46
	7	15.5	22.5	29.89	34.65	5.33 (94)	2.10 (44)	8.2	8.0	4.00	1.60	6.62	4.76
Gulfport 14	2	15.1	26.5	28.76	27.35	4.94 (86)	4.21 (90)	8.2	8.1	3.50	1.00	5.45	1.57
	3-4			29.35	32.49			8.2	8.0	5.00	1.20	7.89	1.98
	6	15.0	22.9	29.72	34.71	5.17 (90)	2.23 (45)	8.2	8.0	7.30	1.30	12.60	2.93

* Average of two replicates except at Station 1, bottom depth (n=1); percent saturation given in parentheses

TABLE A-4
CONCENTRATIONS OF PARTICULATE AND DISSOLVED TRACE METALS AT MIDDEPTH IN THE WATER COLUMN AT MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES (μg/liter)

Station	Particulate						Dissolved					
	Hg		Cd		Pb		Hg		Cd		Pb	
	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun
Mobile 1	0.001	<0.0005	0.016	0.037	0.039	<0.005	0.018	<0.003	0.031	<0.010	<0.20	<0.03
Mobile 6	0.001	0.001	0.034	0.094	0.011	0.026	<0.003	0.005	0.085	0.023	<0.20	0.18
Pensacola 11	0.002	0.004	0.018	0.015	0.005	0.001	<0.003	0.002	0.087	0.036	<0.20	0.07
Pensacola 12	0.004	0.002	0.004	0.038	0.009	0.008	<0.003	0.003	0.104	0.099	<0.20	0.03
Gulfport 13	0.001	<0.0003	0.011	0.008	0.057	0.002	<0.003	0.004	0.040	0.024	<0.20	0.12
Gulfport 14	0.002	<0.0003	0.022	0.013	0.095	0.021	<0.003	0.003	0.154	0.037	<0.20	0.10

< = None detected

waters in June are somewhat lower than historical values for the region (Rinkel and Jones, 1973), but may be characteristic of the Mobile ODMDS area due to the presence of vertical thermo-haline density stratification.

The pH values for the water column were uniform with depth at all stations in January and decreased slightly with depth in June. January pH values measured 8.1 to 8.2, whereas June pH ranged from 7.8 to 8.2. These values are within the normal range for seawater (7.5 to 8.4) reported by Horne (1969).

Turbidity generally increased with depth during both surveys in the vicinity of the Mobile ODMDS but showed no consistent areal or seasonal trends. In January, surface water turbidity ranged from 0.52 (Station 6) to 3.60 NTU (Station 8), averaging 1.82 NTU; bottom water turbidity ranged from 0.78 (Station 6) to 5.10 NTU (Station 9), with a mean of 2.94 NTU. In June, surface turbidity ranged from 0.50 (Station 8) to 3.10 NTU (Station 6), with an average turibidity of 1.60 NTU; bottom water turbidity ranged from 2.30 (Station 1) to 4.40 NTU (Station 9), with a mean of 3.14 NTU. No historical data were available for commparison.

TABLE A-5

CONCENTRATIONS OF CHLORINATED HYDROCARBONS AT MIDDEPTH IN THE WATER COLUMN AT MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES

(ng/liter)

Station	Month	PCB (Aroclor 1221 + 1260)	PCB (Aroclor 1016 + 1242)	Aldrin	Dieldrin	Endrin	Heptachlor	Heptachlor Epoxide	β-BHC	pp'-DDT	pp'-DDE	op-DDE	pp'-DDD
Mobile 1	Jan	0.0032	ND	0.009	ND	ND	ND	0.056	ND	ND	0.011	ND	ND
	Jun	ND	ND	ND	ND	ND	0.16	ND	ND	ND	ND	ND	ND
Mobile 6	Jan	ND	0.0004	ND	ND	ND	ND	0.036	ND	0.042	0.088	0.047	ND
	Jun	ND	ND	ND	6.42	ND	ND	0.065	1.03	ND	ND	4.60	ND
Pensacola 11	Jan	ND	0.0005	ND	ND	0.032	ND	0.011	ND	ND	0.093	0.13	ND
	Jun	ND	ND	ND	8.22	ND	ND	0.071	ND	ND	ND	10.81	ND
Pensacola 12	Jan	ND	0.0023	0.006	ND	ND	ND	ND	ND	ND	0.017	0.028	ND
	Jun	ND	ND	ND	10.75	ND	ND	0.13	ND	ND	ND	5.06	0.056
Gulfport 13	Jan	ND	0.0008	ND	ND	ND	ND	ND	ND	ND	0.014	0.034	ND
	Jun	ND	ND	ND	7.59	ND	ND	0.093	ND	ND	1.60	ND	ND
Gulfport 14	Jan	ND	0.0014	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Jun	ND	ND	ND	7.41	ND	0.54	0.079	ND	ND	ND	ND	ND

ND = None detected

Note: Data represent single determinations; no other CHCs were detected (see Section A.1.1 for CHCs examined)

TSS concentrations were usually consistent with turbidity trends; generally increasing with depth and showing no consistent areal or seasonal trends. In January surface water TSS concentrations ranged from 0.61 (Station 6) to 5.24 mg/l (Station 8), with a mean of 2.48 mg/l; bottom water TSS concentrations ranged from 1.11 (Station 6) to 7.39 mg/l (Station 9), averaging 4.15 mg/l. June surface water TSS concentrations ranged from 1.07 (Station 8) to 5.83 mg/l (Station 6), with a mean of 2.87 mg/l; bottom water TSS concentrations ranged from 2.78 (Station 6) to 7.98 mg/l (Station 9), averaging 5.06 mg/l. These TSS concentrations are higher than those reported in the historical literature (SUSIO, 1975) for mid-Shelf waters in the area; this increased suspended load may be related to the proximity of the disposal sites to Mobile Bay.

Concentrations of dissolved and particulate trace metals measured in the vicinity of the Mobile ODMDS were within or below ranges reported previously (Rinkel and Jones, 1973) for northeastern Gulf Shelf waters and below EPA quality criteria for marine waters (45 FR 79318). Single measurements of trace metal concentrations at one station inside and one station outside the Mobile ODMDS were variable and showed no consistent spatial or seasonal trends. Particulate Hg concentrations measured at both stations were below or approached minimum detectable levels (<0.0005 to 0.001 μg/l). Particulate Cd concentrations ranged from 0.016 to 0.094 μg/l and particulate Pb concentrations from less than detectable levels (< 0.005 μg/l) to 0.039 μg/l. Dissolved trace metal concentrations ranged from less than detectable levels (<0.003 μg/l) to 0.018 μg/l for Hg, and from below detectable levels (<0.010 μg/l) to 0.085 μg/l for Cd. Dissolved Pb concentrations during both surveys were less than 0.2 μg/l.

Concentrations of CHCs examined (see Section A.1.1) were generally below detectable levels and were less than 7 ng/l in all samples. These concentrations are similar to those reported for northeastern Gulf Shelf waters by Rinkel and Jones (1973).

PENSACOLA

Surface (2m depth) and bottom (8 to 9m depth) water temperatures in the vicinity of the Pensacola ODMDS decreased with depth during both surveys and were similar between stations. Temperatures were higher in June than January. January surface temperatures ranged from 16.0 to 16.2°C; bottom temperatures ranged from 15.8 to 15.9°C. June surface temperatures ranged from 26.1 to 26.8°C, whereas bottom temperatures measured 22.8°C.

Salinity increased with depth during both surveys with the increase being greater in June than January. Surface waters were slightly less saline in June, probably due to increased freshwater runoff. Bottom waters were less saline in January. Surface water salinity ranged from 33.33 to 33.59^{o}/oo in January and from 31.95 to 32.67^{o}/oo in June. Bottom water salinity ranged from 33.97 to 34.51^{o}/oo in January and from 34.99 to 35.01^{o}/oo in June. Appropriate historical temperature and salinity data were not available for comparison.

The water column in the vicinity of the Pensacola ODMDS was well oxygenated at all depths during both surveys. Surface dissolved oxygen concentrations in January ranged from 5.28 to 5.55 ml/l with saturation levels ranging from 96 to 102%; bottom water dissolved oxygen concentrations measured 5.22 ml/l with saturation levels of 95 and 96%. Surface dissolved oxygen concentrations in June ranged from 4.97 to 5.13 ml/l (108 to 111% saturation), and bottom dissolved oxygen concentrations ranged from 4.29 to 4.30 ml/l (90% saturation). The above results were generally similar to data reported previously for the month of September in the area (Rinkel and Jones, 1973).

The pH values for the water column were generally uniform with depth and between seasons. Values ranged from 8.1 to 8.3, within the normal range for seawater (Horne, 1969).

Turbidity was uniform or decreased slightly with depth in January but increased with depth in June. Turbidity was similar between stations. In January, surface water turbidity ranged from 0.40 to 0.50 NTU; bottom water turbidity ranged from 0.30 to 0.40 NTU. In June, surface water turbidity ranged from 0.37 to 0.44 NTU; bottom water turbidity ranged from 0.73 to 0.88 NTU. No historical data were available for comparison.

TSS concentrations showed trends similar to those for turbidity, i.e., variable with depth in January and increasing with depth in June. Surface water TSS concentrations ranged from 0.76 to 0.90 mg/l in January and from 0.78 to 0.94 mg/l in June. Bottom water TSS concentrations ranged from 0.72 to 1.59 mg/l in January and from 0.97 to 1.27 mg/l in June.

Particulate and dissolved trace metal concentrations in the vicinity of the Pensacola ODMDS were uniformly low and showed no consistent areal or seasonal trends. Particulate Hg, Cd, and Pb concentrations during both surveys ranged from 0.002 to 0.004 $\mu g/l$, 0.004 to 0.038 $\mu g/l$, and 0.001 to 0.009 $\mu g/l$, respectively. These particulate trace metal concentrations were within or below the ranges reported for the Mississippi Delta Region by Dames and Moore (1979).

Dissolved Hg concentrations were near or below minimum detectable levels (0.003 $\mu g/l$) during both surveys. Dissolved Cd concentrations were also similar for both surveys; ranging from 0.036 to 0.104 $\mu g/l$. Dissolved Pb concentrations were less than 0.2 $\mu g/l$ in January and June. Concentrations for dissolved trace metals were within ranges reported for northeastern Gulf Shelf waters (Rinkel and Jones, 1973) and below EPA quality criteria for marine waters (45 FR 79318).

Dissolved PCB concentrations were detectable only in January and ranged from 0.0005 to 0.0023 ng/l. Pesticide (and derivative) concentrations were most frequently below detectable levels and were below 11 ng/l in all samples. These pesticide concentrations are similar to those reported for northeastern Gulf Shelf waters by Rinkel and Jones (1973).

GULFPORT

Surface (2m depth) and bottom (6 to 7m depth) water temperatures in the vicinity of the Gulfport ODMDS were uniform with depth and showed little areal variability in January. In June, temperatures were higher and decreased markedly with depth, but were similar between the two stations. January surface temperatures ranged from 15.1 to 15.7°C; bottom temperatures ranged from 15.0 to 15.5°C. June surface temperatures measured 26.5°C, whereas bottom temperatures ranged from 22.5 to 22.9°C. Temperatures were generally consistent with previously reported values for the area (Eleuterius, 1976).

Salinity increased with depth during both surveys. Surface waters were less saline in June, probably as a result of greater freshwater runoff in spring. Bottom waters were less saline in January. Surface water salinities ranged from 28.76 to 28.97°/oo in January and from 25.66 to 27.35°/oo in June; bottom water salinity ranged from 29.72 to 29.89°/oo in January and from 34.65 to 34.71°/oo in June. Salinities were similar to previously reported values for January and June (Christmas, 1973).

Surface water dissolved oxygen levels were above or near saturation during both surveys, ranging from 86 to 94% (4.94 to 5.33 ml/l) in January and from 90 to 117% (4.21 to 5.58 ml/l) in June. Bottom waters were well oxygenated in January with saturation levels ranging from 90 to 94% (5.17 to 5.33 ml/l); however, bottom waters were relatively oxygen depleted in June with saturation levels approximately 45% (2.10 to 2.23 ml/l). Similar values have been reported by Christmas (1973) for the area.

Values for water column pH were quite uniform with depth, between stations, and between surveys. January pH values measured 8.2, except for a 7.7 middepth reading (3 to 4m) at Station 13; June pH values ranged from 8.0 to 8.1. All pH values were within the normal range for seawater (Horne, 1969).

Turbidity levels increased with depth during both surveys and were higher in January than June. Turbidity was higher outside the site in January but higher inside the site in June. Overall, turbidity ranged from 1.0 to 7.3 NTU.

TSS concentrations paralleled turbidity, increasing with depth and higher in January than June. TSS concentrations were higher outside the site in January but higher inside in June. Surface TSS concentrations ranged from

5.19 to 5.45 mg/l in January and from 1.57 to 4.69 mg/l in June; bottom TSS concentrations ranged from 6.62 to 12.60 mg/l in January and from 2.93 to 4.76 mg/l in June. These TSS concentrations are higher than those reported for northeastern Gulf mid-Shelf waters (SUSIO, 1975) and may be due to the relatively high suspended material load contributed to the nearshore area from Mississippi Sound.

Particulate trace metal concentrations were generally low but slightly higher outside the disposal site. Levels were somewhat higher in January than June. Particulate metal concentrations ranged from undetectable (<0.0003) to 0.002 μg/l for Hg, from 0.008 to 0.022 μg/l for Cd, and from 0.002 to 0.095 μg/l for Pb. The above particulate trace metal concentrations were generally lower than those reported for the Mississippi Delta Region by Dames and Moore (1979).

Dissolved Hg concentrations were all near or below detectable levels (<0.003 to 0.004 μg/l) in January and June. Although differences were small, dissolved Cd levels were higher outside the site and higher in January than June. Concentrations ranged from 0.040 to 0.154 μg/l in January and from 0.024 to 0.037 μg/l in June. Dissolved Pb concentrations were less than 0.2 μg/l during both surveys. Concentrations for dissolved trace metals were within the range reported for northeastern Gulf Shelf waters (Rinkel and Jones, 1973) and below EPA quality criteria for marine waters (45 FR 79318).

Dissolved PCB concentrations (Aroclor 1016 + 1242) were detectable only in January and ranged from 0.0008 to 0.0014 ng/l. Pesticide (and derivative) concentrations were below detectable levels in most samples and below 8 ng/l in all samples; concentrations were similar at both stations. These concentrations are comparable to those reported for northeastern Gulf Shelf waters by Rinkel and Jones (1973).

A.2.2 SEDIMENT CHARACTERISTICS

Grain size characteristics of sediments in the vicinities of the Mobile, Pensacola, and Gulfport ODMDSs are summarized in Table A-6. Table A-7 lists the concentrations of total organic carbon (TOC), oil and grease, and trace

TABLE A-6
SEDIMENT GRAIN SIZE COMPOSITION AT
MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES

Station	Gravel (%)		Sand (%)		Fines (%)	
	Jan	Jun	Jan	Jun	Jan	Jun
Mobile 1	0.81 ± 0.43	10.43 ± 11.47	96.92 ± 0.44	68.61 ± 24.31	2.11 ± 0.68	31.27 ± 24.35
Mobile 2	0.36 ± 0.56	0.14 ± 0.11	71.17 ± 18.23	63.18 ± 38.17	28.47 ± 18.23	36.51 ± 6.00
Mobile 3	0.91 ± 0.93	0.61 ± 0.61	59.10 ± 31.03	58.51 ± 36.94	39.98 ± 31.64	40.73 ± 37.49
Mobile 4	7.60 ± 19.14	0.42 ± 0.23	70.21 ± 13.00	65.12 ± 9.86	29.25 ± 12.96	34.45 ± 9.93
Mobile 5	0.48 ± 0.50	0.27 ± 0.35	53.55 ± 31.37	53.90 ± 34.34	44.54 ± 33.34	46.04 ± 34.03
Mobile 6	5.62 ± 14.28	0.34 ± 0.74	99.30 ± 0.33	98.37 ± 0.71	0.59 ± 0.38	1.66 ± 0.63
Mobile 7	0.88 ± 0.95	0.84 ± 0.97	42.68 ± 36.83	43.77 ± 42.34	56.43 ± 37.61	55.34 ± 43.25
Mobile 8	0.37 ± 0.20	0.38 ± 0.29	83.04 ± 10.62	76.56 ± 7.56	16.58 ± 10.72	20.19 ± 10.34
Mobile 9	0.28 ± 0.34	0.60 ± 0.68	35.27 ± 24.43	42.93 ± 25.08	64.45 ± 24.67	50.76 ± 31.36
Mobile 10	0.36 ± 0.56	0.12 ± 0.07	75.62 ± 14.80	85.94 ± 3.52	22.60 ± 16.60	13.93 ± 3.57
Pensacola 11	0.09 ± 0.05	0.05 ± 0.04	99.19 ± 0.65	98.83 ± 1.06	0.72 ± 0.64	1.37 ± 0.76
Pensacola 12	0.14 ± 0.13	0.12 ± 0.10	98.89 ± 0.92	98.67 ± 0.63	0.96 ± 0.94	1.39 ± 0.39
Gulfport 13	0.30 ± 0.57	0.08 ± 0.14	26.37 ± 21.97	9.08 ± 16.42	73.33 ± 22.29	90.83 ± 16.55
Gulfport 14	5.55 ± 6.00	4.81 ± 3.61	72.56 ± 6.00	65.81 ± 3.58	21.98 ± 8.34	29.37 ± 4.70

Note: Values listed are mean ±1 standard deviation for seven replicate box cores at each station; fines = silt plus clay (<0.0625 mm)

metals. Table A-8 reports concentrations of CHCs in sediments in the vicinity of the three disposal sites. Statistical tests described below are the result of two-way ANOVAs partitioned over stations and surveys.

MOBILE

Sediments in the vicinity of the Mobile ODMDS consisted primarily of sand (35 to 99%) with significant proportions of silt- and clay-sized particles (1 to 64%) and smaller fractions of gravel (<1 to 10%). The generally large standard deviations for each station and the range of values over the study area during both surveys indicates a relatively heterogeneous distribution of sediment texture in the site vicinity. The amount of gravel in the sediments showed no obvious spatial or seasonal trends. The percentage of fine grained sediments (silt and clay) showed significant ($p<0.05$) statistical differences

TABLE A-7
TOTAL ORGANIC CARBON, OIL AND GREASE,
AND TRACE METAL CONCENTRATIONS IN SEDIMENTS AT
MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES

Station	Total Organic Carbon (mg/g)		Oil and Grease (mg/g)		Trace Metals (mg/kg)					
					Hg		Cd		Pb	
	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun
Mobile 1	0.68	15.49	1.98	0.91	0.007	0.058	0.002	0.042	0.046	7.91
	0.57	1.35	0.55	0.45	0.008	0.006	0.004	0.001	0.24	0.28
Mobile 2	3.22	19.15	3.11	1.13	0.019	0.049	0.002	0.051	1.36	0.083
	5.97	5.91	0.77	0.77	0.044	0.019	0.007	0.014	0.57	1.11
Mobile 3	7.39	6.06	2.61	0.82	0.030	0.058	0.004	0.023	0.035	2.39
	14.32	0.45	1.45	0.71	0.079	<0.0001	0.027	0.001	0.44	0.22
Mobile 4	4.70	5.91	5.56	0.87	0.029	0.012	0.002	0.017	0.023	4.07
	7.45	6.20	0.13	0.53	0.050	0.021	0.006	0.15	0.030	3.17
Mobile 5	3.82	2.18	1.81	0.71	0.038	0.020	0.004	0.006	0.082	0.88
	2.29	4.45	3.09	0.61	0.012	0.027	0.012	0.003	1.38	0.026
Mobile 6	0.15	0.37	3.06	0.28	<0.001	<0.0003	0.001	<0.001	0.11	0.20
	0.18	0.41	0.98	0.70	0.005	0.002	0.001	<0.001	0.073	0.27
Mobile 7	0.51	21.47	2.19	1.93	0.007	0.15	0.002	0.060	0.043	19.14
	4.81	16.29	2.08	1.88	0.074	0.10	0.036	0.045	0.63	13.60
Mobile 8	4.65	5.52	2.11	0.51	0.040	0.033	0.003	0.012	0.036	0.21
	1.72	7.45	3.93	0.70	0.017	0.043	0.005	0.011	0.26	0.048
Mobile 9	4.78	15.54	2.32	1.50	0.017	0.11	0.008	0.011	0.15	0.12
	6.96	11.07	2.32	0.87	0.021	0.083	0.008	0.008	0.086	0.033
Mobile 10	4.27	2.62	2.07	0.38	0.006	<0.0002	0.008	0.009	1.01	0.18
	2.55	4.02	1.17	0.39	0.008	0.025	0.001	0.011	0.012	0.070
Pensacola 11	0.23	0.38	7.77	0.68	0.001	0.30	0.001	0.001	0.086	0.13
	0.24	0.69	0.41	0.43	0.002	0.001	0.001	<0.001	0.069	0.24
Pensacola 12	0.33	0.54	2.35	0.34	0.001	0.001	0.003	<0.001	0.069	0.14
	0.34	0.66	0.79	0.42	0.001	0.012	0.001	0.003	0.071	0.12
Gulfport 13	2.04	9.47	1.02	2.08	0.002	0.036	0.005	0.042	1.32	1.14
	7.09	9.16	0.92	0.91	0.019	0.038	0.010	0.012	0.21	0.015
Gulfport 14	4.38	4.10	4.86	0.49	0.004	0.029	0.005	0.007	0.020	0.004
	3.62	4.86	0.58	0.95	0.005	0.026	0.002	0.009	0.017	<0.004

< = None detected

TABLE A-8
CONCENTRATIONS OF CHLORINATED HYROCARBONS IN SEDIMENTS AT MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES (ng/g)

Station	PCB (Arochlor 1016 & 1242)		Dieldrin		Heptachlor		Heptachlor Epoxide		op'DDE		pp'DDE		pp'DDD		pp'DDT	
	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun
Mobile 1	ND	ND	ND	ND	ND	ND	ND	0.55	ND	ND	ND	3.29	ND	0.26	ND	ND
Mobile 6	ND	ND	ND	ND	ND	ND	ND	ND	0.056	ND	0.13	0.18	ND	ND	ND	ND
Pensacola 11	0.0001	ND	ND	ND	ND	ND	ND	ND	0.004	ND	0.005	ND	ND	ND	ND	ND
Pensacola 12	ND	ND	0.022	ND	ND	ND	ND	ND	ND	ND	ND	0.079	ND	ND	ND	ND
Gulfport 13	ND	ND	ND	ND	ND	0.028	ND	ND	ND	ND	ND	1.62	ND	0.060	ND	0.088
Gulfport 14	ND	ND	4.21	ND	ND	ND	ND	ND	ND	ND	0.17	0.91	ND	0.11	ND	ND

ND = None detected

Note: Data represent single determinations; no other CHCs were detected (see Section A.1.2 for CHCs examined)

between stations. The data indicate that, in general, sediments inside the site had somewhat lower percentages of fines in January but higher percentages in June. Proportions of fines within the site were higher in all stations in June relative to January, which may be due to dredged material dumping between surveys, or inputs of fine riverine sediments during the spring high runoff period. Higher proportions of fines occurred along the north-south transect relative to the east-west transect. This trend may be attributable to dumping inaccuracy, greater north-south transport of dumped fine sediments, and/or natural topographic effects on sediment deposition. Overall, the content of fine sediments in the Mobile ODMDS was slightly less than the percentage of fines reported for mid-Shelf sediment in the general area by Dames and Moore (1979).

Sediment TOC concentrations showed a statistically significant ($p<0.05$) increase from January to June; TOC concentrations ranged from 0.15 to 14.32 mg/g in January and from 0.41 to 21.47 mg/g in June. The largest seasonal increases occurred at Stations 1, 2, 7, and 9. TOC concentrations inside and outside the site were similar between surveys with the highest levels generally located at Station 7, south of the site. The TOC concentrations measured were generally within the range reported for mid-Shelf sediments in the area by Dames and Moore (1979).

Oil and grease concentrations were significantly ($p<0.05$) lower in June than January; June concentrations ranged from 0.38 to 1.93 mg/g whereas January concentrations ranged from 0.13 to 5.56 mg/g. No spatial trends in oil and grease concentrations were evident and concentrations in the sediments inside the site were similar to those outside the site.

Sediment mercury concentrations showed statistically significant differences ($p<0.05$) between surveys. The concentrations appeared higher in June than January but were comparable in sediments inside relative to outside the site. Sediment mercury concentrations ranged from <0.001 to 0.079 mg/kg in January and from <0.0001 to 0.15 mg/kg in June. Sediment cadmium concentrations were significantly different ($p<0.05$) between surveys with June having generally higher values. Concentrations inside and outside the site were similar and no areal trends were apparent. Sediment cadmium concentrations ranged from 0.001 to 0.036 mg/kg in January, and from <0.001 to 0.15 mg/kg in June. Sediment lead values also were significantly higher ($p<0.05$) in June than January. At some stations, the differences in lead concentrations between surveys were relatively large, i.e. up to 19 mg/kg. Concentrations were, however, comparable to those reported by Trefry and Presley (1976) for coastal and mid-Shelf sediments of the Mississippi Delta region. Lead concentrations in sediments within the site were similar to those at the control stations. Lead concentrations ranged from 0.012 to 1.38 mg/kg in January and from 0.026 to 19.14 mg/kg in June.

Overall, sediment trace metal levels for the Mobile ODMDS exhibited statistically significant increases between surveys; however, the increases for mercury and cadmium were minor. Sediment trace metal concentrations within the disposal site were similar to those at the control stations. Consequently, it is not clear whether the cause of the seasonal changes was dredged material dumping or natural seasonal deposition of river-derived fine sediment and adsorbed metals.

PCB concentrations were not detectable in the sediments of the Mobile ODMDS. Detectable pesticide (and derivative) concentrations (Table A-8) in the sediments were less than 0.5 ng/g for most samples during both surveys and were less than 4 ng/g in all samples. The highest concentration, 3.29 ng/g pp'DDE, was found at dumpsite Station 1 in June; however, this concentration is low and its source is unclear. Comparable historical data were not available.

PENSACOLA

Sediments at the Pensacola ODMDS and control station were predominantly sand (99%) with small fractions of gravel (<1%) and silt and clay (<2%) with little seasonal variation. This sediment texture is consistent with that reported for the area by CE (1979).

TOC concentrations showed slight increases from January to June, but were comparable inside and outside the site. Concentrations ranged from 0.23 to 0.34 mg/g in January and ranged from 0.38 to 0.69 mg/g in June. These TOC concentrations are slightly higher than those found west of Pensacola Bay by Dames and Moore (1979). Oil and grease concentrations were comparable inside and outside the site during both surveys except for a concentration of 7.77 mg/g inside the site in January. Concentrations ranged from 0.41 to 7.77 mg/g in January and from 0.34 to 0.68 mg/g in June. No explanation can be provided for the higher level inside the ODMDS in January

Sediment trace metal concentrations were all below 0.3 mg/kg and similar for the ODMDS and control stations. Sediment Hg and Cd concentrations were comparable between surveys but Pb concentrations showed a small increase between January and June. Sediment Hg concentrations ranged from 0.001 to 0.30 mg/kg, averaging 0.05 mg/kg. Sediment Cd concentrations ranged from <0.001 to 0.003 mg/kg for all samples over both surveys. Sediment Pb concentrations ranged from 0.069 to 0.086 mg/kg in January, (averaging 0.07 mg/g) and from 0.12 to 0.24 mg/kg in June (averaging 0.16 mg/kg). These concentrations were similar to those reported by Rinkel and Jones (1973) for the area.

PCB (Arochlor 1016 + 1242) was detected only in sediments of the Pensacola ODMDS, and measured 0.0001 ng/g. Pesticide (and derivative) concentrations (Table A-8) were generally undetectable and never exceeded 0.1 ng/g.

GULFPORT

The sediments at the Gulfport ODMDS were predominantly (73 to 91%) silt and clay within the site and mainly (66 to 73%) sand outside the site during both surveys. An increase in percent fines occurred at both stations from January to June. Grain size distributions have been reported to be similarly variable in this area by CE (1979).

Sediment TOC concentrations increased from January to June inside the site but remained uniform outside the site. TOC concentrations were higher within the site in June but were comparable inside and outside in January. Concentrations ranged from 2.04 to 9.47 mg/g over both surveys. These concentrations are within ranges reported for northeastern Gulf mid-Shelf sediments (Dames and Moore, 1979). Oil and grease concentrations showed no consistent spatial or seasonal trends and ranged from 0.49 to 4.86 mg/g over both surveys.

Sediment trace metal concentrations were all less than 1.5 mg/kg. Sediment Hg concentrations were similar inside and outside the site but were slightly higher in June than January. Concentrations ranged from 0.002 to 0.019 mg/kg in January and from 0.026 to 0.038 mg/kg in June. These sediment Hg concentrations are lower than concentrations found by Windom (1973). Sediment Cd concentrations were comparable between stations and surveys and ranged from 0.002 to 0.042 mg/kg. Sediment Pb concentrations were higher inside the site than outside during both surveys, possibly due to previous dredged material disposal or natural deposition of relatively metal-rich riverine fines along the side of the ship channel. Concentrations ranged from <0.004 to 0.21 mg/kg over both surveys. The concentrations of Cd and Pb in the sediments of the Gulfport ODMDS are similar to or lower than those reported for shallow mid-Shelf sediments of the northeastern Gulf by Dames and Moore (1979).

PCBs were not detected in the sediments of the Gulfport ODMDS. Pesticide (and derivative) concentrations showed no spatial or seasonal trends and values ranged from 0.28 to 4.21 ng/g.

A.2.3 ELUTRIATE TESTS

Elutriate tests indicated small or no releases of cadmium, lead, or mercury to the dissolved phase upon mixing of site waters with sediments from the vicinities of the ODMDSs (Table A-9). Results for sediments from inside and outside the Pensacola and Gulfport sites were similar; dissolved trace metal concentrations in the elutriate were nearly identical to pre-test levels. For Mobile, however, small releases of trace metals from sediments collected within the site (Station 1) were observed. This was not the case for sediments collected outside the Mobile ODMDS.

A.2.4 TISSUES

Trace metal (cadmium, lead, and mercury) concentrations in epifauna from Mobile, Pensacola, and Gulfport ODMDSs are summarized in Table A-10. Cadmium concentrations in all species collected during both surveys ranged from 0.02 to 0.47 mg/kg. Lead concentrations ranged from <0.02 to 0.88 mg/kg. Values for cadmium and lead in shrimp and crabs were low and within the ranges reported by Dames and Moore (1979) for unidentified shrimp and crabs. Mercury concentrations in all species collected ranged from 0.03 to 0.46 mg/kg, which is less than the Federal Food and Drug Administration (FDA) action level of 1.0 mg/kg for commercial fish (FDA, 1980). No historical data for mercury concentrations in the species captured were available for the area.

Pesticide concentrations in tissues are summarized in Table A-11. Concentrations of degradation products of DDT (op'DDE, pp'DDD, pp'DDE) were detected in organisms from the Mobile ODMDS area; values ranged from 0.157 to 23.129 ng/g. All concentrations were below the FDA action level of 5.0 mg/kg (FDA, 1980). Dieldrin and endrin were also measured in organisms, but levels were well below the FDA action level of 0.3 mg/kg (FDA, 1980). Trace concentrations (0.004 and 0.008 ng/g) of PCB Arochlor 1242 were measured in organisms collected from the area of the Gulfport and Mobile ODMDSs.

TABLE A-9
RESULTS OF ELUTRIATE TESTS FOR SEDIMENTS INSIDE
AND OUTSIDE THE MOBILE, PENSACOLA, AND GULPORT ODMDSs

Station	Concentration in Test Water			Pre-test Concentration**		
	Cd	Pb	Hg	Cd	Pb	Hg
Mobile 1 (inside)	0.065	0.22	0.014	0.009	0.11	0.007
6 (outside)	0.022	0.13	0.005	0.031	0.37	0.009
Pensacola 11 (inside)	<0.030	0.21	0.005	<0.030	0.10	0.004
12 (outside)	0.021	<0.12	0.010	0.027	<0.12	0.006
Gulfport						
13 (inside)	<0.030	<0.12	<0.003	0.010	<0.12	<0.003
14 (outside)	<0.030	<0.12	0.016	0.012	<0.12	0.015

** Seawater collected at middepth at indicated station.
< = None detected

Note: A single test was performed on each sediment sample; sediments and water collected during January 1980; all concentrations are μg/liter in dissolved phase.

A.2.5 MACROFAUNA

Although macrofaunal studies have been conducted in bays, sounds, estuaries, and shallow and mid-Shelf areas in the Gulf of Mexico (see CE, 1978; Water and Air Research, Inc., 1975; SUSIO, 1975; Dames and Moore, 1979), very little information is available regarding the benthic communities in the areas of the three ODMDSs surveyed by EPA/IEC. However, Vittor (1977) characterized benthic habitats on the Mississippi-Alabama Shelf, adjacent to Mobile Bay, and detailed information regarding the benthic community in the Mississippi Sound near the Gulfport ODMDS has been given by Water and Air

TABLE A-10
TRACE METAL CONCENTRATIONS (mg/kg) IN TISSUES OF SPECIES COLLECTED IN AND NEAR THE MOBILE, PENSACOLA, AND GULFPORT ODMDSs

Month Collected	Sampling Station (Site)	Species Collected	Metal	Concentration (mg/kg)
January	1 (Mobile)	Portunus gibbessi	Hg	0.04
			Cd	0.35
			Pb	0.14
	13 (Gulfport)	Trachypenaeus similis	Hg	0.04
			Cd	0.04
			Pb	<0.17
	14 (Gulfport)	Trachypenaeus constrictus	Hg	0.06
			Cd	0.12
			Pb	<0.20
June	1 (Mobile)	Penaeus aztecus	Hg	0.08
			Cd	0.05
			Pb	<0.02
	6 (Mobile)	Penaeus aztecus	Hg	0.03
			Cd	0.05
			Pb	<0.02
	13 (Gulfport)	Penaeus aztecus	Hg	0.03
			Cd	0.08
			Pb	0.88
	1 (Mobile)	Callinectes similis	Hg	0.46
			Cd	0.47
			Pb	<0.04
	11 (Pensacola)	Etropus rimosus	Hg	0.15
			Cd	0.02
			Pb	0.53

Research, Inc. (1975). These studies, particularly those by Vittor and Water and Air Research, Inc., indicate that the nearshore benthic communities in the vicinity of the ODMDSs are dominated by species of polychaetes and molluscs. Many of the dominant species found in the present surveys (reported below), also reported to be common in the above studies, are considered characteristic of these areas.

TABLE A-11
PESTICIDE CONCENTRATIONS IN TISSUES OF
SPECIES FROM THE MOBILE AND GULFPORT ODMDSs AND VICINITIES

Month Collected	Sampling Station	Species Collected	Pesticide	Concentration (ng/g)
January	1	*Portunus gibbessi*	Arochlor 1242	0.008
			op-DDE	3.636
			pp-DDE	23.129
			Dieldrin	6.934
			Endrin	0.435
	14	*Trachypenaeus constrictus*	Arochlor 1242	0.004
June	1	*Penaeus aztecus*	op-DDE	1.410
			pp-DDE	14.754
			pp-DDD	0.157
	6	*Penaeus aztecus*	op-DDE	0.534
			pp-DDE	18.378
			pp-DDD	0.415

MOBILE

Fifty species of macrofauna were common in the area of the existing Mobile ODMDS during the January and June 1980 surveys (Table A-12 and A-13). Polychaete worms dominated the fauna, with *Magelona cf. phyllisae* and *Paraprionospio cirrifera* being the most abundant in January and June, respectively. Sipunculans were abundant due to the occurrence of a single species, *Golfingia murinae bilobatae*. All other groups, such as crustaceans and molluscs, were poorly represented. Although not abundant, many species of macrofauna present in January were not found in June; this was particularly apparent for the crustaceans.

The disposal of dredged material will directly disturb a benthic community through burial and smothering of organisms (Diaz and Boesch, 1977). The overburden may be recolonized by some individuals which survive burial, and can vertically migrate back to their former levels in the sediment (Richardson et al., 1977; Maurer et al., 1981). However, the major process of recolonization appears to be caused by larval settlement (Oliver and Slattery, 1973;

TABLE A-12
ABUNDANCES OF COMMON MACROFAUNA AT MOBILE ODMDS AND VICINITY (JANUARY 1980)

Species	Trophic Level*	Station 001	002	003	004	005	006	007	008	009	010
Nemertea											
Nemertean sp. A	C	-	1.0 ± 1.0	1.4 ± 1.7	-	-	-	1.8 ± 1.5	-	-	-
Cerebratulus lacteus	C	-	-	-	-	3.0 ± 3.2	-	1.6 ± 1.5	3.0 ± 3.7	14.4 ± 26.3	9.2 ± 6.6
Annelida											
Amphinomidae											
Linopherus/ *Paramphinome* species complex	C	-	-	-	-	1.8 ± 2.6	-	-	-	1.4 ± 3.1	-
Pilargidae											
Sigambra tentaculata	C	-	1.8 ± 1.6	3.6 ± 4.8	-	0.6 ± 0.9	-	-	-	-	-
Nereidae											
Neanthes micromma	D	-	0.8 ± 1.3	-	-	-	-	-	4.4 ± 2.1	3.0 ± 2.1	2.8 ± 1.5
Nephtyidae											
Aglaophamus verrilli	C	-	-	-	-	-	-	-	-	-	2.0 ± 2.3
Nephtys picta	C	-	-	-	-	-	0.8 ± 0.8	-	-	-	-
Goniadidae											
Glycinde solitaria	C	-	3.0 ± 2.1	-	-	-	-	1.4 ± 0.9	-	-	-
Onuphidae											
Diopatra cuprea	D	-	0.6 ± 0.3	8.6 ± 8.5	21.0 ± 4.5	2.0 ± 2.9	-	16.0 ± 17.0	10.8 ± 3.3	4.4 ± 1.8	3.4 ± 3.9
Lumbrineridae											
Ninoe nigripes	D	-	-	-	-	-	-	-	1.6 ± 1.5	-	-
Lumbrineris verrilli	D	-	-	6.8 ± 7.2	10.4 ± 6.7	-	-	9.4 ± 7.1	4.2 ± 1.9	1.2 ± 1.6	4.4 ± 3.1
Dorvilleidae											
Schistomeringos cf. *longicornis*	D	-	-	-	-	-	-	-	0.8 ± 1.3	-	-
Spionidae											
Apoprionospio pygmaea	D	34.0 ± 11.2	1.0 ± 1.4	13.4 ± 20.3	-	-	9.6 ± 21.5	0.8 ± 1.8	8.2 ± 11.2	-	4.0 ± 7.8
Dispio uncinata	D	-	-	-	-	-	1.0 ± 1.8	-	-	-	-
Paraprionospio pinnata	D	2.4 ± 2.3	4.8 ± 4.2	4.0 ± 3.4	12.2 ± 7.9	3.0 ± 3.6	-	2.6 ± 1.8	3.0 ± 2.1	3.8 ± 2.5	2.8 ± 3.6
Prionospio cirrifera	D	-	-	-	-	-	-	2.2 ± 4.6	-	-	2.4 ± 2.9
Scolelepis cf. *texana*	D	-	-	-	-	-	8.6 ± 7.9	-	-	-	-
Spio pettiboneae	D	-	-	-	-	-	2.6 ± 2.7	-	-	-	-
Spiophanes bombyx	D	32.0 ± 7.5	1.2 ± 2.2	3.4 ± 5.6	0.8 ± 1.8	-	5.6 ± 2.1	0.8 ± 1.8	2.8 ± 2.7	-	1.2 ± 2.7
Magelonidae											
Magelona cf. *cornuta*	D	-	-	-	-	-	-	-	-	0.8 ± 0.8	-
M. cf. *pettiboneae*	D	20.8 ± 9.9	8.8 ± 6.6	13.8 ± 11.1	35.4 ± 22.3	17.6 ± 12.5	-	23.4 ± 10.0	16.0 ± 6.0	32.8 ± 13.8	15.6 ± 6.7
Cirratulidae	D	-	-	-	-	-	-	1.8 ± 1.7	-	-	-
Chaetozone corona	D	4.6 ± 1.1	-	1.6 ± 2.6	-	1.8 ± 2.0	-	-	3.4 ± 2.9	1.4 ± 1.9	-
Opheliidae											
Armandia maculata	D	3.2 ± 1.3	-	0.0 ± 0.5	0.2 ± 0.4	-	1.0 ± 1.2	0.6 ± 0.9	0.2 ± 0.4	-	-
Cossuridae											
Cossura delta	D	-	-	-	-	-	-	-	-	-	2.0 ± 1.2
Capitellidae											
Mediomastus californiensis	D	9.6 ± 5.9	5.8 ± 7.8	12.4 ± 16.2	9.8 ± 5.9	3.6 ± 3.0	-	0.4 ± 7.0	6.4 ± 6.3	7.8 ± 13.2	-
Maldanidae											
Asychis carolinae	D	-	-	-	-	-	-	-	-	-	3.0 ± 3.1
Oweniidae											
Myriowenia californiensis	D	6.0 ± 5.7	-	-	-	-	-	-	-	-	-
Archiannelida											
Polygordius sp. A	O	3.2 ± 6.6	-	1.2 ± 2.7	-	-	-	-	-	-	-
Arthropoda											
Mysidopsis bigelowi	S	-	1.8 ± 3.8	-	-	-	-	-	-	-	-
Oxyurostylis smithi	D	3.0 ± 2.6	14.8 ± 14.0	3.6 ± 5.3	8.0 ± 8.1	-	-	-	-	2.0 ± 3.9	-
Ampelisca abdita	S	-	-	-	-	-	-	-	1.8 ± 2.6	-	-
Lepidactylus sp. A	?	-	-	-	-	-	1.8 ± 1.8	-	-	-	-
Microprotopus cf. *raneyi*	?	-	2.4 ± 4.8	-	-	-	-	-	-	-	-
Monoculodes cf. *edwardsi*	?	-	-	-	-	-	0.4 ± 0.9	-	-	-	-
Protohaustorius sp. A	S	-	-	-	-	-	9.0 ± 0.7	-	-	-	-
Synchelidium americanum	D	-	-	-	-	-	0.6 ± 0.9	-	-	-	-
Tiron tropakis	D	2.0 ± 3.6	-	-	-	-	-	-	-	-	-
Pagurus sp.	O	2.0 ± 2.9	-	-	-	-	-	-	-	-	-
Ogyrides limicola	?	-	-	-	-	-	-	-	-	-	1.4 ± 3.1
Mollusca											
Pelecypoda	?	-	-	-	-	-	-	1.2 ± 1.3	-	-	-
Gemma purpurea	S	1.4 ± 3.1	-	-	-	-	-	-	-	2.2 ± 2.2	-
Mulinia lateralis	S	-	11.2 ± 7.5	-	-	3.4 ± 3.6	-	-	-	-	-
Echinodermata											
Microphiopholis atra	O	-	-	-	-	-	-	-	-	-	2.6 ± 3.0
Sipuncula											
Golfingia murinae bilobatae	D	2.0 ± 1.2	4.6 ± 6.3	2.2 ± 3.2	13.4 ± 10.9	3.2 ± 6.9	-	15.0 ± 12.0	32.4 ± 23.0	3.0 ± 1.9	33.0 ± 63.0
Phascolion strombi	D	2.0 ± 3.1	-	-	-	1.0 ± 1.7	-	-	-	1.8 ± 4.0	-
Chaetognatha											
Sagitta spp.	C	3.2 ± 2.9	-	-	-	-	-	-	-	-	-
Cephalochordata											
Branchiostoma caribaeum	S	-	-	1.8 ± 1.7	-	-	3.0 ± 1.9	-	-	-	-

*D = Deposit feeder
C = Carnivore
O = Omnivore
? = Unknown
- None collected or rare at station

Note: Data are mean number/0.04 m^2 ± 1 standard deviation, n=5 replicate box cores at each station

TABLE A-13
ABUNDANCES OF COMMON MACROFAUNA AT MOBILE ODMDS AND VICINITY (JUNE 1980)

Species	Trophic Level[a]	Station 001	002	003	004	005	006	007	008	009	010
Annelida											
Polychaeta											
Amphinomidae											
Linopherus/ Paramphinome species complex	C	6.6 ± 13.1	-	-	-	-	-	-	-	-	-
Pilargidae											
Sigambra tentaculata	C	6.0 ± 5.0	-	-	-	2.2 ± 0.8	-	2.0 ± 1.6	2.2 ± 2.2	-	-
Onuphidae											
Diopatra cuprea	O	0.2 ± 0.5	0.4 ± 0.9	0.4 ± 0.5	8.0 ± 10.3	7.0 ± 9.2	-	1.4 ± 3.1	6.6 ± 10.3	8.0 ± 5.9	1.6 ± 0.9
Spionidae											
Apoprionospio pygmaea	D	12.8 ± 13.9	29.0 ± 31.2	-	-	-	29.2 ± 23.6	-	-	-	2.0 ± 0.0
Paraprionospio pinnata	D	136.0 ± 85.0	74.8 ± 30.7	159.4 ± 112.8	66.2 ± 33.9	152.6 ± 134.6	4.6 ± 3.8	104.6 ± 24.2	75.0 ± 30.2	76.2 ± 21.0	65.2 ± 33.8
Spiophanes bombyx	D	5.0 ± 5.4	2.6 ± 2.8	5.6 ± 12.5	1.4 ± 2.1	0.2 ± 0.4	1.8 ± 2.5	2.4 ± 4.3	0.8 ± 0.8	-	3.8 ± 6.3
Magelonidae											
Magelona cf. phyllisae	D	12.0 ± 11.6	2.2 ± 3.8	15.2 ± 12.0	16.6 ± 9.0	14.8 ± 7.0	-	9.0 ± 10.3	5.2 ± 2.4	35.4 ± 8.4	18.8 ± 7.3
M. sp. F	D	-	13.6 ± 13.8	-	-	-	32.8 ± 22.2	-	-	-	-
Cirratulidae											
Chaetozone gayheadia	D	-	-	-	6.0 ± 12.3	-	3.8 ± 3.6	6.2 ± 8.0	-	-	6.6 ± 9.3
Opheliidae											
Armandia maculata	D	1.0 ± 1.2	-	-	-	-	-	0.4 ± 0.5	-	-	-
Capitellidae											
Mediomastus californiensis	D	10.6 ± 17.3	5.4 ± 3.2	6.2 ± 5.8	-	10.4 ± 10.4	-	4.2 ± 3.3	-	5.2 ± 2.9	-
Ampharetidae											
Ampharete sp. B	D	-	-	-	-	-	-	15.4 ± 29.1	-	-	-
Melinna cristata	D	-	-	-	-	-	-	-	2.4 ± 3.2	-	-
Terebellidae											
Loimia viridis	D	31.0 ± 26.1	25.0 ± 11.6	7.8 ± 13.0	19.8 ± 13.6	14.2 ± 6.8	11.0 ± 9.0	-	13.2 ± 5.6	8.2 ± 4.4	12.4 ± 6.5
Mollusca											
Mulinia lateralis	S	-	-	-	-	-	398.6 ± 510.2	-	-	-	-
Sipuncula											
Golfingia murinae bilobatae	D	0.6 ± 0.9	0.4 ± 0.5	4.4 ± 3.6	19.4 ± 11.3	1.2 ± 1.1	-	2.6 ± 4.8	37.2 ± 20.6	10.8 ± 4.6	32.8 ± 18.6

[a] D = Deposit feeder
C = Carnivore
O = Omnivore
S = Suspension feeder
? = Unknown
- None collected or rare at station

Note: Data are mean number/0.06 m^2 ± 1 standard deviation, n=5 replicate box cores at each station

Oliver et al., 1977). Oliver et al. (1977) have shown that the first colonizers will be opportunistic species which are capable of rapid population growth and possess flexible life histories (Grassle and Grassle, 1974). Gray (1979) has shown that these species are often the dominant inhabitants of disturbed areas. Many opportunistic macrofauna are small-bodied deposit-feeders, such as spionid and capitellid polychaetes, or corophiid amphipods (for example, see Dorsey, 1982).

Knowledge of the species composition, abundance, and feeding methods of organisms inhabiting an ODMDS may enable identification of the presence of a disturbed benthic community. Comparison of the ODMDS community with surrounding undisturbed (by disposal) benthic communities will facilitate the detection of effects caused by the disposal of dredged material. For example, a high abundance of opportunistic species and a trophic structure dominated by deposit feeders would stand out from undisturbed areas having a greater diversity of species and feeding methods (e.g., more suspension feeders, omnivores and/or carnivores). Therefore, this approach has been used to characterize the trophic structure of macrofauna at each station. Each of the identified species were placed into the following feeding categories based on Barnes (1968); Bloom et al. (1972); Santos and Simon, (1974); Fauchald and Jumars, (1979); Maurer et al. (1979); and Daurer, (1980):

- Deposit feeders which ingest sediment and detritus;
- Suspension feeders which filter food particles from the water column;
- Omnivores which can feed on a wide range of plant, animal, detrial, or sediment particles; and
- Carnivores which feed on living animal tissue.

Mean abundance of species from Tables A-12 and A-13 were summed for each trophic category at each station, and percentages were calculated and presented in Figure A-4.

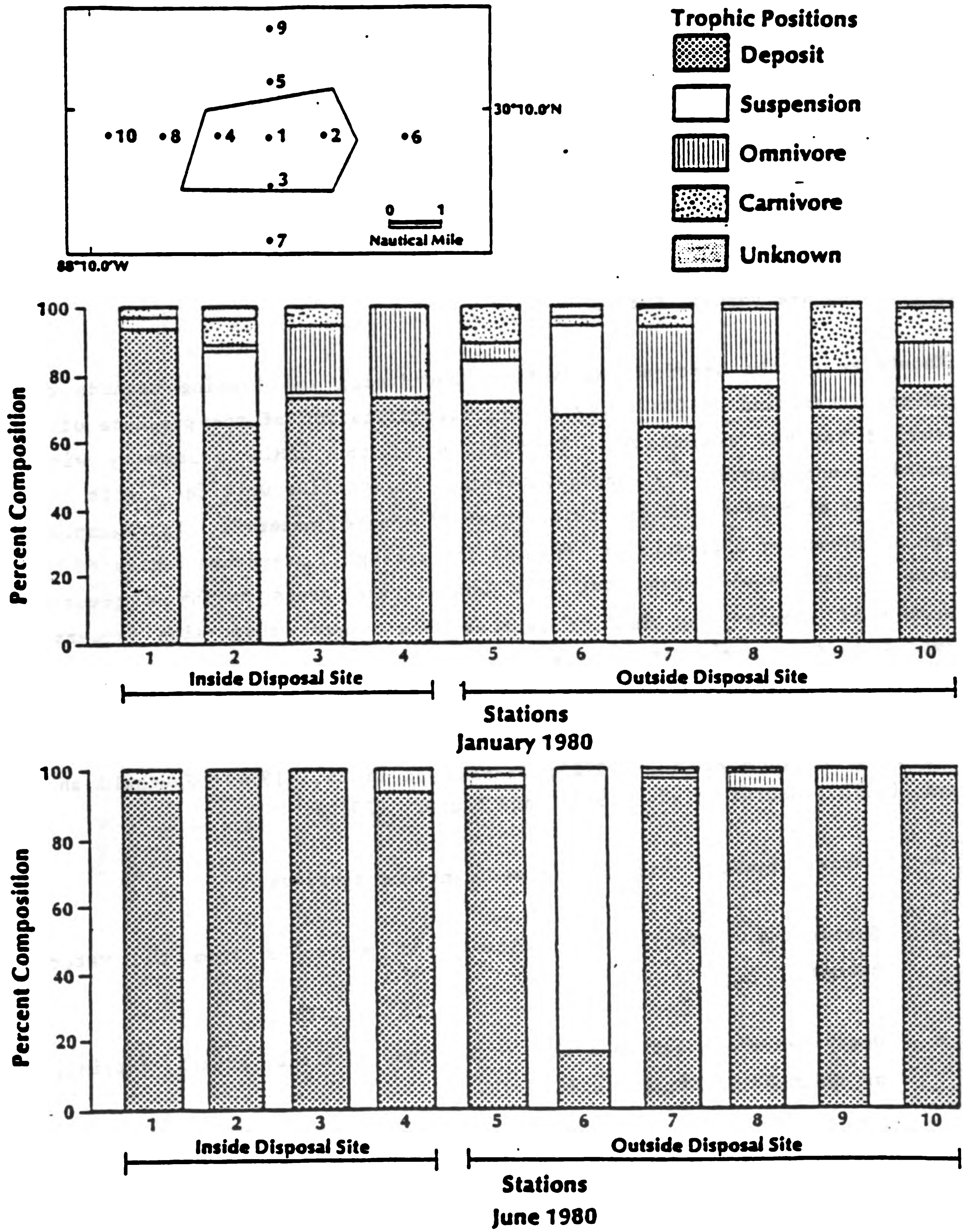


Figure A-4. Percent Composition of Feeding Types in the vicinity of the Mobile ODMDS

Over 60% of the macrofauna in the area of the Mobile ODMDS during January were deposit feeding organisms. These deposit feeders were best represented by polychaetes, particularly Apoprionospio pygmaea, Paraprionospio pinnata, Spiophanes bombyx, Mediomastus californienses, and Magelona spp. Other common deposit feeding macrofauna included the sipunculan Golfingia murinae bilobatae and the cumacean Oxyurostylis smithi.

Suspension feeders were present throughout the study area, but only in limited abundances compared with deposit feeders. This feeding group was represented by the bivalves Gemma purpurea and Mulinia lateralis, the sea lancelet Branchiostoma caribaeum, and some crustaceans.

Carnivores and omnivores were present at all stations, but only in limited abundances compared with deposit feeders. Carnivores were represented mainly by nemerteans and the polychaetes Sigambra tentaculata, Linopherus-Paramphinome species complex, and Diopatra cuprea.

In June, deposit feeders generally became more abundant at all stations, particularly spionids and magelonids, which may represent seasonal recruitment within their populations. Numbers of suspension feeders decreased at all stations except Station 6, where the bivalve Mulinia lateralis was very abundant, probably due to recruitment of juveniles. Carnivores slightly increased in numbers between January to June, but their relative percentages fell due to the large densities of deposit feeders in June.

Dredged material disposal occurred in February and March between the two EPA/IEC surveys of January and June. Species composition and abundance were similar among all stations at and surrounding the ODMDS in June, therefore no effects of the previous dumping were apparent from the data.

The trophic structure of the macrofaunal assemblage in the vicinity of the Mobile ODMDS is characteristic of a muddy-sand habitat. The density of polychaete worms increased between surveys, but these increases were widespread throughout the entire area, and not confined to either the ODMDS or control stations. Presumably, the increased abundance of polychaetes was seasonal and not a result of disposal activities.

The distribution of benthic organisms in the vicinity of the Mobile ODMDS was examined. For instance, Golfingia showed a distinct increase in mean density to the west of the site (>30 individuals/0.06 m^2) as compared with low mean abundances (<3 individuals/0.06 m^2) to the east and near the center of the site (Figure A-5). A similar pattern was observed for D. cuprea. Most species were patchily distributed throughout the study area with no apparent pattern. The distribution of all species, however, are probably regulated by small-scale changes in sediment composition.

GULFPORT

Twenty-four species of macrofauna were common in the vicinity of the Gulfport ODMDS during the January and June 1980 surveys (Table A-14). Abundant species included the sipunculan, Golfingia murinae bilobatae, and the polychaetes Paraprionospio pinnata, Magelona cf. phyllisae, and Mediomastus californiensis. Molluscs (e.g. Pelecypoda, Abra aequalis, Mulinia lateralis) were common within the site (Station 13) during January.

The trophic composition of the macrofauna at Gulfport, illustrated in Figure A-6, was examined as described for Mobile. Trohic composition at Gulfport during January was very similar to that described for Mobile; deposit feeders were the dominant group at Station 14 due to densities of spionid and magelonid polychaetes, and suspension feeders were well represented at Station 13 due to the presence of the bivalves Abra aequalis and Mulinia lateralis. In June, densities of deposit feeders greatly increased, whereas other groups diminished. As with the Mobile site, these results suggest a seasonal increase due to recruitment of juveniles into the population. However, few conclusions can be drawn from the data due to the small number of stations sampled.

PENSACOLA

Twenty-two species of macrofauna were common in the vicinity of the Pensacola ODMDS during the January and June 1980 surveys (Table A-15). Polychaetes dominated the fauna, with arthropods (particularly

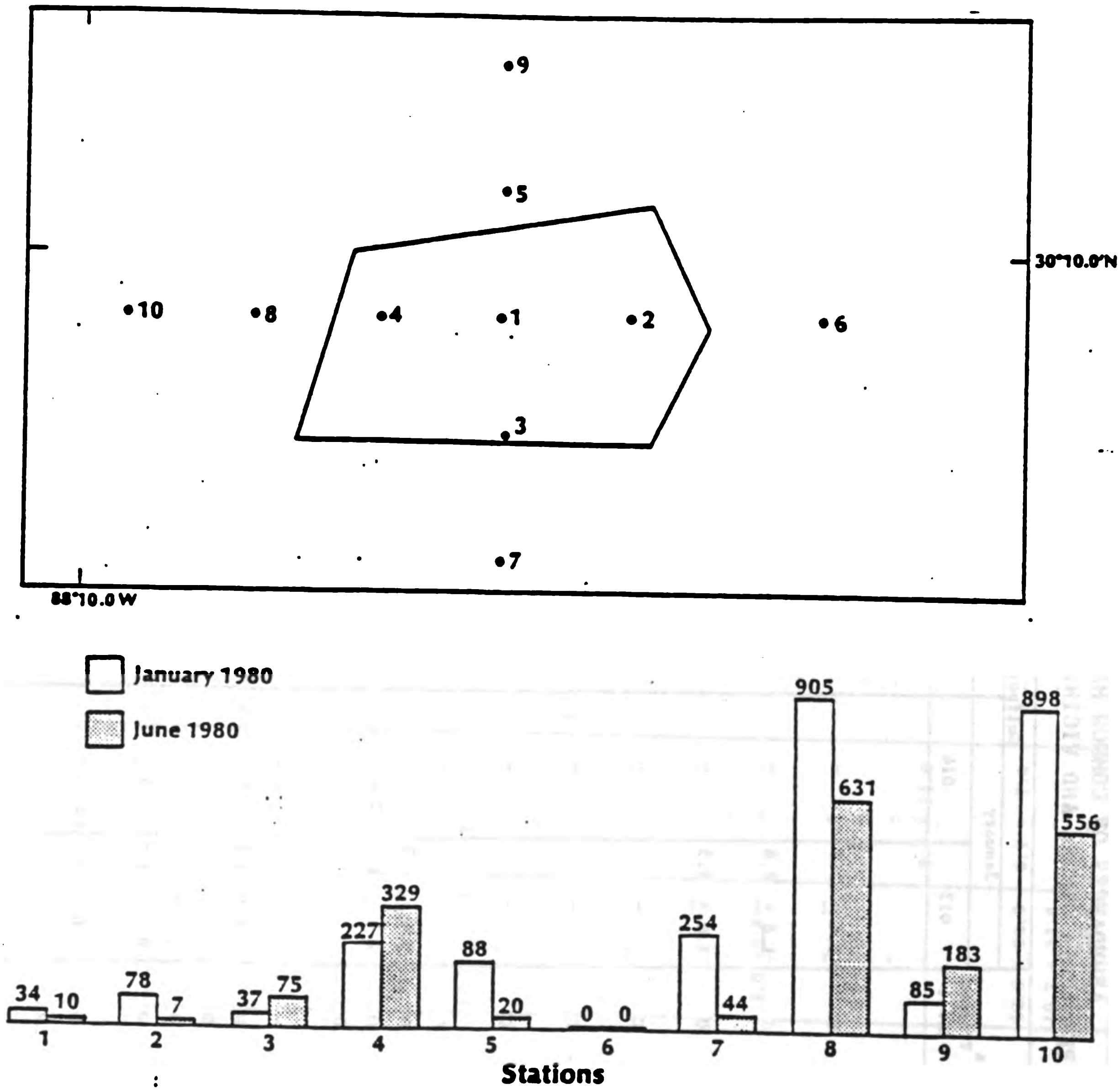


Figure A-5. Distribution of Golfingia murinae bilobatae in the Vicinity of the Mobile ODMDS

TABLE A-14
ABUNDANCES OF COMMON MACROFAUNA AT GULFPORT AND
PENSACOLA ODMDSs AND VICINITIES (JANUARY AND JUNE 1980)

Species	*Trophic level	Gulfport January 013	Gulfport January 014	Gulfport June 013	Gulfport June 014	Pensacola January 011	Pensacola January 012	Pensacola June 011	Pensacola June 012
Annelida									
Chrysopetalidae									
<u>Paleanotus heteroseta</u>	C	2.4 ± 2.9	-	-	-	-	-	-	-
Pilargidae									
<u>Sigambra tentaculata</u>	C	1.8 ± 2.0	-	-	5.0 ± 4.6	-	-	-	-
Hesionidae									
<u>Gyptis brevipalpa</u>	C	1.8 ± 2.5	-	-	-	-	-	-	-
Syllidae									
<u>Brania wellfleetensis</u>	C	-	-	-	-	2.4 ± 3.8	1.6 ± 3.0	-	-
Nephtyidae									
<u>Nephtys picta</u>	C	-	-	-	-	-	-	6.0 ± 7.6	6.6 ± 4.5
Glyceridae									
<u>Glycera oxycephala</u>	C	-	-	-	-	-	2.8 ± 1.1	-	-
Goniadidae									
<u>Glycinde solitaria</u>	C	-	-	2.6 ± 0.5	2.6 ± 1.8	-	-	-	-
Onuphidae	O	3.4 ± 4.9	-	-	-	-	-	-	-
<u>Diopatra cuprea</u>	O	2.6 ± 3.7	0.4 ± 0.5	4.2 ± 3.0	0.8 ± 0.4	-	-	-	-
<u>Onuphis eremita</u>	O	-	-	-	-	-	1.8 ± 2.5	-	-
Spionidae									
<u>Apoprionospio pygmaea</u>	D	-	2.6 ± 1.7	-	-	0.4 ± 0.9	2.6 ± 3.7	8.0 ± 11.7	8.8 ± 7.2
<u>Paraprionospio pinnata</u>	D	5.2 ± 2.6	11.0 ± 5.6	85.0 ± 24.8	108.0 ± 42.0	-	-	4.0 ± 4.6	7.0 ± 8.0
<u>Prionospio cirrifera</u>	D	-	-	5.4 ± 5.1	-	-	-	-	-
<u>P. cristata</u>	D	-	-	-	-	1.0 ± 1.2	-	-	-
<u>Spiophanes bombyx</u>	D	0.8 ± 1.8	15.6 ± 5.6	-	0.6 ± 0.9	8.6 ± 3.0	7.8 ± 1.9	3.6 ± 4.3	2.6 ± 1.9
Magelonidae									
<u>Magelona</u> cf. <u>phyllisae</u>	D	18.0 ± 9.2	107.4 ± 22.9	5.0 ± 5.4	102.2 ± 37.6	-	-	-	-
<u>M.</u> sp. F	D	-	-	-	-	-	-	3.8 ± 2.2	-
Cirratulidae									

TABLE A-14. (continued)

Species	*Trophic Level	Gulfport				Pensacola			
		January		June		January		June	
		013	014	013	014	011	012	011	012
<u>Chaetozone</u> <u>gayheadia</u>	D	3.2 ± 2.4	-	-	-	-	-	-	-
Paraonidae									
<u>Aricidea</u> sp. A	D	-	-	-	-	-	-	-	5.0 ± 5.9
<u>A</u>. sp. B	D	-	-	-	-	-	2.0 ± 1.9	-	-
Opheliidae									
<u>Armandia</u> <u>maculata</u>	D	0.2 ± 0.4	0.2 ± 0.4	-	-	4.4 ± 2.9	2.6 ± 1.5	1.4 ± 1.7	3.2 ± 3.1
Cossuridae									
<u>Cossura</u> <u>delta</u>	D	8.0 ± 8.2	-	-	-	-	-	-	-
Capitellidae									
<u>Mediomastus</u> <u>californiensis</u>	D	12.0 ± 12.4	9.2 ± 8.0	-	57.0 ± 22.1	-	1.2 ± 2.7	3.6 ± 6.1	12.4 ± 19.1
Maldanidae	D	-	-	-	-	1.0 ± 1.2	1.0 ± 1.7	-	-
Terebellidae									
<u>Loimia</u> <u>viridis</u>	D	-	-	5.0 ± 6.2	28.2 ± 6.7	-	-	-	-
Archiannelid									
<u>Polygordius</u> sp. A	O	-	-	-	-	10.4 ± 16.9	6.6 ± 14.2	-	-
Arthropoda									
<u>Cyclaspis</u> sp. A	D	-	-	-	-	1.6 ± 1.9	-	-	-
<u>Oxyurostylis</u> <u>smithi</u>	D	2.0 ±2.8	-	-	-	-	-	-	-
<u>Lepidactylus</u> sp. A	?	-	-	-	-	4.0 ± 2.5	5.2 ± 3.5	-	-
Platyischnopidae sp. A	?	-	-	-	-	19.0 ± 12.5	30.4 ± 11.6	-	-
<u>Protohaustorius</u> sp. A	S	-	-	-	-	-	6.0 ± 7.2	-	-
<u>Synchelidium</u> <u>americanum</u>	D	-	-	-	-	1.4 ± 2.1	-	-	-
<u>Pinnixa</u> <u>pearsei</u>	O	-	9.0 ± 11.9	-	-	-	-	-	-
Mollusca									
Pelecypoda	?	50.8 ± 90.9	6.2 ± 7.4	-	-	-	-	-	-
<u>Abra</u> <u>aequalis</u>	S	10.2 ± 22.8	-	-	-	-	-	-	-
<u>Mulinia</u> <u>lateralis</u>	S	28.4 ± 50.4	-	-	-	-	-	-	-

TABLE A-14. (continued)

Species	*Trophic level	Gulfport				Pensacola			
		January		June		January		June	
		013	014	013	014	011	012	011	012
Echinodermata									
Mellita quinquiesperforata	D	-	-	-	-	9.5 ± 1.7	2.0 ± 1.6	-	-
Micropholis atra	O	-	4.8 ± 6.4	-	-	-	-	-	-
Sipuncula									
Golfingia murinae bilobatae	D	0.4 ± 0.5	10.8 ± 7.2	0.6 ± 0.9	12.8 ± 12.9	-	-	-	-
Hemichordata									
Balanoglossus aurantiacus	S	0.8 ± 1.8	6.8 ± 11.3	-	-	-	-	-	-
Cephalochordata									
Branchiostoma caribaeum	S	-	-	-	-	1.6 ± 1.1	5.0 ± 3.2	9.4 ± 11.3	29.0 ± 23.9

* D = Deposit feeder
C = Carnivore
O = Omnivore
S = Suspension feeder
? = Unknown
\- None collected or rare at station

Note: Data are mean number/0.06 m^2 ± 1 standard deviation, n=5 replicate box cores at each station

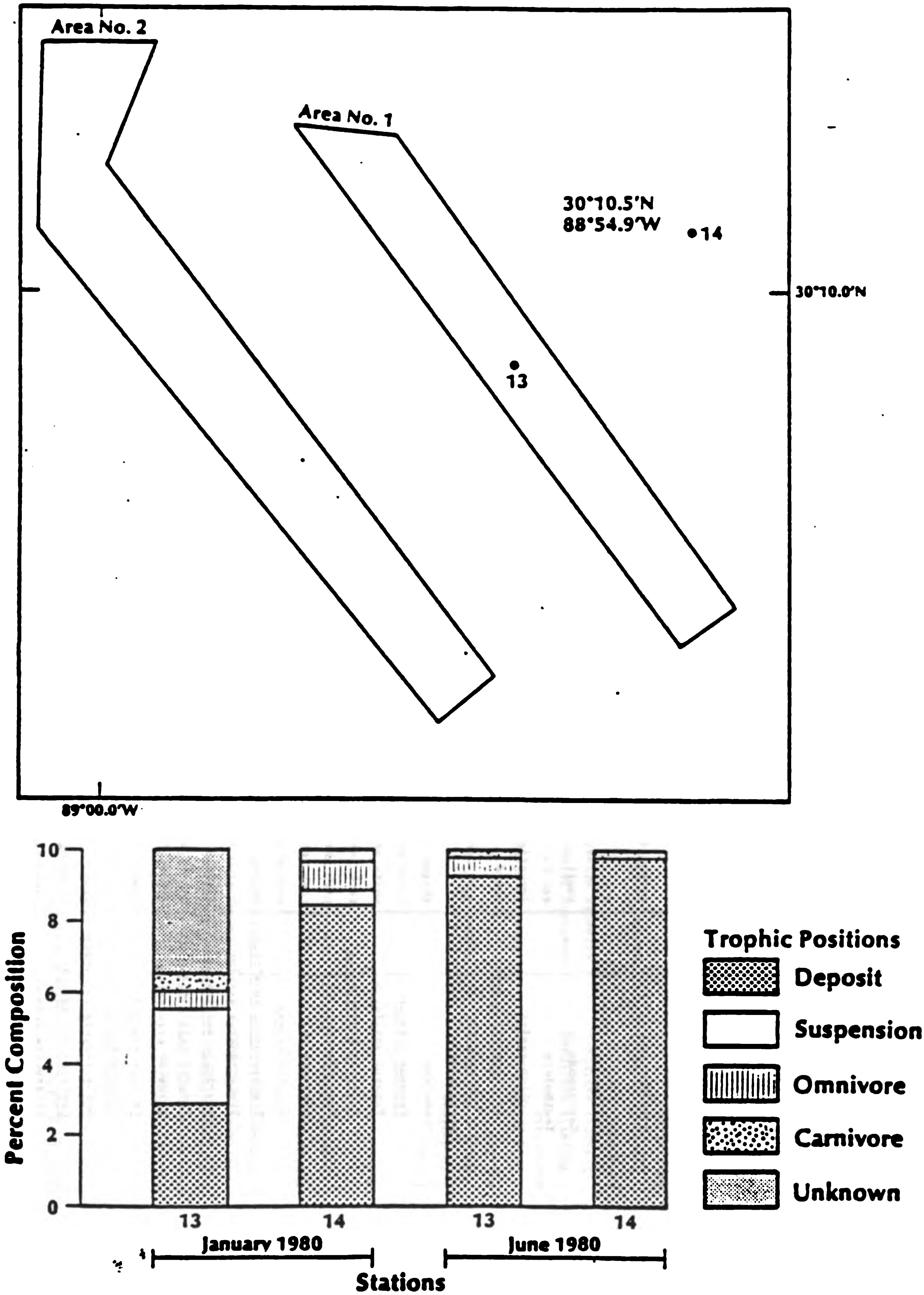


Figure A-6. Percent Composition of Feeding Types in the Vicinity of the Gulfport ODMDS

TABLE A-15
EPIFAUNA COLLECTED IN OTTER TRAWLS AT MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES (JANUARY 1980)

Species	Common Name	Mobile				Pensacola				Gulfport			
		Station 1		Station 6		Station 11		Station 12		Station 13		Station 14	
		Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2
Cnidaria													
Scyphozoa	jellyfish	-	-	P	2	1	-	-	-	1	-	-	-
Annelida													
Nereidae	polychaete	-	-	-	-	-	-	-	-	-	-	1	-
Mollusca													
Gastropoda	snail	-	1	-	-	-	-	-	-	-	-	-	-
Teuthoidea	squids	-	-	-	-	25	40	-	-	-	1	1	1
Loligo pealei	long-finned squid	-	-	-	-	-	-	60	50	-	-	-	-
Lolliguncula brevis	squid	79	100	-	30	-	-	-	-	1	-	-	-
Arthropoda													
Penaeidae	shrimp	-	-	-	-	-	24	-	-	-	18	-	-
Penaeus aztecus	brown shrimp	-	60	-	-	-	-	-	-	-	-	-	-
Penaeus setiferus	white shrimp	-	-	-	P	-	-	-	-	-	-	-	-
Sicyonia brevirostris	rock shrimp	-	7	-	-	1	-	-	2	-	1	-	-
Sicyonia dorsalis	rock shrimp	3	3	-	-	-	-	-	-	-	-	-	-
Sicyonia sp.	rock shrimp	-	-	-	-	-	8	-	-	-	-	6	1
Squilla empusa	mantis shrimp	5	12	-	P	-	-	-	-	3	8	7	9
Trachypenaeus constrictus	shrimp	-	-	-	-	-	-	20	10	-	-	30	36
Trachypenaeus similus	broken-necked shrimp	4	-	-	-	-	-	-	-	31	-	-	-
Scyllarus americanus	Spanish lobster	-	-	-	-	-	1	-	-	-	-	-	-
Pagurus pollicaris	hermit crab	-	-	-	-	-	-	-	-	-	-	1	-
Arenaeus cribrarius	speckled crab	-	-	-	P	-	-	-	-	-	-	-	-
Calappa angusta	crab	-	1	-	-	-	-	-	-	-	-	-	-
Libinia dubia	spider crab	-	-	-	-	-	-	-	-	2	-	-	-
Metoporhaphis calcarata	crab	1	-	-	-	-	-	-	-	-	-	1	-
Ovalipes floridanus	swimming crab	-	-	-	P	-	-	-	-	-	-	-	-
Persephona crinita	purse crab	-	-	-	-	-	-	-	-	-	1	-	-

TABLE A-15. (continued)

Species	Common Name	Mobile Station 1 Tow 1	Mobile Station 1 Tow 2	Mobile Station 6 Tow 1	Mobile Station 6 Tow 2	Pensacola Station 11 Tow 1	Pensacola Station 11 Tow 2	Pensacola Station 12 Tow 1	Pensacola Station 12 Tow 2	Gulfport Station 13 Tow 1	Gulfport Station 13 Tow 2	Gulfport Station 14 Tow 1	Gulfport Station 14 Tow 2
Portunus gibbesi	swimming crab	6	30	-	-	-	-	1	-	5	-	10	-
Portunus spinimanus	swimming crab	-	-	-	-	-	-	-	-	-	-	-	1
Portunus sp.	swimming crab	-	-	-	-	-	-	-	-	-	12	-	-
Echinodermata													
Astropecten articulatus	starfish	-	-	-	-	-	1	-	-	-	-	-	-
Tunicata		-	-	-	-	-	-	-	-	-	-	1	-
Pisces													
Torpedinidae													
Narcine brasiliensis	lesser electric ray	-	1	-	-	-	-	-	-	-	-	-	-
Rajidae													
Raja eglanteria	clearnose skate	-	-	-	-	-	-	1	-	-	-	-	-
Dasyatidae													
Dasyatis americana	southern stingray	-	-	-	-	-	-	1	-	-	-	-	-
Dasyatis sabina	atlantic stingray	-	-	-	-	-	-	-	-	-	-	-	1
Clupeidae													
Harengula pensacolae	scaled sardine	-	-	5	P	-	-	-	-	-	-	-	-
Engraulidae		-	-	-	-	-	-	-	-	-	100	-	100
Anchoa hepsetus	striped anchovy	9	3	-	25	120	10	150	120	-	-	-	-
Anchoa mitchilli	bay anchovy	-	-	-	-	-	-	-	-	20	-	25	-
Synodontidae		-	-										
Synodus foetens	inshore lizardfish	-	-	-	-	-	1	-	-	-	-	-	-
Ariidae		-	-										
Arius felis	sea catfish	-	-	300	100	-	1	-	-	70	5	-	-
Gadidae													
Urophycis floridanus	southern hake	1	2	-	-	P	3	-	-	-	-	-	-
Urophycis regius	spotted hake	-	-	-	-	1	-	1	-	-	-	-	-

TABLE A-15. (continued)

Species	Common Name	Mobile Station 1 Tow 1	Mobile Station 1 Tow 2	Mobile Station 6 Tow 1	Mobile Station 6 Tow 2	Pensacola Station 11 Tow 1	Pensacola Station 11 Tow 2	Pensacola Station 12 Tow 1	Pensacola Station 12 Tow 2	Gulfport Station 13 Tow 1	Gulfport Station 13 Tow 2	Gulfport Station 14 Tow 1	Gulfport Station 14 Tow 2
Ophidiidae													
<u>Ophidion</u> <u>grayi</u>	blotched cusk-eel	-	-	-	-	-	-	1	2	-	-	-	-
Syngnathidae													
<u>Syngnathus</u> <u>springeri</u>	bull pipefish	-	2	-	-	-	-	-	-	-	-	-	-
Serranidae													
<u>Diplectrum</u> <u>bivittatum</u>	dwarf sand perch	-	-	-	-	-	1	-	-	-	-	-	-
Carangidae		-	-										
<u>Caranx</u> <u>crysos</u>	blue runner	-	-	20	-	-	-	-	-	-	-	-	-
<u>Chloroscombrus</u> <u>chrysurus</u>	Atlantic bumper	6	8	10	100	-	-	-	-	-	-	-	-
<u>Vomer</u> <u>setapinnis</u>	Atlantic moonfish	-	-	75	200	-	-	-	-	-	-	-	-
Pomadasyidae													
<u>Orthopristis</u> <u>chrysoptera</u>	pigfish	-	-	-	-	-	-	-	1	-	-	-	-
Sciaenidae													
<u>Cynoscion</u> <u>arenarius</u>	sand seatrout	14	110	7	10	-	-	-	-	-	-	-	-
<u>Larimus</u> <u>fasciatus</u>	banded drum	39	125	-	15	-	-	-	-	-	1	15	5
<u>Leiostomus</u> <u>xanthurus</u>	spot	-	1	4	-	-	-	4	2	-	-	-	-
<u>Menticirrhus</u> <u>americanus</u>	southern kingfish	3	12	20	-	-	-	-	-	-	-	-	-
<u>Menticirrhus</u> cf. <u>americanus</u>	southern kingfish	-	-	-	-	-	-	-	-	-	-	20	-
<u>Menticirrhus</u> <u>littoralis</u>	Gulf kingfish	-	-	-	-	-	-	-	-	11	-	-	-
<u>Menticirrhus</u> sp.	kingfish	-	-	-	-	-	-	-	-	-	14	-	15
Ephippidae													
<u>Chaetodipterus</u> <u>faber</u>	Atlantic spadefish	-	1	-	-	-	-	-	-	-	-	-	-
Scombridae													
<u>Scomberomorus</u> <u>maculatus</u>	Spanish mackerel	-	-	4	-	-	-	-	-	-	-	-	-
Trichiuridae													
<u>Trichiurus</u> <u>lepturus</u>	Atlantic cutlassfish	2	2	3	5	-	-	-	-	1	-	-	-
Stromateidae													
<u>Peprilus</u> <u>burti</u>	Pacific pompano	1	-	-	-	1	-	-	-	-	-	-	-
<u>Peprilus</u> <u>paru</u>	butterfish	-	-	-	-	-	-	-	-	12	7	3	-

TABLE A-15. (continued)

Species	Common Name	Mobile				Pensacola				Gulfport			
		Station 1		Station 6		Station 11		Station 12		Station 13		Station 14	
		Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2
Triglidae													
<u>Prionotus</u> <u>tribulus</u>	bighead searobin	4	11	-	-	1	1	-	-	-	-	15	-
<u>Prionotus</u> <u>tribulus</u> (juv.)	bighead searobin	-	-	-	-	-	2	-	-	-	-	-	-
<u>Prionotus</u> sp.	searobin	-	-	-	-	-	-	-	-	-	-	-	14
Bothidae													
<u>Citharichthys</u> <u>macrops</u>	spotted whiff	-	-	-	-	-	2	-	-	-	-	-	-
<u>Etropus</u> <u>crossotus</u>	fringed flounder	8	20	-	40	-	3	-	-	-	-	1	-
<u>Paralichthys</u> <u>albigutta</u>	Gulf flounder	-	-	-	-	-	2	-	2	-	-	-	-
Cynoglossidae													
<u>Symphurus</u> <u>civitatus</u>	offshore tonguefish	-	-	-	-	-	-	-	-	15	-	-	-
<u>Symphurus</u> <u>plagiusa</u>	blackcheek tonguefish	7	13	-	-	-	-	-	-	-	-	20	-
<u>Symphurus</u> sp.	tonguefish	-	-	-	-	-	-	-	-	-	-	-	3
Family unidentified	flatfish	-	-	-	-	-	-	-	-	-	12	-	-
Tetraodontidae													
<u>Sphoeroides</u> <u>parvus</u>	least puffer	1	17	-	1	-	-	-	-	2	3	5	-

P = Present
\- None collected

Note: Counts above 30 are approximate

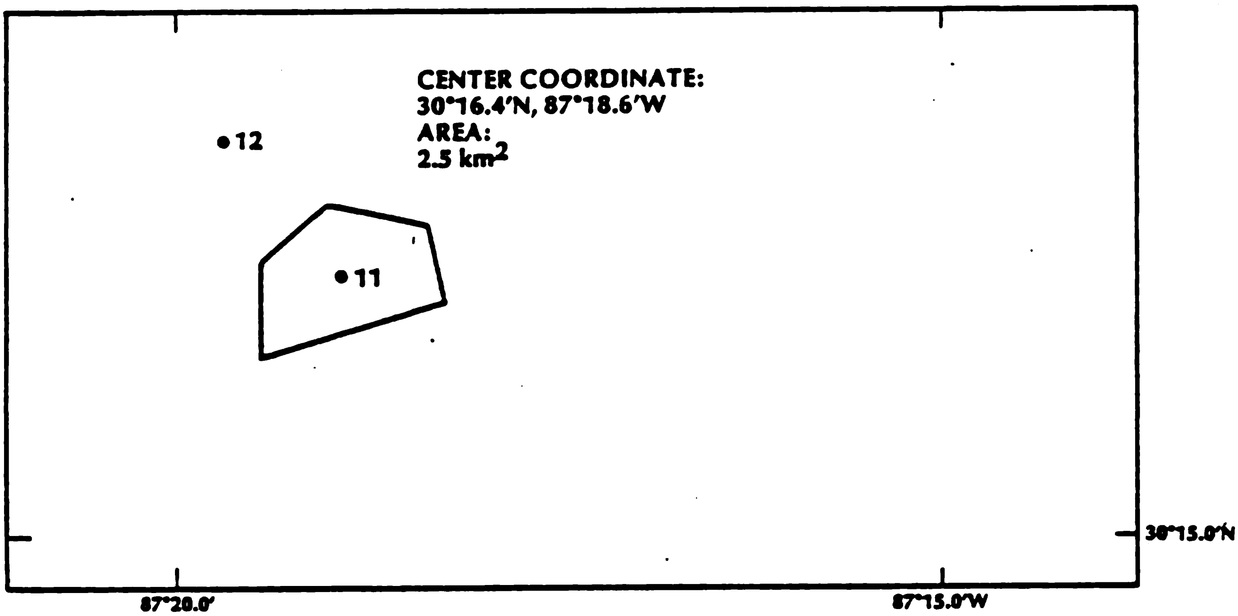
Platyischnopidae sp. A) and cephalochordates (Branchiostoma caribaeum) abundant at most stations. Apoprionospio pygmaea and Spiophanes bombyx were the most abundant polychaete species.

The trophic composition of the macrofauna in the vicinity of the Pensacola ODMDS is illustrated in Figure A-7. The Pensacola site has a low percent composition of deposit feeders (<60%) and a higher concentration of suspension feeders, omnivores, and carnivores relative to Mobile and Gulfport. Sediments in the vicinity of the Pensacola ODMDS are predominantly sand, while Mobile and Gulfport have higher concentrations of fine sediment. High concentrations of silt and clay can clog feeding structures of suspension feeders or cause problems in the maintenance of burrows or tubes (Gray, 1974); these reasons could explain why Mobile and Gulfport had fewer suspension feeders than Pensacola.

A.2.6 EPIFAUNA

A total of 45 invertebrate and 57 chordate species were captured in otter trawls in the vicinities of the Mobile, Pensacola, and Gulfport ODMDSs (Tables A-15 and A-16). Bottom dwelling species were best represented by the sea catfish Arius felis, shrimp Acetes americanus, longspine porgy Stenotomus caprinus, banded drum Larimus fasciatus, and brown shrimp Penaeus aztecus. This compared favorably with common epifaunal species previously reported in the Northeastern Gulf of Mexico (Rogers, 1977; Swingle, 1971). Mid-water species were often taken while the trawl net was lowered or brought to the surface. Abundances of mid-water species were high for all three sites, particularly jellyfish, the squids Loligo pealei and Loliguncula brevis, the anchovies Anchoa hepsetus and Anchoa mitchelli, and Atlantic bumper Chloroscombrus chrysurus. Many of the species collected in this study are commercially important (Swingle, 1971).

Epifauna were similar in the vicinities of the Mobile, Pensacola, and Gulfport ODMDSs; however, the number of species and abundances in the Mobile site were generally higher than the Pensacola and Gulfport sites. Greater number of species and higher abundance of fish were collected in the vicinity of the ODMDSs in January than June, which is consistent with reported



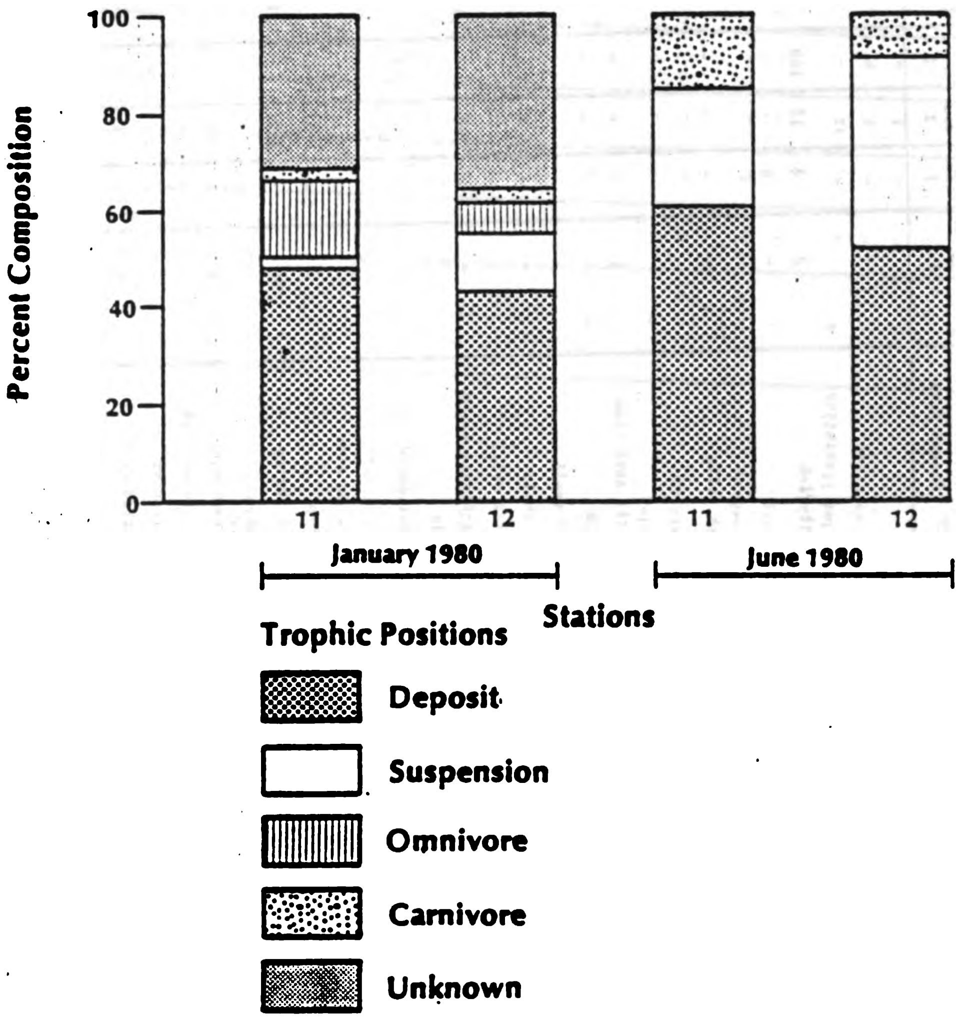


Figure A-7. Percent Composition of Feeding Types in the Vicinity of the Pensacola ODMDS

TABLE A-16
EPIFAUNA COLLECTED IN OTTER TRAWLS AT MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES (JUNE 1980)

Species	Common Name	Mobile			Pensacola				Gulfport			
		Station 1	Station 6		Station 11		Station 12		Station 13		Station 14	
		Tow 1	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2
Invertebrate												
Cnidaria												
Scyphozoa	jellyfish	2	5	15	100	-	100	20	3	2	5	10
Ctenophora		-	6	-	-	-	-	-	-	-	4	7
Pleurobrachia cf. *hedgpethi*	comb jelly	-	-	-	-	1	-	-	-	-	-	-
Mollusca												
Mulinia lateralis	little surf clam	1	-	-	-	-	-	-	-	-	-	-
Busycon sp. (egg case)	whelk	-	-	-	-	-	-	-	-	-	1	-
Polinices sp. (egg case)	moon snail	-	-	-	-	-	-	-	-	-	1	-
Sinum perspectivum	ear shell	-	-	-	-	-	-	-	-	1	-	-
Urosalpinx cinerea	oyster drill	-	-	-	-	-	-	-	5	3	-	-
Loligo pealei	long-finned squid	-	-	40	-	30	-	-	-	-	-	-
Loligo sp. (juv.)	squid	-	-	-	-	-	5	5	-	-	-	-
Lolliguncula brevis	boreal squid	2	-	-	50	-	-	-	-	P	3	3
Arthropoda												
Acetes americanus	shrimp	-	200	-	-	-	-	-	-	-	-	-
Penaeus aztecus	brown shrimp	200	-	110	-	1	-	-	-	2	2	-
Penaeus sp.	shrimp	-	-	-	-	-	-	-	3	-	-	-
Squilla empusa	mantis shrimp	50	1	40	-	-	-	-	2	2	1	1
Pagurus pollicaris	long-clawed crab	-	-	-	-	-	-	-	2	P	-	-
Pagurus sp.	hermit crab	-	-	-	-	-	-	-	-	P	-	-
Arenaeus cribrarius	speckled crab	-	-	1	-	-	-	-	-	-	-	-
Callinectes sapidus	blue crab	-	-	-	-	-	-	-	1	5	-	-
Callinectes similis	swim crab	20	-	-	-	-	-	-	-	-	-	-
Callinectes cf. *similis*	swim crab	-	-	25	-	-	-	-	-	-	-	-
Hepatus epheliticus	calico crab	-	-	1	-	-	-	-	1	-	1	-
Metoporhaphis calcarata	crab	-	-	1	-	-	-	-	-	-	-	-
Ovalipes floridanus	swimming crab	-	-	-	-	-	1	1	-	-	-	-

TABLE A-16 (continued)

Species	Common Name	Mobile Station 1 Tow 1	Mobile Station 6 Tow 1	Mobile Station 6 Tow 2	Pensacola Station 11 Tow 1	Pensacola Station 11 Tow 2	Pensacola Station 12 Tow 1	Pensacola Station 12 Tow 2	Gulfport Station 13 Tow 1	Gulfport Station 13 Tow 2	Gulfport Station 14 Tow 1	Gulfport Station 14 Tow 2
Ovalipes floridanus	swimming crab	-	-	-	-	1	-	-	-	-	-	-
Persephona crinita	purse crab	-	-	1	-	-	-	-	1	-	1	-
Portunus spinimanus	swimming crab	-	-	-	-	1	1	-	-	-	3	-
Portunus sp. (juv.)	swimming crab	-	2	-	-	-	-	-	-	-	-	2
Portunid (juv.)	swimming crab	-	-	-	-	-	-	-	6	-	-	-
Echinodermata												
Astropecten articulatus	margined sea star	-	-	-	-	1	-	-	-	-	-	-
Luidia clathrata	slender sea star	-	-	-	10	1	2	5	-	-	-	-
Encope cf. *michelini*	arrowhead sand dollar	-	-	-	30	20	75	20	-	-	-	-
Mellita quinquiesperforata	keyhole sand dollar	2	-	-	-	-	-	-	-	-	-	-
Pisces												
Ophichthidae												
Ophichthus gomesi	shrimp eel	-	-	3	-	-	-	-	-	-	-	-
Clupeidae												
Etrumeus teres	rock herring	-	-	-	-	-	-	3	-	-	-	-
Harengula pensacolae	scaled sardine	-	1	-	-	-	-	-	-	-	-	-
Engraulidae												
Anchoa hepsetus	striped anchovy	-	-	4	-	-	-	-	1	-	1	3
Anchoviella perfasciata	flat anchovy	-	-	-	-	-	20	-	-	-	-	-
Synodontidae												
Saurida brasiliensis	large scaled lizardfish	-	-	-	12	-	-	-	-	-	-	-
Synodus foetens	inshore lizardfish	-	-	-	7	P	-	3	-	-	-	-
Trachinocephalus myops	snakefish	-	-	-	3	P	-	-	-	-	-	-
Ariidae												
Arius felis	sea catfish	-	-	-	-	-	1	5	-	-	-	-
Batrachoididae												
Porichthys porosissimus	Atlantic midshipman	1	-	1	-	-	-	-	-	-	-	-

TABLE A-16 (continued)

Species	Common Name	Mobile Station 1 Tow 1	Mobile Station 6 Tow 1	Mobile Station 6 Tow 2	Pensacola Station 11 Tow 1	Pensacola Station 11 Tow 2	Pensacola Station 12 Tow 1	Pensacola Station 12 Tow 2	Gulfport Station 13 Tow 1	Gulfport Station 13 Tow 2	Gulfport Station 14 Tow 1	Gulfport Station 14 Tow 2
Ogcocephalidae												
<u>Halieutichthys aculeatus</u>	pancake batfish	2	-	-	-	-	-	-	-	-	-	-
Gadidae												
<u>Urophycis floridanus</u>	southern hake	-	-	3	-	-	-	-	-	-	-	-
Ophidiidae												
<u>Ophidion welshi</u>	crested cusk-eel	20	-	9	-	-	-	-	-	-	-	-
Serranidae												
<u>Centropristis philadelphica</u>	rock sea bass	-	-	-	5	-	-	-	-	-	-	-
<u>Diplectrum formosum</u>	sand perch	-	-	-	2	-	-	-	-	-	-	-
Carangidae												
<u>Chloroscombrus chrysurus</u>	Atlantic bumper	-	-	-	-	-	75	10	-	-	-	-
<u>Decapterus punctatus</u>	round scad	-	-	-	-	-	-	5	-	-	-	-
<u>Vomer setapinnis</u>	Atlantic moonfish	-	-	-	-	-	1	-	-	1	-	-
Pomadasyidae												
<u>Orthopristis chrysoptera</u>	pigfish	-	-	-	-	-	2	-	-	-	-	-
Sparidae												
<u>Stenotomus caprinus</u>	longspine porgy	200	-	25	40	-	-	-	6	5	2	-
Sciaenidae												
<u>Larimus fasciatus</u>	banded drum	-	-	20	-	-	-	-	-	-	-	-
<u>Leiostomus xanthurus</u>	spot	-	-	-	-	-	-	5	-	-	-	-
<u>Menticirrhus americanus</u>	southern kingfish	-	-	2	-	-	2	-	-	-	-	-
<u>Menticirrhus saxatilis</u>	northern kingfish	-	-	-	-	-	-	3	-	-	-	-
<u>Micropogon undulatus</u>	croaker	-	-	-	-	-	-	-	-	-	1	-
Trichiuridae												
<u>Trichiurus lepturus</u>	Atlantic cutlassfish	-	-	2	-	-	-	-	-	-	-	-
Stromateidae												
<u>Peprilus paru</u>	butterfish	-	-	6	-	-	-	5	-	-	-	-
<u>Peprilus</u> sp.	butterfish	-	-	-	-	-	-	5	-	-	-	-
Triglidae												
<u>Prionotus roseus</u>	bluespotted searobin	-	-	-	-	-	1	1	-	-	-	-
<u>Prionotus rubio</u>	blackfin searobin	50	2	15	-	P	-	-	-	-	1	-

TABLE A-16 (continued)

Species	Common Name	Mobile			Pensacola				Gulfport			
		Station 1	Station 6		Station 11		Station 12		Station 13		Station 14	
		Tow 1	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2
Bothidae												
<u>Etropus</u> <u>rumosus</u>	gray flounder	3	-	10	2	P	3	-	-	-	-	-
Cynoglossidae												
<u>Symphurus</u> <u>plagusia</u>	blackcheek tonguefish	-	-	17	-	-	-	-	-	-	-	-
Tetraodontidae												
<u>Sphoeroides</u> <u>parvus</u>	least puffer	2	-	-	-	-	-	-	-	1	-	-

P = Present
- None collected

Note: Counts above 30 are approximate

migration patterns of coastal fishes (Christmas, 1973). Some differences in species composition and abundance were observed between trawls taken within and outside the ODMDS, particularly at Mobile; however, no explanation for this trend can be concluded from the data.

A.2.7 MICROBIOLOGY

In January, total and fecal coliforms were analyzed in tissue samples from three stations: one from Mobile (Station 1) and two from Gulfport (Stations 13 and 14). Tissue samples were not collected from the Pensacola site. No total or fecal coliforms were detected in the tissues analyzed (Table A-17). No sediment samples were collected for total and fecal coliform analysis during January.

Eight stations were analyzed for total and fecal coliforms in June: four stations around the Mobile site (Stations 1,4,6, and 10), two at Pensacola (Stations 11 and 12), and two at Gulfport (Stations 13 and 14). Sediment samples were collected at all eight stations; tissue samples were collected at only two stations (1 and 6). Total coliforms were detected in the sediment and tissue samples collected from within the Mobile site and from one sediment station outside the Gulfport ODMDS (Table A-17). The highest total counts, in both sediments and tissues, were found at the Mobile site. No clear explanation for the source of total coliforms at the sites can be given; however, possible sources include outflow from rivers or dredged material disposal.

A.3 SUMMARY

A.3.1 CHEMISTRY

The temperature, salinity, and pH of the waters in the vicinities of the Mobile, Pensacola, and Gulfport ODMDSs were generally similar. Surface dissolved oxygen concentrations were comparable among the sites; but bottom dissolved oxygen concentrations were relatively low in the vicinities of the Mobile and Gulfport ODMDSs. Reduced dissolved oxygen levels in bottom waters at the latter two sites were widespread and apparently unrelated to dredged

TABLE A-17
TOTAL AND FECAL COLIFORM COUNTS IN SEDIMENTS AND TISSUES OF SPECIES FROM THE MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES

SEDIMENTS			SHELLFISH		
Date/ Station No.	Total Coilforms (MPN/100g)	Fecal Coliforms (MPN/100g)	Species	Total Coliforms (MPN/100g)	Fecal Coliforms (MPN/100g)
January 1980					
1	NC	NC	Portunas gibbessi (a)	<200	<200
13	NC	NC	Trachvpenaeus similis(b)	<182	<182
14	NC	NC	Trachvpenaeus constrictus(c)	<222	<222
June 1980					
1	102	<15	Penaeus aztecus(d)	3,608	<24
4	63	<14	NC		
6	<18	<18	Penaeus aztecus(d)	<37	<37
10	<19	<16	NC		
11	<16	<16	NC		
12	<18	<18	NC		
13	<14	<14	NC		
14	<17	<15	NC		

= Not detected
NC = Not collected
(a) Swimming crab
(b), (c) Shrimp, no common name
(d) Brown shrimp

material disposal. Turbidity and TSS concentrations were highest at Gulfport and lowest at Pensacola, with Mobile having intermediate values. Particulate and dissolved trace metal concentrations were generally low and showed no apparent differences among sites or between site and control stations. PCB concentrations in the sites' waters were similar but water column pesticide concentrations were highest near the Pensacola ODMDS. All pesticide concentrations were within ranges for Gulf Shelf waters reported in historical literature. Elutriate tests indicated little or no releases of trace metals upon mixing with seawater.

The grain size distribution of sediments at the three sites showed the highest proportions of sand at Pensacola and the least sand at Gulfport. Sediments in the area of the Gulfport ODMDS had the greatest proportions of fine sediments. Sediments in and near the Gulfport ODMDS had the highest concentrations of TOC, consistent with their higher proportion of fine sediments. All TOC values were within previously reported ranges. Sedimentary oil and grease, Hg, Cd, and pesticide concentrations were generally low and comparable for all sites. Sediment Pb concentrations were slightly higher at the Mobile site but values were within the historical range. No effects on sediment physical or chemical composition could be clearly attributed to dredged material disposal.

Trace metal, PCB, and pesticide concentrations in tissues were within historical ranges and below applicable FDA action levels.

A.3.2 BIOLOGY

The macrofaunal assemblages described by the EPA/IEC surveys were similar with results of other studies performed in the northeastern Gulf of Mexico. Macrofaunal community characteristics for Mobile and Gulfport ODMDSs were similar due to the muddy-sand composition of their sediment and the abundance of spionid, magelonid, and captellid polychaetes. The macrofaunal community of the Pensacola ODMDS differed somewhat from Mobile and Gulfport due to sandier sediments. Trophic structure at all sites was generally dominated by deposit feeding organisms. Increases in the density of deposit feeders were probably due to seasonal recruitment into the populations. Epifauna at the Mobile, Pensacola, and Gulfport sites were primarilly commercially-important species, which is typical for the region.

Appendix B

HURRICANE AND STORM EFFECTS ON THE GULF OF MEXICO INNER SHELF CURRENTS

The northern Gulf of Mexico is periodically subjected to hurricanes and tropical storms. Some of the better-known marine effects of these hurricanes and storms are high winds, heavy rainfall, high waves, elevated sea levels, and strong currents. The magnitudes of these strong currents and their potential enviromental effects are discussed below.

MEASUREMENTS

The catastrophic nature of hurricanes and tropical storms have rarely permitted reliable measurements of the currents so produced. Few investigators have measured currents from storms because it is difficult to predict occurrences, and most instruments are not designed to withstand severe conditions. Three sets of data taken during past 11 years give excellent forecasts of what can be expected. Near-bottom currents were measured in 1969 at a site 160 km from the closest approach of Hurricane Camille (Murray, 1970). Forristall et al. (1977) reported the results of Tropical Storm Delia passing directly over an instrumented platform in 1973. Currents in the fringe of Hurricane Anita in August and September 1977 were measured by Smith (1978).

In 1969 a current meter was placed 360m offshore (90m seaward of the Outer Bar), at a depth of 6.3m, off the coast of the Florida Panhandle (Murray, 1970). One week after installation of the current meter Hurricane Camille passed to the west. At closest approach, the eye of Camille was about 160 km from the installation. The data presented by Murray (1970) showed the following chronological relationship:

- While the eye of the hurricane was more than 530 km (290 nmi) from the site, the normal 5 to 10 cm/s (0.10 to 0.12 kn) current speeds were observed near the bottom.

- With the eye between 400 and 530 km from the site, near-bottom currents averaged about 35 cm/s (0.69 kn). This increased velocity is attributed to a seaward growth of the longshore current in the surf zone.

- As the eye approached from a distance of 400 km to about 180 km, current speeds rose to average values of nearly 100 cm/s (1.96 kn), with pulses to 160 cm/s (3.14 kn).

- At the point where the eye of the hurricane was about 180 km from the installation, the current meter speed impeller jammed and 7 hours later the meter broke away from its base.

In 1973, Tropical Storm Delia formed in the Gulf of Mexico, wandered generally northwest, and crossed the Texas coast about 50 km southwest of Galveston. During its travel it passed almost directly over a Buccaneer Oil Field platform, which had three current meters suspended on a taut wire between the platform and an 18,000-lb steel anchor (Forristall et al., 1977). The three current meters were 3m, 10m, and 16m above bottom, in a total water depth of 20m. Forristall et al. (1977) made the following observations during this storm passage:

- Tropical Storm Delia was a relatively weak storm (maximum wind velocities were about 60 kn) yet it produced water currents of 200 cm/s (3.92 kn), with the deepest current meter experiencing a maximum current of about 175 cm/s (3.43 kn).

- Scour on the bottom was such that the 18,000-lb steel anchor rotated 31° and shifted about 1m to the east during the strong currents.

Hurricane Anita passed from east to west across the northwestern Gulf of Mexico in August and September 1977. During the storm two current meters operated 21.5 km off the Texas coast near Port O'Connor. These instruments were 2m and 10m above bottom in 17m of water. The following observations were made (Smith, 1978):

- The closest approach of the storm center to the instruments was about 350 km.
- Maximum current speeds reached 80 cm/s (1.57 kn) for the upper current meter and 70 cm/s (1.37 kn) for the lower.
- Current speeds near the bottom exceeded 50 cm/s (0.98 kn) continuously for 4 days.

IMPLICATIONS

SEDIMENT MOVEMENT

Under the sponsorship of the Dredged Material Research Program (DMRP), Moherek (1978) conducted flume experiments on sediments taken from the Existing Galveston Site. The four different sediment types tested showed different mixtures of sand, silt, and clay, and represent the typical sediment characteristics of Inner Shelf sediments in the Gulf of Mexico. Moherek (1978) determined the critical shear stress and corresponding water speed "...necessary to initiate rapid erosion of the dense bed." From both theoretical considerations of open-channel flow and direct observation, the speed at the transition into rapid erosion was about 24 cm/s. The velocity and critical shear stress values did not significantly vary from one type of sediment to another, suggesting that resistance to erosion was mainly due to the degree of cohesive force acting between sedimentary particles (ibid.) This is reasonable whenever a high percentage of the material is in the silt and clay range.

At velocities above that corresponding to the critical shear stress, two processes will be active in contributing to sediment transport. First, sediment will be drawn up and away from the bottom and carried along as a suspended load. Second, sediment will move along the bottom as bedload. In effect, the entire surface of the bottom will be in motion above the critical shear stress value. The depth of this motion (bedload), below the surface of the bottom, increases with the speed of the water above the bottom. At a water speed just above the critical value the moving layer may, theoretically, be only the thickness of a single sediment grain. As speeds increase, this layer may expand to several centimeters in thickness. Quantification is difficult in such matters, but some generalizations are possible.

If the critical water speed is about 24 cm/s (0.47 kn), then at values of 50 to 60 cm/s (0.98 to 1.18 kn), erosion of the bottom is likely and definitely more than a single-grain thickness layer will be in motion as bedload. For values of water speed in the range of 150 to 200 cm/s (2.94 to 3.92 kn), massive movement of bottom sediments will take place. At least several centimeters of the bottom will be in motion as bedload.

MOUNDING

Mounds created by disposal of dredged material on the Inner Shelf of the Gulf of Mexico are not likely to be stable features. Rapid bottom currents, created by storms and hurricanes, remove any mound-like structures in two principal ways. First, a mound on the relatively flat and smooth Inner Shelf is a distinct and anomalous topographic feature. A mound creates additional turbulence in strong current flows, and probably increases the erosive power of the moving water, which differentially erodes the mound. Second, a mound projects up from the smooth bottom, through the normal boundary layer, and into higher velocity layers above. Thus, the mound experiences higher stresses on its upper surfaces and the higher portions are eroded faster than the natural flat bottom.

OXYGEN DEPLETION

In nearshore areas where significant amounts of fine sediments (silts and clays) settle during calm periods, it is possible that substantial amounts of organic matter also settle out. This condition can cause the upper layer, or a layer near the surface of the sediments, to become anoxic and sulfide-bearing. If strong currents occur in such a location and stir up the bottom, the near-bottom waters could be depleted of oxygen and contain hydrogen sulfide. An example of this type of situation was observed near Sabine Pass, Texas, after Hurricane Cindy in 1963 (Keith and Hulings, 1965).

BENTHOS

Increased current speeds and bedload movement during hurricanes and storms directly affect shallow-water benthic communities. Species that inhabit unstable, sandy sediments are usually better able to withstand storm turbulence than species in muddy sediments. However, mass mortalities can occur in either habitat during hurricanes (Keith and Hulings, 1965).

Storms and hurricanes increase surface-sediment suspension, which cause the clogging of filtering structures in suspension-feeding animals. As bedload increases, smaller, less-mobile fauna are buried and smothered; depressed oxygen concentration and the presence of hydrogen sulfide aggravate the effect. Powerful bottom currents erode or bury benthic communities, uproot newly settled larvae, and sweep away surface-dwelling organisms (Oliver et al., 1977). Radical changes in salinity due to influx of fresher water cause mass mortality of all but the most euryhaline species (Keith and Hulings, 1965).

The long-term impacts of these disturbances are decreases in abundance and diversity and interruption of community succession. Disrupted areas are reinhabited and dominated by opportunistic species. The opportunists are eventually displaced by more competitive species; the latter are usually species which dominated before any disruptions. The rate and extent of recolonization is primarily dependent on the degree of sediment alteration during the disturbance. Significant changes in silt content can exclude indigenous species, prolong recolonization, or promote a rapid introduction and proliferation of new colonizers.

APPENDIX C

ALTERNATIVES ANALYSIS

ALTERNATIVES TO USING THE PENSACOLA, FLORIDA
OCEAN DREDGED MATERIAL DISPOSAL SITE

The following is an analysis of alternative disposal options for the disposal of dredged material in the Pensacōla, Florida area. The majority of material included in this appendix is derived from a Army Corps of Engineers study entitled "Pensacola Harbor Florida Stage 2 Study Documentation (Milestone 03) and Revised Plan of Study" and other Corps reports (see Table 1). This study is not specific to existing dredging activities occurring in the Pensacola area. However, the analysis of alternative disposal methods and locations, and the relative costs and effects associated with these alternatives is expected to be similar when applied to existing dredge and disposal activities in the Pensacola Bay area.

EXISTING PROJECT

The existing Federal project for Pensacola Harbor provides for (1) a 35- by 500-foot entrance channel about 5 miles long, from the Gulf of Mexico to lower Pensacola Bay; (2) a 33-by 300-foot bay channel; (3) two 33- by 300-foot parallel approach channels to opposite ends of the inner-harbor channel; (4) an inner-harbor channel 500 feet wide, 33 feet deep, and 3,950 feet long; (5) a 30- by 250-foot approach channel to the pierhead line south of the Muscogee wharf; and (6) a 15- by 100-foot entrance channel into Bayou Chico, thence a channel 14 feet deep, 75 feet wide, and about 4,400 feet long to a turning basin 14 feet deep and 500 feet square. In February and March of 1975 and February 1981 approximately 1.16 and .64 million cubic yards respectively of material was removed from these channels and disposed of at the existing ODMDS.

Prior Reports

Locality	Date transmitted to Congress	Where published	Recommendation
Pensacola Harbor, Fla.	Dec. 16. 1829[1]	Not published	
"	Aug. 28, 1879	"	
"	Feb. 19, 1881	"	Favorable
"	Feb. 12, 1885	H. Ex. Doc. No. 224, 48th Cong., 2d sess.	"
"	Feb. 8, 1889[1]	Not published	"
"	Jan. 14, 1891	"	
"	May 18, 1926	"	Unfavorable
"	Feb. 16, 1932	H. Doc. 253, 72d Cong., 1st sess.	Favorable
Bayou Texar Fla.	Oct. 22, 1919	H. Doc. 281, 66th Cong., 1st sess.	Unfavorable
Bayou Chico, Fla.	Aug. 11, 1925[1]	Not published	"
"	Mar. 14, 1934	"	"
"	Apr. 25, 1936	H. Doc. 96, 74th Cong., 2d sess.	Favorable
Bayou Chico, Fla.	July 31, 1943	H. Doc. 743, 79th Cong., 2d sess.	"
Pensacola Harbor, Fla.	Aug. 14, 1962	H. Doc. 582, 87th Cong. 2d. sess.	"

1 Date of district engineer's report

ENVIRONMENTAL PROBLEMS

Circulation

Because of poor circulation and flushing characteristics, the assimilative capacity of the Pensacola Bay system is extremely limited and the bay is barely able to assimilate natural inputs of nutrients and oxidizing materials.

Water Quality

The degradation of water quality in the Pensacola Bay System, especially the Escambia Bay area, has been of considerable concern over the past several years. The EPA has directed "Environmental and Recovery Studies of Escambia Bay and the Pensacola Bay System" to determine methods of accelerating the recovery of the bay system over the above reducing waste discharges. EPA's draft report recommended that "a detailed evaluation of the effects of open water disposal of dredged material on the environment, which includes a cost-benefit analysis containing the cost of environmental damage, should be performed before open water spoil disposal is allowed in Pensacola, East, and Blackwater Bay." Also, "no open water disposal of dredged material should be allowed in Escambia Bay."

The water quality problems in the Pensacola Bay system are made more acute by the extremely limited assimilative capacity of the system. Poor circulation and flushing characteristics are the main causes of limited assimilative capacity.

TABLE 1

DISPOSAL METHODS

Location	Type of Dredge
Open water (overbroad)	Pipeline
Upland	Pipeline
Diked port expansion	Pipeline
Gulf	Hopper or dump scow or bucket dredge
Beach nourishment	Pipeline or hopper
Disposal islands	Pipeline

The various combinations of dredging and disposal methods (identified in Table 1) represent physically and technically practical alternatives for improving the existing Pensacola Navigation channel. However, the institutional problems, acceptability and margins of contributions to the planning objectives vary greatly. Disposal locations range from the highly opposed but most economical open-water method to the more often preferred and more expensive ocean disposal and beach nourishment plan.

To assure that no better intermediate plans existed, upland disposal, new land development and bay island construction options were also developed. Upland disposal, when practical, can have environmental advantages. Use of the dredged material for the creation of new land was considered because of local interests and needs. Island construction was investigated as a means of providing a relatively nearby disposal area. However, preliminary studies of this plan indicate that the high cost of containment would overcome other economic advantages. Further, containment cost would be a local cost that is believed to be beyond the local financial capability. Any island would also remove significant bay bottoms from biological production and possibly have further adverse effect on Pensacola Bay's already poor circulation. In view of the lack of any beneficial economic or environmental advantages, this plan was dropped from further consideration. The other disposal options were considered worthy of further study.

The dredging techniques (identified in Table 2) essentially cover the full range of possibilities. In addition to the economic and environmental ramifications of these techniques, the equipment availability also becomes a factor in their consideration. Hydraulic pipeline dredges currently are the most economical dredges when pumping short distances and perform the majority of dredging work. Hopper dredges as well as dump barges are less available but are being demanded in increasing numbers because of their ability to convey dredged material over a long distance. Only the bucket dredges are essentially unavailable in this country. In view of the bucket dredge's greatest application in the excavation of very firm solids, the very soft nature of sediments in Pensacola Bay and the dredge's scarcity, it was dropped from further consideration. The other dredging techniques in combination with the disposal options maintained for further study were carried into the second stage of evaluation.

ALTERNATIVES CONSIDERED FOR FURTHER ANALYSIS

Through the above screening process, only structural channel modifications are potential solutions for navigation difficulties at Pensacola Harbor. In addition to the "No-Action" plan, five combinations of dredging and disposal were selected for further study. These plans are listed in Table 2.

TABLE 2
INTERMEDIATE PLANS CONSIDERED

Plan A	Hopper dredging entire channel; Gulf disposal
Plan B	Hooper dredigng entrance; pipeline remainder; overboard & Gulf disposal
Plan C	Hopper dredging entrance; pipeline remainder; diked shore-line & Gulf disposal
Plan D	Hopper dredging entrance; pipeline remainder; upland & Gulf disposal
Plan E	Hopper dredging entrance; pipeline & dump scow; Gulf disposal

Plan A

Hopper dredging of the entrance channel with disposal in the Gulf southwest of the channel has been the historical method for dredging that channel. Although this method of dredging and disposal has been accepted in the past, the State of Florida has requested the suitable material dredged from the entrance channel be placed on the downdrift beach for nourishment. Placement of the material on the beach has not been done mainly because of lack of appropriate equipment for transfer of the material from the dredge to the beach. However, continued hopper dredging of the entrance with disposal either offshore or on the downdrift beach remains the most practical and acceptable option for accomplishing the entrance channel work and is assumed herein not only for Plan A but for all other plans investigated. Hopper dredging the entire channel would probably be the most acceptable method for overall project modification and maintenance. However, the suitability of placing the material from the interior channel either offshore or on the beaches would require additional studies, both of the material to be dredged (bio-assay) and of the sites' suitability to receive the material.

Hopper dredging of the entire channel with a single dredge with a hopper capacity of 3,000 cubic yards would require approximately 2 months for a depth of 36 feet. This estimate assumes an average round trip of 18 miles to the existing dumping area about 3 miles southwest of the entrance channel, a dredge speed of about 12 miles per hour, and an average load would be about 2,150 cubic yards. A dredge of this size can safely turn in about 30 feet of water if light loaded such that the dredge may turn around and fill its hoppers on the way out towards the Gulf.

TABLE 3
ESTIMATES FIRST COSTS HOPPER DREDGING (Plan A)

Depth	36'
Volumes (yds^3)	998,000
First Cost	$1,965,000

Plan B

This plan assumes a continuation of past practices of dredging the entrance by hopper dredge with the material being disposed in the Gulf or on downdrift beaches. However, only if appropriate equipment is available in the future and dredging of the bay portion of the channel by hydraulic pipeline dredge with the material being disposed in open water adjacent to the channel is possible. Dredged material studies to date indicate that unless openwater disposal is such that it creates build-up that will

TABLE 4
ESTIMATED FIRST COSTS HOPPER DREDGING (Plan A)

Depth	36'
Annual Charge	
6 5/8%	135,700
Annual Maint.	1,025,200
Total	$1,160,900

affect circulation patterns, its effects on benthic organisms and the water column are relatively short termed. However as previously noted, there is strong state opposition to continuation of openwater disposal in the bay as it is perceived to aggravate the poor water quality conditions of the area. In view of past opposition to open water disposal in the bay, this element of Plan B must be regarded generally as unacceptable by local interests. However Plan B is evaluated to identify the most economical plan.

Under Plan B the disposal site for the entrance channel would be the same location as identified for Plan A; in the Gulf about three miles southwest of the entrance. The remainder of the channels would be dredged using a pipeline dredge and disposing of the dredged material along side the channels. Table 5 shows the estimated volume of hopper dredging and pipeline dredging and the estimated first costs including contingencies, engineering and design, and supervision for construction of Plan B.

TABLE 5

ESTIMATED FIRST COSTS OVERBOARD DISPOSAL (Plan B)

Depth	36'
Volumes (yds^3)	
Hopper Dredging	561,000
Pipeline Dredging	473,000
First Cost	$2,345,000

When estimating costs for Table 5 a hopper dredge similar to Plan A 24" hydraulic dredge were used. The unit cost assumed a pipeline length of 3,000 feet. Table 6 shows the average annual Federal costs involved with this alternative and includes estimated maintenance costs.

TABLE 6
AVERAGE ANNUAL COST OVERBOARD DISPOSAL (Plan B)

Depth	36'
Annual Charge	
6 5/8%	161,900
Annual Maintenance	
Hopper	396,100
Pipeline	879,300
Total	$1,437,300

Plan C

The entrance channel for this alternative would be dredged with a hopper dredge as was done in Plan A with the same Gulf disposal site. The remainder of the channels would be dredged using a pipeline dredge and disposing of the dredged material within a diked area west of the existing port facilities. The average pipeline length would be about 15,000 feet.

This plan, as conceived, would provide approximately 200 acres of new land for needed expansion of existing port facilities. An area would also be provided to contain future maintenance material. Disavantages of the plan would be loss of bay bottoms essentially equivalent of the land area gained. Approximately 8,500 linear feet of bulkheading and/or diking would be required. This local cost is estimated to total as much as $950,000. A contribution toward the first cost of general facilities by local interests would also be required for land enhancement. It is also highly questionable as to whether the material that would be excavated from the inner channels have sufficient structural quality to be suitable for fill material. Assuming these problems can be overcome, construction time for the dredging work would be 1 month for the hopper dredge and 3 months for the pipeline dredge depending on depth provided. Estimated first costs are shown in Table 7.

TABLE 7
ESTIMATED FIRST COSTS DIKED DISPOSAL (Plan C)

Depth	36'
Volume (yd^3)	
Hopper	561,000
Pipeline	437,000
Dike	527,000
Dredging	3,387,000
First Cost	$3,914,000

Table 8 shows the total estimated annual charges for maintenance of Plan C.

TABLE 8
AVERAGE ANNUAL COST DIKED SHORELINE DISPOSAL (Plan C)

Depth	36'
Annual Charge	
6 5/8%	270,200
Annual Maint.	
Hopper	396,100
Pipeline	1,506,300
Total	$2,172,600

Plan D

This alternative would provide for the entrance channel to be dredged by hopper dredge as under the other plans while the remaining channels would be dredged by pipeline dredge with the material hydraulically pumped to upland, diked disposal areas. Surveys were conducted for suitable areas within an eight-mile radius of the intersection of the bay channel and the west approach channel. This distance was arbitrarily taken as the maximum pipeline length that could be considered since it approached that which would be required to pump the material to deep-water in the Gulf of Mexico. A diking cost of $15 per linear foot was assumed based on an average fill height of 10 feet and calculating the dimensions of a square disposal area required for each channel depth. The length of dike thus calculated were 4350, 8920, 12,700, and 16,560 feet. Land costs were arbitrarily estimated at $1,000 per acre. The availability of land areas were determined at this stage of study only to the extent that such undeveloped areas existed and had suitable terrain for containment and dredge return water. Such an area was identified near the limits of the investigated range, north of U.S. Highway 98 of Santa Rosa Pensinsula and in the vicinity of Hernandez Point of the North east side of Pensacola Bay. Since three boosters are needed for the extremely long pumping distance, the rate of production is low. Consequently, the construction times estimated for the hydraulic pipeline dredge is 5 months. The unit costs also was affected by the pumping distance and ranged around the $7.25/yd^3$ mark. Based upon these assumptions Table 9 shows the estimated first costs for this alternative.

The same areas assumed for disposal of the new work were also assumed for disposal of maintenance material. No additional cost for purchase of additional land was included in the maintenance cost estimates. The total average annual charges for upland disposal are shown in Table 10.

TABLE 9
ESTIMATED FIRST COST UPLAND DISPOSAL (Plan D)

Depth	36'
Volume (yd^3)	
Hopper	561,000
Pipeline	437,000
Dredging	5,472,000
Diking	62,000
Land	27,000
Total	$5,561,000

TABLE 10
AVERAGE ANNUAL COSTS UPLAND DISPOSAL (Plan D)

Depth	36'
Annual Charge 6 5/8%	384,000
Annual Maint.	
Hopper	396,100
Pipeline	2,767,700
Total	$3,547,800

Plan E

Plan E entails dredging of the entrance channel by hopper dredge with disposal of the material either offshore or on the downdrift beaches, excavation of the interior channels by pipeline dredge and conveyance of the material to the Gulf by means of hydraulic bottom dump barges. Tugs would move the scows beside the pipeline dredges for filling and thence to the Gulf disposal areas. Through this method, no non-production time for the dredge would be involved in conveying the material to the Gulf. It is estimated that essentially continuous operation of a single large hydraulic pipeline dredge would require up to 6- 3,000 cubic yard dump barges and 3- 1,500 h.p. tugs. The evaluative studies noted for Plan A to determine the impacts of disposal of the inter harbor channel material in the Gulf would also be required for Plan E. This plan like Plan A is considered to have a high degree of acceptability with the state of Florida and other local interests. The economies of this type operation improve as the quantity of material to be moved increases. Construction times is estimated at 1 month for hopper dredging and 2 months for the dump barge portion. Filling time for each barge using a 24" dredge would vary from 1-2 hrs depending on depth of cut. It was estimated that the average time required to travel to the disposal site, dump, and return was 3.81 hours. Operations were estimated to be carried on 18 hr. a day for an average of 24 days per month. The estimated first costs for Plan E are shown in Table 11.

TABLE 11
ESTIMATED FIRST COST DUMP-SCOW (Plan E)

Depth	36'
Volume (yd^3)	
Hopper	561,000
Dump-Scow	437,000
First Cost	$2,664,000

TABLE 12
AVERAGED ANNUAL COSTS DUMP SCOWS (PLAN E)

Depth	36'
Annual Charge 6 5/8%	$1,652,200
Annual Maint. Hopper	396,100
Pipeline & Scows	$1,072,200
Total	$1,652,200

TABLE 13
BENEFIT-COST RATIO COMPARISONS FOR ALTERNATIVE PLANS

Depth	36'
Plan A	0.94
Plan B	0.76
Plan C	0.50
Plan D	0.31
Plan E	0.65

Table 13 indicates that based upon the preliminary cost estimates and assumption made therein that several alternative plans appear to produce benefits greater or near that of the expected cost. This comparison suggests that hopper dredging, overboard disposal and dump barges may be economically feasible and that diked disposal, whether upland or along the shore, appear to be unworthy of further study from an economic view point.

ENVIRONMENTAL EVALUATION OF ALTERNATIVES

In general, Alternative Plan B is the least environmentally desirable plan because of the adverse impacts associated with overboard disposal of silty and polluted dredged material. This plan is basically unacceptable to local interests for these reasons. Alternative Plan C and D, would eliminate the adverse impacts associated with the open water disposal of dredged material; however, Plan C could slightly affect circulation adversely in Pensacola Bay and Plan D would cause significant adverse social and terrestrial habitat impacts. Alternative Plans A and E would be the more environmentally desirable and overall acceptable to local interests because they would eliminate most of the adverse impacts on the water quality of Pensacola Bay. The acceptability of these plans could be enhanced further if the option of beach nourishment with the material excavated from the entrance channel could be assured.

CONCLUSIONS AND STUDY DIRECTION

The basic purpose of this report is to determine if further studies should be conducted on Pensacola Harbor. The alternatives to "No-Action" that have been screened from possible solutions have been evaluated in terms of firm benefits, preliminary cost estimates and only essentially obvious environmental impacts. On the basis of these evaluations three alternatives are indicated to be above or near economic feasibility, two of which are indicated to have a high degree of environmental acceptability. On the basis of these evaluations, further more detailed studies of the acceptable plans are warranted.

Alternatives investigated that are not indicated to warrant further study are open water disposal in Pensacola Bay, Island construction or land development along the shoreline, upland disposal of dredged material and the use of bucket dredging equipment. Open water disposal of dredged material adjacent to the channels in the bay is the most economical plan and is the practice that has been followed historically. However, this practice has been stopped by opposition from the state of Florida and is regarded as unacceptable to Federal Agencies, the state and local interests as a means for modification and future practice. Filling of shoreline areas or island creation are not economically competitive or environmentally desirable. Upland disposal is not a competitive plan due to the great distance that would be required to pump the dredged material and the associated high costs that would be involved. Basically development that surrounds the Pensacola Bay area is such that areas of sufficient size neither exist nor are acceptable for dredged material disposal within what can be considered a practical pumping distance from the bay channels. The basic problem in considering bucket dredging equipment is its non-availability.

The two plans indicated to have the greatest merit are two alternatives for conveying the dredged material to the Gulf of Mexico for disposal. These are use of a hopper dredges for the complete plan of improvement and the use of a hopper dredge for the entrance channel and the more conventional pipeline dredge in combination with the dump barges for the interior channels. Both of the better plans face common problems and would require similar studies for further analysis. Both types of equipment (hopper dredges and dump barges) are presently in limited supply.

However, there are indications that this equipment will be produced in greater numbers in the near future and is being increasingly relied upon for dredged and dredged material disposal at other ports where dredged material disposal options not adversely affecting water quality do not exist.

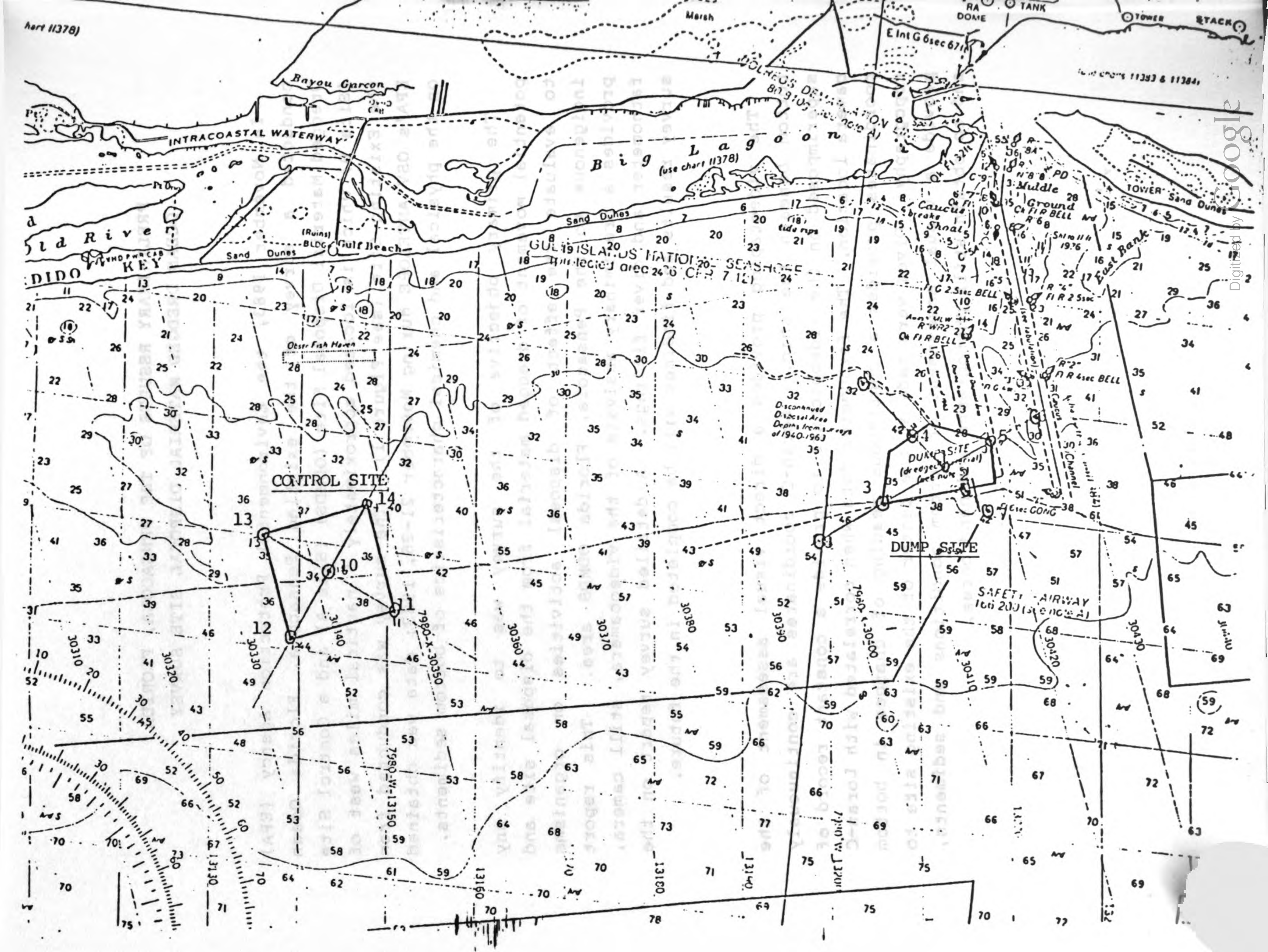
APPENDIX D
RESULTS OF THE PENSACOLA, FLORIDA
OCEAN DREDGED MATERIAL DISPOSAL SITE

PRELIMINARY RESULTS OF THE PENSACOLA, FLORIDA
OCEAN DREDGED MATERIAL DISPOSAL SITE SURVEY

In November 1983, the Environmental Protection Agency (EPA) conducted a survey of the existing Pensacola, Florida Ocean Dredged Material Disposal Site (ODMDS) (Site A) and a Control Site (Site B) which is located approximately 5 nautical miles west of the Existing Site (see Figure 1). The survey was conducted from EPA's OSV ANTELOPE during November 21-26, 1983; data was obtained on the physical and chemical characteristics of bottom sediments.

The primary objective of the survey was to identify any potential movement of dredged material from the disposal site and to evaluate the effect of disposal activities on organisms indigenous to the Pensacola, Florida ODMDS area. This report provides a preliminary analysis of the videocamera, still camera, fathometer and diver findings. A detailed survey report on the survey results and findings will be completed in the future.

The videotaping provides a direct visual assessment of the bottom beneath the ship. Loran-C coordinates are continuously superimposed on the videopicture to provide a constant record of camera location. The fathometer data when correlated with Loran-C coordinates provides a continuous reading of changes in bottom topography. Dives were made at the center of the existing site to provide a visual assessment of bottom conditions and sediments, and to obtain still photographs and hand cores.


Bayou Garcon
INTRACOASTAL WATERWAY
Big Lagoon
(use chart 11378)
Old River
PERDIDO KEY
Sand Dunes
Gulf Beach
GULF ISLANDS NATIONAL SEASHORE
Marsh
TANK
TOWER
STACK
Middle Ground
Caucus Shoal
East Bank
CONTROL SITE
DUMP SITE
SAFETY FAIRWAY
Obstr Fish Haven
Discontinued Disposal Area

METHODOLOGY FOR VIDEOTAPING

Two transects each were made of Site A and Site B while continuously running the videocamera linked to a VHS recorder.

Approximately 10 hours color videotape were viewed and recorded with a VHS color videotape recorder. Loran-C coordinates of the vessel's position were recorded directly on the videopicture to provide an accurate record of camera locations. Two 750 watt lights were used to improve picture quality. Figures 2 and 3 show the ship course in relation to the site boundaries during the videotaping session.

Underwater television provides a direct and highly detailed visual assessment of a relatively narrow track (several meters wide) of the bottom. Upon viewing the videotape, it became apparent that three bottom types were present (see Figures 6 and 7). A bottom determination was made by identifying the most common bottom type observed since the last entry in the videotape log. In some instances the bottom type observed was a combination of two bottom types, or constantly fluctuated from one type to another and back again. In these cases, both bottom types were entered in the log.

Periodically, the VHS footage, Loran-C coordinates, and bottom type were recorded on a videotape observation log. The respective bottom types are recorded in coded form in Figures 2, and 3. The combination of coded charts, videotape log, and videotapes constitute an effective system for reviewing underwater pictures.

METHODOLOGY FOR FATHOMETER READINGS

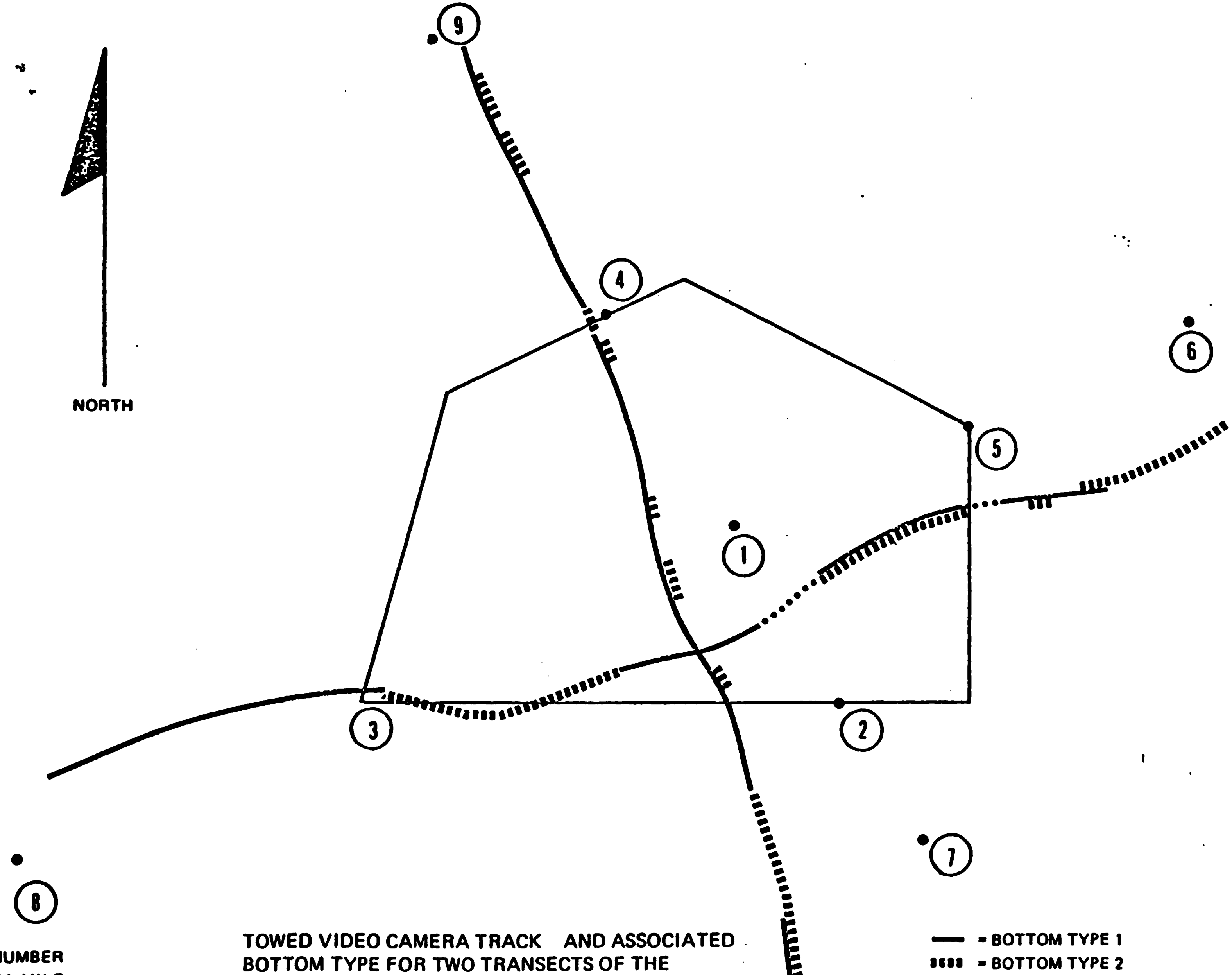
Two transects each were made of Site A, and Site B while continuous readings of bottom elevation were taken on the ship fathometer. In both cases, the transect placement was designed to allow the ship to pass over each sample station and to bisect the site into four approximately equal parts (see Figures 4, and 5). As a result portions of the transect of Site A lie outside the site; all of the transects of Site B lie totally within the site boundaries. Loran-C coordinates were periodically marked directly on the fathometer readings to monitor the ship's course as it made transects of the sites.

The fathometer readings along with the ship's course, were transposed on to 1"=1/4 mile scale maps of the respective sites. Contour lines were then inserted to aid in assessing bottom contours and relief.

DIVE METHODOLOGY

Three dives utilizing two divers each, were made at the center of Site A. During each dive, divers collected hand cores, video-pictures, still photographs, and made a visual assessment of surface and sub-surface sediments. Hand cores were used to visually assess profiles of bottom sediments. The videotapes, and still photographs allow for a more detailed assessment of surface, and sub-surface sediments, and features, and also allow for a more detailed interpretation of the videotape at a later time.

EXISTING PUMP SITE (SITE A)
Pensacola, Florida



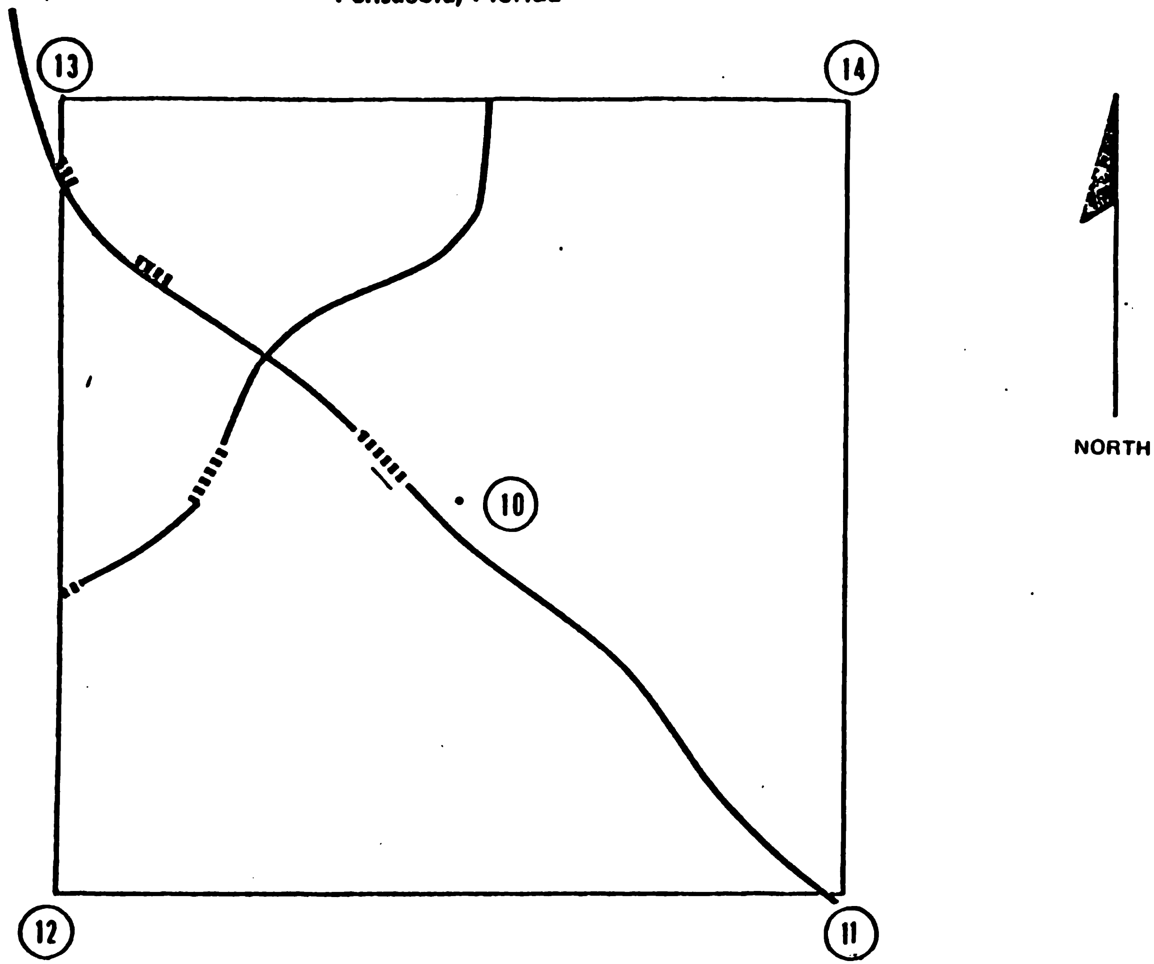
TOWED VIDEO CAMERA TRACK AND ASSOCIATED BOTTOM TYPE FOR TWO TRANSECTS OF THE EXISTING SITE, NOVEMBER 1983

▬ = BOTTOM TYPE 1
▮▮▮▮ = BOTTOM TYPE 2
— = BOTTOM TYPE 3
••• = NO DATA

(1) = STATION NUMBER
1" = ¼ NAUTICAL MILE
SITE AREA IS 0.64 NAUTICAL MILES

Figure 3

CONTROL SITE (SITE B)
Pensacola, Florida



TOWED VIDEO CAMERA TRACK AND ASSOCIATED BOTTOM TYPE FOR TWO TRANSECTS OF THE CONTROL SITE NOVEMBER 1983.

① = STATION NUMBER
1" = ½ NAUTICAL MILE
SITE = ONE NAUTICAL MILE SQUARE

— = BOTTOM TYPE 1
IIII = BOTTOM TYPE 2
-- = BOTTOM TYPE 3

VIDEOTAPE ANALYSIS

Characteristic Bottom Types

Three bottom types were identified from the videotapes. The area surveyed was assigned one or more of these categories according to the code described in Figures 6 and 7. Due to the variable factors involved in underwater videotaping, i.e., ship speed, field of view, distance of camera from the bottom, and clarity of the water, the classification system represents only visually identifiable changes in the appearance of the bottom.

Site Characteristics

Site A and Site B are the existing Ocean Dredged Material Disposal Site for Pensacola, Florida and the Control Site, respectively. Two transects were made of each site while towing a sled-mounted color videocamera (see Figures 2, and 3). An attempt was made to have the camera pass directly over each of the sample station's. However, due to the slow towing speed, winds, and currents, this was not always possible. For Site A, each transect began and ended approximately 0.5 mile outside the site and passed through the center of the site. Transects of Site B also attempted to pass over each station, and each transect started and ended at the site boundary lines. This permits comparisons to be made of bottom features in and outside Sites A, and Site B.

Portions of the video footage was poor, due to cloudy waters. The topography of the area is generally flat with intermittent sand ripples. Infrequently starfish, small finfish, and sand dollars were visible both in and outside Site A, and inside Site B. Surface sediments in and outside Site A and in Site B all appeared to be sandy in texture and have a similar yellow color with very little change over the entire area viewed. Bottom topography and features were also consistent throughout the viewed area, with no evidence that would indicate previous disposal activities (e.g., wood bits, harbor rubble, rocks, or mounds). Bottom sediments and features were similar throughout the area viewed. The superimposed Loran-C coordinates were quite helpful in determining the precise location of the camera.

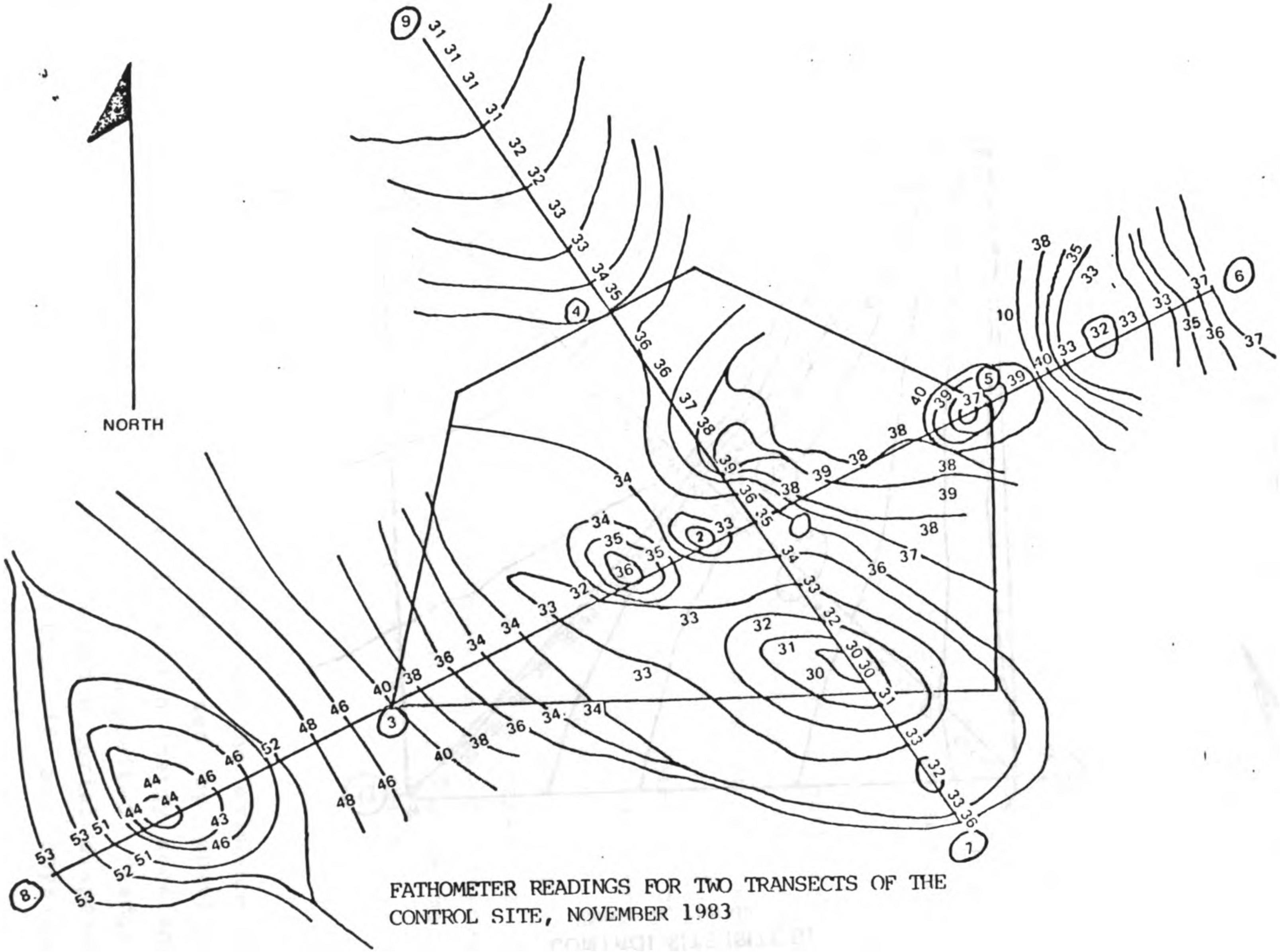
FATHOMETER DATA ANALYSIS

Figures 4 and 5 show the ship's transect of Site A and B while fathometer readings were being taken. Associated depths were marked at intervals along the transect line. Contour lines were then drawn to allow for an interpretation of bottom relief.

The fathometer records do not warrant detailed study, but are useful for a general assessment of bottom topography and relief. The primary purpose of this data is to determine the presence of natural geologic formations such as mounds or elevated areas caused by previous disposal activities. This data also aids in determining the movement of dredged material out of the site. Frequency and rate of change in bottom elevation was greater at Site A than at Site B. However, these differences are not considered significant. Barge operators commonly deposit dredged material in the center of a disposal site, or in the portion of the site closest to the dredging activity the center and the northern section of Site A respectively. There was no evidence of significant mounding in these areas or in any portion of the site surveyed.

A slightly elevated area was evident in the southeast section of Site A which may be the result of previous disposal activities. Since 1975, approximately 1.8 million yd^3 of dredged material have been deposited at Site A. If it is assumed that this volume of material was evenly distributed throughout the site, it would

EXISTING DUMP SITE (SITE A)
Pensacola, Florida



① = STATION NUMBER
1" = ¼ NAUTICAL MILE
ITE AREA 0.64 NAUTICAL SQUARE MILES

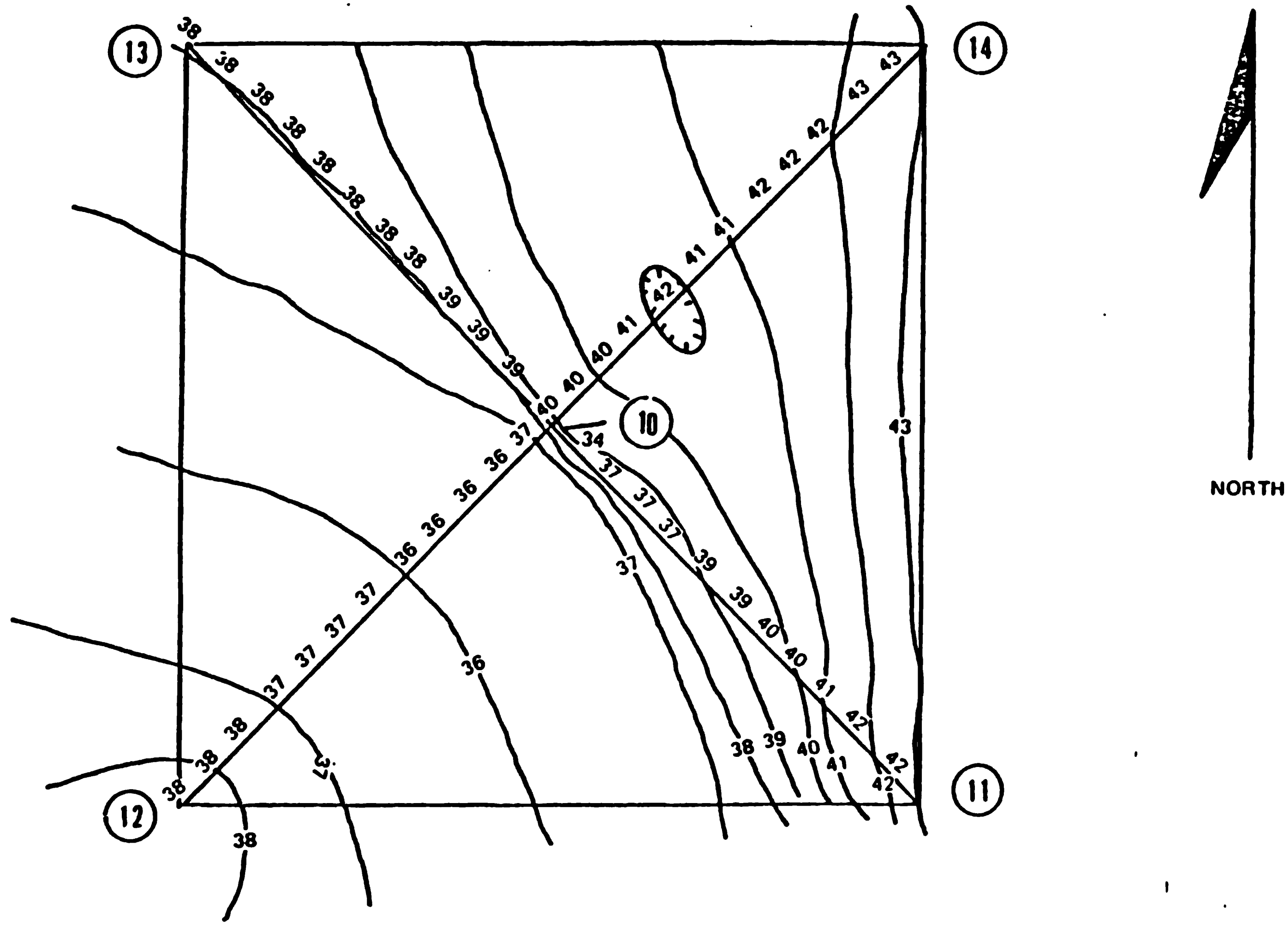
FATHOMETER READINGS FOR TWO TRANSECTS OF THE CONTROL SITE, NOVEMBER 1983

CONTOURS ARE DRAWN BASED ON TWO TRANSECTS, AND MAY BE TOTALLY ACCURATE

DEPTHS ARE MARKED IN FEET

Figure 5

CONTROL SITE (SITE B)
Pensacola, Florida



FATHOMETER READINGS FOR TWO TRANSECTS OF THE CONTROL SITE, NOVEMBER 1983

CONTOURS ARE DRAWN BASED ON TWO TRANSECTS, AND MAY BE TOTALLY ACCURATE

DEPTHS ARE MARKED IN FEET

① = STATION NUMBER
1" = ¼ NAUTICAL MILE
SITE IS ONE NAUTICAL MILE SQUARE

raise the bottom elevation approximately 2 feet 9 inches. If this material were not evenly distributed, mounds would have developed which would be much higher than the elevated area in Site A. It is also possible that all disposed materials have been dissipated by normal oceanic wave energy forces.

DIVE RESULTS

The primary purpose of the dives at the center of Site A was to allow for a more detailed interpretation of videopictures, and to obtain still photographs. Additionally, the collection of hand cores and a direct assessment of surface and subsurface sediments was obtained.

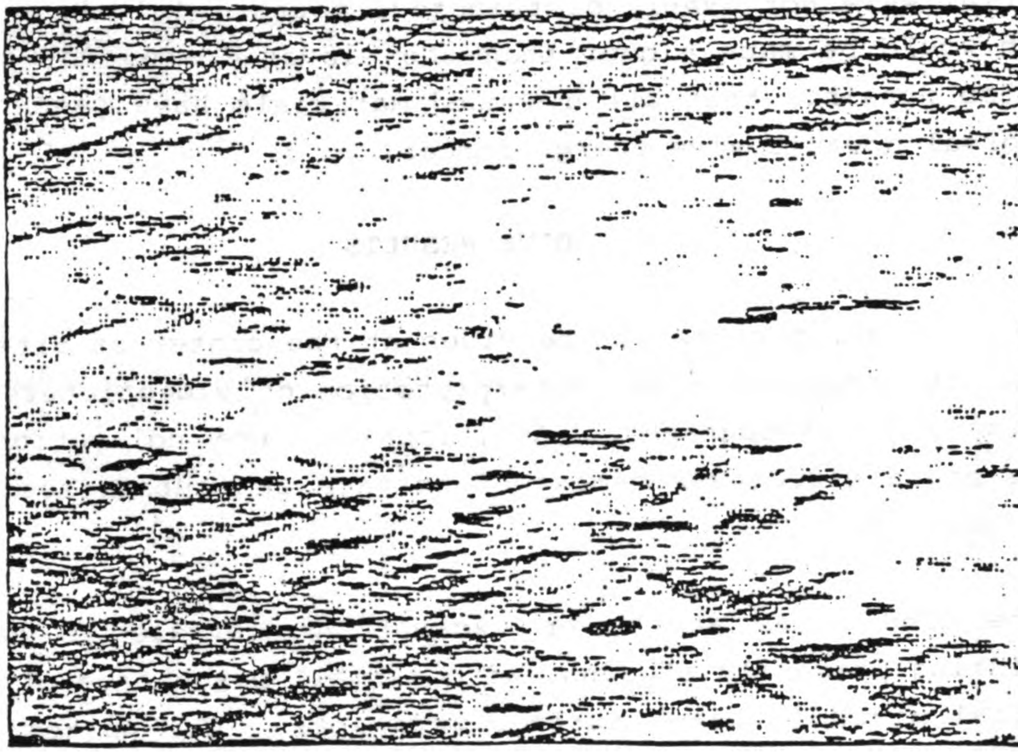
The hand cores and diver excavations revealed a dark layer consisting primarily of sand, with a small percentage of dark fine material mixed in below surface sediments. The darker sediments were approximately two to three inches below the surface, and were from one to four inches in thickness. Similar dark sediment layers were evident in two of the 56 box corer grain size, and sediment trace metal samples collected during the survey. This darker material may be a result of previous disposal activities or may simply be naturally occurring darker sand grains. Sediment grain size and sediment metal data and analyses will be included in the final survey report and will provide more information on the content and distribution of this material.

CONCLUSION

Based on these preliminary results, there was no evidence of significant adverse environmental effects caused by previous disposal activities. Site A is located in a high energy area and has been able to assimilate previously deposited dredged materials. The site has been used for dredged material disposal for at least 30 years and has shown little if any physical evidence of previous disposal activities.

Figure 6

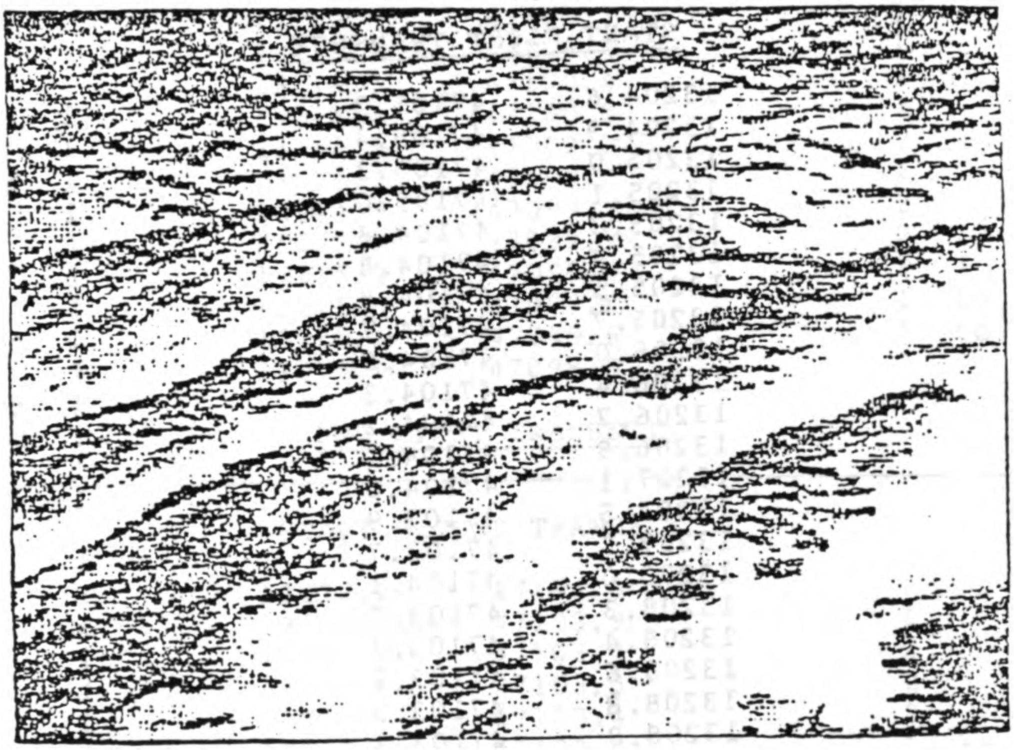
Type 1. Sandy bottom - (▬) flat to slightly rippled sand.



Type 2. Small scale sand ripples - (▪▪▪▪) small sand ripples, approximately 1"-3" high.

Figure 7

Type 3. Large scale sand ripples (——) Larger sand ripples, approximately 6" - 8" high.



SITE A
EXISTING SITE VIDEO TAPE LOG
PENSACOLA, FLORIDA

November 83

VCR COUNT	LORAN-C READING		BOTTOM TYPE DESCRIPTION
	START FIRST TRANSECT		
302	13204.6	47105.3	1
340	13204.9	47105.4	1
348	13205.0	47105.3	1 to 2
362	13205.1	47105.0	1 " 2
380	13205.3	47104.8	1 " 2
390	13205.4	47104.8	1 " 2
397	13205.5	47104.8	1 " 2
410	13205.7	47104.7	1 to 2
437	13206.0	47104.5	1
461	13206.4	47104.3	1 to 2
480	13206.7	47104.2	1 to 2
498	13206.9	47104.1	1
510	13207.1	47104.0	1
530	13207.5	47103.9	1
551	13207.7	47103.7	1
572	13208.0	47104.1	1
590	13208.3	47103.7	1
600	13208.4	47103.4	2
612	13208.6	47103.2	1
621	13208.8	47103.5	1
631	13208.8	47103.3	1 to 2
645	13209.0	47103.3	1
658	13209.2	47103.1	1
667	13209.4	47103.3	1
682	13209.6	47103.0	1
700	13209.9	47102.8	1
710	13210.0	47102.6	1
730	13210.2	47102.4	1
742	13210.3	47102.2	no data
754	13210.4	47102.1	no data
760	13210.5	47102.4	1
773	13210.5	47101.9	1 to 2
787	13210.8	47101.6	1 " 2
803	13211.1	47101.8	1
818	13211.3	47101.4	1 to 2
826	13211.5	47101.5	1 " 2
839	13211.7	47101.3	1
850	13211.9	47101.3	1
864	13212.3	47101.1	1
874	13212.6	47101.0	1
888	13212.8	47101.1	1 to 2
900	13213.1	47101.1	1 " 2
916	13213.3	47100.9	1

(SITE A) (Cont'd)

PENSACOLA, FLORIDA

VCR COUNT	LORAN-C READING		BOTTOM TYPE DESCRIPTION
927	13213.5	47100.9	1
939	13213.8	47100.7	1
950	13213.9	47100.4	1
965	13214.3	47100.4	1
973	13214.4	47100.5	2
983	13214.5	47100.2	2
996	13214.7	47100.0	2
1006	13214.9	47099.7	2
1016	13215.1	47099.7	2
1025	13215.3	47099.6	2
1038	13215.3	47099.6	1 to 2
1050	13215.6	47099.6	1 to 2
1061	13215.9	47098.8	

END FIRST TRANSECT

START SECOND TRANSECT

1259	13222.2	47104.0	
1270	13222.3	47103.9	2
1288	13221.4	47103.4	2
1299	13221.0	47103.3	2
1306	13220.6	47103.4	2
1316	13220.2	47103.4	1 to 2
1325	13219.8	47103.3	1
1335	13219.4	47103.4	1
1345	13218.9	47103.1	1 to 2
1357	13218.3	47103.0	1
1365	13217.9	47103.2	___no data
1372	13217.6	47103.0	___no data
1375	13217.4	47102.8	1 to 2
1387	13217.0	47103.1	1 " 2
1399	13216.4	47102.6	1 " 2
1409	13216.1	47102.6	1 " 2
1419	13215.8	47102.7	1 " 2
1431	13215.4	47102.3	1 " 2
1439	13215.1	47102.5	1 " 2
1455	13214.5	47102.1	1 " 2
1465	13214.2	47102.2	1
1472	13213.9	47101.8	___no data
1478	13213.8	47101.7	" " "
1490	13213.4	47101.7	" " "
1500	13213.1	47101.6	___no data
1508	13212.9	47101.8	1
1520	13212.3	47101.2	1

SITE A (Cont'd)

PENSACOLA, FLORIDA

VCR COUNT	LOPAN-C READING		BOTTOM TYPE DESCRIPTION
1530	13212.1	47101.3	1
1540	13211.6	47101.2	1
1543	13211.4	47100.9	1
1553	13211.1	47101.2	1
1566	13210.4	47100.8	1
1573	13210.0	47100.7	2
1580	13209.7	47100.9	2
1588	13209.4	47100.9	2
1600	13209.0	47100.9	2
1610	13208.4	47100.5	2
1620	13207.8	47100.2	2
1630	13207.5	47100.1	2
1640	13206.9	47100.0	2
1651	13206.4	47199.9	1
1661	13205.9	47100.1	1
1672	13205.5	47099.8	___ no data
1683	13205.0	47099.9	___ no data
1688	13204.8	47099.7	2
1698	13204.3	47099.5	1
1708	13203.9	47099.5	1
1718	13203.4	47099.6	1
1724	13203.1	47099.5	1
1734	13202.6	47099.1	1
1738	13202.4	47099.1	1
1750	13202.0	47099.2	1
1755	13201.9	47099.3	1
1765	13201.3	47098.8	1
1775	13200.9	47098.8	1
1785	13200.5	47098.7	1
1795	13200.0	47098.7	1
1803	13199.6	47098.9	1
1813	13199.3		___ no data
1822	13198.6		___ no data
1837	13198.3		___ no data

END SECOND TRANSECT

SITE B

PENSACOLA, FLORIDA

VCR COUNT	LORAN-C READING		BOTTOM TYPE DESCRIPTION
	START FIRST TRANSECT		
2339	13147.5	47092.5	1
2347	13147.9	47092.1	1
2356	13148.1	47092.1	1
2366	13148.4	47092.4	1
2376	13148.7	47091.9	1
2387	13147.0	47091.7	1
2396	13149.2	47091.7	1
2408	13149.6	47091.6	1
	END FIRST TRANSECT		
	START SECOND TRANSECT		
2414	13144.3	47095.3	1
2428	13144.0	47095.0	1
2440	13143.7	47095.3	1
2452	13143.4	47094.9	1
2465	13142.9	47095.4	1
2475	13142.7	47094.6	1
2486	13142.4	47094.2	1
2499	13142.2	47094.6	1
2509	13142.1	47094.4	1
2520	13141.8	47094.2	1
2530	13141.6	47094.4	1
2540	13141.3	47094.0	1
2550	13141.3	47094.4	1
2560	13141.2	47093.8	1
2571	13141.2	47093.7	1
2583	13140.9	47093.7	1
2593	13140.7	40093.7	1
2600	13140.6	47093.5	2
2610	13140.8	47093.3	2
2620	13140.1	47093.2	2
2630	13139.9	47092.9	1
2647	13139.6	47092.7	1
2656	13139.5	47092.5	1
2676	13139.0	47092.4	1
2686	13138.8	47092.3	1
2696	13138.6	47092.4	1
2714	13138.6	47092.0	1
2724	13138.6	47092.0	2
	END SECOND TRANSECT		

FINAL REPORT

MACROINFAUNAL AND SEDIMENT ANALYSIS OF THE PENSACOLA, FLORIDA OCEAN DREDGED MATERIAL DISPOSAL SITE SURVEY

1983

Submitted to:

JRB ASSOCIATES
8400 Westpark
McLean, VA 22102

Under Contract to:
Environmental Protection Agency
EPA Contract No. 68-01-6388
JRB Project No. 2-813-03-852-61

Prepared by:

Barry A. Vittor & Associates, Inc.
8100 Cottage Hill Road
Mobile, Alabama 36609

June 7, 1984

Barry A. Vittor

Barry A. Vittor, Ph.D.
Director

C. Kevin Shaw

J. Kevin Shaw, M.S.
Technical Coordinator

TABLE OF CONTENTS

Page

LIST OF FIGURES iv

LIST OF TABLES v

1.0 INTRODUCTION 1

2.0 DESCRIPTION OF SURVEY AREA 1

3.0 PREVIOUS INVESTIGATIONS 4

4.0 METHODOLOGY 5

4.1 Bottom Sampling 5

4.2 Sediment Grain Size 5

4.3 Macroinfauna 6

5.0 RESULTS 6

5.1 Bottom Habitat Characterization 6

5.2 Macroinfauna 6

5.2.1 Faunal Composition Abundance, and Community Structure--EPA Pensacola 1983 Survey 6

5.2.2 Faunal Composition Abundance, and Community Structure--EPA Pensacola 1980 Survey 13

5.3 Numerical Classification Analysis 19

5.3.1 EPA Pensacola 1983 19

5.3.2 EPA Pensacola 1980 23

5.4 Comparison of EPA Pensacola 1983 Survey ODMDS (Site A) and Control (Site B) 25

5.5 Comparison of EPA Pensacola 1980 and 1983 Surveys 25

6.0 DISCUSSION SURVEYS 28

7.0 LITERATURE CITED 32

APPENDIX A - EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS - FAUNAL DATA, 1983

APPENDIX B - PHYLOGENETIC LISTING FOR EPA PENSACOLA DREDGED MATERIAL DISPOSAL AND CONTROL SITES, 1983

APPENDIX C - IEC (EPA) PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS - FAUNAL DATA, 1980

APPENDIX D - PHYLOGENETIC LISTING FOR IEC PENSACOLA, 1980

ATTACHMENT I - EPA PENSACOLA 1983 SURVEY SEDIMENT REPLICATE DATA

ATTACHMENT II - EPA PENSACOLA 1983 SURVEY BIOMASS REPLICATE DATA

LIST OF FIGURES

FIGURE		Page
1	Location of EPA Pensacola ODMDS survey site and control site.	2
2	Number of species and individuals m^{-2} of macroinfauna collected at each ODMDS station, 1983	12
3	Number of species and individuals m^{-2} of macroinfauna collected at each Control Site station, 1983.	14
4	Normal (station) and inverse (species) numerical classification analysis of macroinfaunal data from EPA Pensacola 1983 survey.	20
5	Nodal analysis representing group constancy based on results of numerical classification analysis of macroinfaunal data from EPA Pensacola 1983 survey.	22
6	Normal (station) and inverse (species) numerical classification analysis of macroinfaunal data from EPA Pensacola 1980 survey.	24

LIST OF TABLES

TABLE		Page
1	Station depths, latitude/longitude coordinates and bottom type at ODMDS, Control, and 1980 ODMDS survey sites.	3
2	General sediment parameters for EPA Pensacola survey sites, 1983.	7
3	Taxonomic listing of phyla and numerically dominant taxa from EPA Pensacola 1983 survey sites	9
4	General community structure parameters for EPA Pensacola survey sites, 1983	11
5	Percent composition of major taxa groups by station for EPA Pensacola sites 1980 and 1983.	15
6	Taxonomic listing of phyla and numerically dominant taxa from EPA Pensacola 1980 survey sites	17
7	General community structure parameters for EPA Pensacola survey sites, 1980	18
8	Multivariate analysis of variance (MANOVA) based on Wilks' lambda statistic performed on physical and community structure parameters at ODMDS and Control Site	26
9	Results of t-tests performed on individual variables at ODMDS and Control Site	27
10	Possible candidate species for Group I, II, and III colonizers of offshore sand faunal assemblages in the EPA Pensacola study area.	31

1.0 INTRODUCTION

During the period November 21-26, 1983, the Environmental Protection Agency (EPA) conducted a survey of the existing Pensacola, Florida Ocean Dredged Material Disposal Site (ODMDS) (Site A) and a Control Site (Site B) which is located approximately 5 nautical miles west of the existing site. The survey was conducted from EPA's OSV ANTELOPE and focused on benthic macroinfauna as well as the physical and chemical characteristics of bottom sediments.

The primary objective of the survey was to identify any potential movement of dredged material from the disposal site and to evaluate the effect of disposal activities on organisms indigenous to the Pensacola, Florida ODMDS area. This report provides results of the benthic macroinfauna and sediment grain size analyses. The benthic habitat and community analysis of each site is presented and similarities/dissimilarities between disposal and control sites are evaluated. These results are compared with the ODMDS survey conducted by EPA in January and June, 1980.

2.0 DESCRIPTION OF STUDY AREA

The Pensacola, Florida ODMDS survey area is located at the existing ODMDS (Site A) located approximately 4.5 km south of the entrance to the Pensacola ship channel between Perdido Key and Santa Rose Sound (Figure 1). This site is west of the Caucus Channel. The Control (Site B) is located approximately 9.5 km west of the existing site and 5 km south of Gulf Beach, Florida.

Loran-C coordinates provided by EPA were extrapolated to latitude and longitude for each station. Table 1 presents station coordinates, depth, and qualitative description of bottom sediments for the 1980 and 1983 surveys.

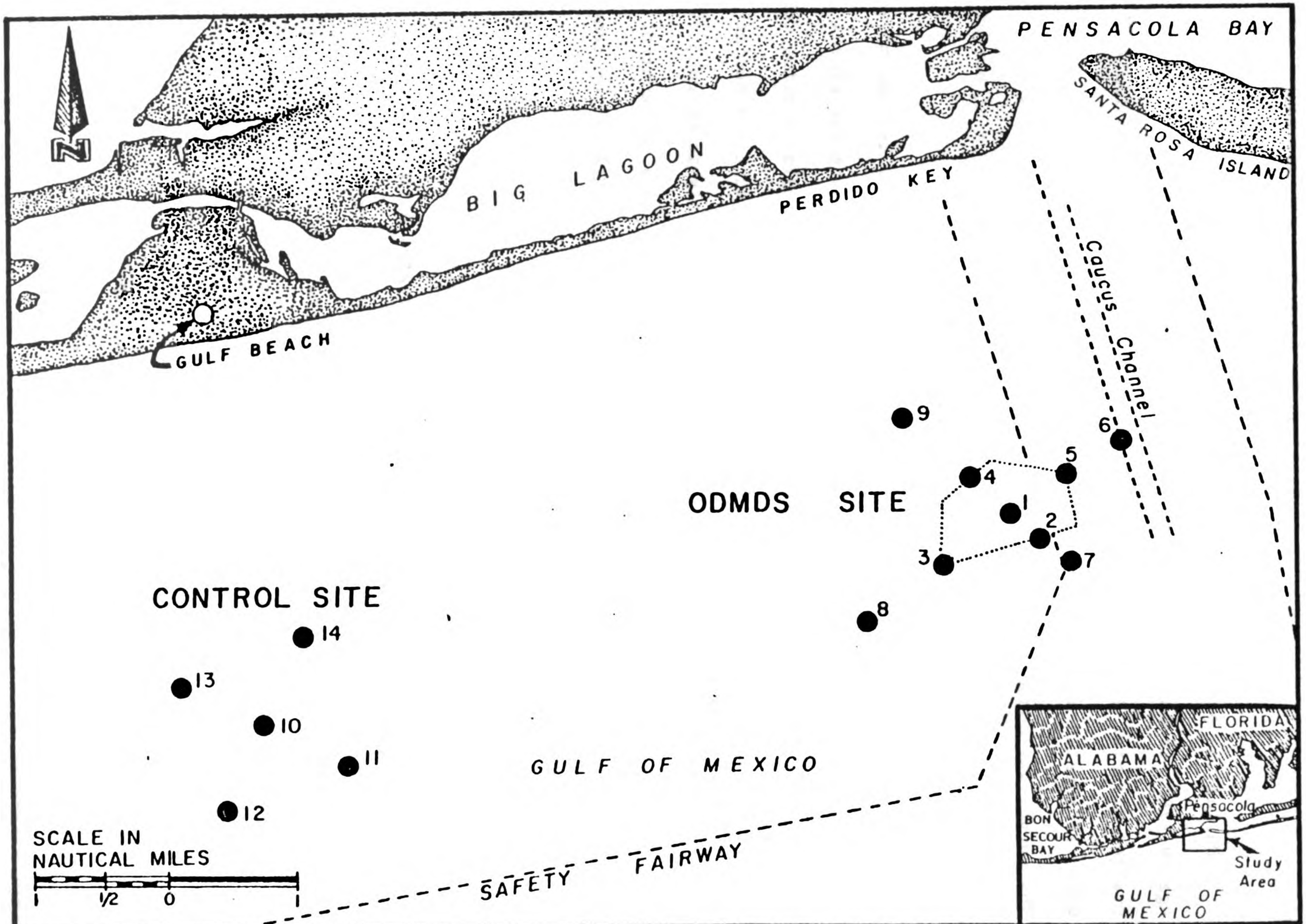


Figure 1 . Location of EPA Pensacola ODMDS survey site and control site.

Table 1. Station depths, latitude/longitude coordinates and bottom type at ODMDS, control, and 1980 ODMDS survey sites.

ODMDS (Site A)	Depth (m)	Latitude/Longitude		Bottom Type
Sta. 1	9.4	30°16.3'N	87°18.8'W	Sand
2	9.1	16.0'N	18.6'W	Sand
3	11.6	15.1'N	19.4'W	Sand
4	11.5	16.6'N	19.7'W	Sand
5	10.7	16.6'N	18.3'W	Sand
6	11.2	16.9'N	17.8'W	Sand
7	11.3	15.7'N	18.4'W	Sand
8	14.7	15.5'N	20.1'W	Sand
9	9.0	17.1'N	19.7'W	Sand
Sta. 10	10.7	30°14.8'N	87°25.4'W	Sand
11	11.5	14.6'N	24.6'W	Sand
12	12.6	14.2'N	25.7'W	Sand
13	10.8	15.2'N	26.1'W	Sand
14	13.8	15.4'N	24.9'W	Sand
ODMDS (IEC, 1980)				
Sta. 11	11.0	30°16.4'N	87°18.8'W	Sand
12	10.0	17.2'N	19.8'W	Sand

The bottom substrate consists of fine to medium grade sand with little or no silt/clay fraction and may appear flattened or as sand ripples. Based on preliminary results of underwater video tapes and dive reconnaissance, Site A is located in a high energy area and little, if any, physical evidence of 30 years of disposal activities is apparent.

3.0 PREVIOUS INVESTIGATIONS

Besides the previous Pensacola ODMDS survey conducted by EPA in 1980, several other environmental investigations have been conducted within a 50 km radius of the study area. Stations sampled by Bault (1972) in his assessment of the hydrology of Alabama estuarine areas as part of a Cooperative Gulf of Mexico Estuarine Inventory, were in proximity to Site B. Parameters studied included micronutrient and chemophysical factors, and tidal and meteorological effects. The geology of the sediments in the study area has been reviewed by Ludwick (1964) and Doyle and Sparks (1980). One transect, consisting of five stations, included in the ESCAROSA I study conducted by the Florida Coastal Coordinating Council (1973) was in close proximity to the survey site and included data on sediment composition, trace metal and pesticide characteristics. TechCon (1980) and Continental Shelf Associates (1981, 1982) investigated benthic communities at the mouth of Mobile Bay, while Racal-Decca Survey (1982) investigated benthic communities offshore of the Ft. Morgan peninsula west of Control Site B. SUSIO (1977) and Dames and Moore (1979) conducted environmental surveys on the continental shelf of Mississippi, Alabama, and eastern Florida for the Bureau of Land Management. Some of the nearshore stations were in proximity to the present study area. Recently, the Mobile District Corps of Engineers has sponsored several studies in offshore waters of Mississippi and Alabama including physical oceanography

(Kjerfve and Sneed, 1984), benthic macroinfauna and sediment composition (Shaw et al., 1982), and trace metal and organic chemistry of existing and potential offshore disposal sites (Harmon Engineering & Testing, 1983). Portions of the above study areas are considered to have sediment and faunal characteristics comparable to Sites A and B. Selected biological characteristics of the area in the vicinity of the study area have been reviewed by Boeschung (1957), Christmas and Gunter (1960), Upshaw et al. (1966), Chermock et al. (1974), TerEco Corporation (1979), Bureau of Land Management (1981), and Vittor & Associates (1983).

4.0 METHODOLOGY

4.1 Bottom Sampling

A box corer, which collects an undisturbed surface area of $0.06m^2$ of bottom, was used to collect macroinfauna and sediment grain size samples. Three box core samples (replicates) were collected at each of 14 stations to penetration depths averaging 9.8 cm. A subsample for sediment analysis was taken from each replicate and refrigerated. The remainder of the sample was washed through a 0.5 mm mesh screen for macroinfauna. Each sample was preserved in 10% formalin solution and sent to the laboratory of Vittor & Associates, Inc. for analysis.

4.2 Sediment Grain Size

The sediment grain size samples were analyzed using standard sieve/hydrometer techniques (Folk, 1980). Preliminary analysis revealed that most samples were composed of clean fine sand and that hydrometer measurements were not required for all replicates. The weight percentage for each one-phi interval was recorded. Calculations of percent sand, percent silt-clay, mean phi, sorting coefficient, skewness, and kurtosis were computed for each replicate according to Folk. Attachment I contains the grain size replicate data, including sample weights, textural description, and Folk's statistics.

4.3 Macroinfauna

Macroinfaunal samples were stained with a solution of 1% Rose Bengal upon arrival at the laboratory and then re-sieved to remove the fine particles. The organisms were sorted by major taxon group, i.e., Annelida, Arthropoda, Mollusca, Echinodermata, and Other Miscellaneous Phyla, and identified to the species level. Unidentifiable immature or damaged animals were taken to the lowest practical identification level (LPIL). A representative of each species identified was placed in a voucher collection designated for the EPA Pensacola study site.

Wet weight biomass determinations were made of the major taxon groups by replicate. Samples were blot-dried and weighed to the nearest 0.1 mg. Attachment II contains the biomass replicate data.

5.0 RESULTS

5.1 Bottom Habitat Characterization

Preliminary results of diver observations, television videotapes, and still-camera photographs showed that the substrate at both sites was composed of clean sand sediment. Sand ripples noted in the survey indicate a relatively high energy habitat.

The grain size analysis revealed that all but two stations were composed of moderately, well-sorted sand: stations 6 and 9 contained replicates of poorly sorted sand. The percentage of sand ranged from 87.0 to 99.9% and silt/clay from 0.1 to 13.0%. Table 2 presents the general sediment parameters for the survey sites based on mean station values.

5.2 Macroinfauna

5.2.1 Faunal Composition, Abundance, and Community Structure--EPA Pensacola 1983 Survey

The species composition at each of the nine ODMDS stations and five

Table 2 . General sediment parameters for EPA-Pensacola survey sites, 1983. Mean values of three replicates per station.

ODMDS (Site A)	Sediment Descrip.	% Sand	% Silt-Clay	Mean phi	Sorting	Skewness	Kurtosis
St. 1	Sand	99.1	0.9	1.56	0.59	0.071	1.34
2	Sand	99.6	0.4	1.52	0.56	0.001	1.30
3	Sand	98.6	1.6	1.77	0.72	0.043	1.05
4	Sand	97.0	3.0	2.02	0.66	-0.099	0.88
5	Sand	99.2	0.8	1.59	0.51	0.046	1.28
6	Sand	92.6	7.4	1.95	1.43	0.109	2.00
7	Sand	99.8	0.2	1.54	0.65	-0.050	1.12
8	Sand	97.8	2.2	1.85	0.74	0.050	0.93
9	Sand	87.0	13.0	3.01	1.84	0.197	1.68
Mean		96.7	3.3	1.87	0.86	0.041	1.29
Control (Site B)							
St. 10	Sand	99.7	0.3	1.37	0.63	-0.089	1.30
11	Sand	99.3	0.7	1.84	0.64	0.126	0.87
12	Sand	98.8	1.2	1.94	0.66	-0.043	0.77
13	Sand	99.9	0.1	1.62	0.64	0.065	1.27
14	Sand	99.6	0.4	1.49	0.72	-0.069	1.16
Mean		99.5	0.5	1.65	0.66	-0.010	1.07

control stations is presented in Appendix A. A phylogenetic listing of the macroinfauna collected in 1983 is found in Appendix B. Table 3 presents the total number of individuals and total number of taxa for the five major groups collected at study sites A (ODMDS) and B (Control). A total of 4977 individuals and 207 taxa were collected from 42 samples. Annelids were the dominant major taxon; they were represented by 109 taxa and accounted for 57% of the macroinfaunal abundance. Oligochaetes, Polygordius, Prionospio cristata, Aricidea sp. H, Paraonis pygoenigmatica, Exogone lourei, Ophelia denticulata, Brania wellfleetensis, and Armandia maculata accounted for an average of 75% of the annelid community in the study area.

Molluscs ranked second in dominance at the study area; they were represented by 42 taxa and accounted for 26.6% of the macroinfaunal abundance. The gastropods Caecum imbricatum and C. pulchellum were more abundant than the pelecypods Tellina texana and T. versicolor; these four species accounted for 73% of the mollusc population in the study area.

Arthropods ranked third in the number of taxa (33), but fourth in number of individuals (4.6%). The amphipod Eudevenopus honduranus was the only arthropod listed among the twenty most abundant species.

The miscellaneous taxa represented by sipunculids, rhynchocoels, turbellarians, brachiopods, and cephalochordates ranked third in the total abundance (9.5%) and fourth in total taxa (17). The cephalochordate Branchiostoma floridae occurred at every station and is one of five most abundant taxa. Other significant species included the brachiopod Glottidia pyramidata and the sipunculid Aspidosiphon albus. These three species accounted for 84% of the miscellaneous taxa individuals enumerated.

The echinoderms contributed only six taxa and comprised 2.3% of the total macroinfaunal abundance. Most of the individuals were represented by juvenile ophiuroids and echinoids.

Table 3. Taxonomic listing of phyla and numerically dominant taxa from EPA Pensacola 1983 survey sites.

Phylum	Phylum Total	% of Grand Total	No. Taxa in Phylum	% Total No. of Taxa
Annelida	2837	57.0	109	52.7
Mollusca	1322	26.6	42	20.3
Arthropoda	230	4.6	33	15.9
Echinodermata	116	2.3	6	2.9
Miscellaneous	472	9.5	17	8.2
Total	4977		207	

NUMERICAL DOMINANTS

Taxon	No. Individuals	% Total	Cum %	f*
Oligochaeta (O)	552	11.09	11.09	13
Polygordius (LPIL) (P)	502	10.09	21.18	5
Caecum imbricatum (M)	463	9.30	30.48	12
Prionospio cristata (P)	344	6.91	37.39	12
Branchiostoma floridae (C)	343	6.89	44.28	14
Caecum pulchellum (M)	339	6.81	51.09	11
Aricidea sp. H (P)	223	4.48	55.57	14
Paraonis pygoenigmatica (P)	177	3.56	59.13	10
Exogone lourei (P)	107	2.15	61.28	9
Tellina texana (M)	106	2.13	63.41	13
Ophelia denticulata (P)	98	1.97	65.38	12
Eudevenopus honduranus (A)	78	1.57	66.95	8
Brania wellfleetensis (P)	76	1.53	68.48	12
Armandia maculata (P)	72	1.45	69.93	13
Tellina versicolor (M)	59	1.19	71.12	8
Olivella sp. B (M)	58	1.16	72.28	12

(A) = Arthropoda, (C) = Cephalochordata, (M) = Mollusca,

(O) = Oligochaeta, (P) = Polychaeta

*frequency of occurrence (maximum = 14)

Offshore Dredged Material Disposal Site

The community structure parameters of the nine disposal site stations and five control site stations are summarized in Table 4. The 27 replicates at the ODMDS (Site A) yielded an average of 30 species and 133 individual organisms per sample. The number of taxa per station ranged from 33 to 85 at stations 1 and 8, respectively, with a mean of 58 taxa for the site. The number of individuals per station ranged from 123 to 809 at stations 2 and 4, respectively, with a mean of 399 organisms per station. Density (number of individuals.m^{-2}) ranged from 684 at station 2 to 4495 at station 4, with a mean station density of 2219 individuals.m^{-2}. The density and number of taxa per station are graphically depicted in Figure 2 for ODMDS (Site A).

Species diversity (H', base e) ranged from 2.55 to 3.73 and species evenness (J') ranged from 0.63 to 0.84 at stations 9 and 8, respectively, with means of 2.96 and 0.74 for Site A. Species richness (D) ranged from 6.14 at station 1 to 15.07 at station 8 with a mean of 9.68 for the site.

Annelids comprised the greatest mean percentage of individuals (63.3%) followed by molluscs (22.9%), miscellaneous taxa (7.6%), arthropods (4.1%), and echinoderms (2.1%) (Table 5). Wet weight biomass measurements reflect slight variability between stations due to the presence of large molluscs and thin shell weights at stations 4 and 9.

Control Site

The 15 replicates collected at the control site yielded an average of 24 taxa and 92 individual organisms per sample. Number of taxa per station ranged from 33 to 61 at stations 10 and 11, respectively, with a mean of 46 taxa for the site (Table 4). Number of individuals per station ranged from 110 to 498 at stations 10 and 11, respectively, with a mean of 277 organisms per station. Density (numbers of individuals.m^{-2}) ranged from 612 at station 10 to 2767 at station 11, with a mean station density of 1536 individuals.m^{-2}.

Table 4 . General community structure parameters for EPA-Pensacola survey sites, 1983. Three replicates per station.

ODMDS (Site A)	Total Taxa	Total Indiv.	Mean Density (no./m^2)	Species Diversity (H_e')	Species Evenness (J')	Species Richness (D)	Wet Wgt. Biomass (g/m^2)
Sta. 1	33	183	1017±673	2.64	0.76	6.14	3.5159
2	35	123	684±145	2.78	0.78	7.06	6.8757
3	62	538	2989±1046	3.17	0.77	9.90	3.6155
4	77	809	4495±2241	3.00	0.69	11.35	716.0709*
5	56	361	2006±315	2.99	0.74	9.34	8.2402
6	76	603	3350±1931	2.91	0.67	11.72	3.7051
7	40	229	1273±395	2.83	0.77	7.18	1.8575
8	85	264	1467±497	3.73	0.84	15.07	108.5424**
9	59	484	2689±3127	2.55	0.63	9.38	12.8982
Mean	58	399	2219	2.96	0.74	9.68	96.1468
Control (Site B)							
Sta. 10	33	110	612±127	2.90	0.83	6.81	3.0046
11	61	498	2767±1812	3.09	0.75	9.66	28.5636+
12	48	415	2306±1715	2.42	0.63	7.80	48.9700+
13	41	177	984±709	3.07	0.83	7.73	27.1095**
14	46	183	1017±87	3.05	0.80	8.64	6.1569
Mean	46	277	1537	2.91	0.77	8.13	22.7609

*biomass skewed by mollusc shell weight

**biomass skewed by echinoderm test weight

+biomass skewed by large arthropod individual

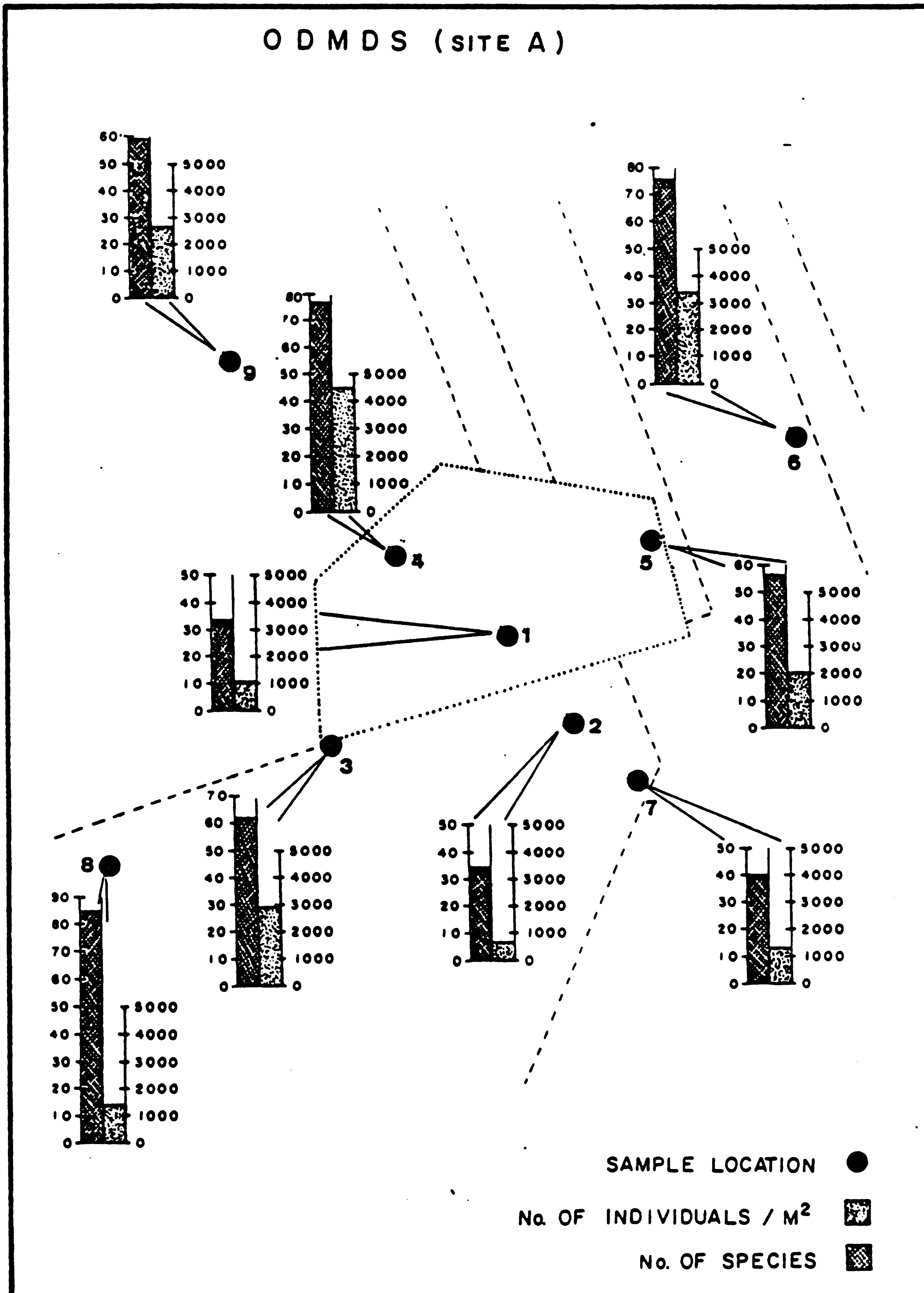


Figure 2 . Number of species and individuals.m^{-2} of macroinfauna collected at each ODMDS station, 1983.

The density and number of taxa per station are graphically depicted in Figure 3 for the control site (Site B).

Species diversity (H') ranged from 2.42 to 3.09 at stations 12 and 11, respectively, with a mean of 2.91 for Site B. Species evenness (J') ranged from 0.63 at station 12 to 0.83 at stations 10 and 13 with a mean of 0.77. Species richness (D) ranged from 6.81 at station 10 to 9.66 at station 11 with a mean of 8.13.

Annelids comprised the greatest mean percentage of individuals (41.1%), followed by molluscs (34.4%), miscellaneous taxa (14.9%), arthropods (7.1%), and echinoderms (2.5%) (Table 5). As reported for Site A, variability in wet weight biomass measurements between stations was due to live animal shell weights.

5.2.2 Faunal Composition, Abundance, and Community Structure--EPA Pensacola 1980 Survey

Results of field surveys conducted at Pensacola ODMDS during January and June 1980 by Interstate Electronics Corporation for EPA are presented in Appendix A of a Draft Environmental Impact Statement (EIS) for the Pensacola, Florida, Mobile, Alabama, and Gulfport, Mississippi Dredged Material Disposal Site Designation (U.S. EPA, 1982). This earlier program differs from the 1983 sampling program in that only two stations were occupied but a greater number of replicates (5) were taken and two seasonal samplings were conducted. Faunal analysis involved the identification of only the six dominant taxa and biomass determination of the major taxon groups. Vittor & Associates has re-evaluated the samples from 1980 and standardized the taxonomy for comparison with results of the 1983 survey. The species composition data by station are found in Appendix C and the phylogenetic listing of macroinfauna collected in 1980 is presented in Appendix D.

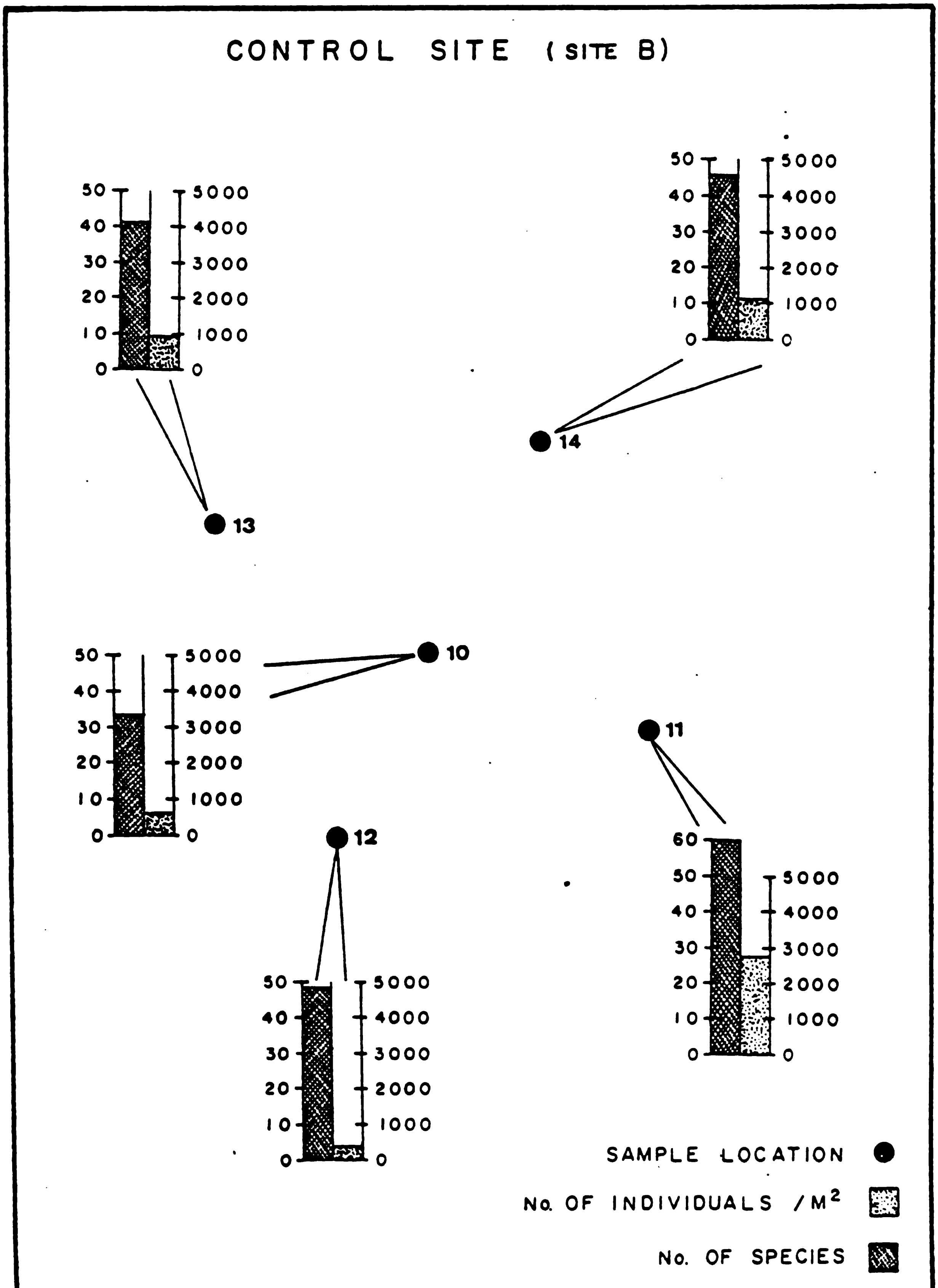


Figure 3 . Number of species and individuals$\cdot m^{-2}$ of macroinfauna collected at each Control Site station, 1983.

Table 5. Percent composition of major taxa groups by station. Percentages reflect mean values for each station at EPA-Pensacola sites collected in 1980 and 1983.

	Percent Composition				
ODMDS (Site A)	Annelida	Arthropoda	Mollusca	Echinodermata	Miscellaneous
Sta. 1	68.3	0.5	27.9	0	3.3
2	62.6	8.1	23.6	2.4	3.3
3	56.9	4.6	28.1	2.2	8.2
4	66.3	3.7	16.2	2.8	11.0
5	49.9	5.0	27.7	3.0	14.4
6	54.4	0.5	30.0	1.2	13.9
7	78.2	3.0	12.7	1.3	4.8
8	54.5	5.3	30.3	2.3	7.6
9	78.5	6.6	9.7	3.3	1.9
Mean	63.3	4.1	22.9	2.1	7.6
Control (Site B)					
10	60.0	4.5	19.1	2.8	13.6
11	69.9	5.6	17.5	1.6	5.4
12	13.7	4.8	73.3	3.9	4.3
13	39.5	7.9	38.5	1.1	13.0
14	22.4	12.5	23.5	3.3	38.3
Mean	41.1	7.1	34.4	2.5	14.9
ODMDS (Jan. '80)					
11	46.8	35.6	3.1	9.9	4.6
12	39.0	48.3	4.4	2.0	6.3
Mean	42.9	42.0	3.7	6.0	6.4
(June '80)					
11	32.6	20.7	36.7	1.5	8.5
12	31.1	33.4	21.4	1.2	12.9
Mean	31.8	27.1	29.0	1.4	10.7

Table 6 presents the total number of individuals and total number of taxa for the five major groups collected at ODMDS in 1980. The top ranked groups (Annelida, Arthropoda, and Mollusca) were rather evenly represented (i.e., 34.6%, 32.5%, and 20.7% by individuals, respectively; however, the number of annelid taxa (92) equalled the combined number of all remaining taxa in the study area. The percent composition of major taxa groups collected by season is found in Table 5.

The pelecypod _Tellina alternata_ was the most abundant taxon collected and the only molluscan species listed in the top 15 occurrences. The cephalochordate _Branchiostoma floridae_ was the second most abundant species and was represented at all stations. The cumacean _Cyclaspis_ sp. A and amphipods _Tittakunara_ sp. A, _Eudevenopus honduranus_, _Protohaustorius bousfieldi_, _Acanthohaustorius_ sp. B, and _Lepidactylus_ sp. A were included among the 20 most abundant taxa and represented 73% of the arthropods. The abundant annelids _Spiophanes bombyx_, _Apoprionospio pygmaea_, _Polygordius_ (LPIL), _Mediomastus_ (LPIL), _Nepthys picta_, _Armandia maculata_, and _Paraprionospio pinnata_ represented only 50% of the total group. Echinoderms were represented by the echinoid _Mellita quinquesperforata_.

The community structure parameters for the ODMDS survey in 1980 are presented in Table 7. The ten replicates collected at stations 11 and 12 in January 1980 yielded an average of 53 taxa and 437 individuals with a density of 1410 individuals.m^{-2}. By comparison, the June 1980 collection averaged 106 taxa, 1158 individuals and 3738 individuals.m^{-2}. Means of measured indices reflect seasonal community structural differences; in January, species diversity (H') = 2.86, species evenness (J') = 0.72, and species richness (D) = 8.56. In June, H' = 3.67, J' = 0.78, and D = 15.20. In January, annelids and arthropods comprised equal percentages of the individuals (42.9% and 42.0%, respectively), followed by miscellaneous taxa (6.4%), echinoderms (6.0%), and

Table 6 . Taxonomic listing of phyla and numerically dominant taxa from EPA Pensacola 1980 survey sites.

Phylum	Phylum Total	% of Grand Total	No. Taxa in Phylum	% Total No. of Taxa
Annelida	1110	34.6	92	50.0
Mollusca	665	20.7	26	14.0
Arthropoda	1043	32.6	45	24.0
Echinodermata	80	2.4	6	3.0
Miscellaneous	311	9.7	15	8.0
Total	3209		184	

NUMERICAL DOMINANTS

Taxon	No. Individuals	% Total	Cum %	f*
Tellina alternata (M)	284	8.85	8.85	2
Branchiostoma floridae (C)	227	7.07	15.92	4
Cyclaspis sp. A (A)	205	6.38	22.30	4
Tittakunara sp. A (A)	162	5.04	27.34	2
Eudevenopis honduranus (A)	152	4.73	32.07	1
Spiophanes bombyx (P)	113	3.52	35.59	4
Apoprionospio pygmaea (P)	99	3.08	38.67	4
Protohaustorius sp. A (A)	99	3.08	41.75	4
Acanthohaustorius sp. B (A)	88	2.74	44.49	2
Polygordius (LPIL) (P)	87	2.71	47.20	3
Mediomastus (LPIL) (P)	80	2.49	49.69	2
Nephtys picta (P)	68	2.11	51.80	4
Mellita quinquiesperforata (E)	61	1.90	53.70	3
Armandia maculata (P)	58	1.80	55.50	4
Paraprionospio pinnata (P)	55	1.71	57.21	2
Lepidactylus sp. A (A)	54	1.68	58.89	4
Abra aequalis (M)	48	1.49	60.38	2
Natica pusilla (M)	40	1.24	61.62	2
Glycera sp. A (P)	39	1.21	62.83	4

(A) = Arthropoda, (C) = Cephalochordata, (E) = Echinodermata,

(M) = Mollusca, (P) = Polychaeta

*frequency of occurrence (maximum = 4)

Table 7. General community structure parameters for EPA-Pensacola survey sites, 1980. Five replicates per station.

ODMDS (IEC, 1980)	Total Taxa	Total Indiv.	Mean Density (no./m^2)	Species Diversity (H_e')	Species Evenness (J')	Species Richness (D)	Wet Wgt. Biomass (g/m^2)
January							
Sta. 11	49	393	1258±237	2.82	0.72	8.04	10.4833
12	57	480	1561±558	2.89	0.72	9.07	17.0122
Mean	53	437	1410	2.86	0.72	8.56	13.7478
June							
Sta. 11	97	862	2759±1014	3.61	0.78	14.50	13.9723
12	115	1474	4717±1618	3.73	0.78	15.90	74.6408
Mean	106	1158	3738	3.67	0.78	15.20	44.3066

molluscs (3.7%) (Table 5). By June, the percent composition of individuals was equally spread among annelids (31.8%), molluscs (29.0%), and arthropods (27.1%) due primarily to a significant increase in the mollusc populations.

5.3 Numerical Classification Analysis

5.3.1 EPA Pensacola 1983

Both normal (station) and inverse (species) classification analysis using Czekanowski's index of similarity and group-average sorting were performed on the EPA Pensacola 1983 data set. Species included in the analysis were selected on the basis of those contributing at least 1% of the total abundance at any given station, taxa occurring at greater than 75% of the stations, and/or any taxa showing distinct spatial distribution. Count data for the thirty species selected for analysis (sixteen polychaetes, seven molluscs, two amphipods, one sipunculid, one brachiopod, one echinoderm, and one oligochaete) are included in a matrix of station and species groups adjoining the resultant dendrograms from classification analysis (Figure 4). Numerically, these taxa account for 82% of the fauna collected during the EPA Pensacola 1983 survey.

Numerical classification of the 14 stations was interpreted at a four group level. Two major groups were delineated at 50% similarity, each of which contained monitoring and control stations. One group (stations 14 to 8) was further subdivided at 65% similarity into Group A (outlier control station 4), Group B (control stations 11, 12, 13 and ODMDS stations 5 and 6), and Group C (ODMDS stations 3, 4, 8, and 9). The other major station group (Group D) contained ODMDS stations 1, 2, 7, and control station 10.

Classification of the 30 dominant taxa at the 14 stations in November, 1983 was interpreted at a six group level (Figure 4). The classification grouped species based on their overall distribution patterns. The relationship of the species or species groups to the habitats recognized by the

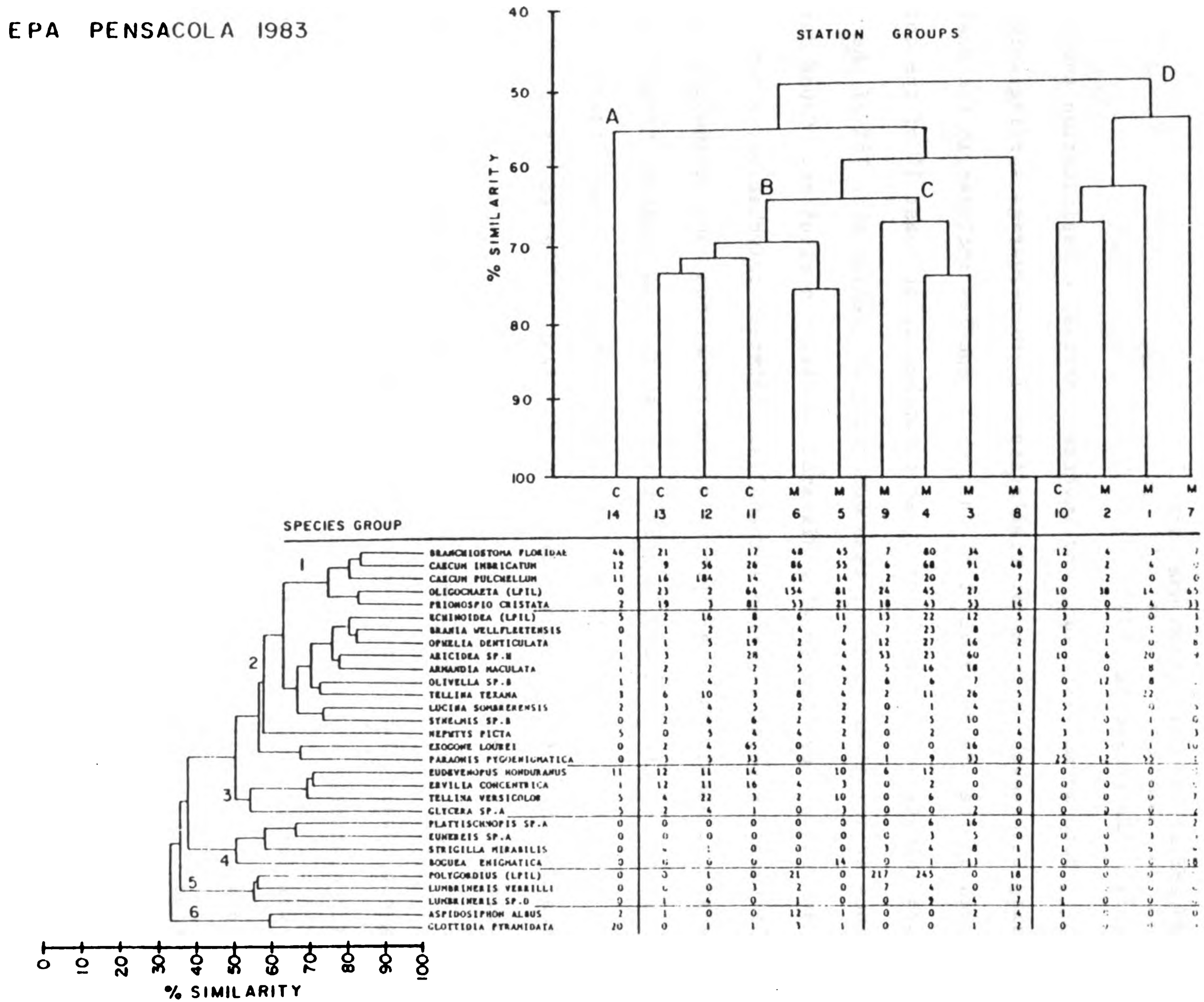


Figure 4 . Normal (station) and inverse (species) numerical classification analysis of macroinfaunal data from EPA Pensacola 1983 survey.

classification of stations is most directly dealt with by evaluating a data matrix rearranged by station and species groups in a two-way table. Such nodal analysis is further simplified by computation of measures of frequency and degree of restriction of species in a group in habitats represented by station groups. Species group constancy, fidelity, and abundance concentration (Boesch, 1977) were assessed for coincidental classifications and the nodal constancy diagram as presented in Figure 5.

The spatial distribution of stations is determined primarily by the occurrence and abundance of several species groups. In general, species fell into two major groupings--those with distinct spatial peaks in occurrence and abundance, and those which occurred ubiquitously throughout the study area in relatively constant numbers. The division of these major groups is seen at 50% similarity. Within the latter category, species considered numerically dominant include representatives of Species Group 1 (Branchiostoma floridae, Caecum imbricatum, Caecum pulchellum, Oligochaeta, and Prionospio cristata). These species are well distributed throughout both sites, but are best represented in station Groups A, B, and C.

Species Group 2 (Echinoidea to Paraonis pygoenigmatica) contained fewer numerically dominant species than Group 1, but these species are widely distributed and show high constancy for the entire study area.

Species Group 3 (Eudevenopis honduranus, Ervilia concentrica, Tellina versicolor, and Glycera sp. A) showed high constancy and moderate fidelity to station Groups A and B.

Species Groups 4, 5, and 6 appear as outliers with similarities of 35 to 40%. Species in Group 4 (Platyischnopis sp. A, Eunereis sp. A, Strigella mirabilis, Boguea enigmatica) were rarely present at control site stations. Their moderate constancy and fidelity for Groups C and D may indicate a population restricted to the habitat ODMDS site. Boguea enigmatica, for example,

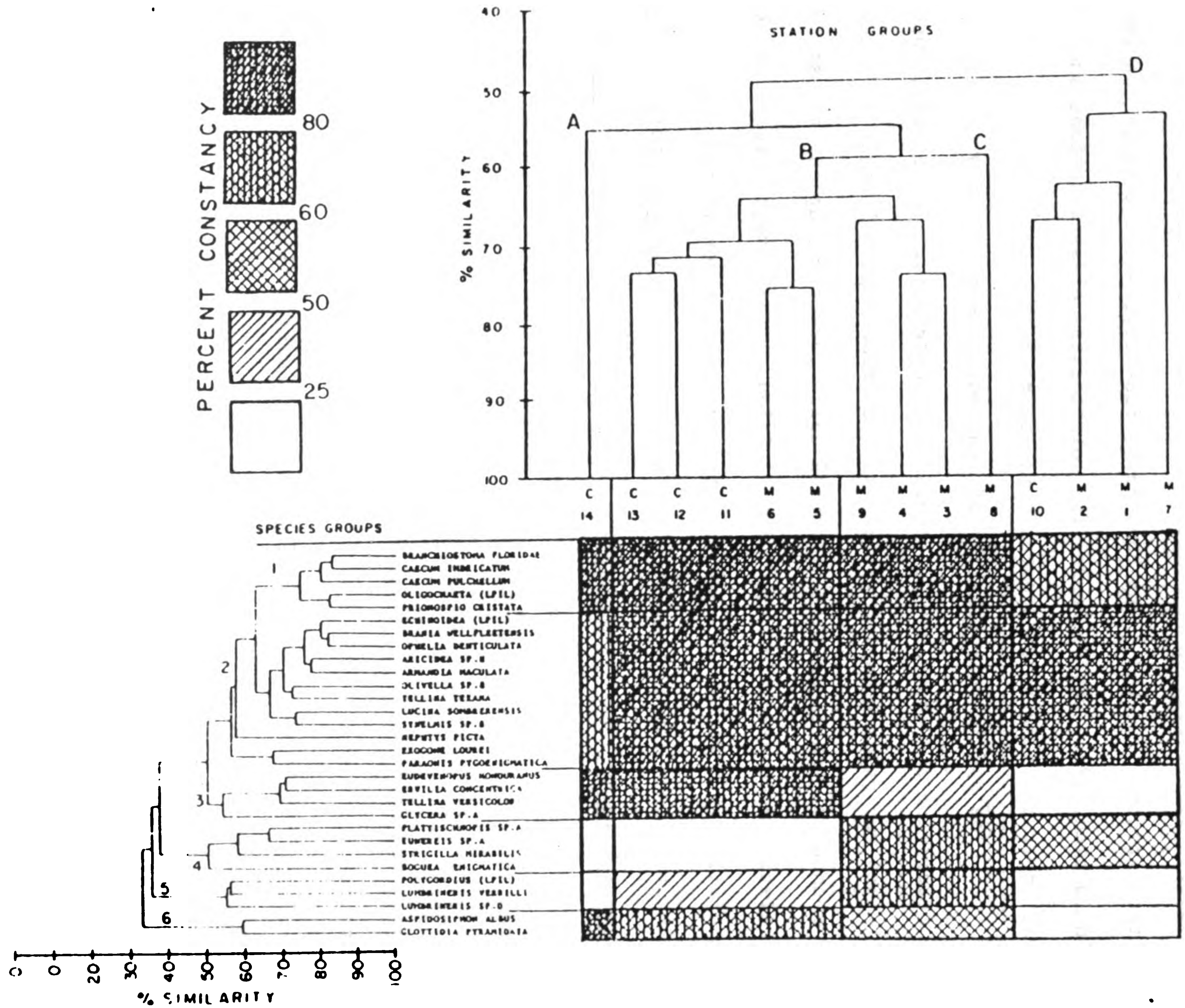


Figure 5 . Nodal analysis representing group constancy based on results of numerical classification analysis of macroinfaunal data from EPA Pensacola 1983 survey.

is generally found in clean sands near tidal passes.

Group 5 is dominated by the seasonally abundant polychaete Polygordius (LPIL) which is known to have several population peaks throughout the year. This group is present in station Groups B and C, but has a moderately high constancy and fidelity for ODMDS stations in Group C.

Group 6 contains the sipunculid Aspidosiphon albus and brachiopod Glottidia pyramidata. These species are considered outliers in all station groups.

5.3.2 EPA Pensacola 1980

Numerical classification of two stations over two seasons and 29 taxa for the EPA Pensacola 1980 survey data resulted in an interesting nodal matrix (Figure 6). The taxa were represented by fifteen polychaetes, six arthropods, five molluscs, one cephalochordate, one echinoderm, and one brachiopod which numerically accounted for 76% of the fauna collected.

Two station groups were delineated at 50% similarity, representing a strong seasonal effect between sampling periods. Likewise, species groups were ordered according to seasonal population peaks of opportunistic species and constancy of the ubiquitous and numerically dominant species. Species not collected in January but with seasonal population peaks in June include Acanthohaustorius sp. A to Aricidea wassi (Figure 6). Acanthohaustorius sp. A, Mediomastus californiensis, Paraprionospio pinnata, Abra aequalis, and Tellina alternata exemplify those species with irruptive populations.

The other major species group (Branchiostoma floridae to Polygordius (LPIL) represents a ubiquitous group of species whose populations are either constant or enhanced by seasonal recruitment patterns, as in the case of Branchiostoma floridae, Cyclaspis sp. A, Apoprionospio pygmaea, and Nephtys picta.

TABLE A-15
EPIFAUNA COLLECTED IN OTTER TRAWLS AT MOBILE, PENSACOLA, AND GULFPORT ODMDSs AND VICINITIES (JANUARY 1980)

Species	Common Name	Mobile				Pensacola				Gulfport			
		Station 1		Station 6		Station 11		Station 12		Station 13		Station 14	
		Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2
Cnidaria													
Scyphozoa	jellyfish	-	-	P	2	1	-	-	-	1	-	-	-
Annelida													
Nereidae	polychaete	-	-	-	-	-	-	-	-	-	-	1	-
Mollusca													
Gastropoda	snail	-	1	-	-	-	-	-	-	-	-	-	-
Teuthoidea	squids	-	-	-	-	25	40	-	-	-	1	1	1
Loligo pealei	long-finned squid	-	-	-	-	-	-	60	50	-	-	-	-
Lolliguncula brevis	squid	79	100	-	30	-	-	-	-	1	-	-	-
Arthropoda													
Penaeidae	shrimp	-	-	-	-	-	24	-	-	-	18	-	-
Penaeus aztecus	brown shrimp	-	60	-	-	-	-	-	-	-	-	-	-
Penaeus setiferus	white shrimp	-	-	-	P	-	-	-	-	-	-	-	-
Sicyonia brevirostris	rock shrimp	-	7	-	-	1	-	-	2	-	1	-	-
Sicyonia dorsalis	rock shrimp	3	3	-	-	-	-	-	-	-	-	-	-
Sicyonia sp.	rock shrimp	-	-	-	-	-	8	-	-	-	-	6	1
Squilla empusa	mantis shrimp	5	12	-	P	-	-	-	-	3	8	7	9
Trachypenaeus constrictus	shrimp	-	-	-	-	-	-	20	10	-	-	38	36
Trachypenaeus similis	broken-necked shrimp	4	-	-	-	-	-	-	-	31	-	-	-
Scyllarus americanus	Spanish lobster	-	-	-	-	-	1	-	-	-	-	-	-
Pagurus pollicaris	hermit crab	-	-	-	-	-	-	-	-	-	-	1	-
Arenaeus cribrarius	speckled crab	-	-	-	P	-	-	-	-	-	-	-	-
Calappa angusta	crab	-	1	-	-	-	-	-	-	-	-	-	-
Libinia dubia	spider crab	-	-	-	-	-	-	-	-	2	-	-	-
Metoporhaphis calcarata	crab	1	-	-	-	-	-	-	-	-	-	1	-
Ovalipes floridanus	swimming crab	-	-	-	P	-	-	-	-	-	-	-	-
Persephona crinita	purse crab	-	-	-	-	-	-	-	-	-	1	-	-

TABLE A-15. (continued)

Species	Common Name	Mobile				Pensacola				Gulfport			
		Station 1		Station 6		Station 11		Station 12		Station 13		Station 14	
		Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2	Tow 1	Tow 2
Portunus gibbesi	swimming crab	6	30	-	-	-	-	1	-	5	-	10	-
Portunus spinimanus	swimming crab	-	-	-	-	-	-	-	-	-	-	-	1
Portunus sp.	swimming crab	-	-	-	-	-	-	-	-	-	12	-	-
Echinodermata													
Astropecten articulatus	starfish	-	-	-	-	-	1	-	-	-	-	-	-
Tunicata		-	-	-	-	-	-	-	-	-	-	1	-
Pisces													
Torpedinidae													
Narcine brasiliensis	lesser electric ray	-	1	-	-	-	-	-	-	-	-	-	-
Rajidae													
Raja eglanteria	clearnose skate	-	-	-	-	-	-	1	-	-	-	-	-
Dasyatidae													
Dasyatis americana	southern stingray	-	-	-	-	-	-	1	-	-	-	-	-
Dasyatis sabina	atlantic stingray	-	-	-	-	-	-	-	-	-	-	-	1
Clupeidae													
Harengula pensacolae	scaled sardine	-	-	5	P	-	-	-	-	-	-	-	-
Engraulidae		-	-	-	-	-	-	-	-	-	100	-	100
Anchoa hepsetus	striped anchovy	9	3	-	25	120	10	150	120	-	-	-	-
Anchoa mitchelli	bay anchovy	-	-	-	-	-	-	-	-	20	-	25	-
Synodontidae		-	-										
Synodus foetens	inshore lizardfish	-	-	-	-	-	1	-	-	-	-	-	-
Ariidae		-	-										
Arius felis	sea catfish	-	-	300	100	-	1	-	-	70	5	-	-
Gadidae													
Urophycis floridanus	southern hake	1	2	-	-	P	3	-	-	-	-	-	-
Urophycis regius	spotted hake	-	-	-	-	1	-	1	-	-	-	-	-

TABLE A-15. (continued)

Species	Common Name	Mobile Station 1 Tow 1	Mobile Station 1 Tow 2	Mobile Station 6 Tow 1	Mobile Station 6 Tow 2	Pensacola Station 11 Tow 1	Pensacola Station 11 Tow 2	Pensacola Station 12 Tow 1	Pensacola Station 12 Tow 2	Gulfport Station 13 Tow 1	Gulfport Station 13 Tow 2	Gulfport Station 14 Tow 1	Gulfport Station 14 Tow 2
Ophidiidae													
Ophidion grayi	blotched cusk-eel	-	-	-	-	-	-	1	2	-	-	-	-
Syngnathidae													
Syngnathus springeri	bull pipefish	-	2	-	-	-	-	-	-	-	-	-	-
Serranidae													
Diplectrum bivittatum	dwarf sand perch	-	-	-	-	-	1	-	-	-	-	-	-
Carangidae		-	-										
Caranx crysos	blue runner	-	-	20	-	-	-	-	-	-	-	-	-
Chloroscombrus chrysurus	Atlantic bumper	6	8	10	100	-	-	-	-	-	-	-	-
Vomer setapinnis	Atlantic moonfish	-	-	75	200	-	-	-	-	-	-	-	-
Pomadasyidae													
Orthopristis chrysoptera	pigfish	-	-	-	-	-	-	-	1	-	-	-	-
Sciaenidae													
Cynoscion arenarius	sand seatrout	14	110	7	10	-	-	-	-	-	-	-	-
Larimus fasciatus	banded drum	39	125	-	15	-	-	-	-	-	1	15	5
Leiostomus xanthurus	spot	-	1	4	-	-	-	4	2	-	-	-	-
Menticirrhus americanus	southern kingfish	3	12	20	-	-	-	-	-	-	-	-	-
Menticirrhus cf. *americanus*	southern kingfish	-	-	-	-	-	-	-	-	-	-	20	-
Menticirrhus littoralis	Gulf kingfish	-	-	-	-	-	-	-	-	11	-	-	-
Menticirrhus sp.	kingfish	-	-	-	-	-	-	-	-	-	14	-	15
Ephippidae													
Chaetodipterus faber	Atlantic spadefish	-	1	-	-	-	-	-	-	-	-	-	-
Scombridae													
Scomberomorus maculatus	Spanish mackerel	-	-	4	-	-	-	-	-	-	-	-	-
Trichiuridae													
Trichiurus lepturus	Atlantic cutlassfish	2	2	3	5	-	-	-	-	1	-	-	-
Stromateidae													
Peprilus burti	Pacific pompano	1	-	-	-	1	-	-	-	-	-	-	-
Peprilus paru	butterfish	-	-	-	-	-	-	-	-	12	7	3	-

TABLE A-15. (continued)

Species	Common Name	Mobile Station 1 Tow 1	Mobile Station 1 Tow 2	Mobile Station 6 Tow 1	Mobile Station 6 Tow 2	Pensacola Station 11 Tow 1	Pensacola Station 11 Tow 2	Pensacola Station 12 Tow 1	Pensacola Station 12 Tow 2	Gulfport Station 13 Tow 1	Gulfport Station 13 Tow 2	Gulfport Station 14 Tow 1	Gulfport Station 14 Tow 2
Triglidae													
<u>Prionotus tribulus</u>	bighead searobin	4	11	-	-	1	1	-	-	-	-	15	-
<u>Prionotus tribulus</u> (juv.)	bighead searobin	-	-	-	-	-	2	-	-	-	-	-	-
<u>Prionotus</u> sp.	searobin	-	-	-	-	-	-	-	-	-	-	-	14
Bothidae													
<u>Citharichthys macrops</u>	spotted whiff	-	-	-	-	-	2	-	-	-	-	-	-
<u>Etropus crossotus</u>	fringed flounder	8	20	-	40	-	3	-	-	-	-	1	-
<u>Paralichthys albigutta</u>	Gulf flounder	-	-	-	-	-	2	-	2	-	-	-	-
Cynoglossidae													
<u>Symphurus civitatus</u>	offshore tonguefish	-	-	-	-	-	-	-	-	15	-	-	-
<u>Symphurus plagiusa</u>	blackcheek tonguefish	7	13	-	-	-	-	-	-	-	-	20	-
<u>Symphurus</u> sp.	tonguefish	-	-	-	-	-	-	-	-	-	-	-	3
Family unidentified	flatfish	-	-	-	-	-	-	-	-	-	12	-	-
Tetraodontidae													
<u>Sphoeroides parvus</u>	least puffer	1	17	-	1	-	-	-	-	2	3	5	-

P = Present
- None collected

Note: Counts above 30 are approximate

Platyischnopidae sp. A) and cephalochordates (Branchiostoma caribaeum) abundant at most stations. Apoprionospio pygmaea and Spiophanes bombyx were the most abundant polychaete species.

The trophic composition of the macrofauna in the vicinity of the Pensacola ODMDS is illustrated in Figure A-7. The Pensacola site has a low percent composition of deposit feeders (<60%) and a higher concentration of suspension feeders, omnivores, and carnivores relative to Mobile and Gulfport. Sediments in the vicinity of the Pensacola ODMDS are predominantly sand, while Mobile and Gulfport have higher concentrations of fine sediment. High concentrations of silt and clay can clog feeding structures of suspension feeders or cause problems in the maintenance of burrows or tubes (Gray, 1974); these reasons could explain why Mobile and Gulfport had fewer suspension feeders than Pensacola.

A.2.6 EPIFAUNA

A total of 45 invertebrate and 57 chordate species were captured in otter trawls in the vicinities of the Mobile, Pensacola, and Gulfport ODMDSs (Tables A-15 and A-16). Bottom dwelling species were best represented by the sea catfish Arius felis, shrimp Acetes americanus, longspine porgy Stenotomus caprinus, banded drum Larimus fasciatus, and brown shrimp Penaeus aztecus. This compared favorably with common epifaunal species previously reported in the Northeastern Gulf of Mexico (Rogers, 1977; Swingle, 1971). Mid-water species were often taken while the trawl net was lowered or brought to the surface. Abundances of mid-water species were high for all three sites, particularly jellyfish, the squids Loligo pealei and Loliguncula brevis, the anchovies Anchoa hepsetus and Anchoa mitchelli, and Atlantic bumper Chloroscombrus chrysurus. Many of the species collected in this study are commercially important (Swingle, 1971).

Epifauna were similar in the vicinities of the Mobile, Pensacola, and Gulfport ODMDSs; however, the number of species and abundances in the Mobile site were generally higher than the Pensacola and Gulfport sites. Greater number of species and higher abundance of fish were collected in the vicinity of the ODMDSs in January than June, which is consistent with reported

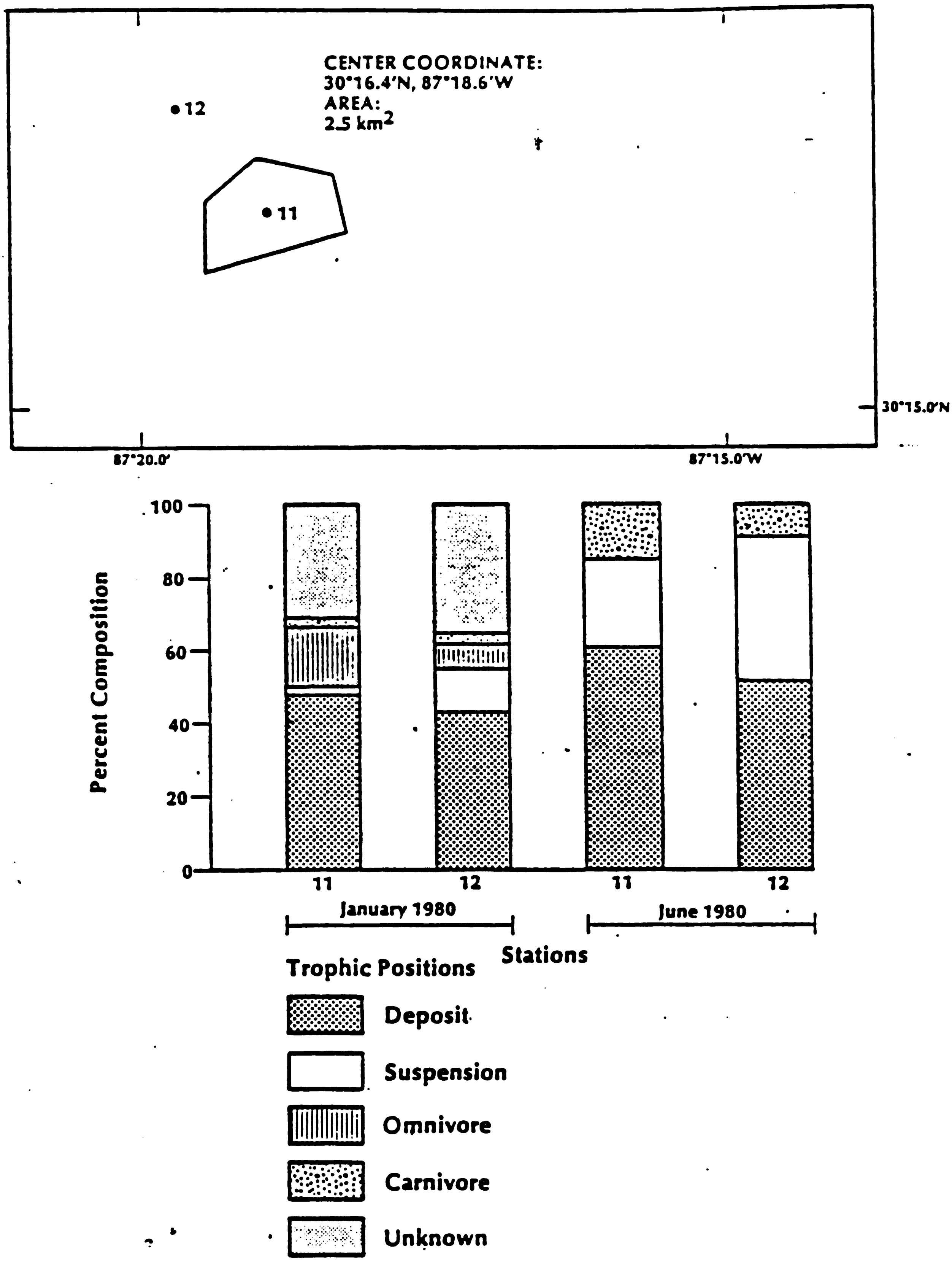
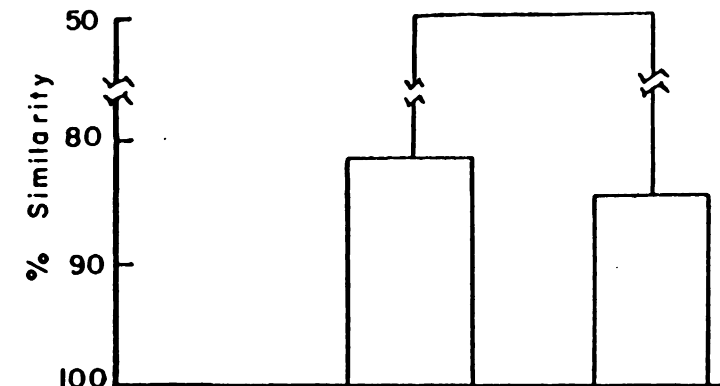
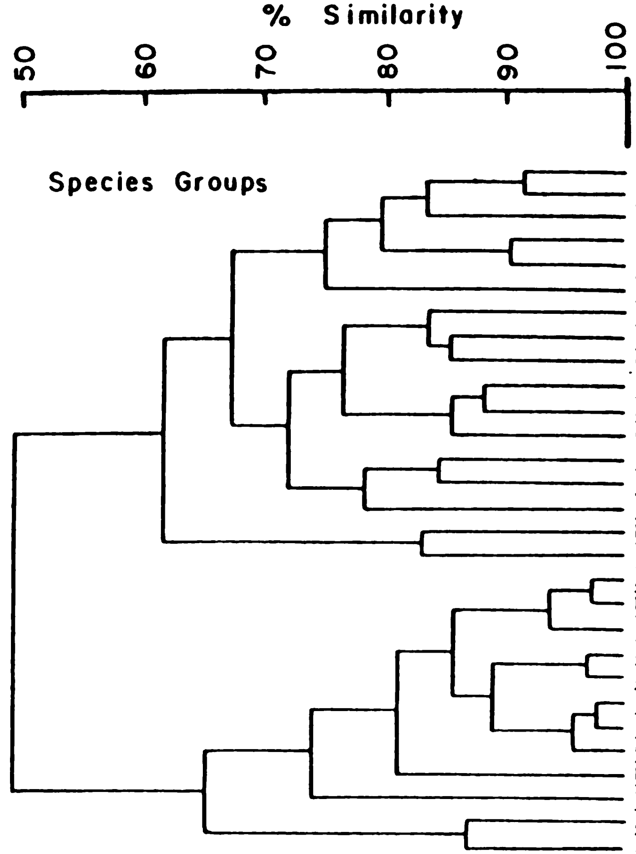


Figure A-7. Percent Composition of Feeding Types in the Vicinity of the Pensacola ODMDS

EPA PENSACOLA 1980





Species	Jun 12	Jun 11	Jan 12	Jan 11
Branchiostoma floridae	145	47	25	10
Cyclaspis sp. A	115	77	5	8
Platyischnopidae (LPIL	121	41	152	95
Apoprionospio pygmaea	44	40	13	2
Nephtys picta	33	30	4	1
Protohaustorius sp. A	65	2	30	2
Lepidactylus sp. A	7	1	26	20
Brania wellfleetensis	4	0	8	12
Onuphis eremita oculata	6	1	9	5
Spiophanes bombyx	13	18	39	43
Armandia maculata	16	7	13	22
Glycera sp. A	9	11	14	5
Synchelidium americanum	10	5	1	7
Dispio uncinata	8	9	[illegible]	[illegible]
Strigilla mirabilis	2	6	5	4
Mellita quinquiesperfora	[illegible]	12	10	39
Polygordius (LPIL)	0	2	33	52
Acanthohaustorius sp. A	74	14	[illegible]	0
Mediomastus californiensis	62	18	[illegible]	0
Paraprionospio pinnata	35	20	[illegible]	0
Natica pusilla	15	25	[illegible]	0
Abra aequalis	20	26	[illegible]	0
Semele proficua	14	11	[illegible]	0
Loimia sp. A	13	9	[illegible]	0
Glottidia pyramidata	15	7	[illegible]	0
Magelona sp. B	7	19	1	0
Tellina alternata	136	148	[illegible]	0
Aricidea sp. H	25	0	0	0
Aricidea wassi	20	1	0	0

Figure 6 . Normal (station) and inverse (species) numerical classification analysis of macro-infaunal data from EPA Pensacola 1980 survey.

5.4 Comparison of EPA Pensacola 1983 Survey ODMDS (Site A) and Control (Site B)

A multivariate analysis of variance (MANOVA) based on Wilks' lambda statistic was performed to compare Site A and Site B for physical and biological differences. The physical parameters include those presented in Table 2 which may reflect habitat characteristics, i.e., depth, percent sand, percent silt-clay, mean phi, and sorting coefficient. The community structure parameters listed in Table 4 were used as the biological characteristics of each site. However, wet weight biomass was not included in the analysis because of the highly skewed measurements due to mollusc shell and echinoderm test weights.

Results of MANOVA indicate that there are not significant differences between the physical or biological characteristics of the ODMDS (Site A) and Control (Site B) at a 95% confidence level (Table 8). T-tests performed on the individual variables also showed no significant differences between sites (Table 9).

5.5 Comparison of EPA Pensacola 1980 and 1983 Surveys

In order to make comparisons between the 1980 and 1983 surveys, data from stations 11 and 12 collected during January, 1980 and stations 1 and 9 collected during November, 1983 were analyzed. Results of community structure parameters (Tables 4 and 7), percent composition of major taxa groups (Table 5), numerical classification analyses (Figures 4 and 6) were utilized for qualitative comparisons of these survey sites. Disregarding the effects of total taxa and individuals due to differences in replication, the mean station density, species diversity, species evenness, and species richness values were similar for the two sites. However, the percent composition of major taxa groups were appreciably different between sites, as shown below:

Table 8 . Multivariate analysis of variance (MANOVA) based on Wilks' lambda statistic performed on physical and community structure parameters at ODMDS and Control Site. Significance at P=0.05.

Physical Parameters:

STATISTIC	VALUE	F	NUM DF	DEN DF	PROB>F
Wilks' lambda	0.4148293	2.257009	5	8	0.146484 n.s.

Community Structure Parameters:

STATISTIC	VALUE	F	NUM DF	DEN DF	PROB>F
Wilks' lambda	.7745512	0.339582	6	7	0.8953392 n.s.

Table . Results of t-tests performed on individual variables at ODMDS and Control Site. Significance at P=0.05

VARIABLE	SITE	N	MEAN	STD. DEV.	T	PROB>/T/
DEPTH	Control	5	11.88	1.3142	1.1280	0.3215 n.s.
	ODMDS	9	10.94	1.7558	1.0341	
SAND	Control	5	99.46	0.4278	1.8911	0.0941 n.s.
	ODMDS	9	96.74	4.2694	1.3931	
SILT-CLAY	Control	5	0.54	0.4278	-1.9112	0.0912 n.s.
	ODMDS	9	3.28	4.2590	-1.4079	
MEAN PHI	Control	5	1.65	0.2372	-1.1454	0.3585 n.s.
	ODMDS	9	1.87	0.4670	-0.9548	
SORTING	Control	5	0.66	0.0363	-1.2828	0.3644 n.s.
	ODMDS	9	0.86	0.4594	-0.9427	
TAXA	Control	5	45.80	10.2811	-1.5686	0.2102 n.s.
	ODMDS	9	58.11	19.0817	-1.3238	
INDIVIDUALS	Control	5	276.60	169.2699	-1.1499	0.3123 n.s.
	ODMDS	9	399.33	225.7382	-1.0547	
DENSITY	Control	5	1537.20	940.2253	-1.1498	0.3124 n.s.
	ODMDS	9	2218.89	1253.9914	-1.0546	
H'	Control	5	2.91	0.2818	-0.2898	0.7902 n.s.
	ODMDS	9	2.96	0.3467	-0.2721	
J'	Control	5	0.77	0.0838	0.6738	0.4795 n.s.
	ODMDS	9	0.74	0.0645	0.7298	
D	Control	5	8.13	1.0738	-1.4884	0.2595 n.s.
	ODMDS	9	9.68	2.7817	-1.1836	

	1980	1983
Annelida	42.9	73.4
Arthropoda	42.0	3.6
Mollusca	3.7	18.8
Echinodermata	6.0	1.6
Miscellaneous	6.4	2.6

Although only a few dominant species were shared between the two surveys according to the nodal matrices (Figures 4 and 6), the contribution of sub-dominant taxa reflects the high diversity of sand habitat assemblages. The presence of species such as *Branchiostoma floridae*, *Polygordius* spp., *Brania wellfleetensis*, *Prionospio cristata*, *Spiophanes bombyx*, *Armandia maculata*, and *Glycera* sp. A, during both surveys indicates a similarity between the predominantly sand assemblages.

6.0 DISCUSSION

The areas sampled during the EPA Pensacola surveys in 1980 and 1983 are representative of sand habitats and their associated fauna found in nearshore coastal waters (5-20 m depth) of the West Florida Shelf in the northeastern Gulf of Mexico. Results of the 1980 survey depict the seasonal variability of macroinfaunal populations at the Pensacola site. This temporal pattern was not expected, as most of the numerically important taxa collected in the study area are known to have late winter to spring periods of recruitment (Johnson, 1980; Shaw *et al.*, 1982).

When compared with benthic studies conducted at a tidal pass at the mouth of Mobile Bay (TechCon, 1980) and offshore of coastal Alabama and Mississippi (Shaw *et al.*, 1982), the assemblage of ubiquitous taxa inhabiting predominantly sand sediments are similar. These include the polychaetes *Spiophanes bombyx*, *Armandia maculata*, *Polygordius* spp., *Nephtys picta*, *Magelona* sp. B, *Aricidea* wassi, Aricidea sp. H, Boguea enigmatica, Brania wellfleetensis, Prionospio cristata, and Poecilochaetus johnsoni; the molluscs Crassinella lunulata, Caecum pulchellum, and Caecum imbricatum; the arthropods Protohaustorius sp. A, Eudevenopus honduranus, Platyischnopidae, Metharpinia floridana, and Acanthohaustorius sp. A; the cephalochordate Branchiostoma floridae; and the sipunculid Aspidosiphon albus.

With respect to dredging and disposal practices, disruption and destruction of benthic communities result from excavation, burial, and/or resuspension of sediments affecting the immediate area of operation. Community recovery or succession is dependent upon the nature of the physical environment (i.e., sediment composition, hydrographic stability) and the structure of the surrounding benthic communities.

Early stage succession begins within a few days with the arrival of swimming crustaceans (i.e., amphipods and cumaceans) and more motile polychaetes and echinoderms (i.e., nereids and nephtyids and large ophiuroids) which immigrate into the defaunated areas as adults from adjacent areas. More importantly, the larvae of relatively opportunistic polychaetes and bivalve molluscs settle randomly or preferentially onto the new substratum from the overlying water column. The latter (Group I colonizers, sensu stricta McCall, 1978) are characterized by short generation times, small size, high fecundity, and high larval availability. These species most commonly experience high mortality and may disappear locally as a result of competition and/or predation from the more motile immigrants.

Latter phases of succession are usually characterized by the gradual re-establishment of Group III species which previously inhabited the undisturbed area or, in the case where sediment composition is severely altered, a new fauna recruited from outside areas (McCall, 1978). Group III colonizers are represented by the less mobile crustaceans, molluscs, and miscellaneous phyla and less opportunistic polychaetes. These species, in contrast to Group I colonizers, maintain more or less constant, relatively low population densities, are usually larger in size and exhibit lower fecundity and recruitment potential. Individuals of these species may persist over long periods of time in the absence of severe perturbations.

Group II species are intermediate in their mode or stage of colonization and life history strategies as described for the more extreme Groups I and III. Group II species are larger, more errant, surface and subsurface burrowing animals and are characteristic species for faunal assemblages. Trophically, the majority of species in this group may be carnivores.

Candidate species likely to fit within these three groups based on results of the present study are listed in Table 10. Tentative categorization of species are based on their population patterns, as exhibited in the present study and inference from other colonization and natural history studies of similar estuarine and nearshore areas (Reish 1972, 1973; Wass 1967; Boesch et al., 1976; McCall 1978, Johnson 1980, Shaw et al., 1982). Confirmation, however, must await successional studies of infaunal benthos which, to date, have not been performed along the northern Gulf coast.

No statistically significant differences of the physical and biological community characteristics were found between EPA Pensacola ODMDS (Site A) and Control (Site B). Community structures and faunal assemblages delineated from the 1980 and 1983 surveys reflect the similarity of taxa characteristic of shallow offshore sand habitats, especially when the November, 1983 and January, 1980 data sets are compared.

Table 10 . Possible candidate species for Groups I, II, and III colonizers of offshore sand faunal assemblages in the EPA Pensacola study area.

Group I

Paraprionospio pinnata	*Polygordius* spp.	*Mellita quinquesperforata*
Mediomastus spp.	*Branchiostoma floridae*	*Glycera* sp. A
Armandia maculata	*Brania wellfleetensis*	*Caecum pulchellum*
Spiophanes bombyx	*Magelona* sp. B	*Nephtys picta*
Protohaustorius sp. A	*Aspidosiphon albus*	*Glottidia pyramidata*
Acanthohaustorius sp. A		

7.0 LITERATURE CITED

Bault, E. I. 1972. Hydrology of Alabama Estuarine Areas-Cooperative Gulf of Mexico Inventory. Alabama Department Cons. Natural Resources, Alabama Marine Resources Laboratory. 25 pp.

Boesch, D. F., M. L. Wass, and R. W. Virnstein. 1976. The dynamics of estuarine benthic communities, pp. 177-196. In: M. L. Wiley (ed.) Estuarine Processes, Vol. I. Academic Press, Inc., New York.

Boeschung, H. J., Jr. 1957. Some interesting records of marine fishes of Alabama. J. Ala. Acad. Sci., 29:33-34.

Bureau of Land Management. 1981. Final environmental impact statement. Proposed OCS Oil and Gas Sales 67 and 69. Prepared by the New Orleans Outer Continental Shelf Office. 300 pp.

Chermock, R. L., P. A. Boone and R. L. Lipp. 1974. The environment of offshore and estuarine Alabama. Geological Survey of Alabama, Information Series 51. 135 pp.

Christmas, J. Y. and G. Gunter. 1960. Distribution of menhaden genus Brevoortia in the Gulf of Mexico. Trans. Amer. Fish Soc., 89(4):338-343.

Continental Shelf Associates, Inc. 1981. Pre-drilling site-specific benthic survey within State of Alabama Oil and Gas Lease Tract 112. Report submitted to Exxon Company, U.S.A. 25 pp.

________. 1982. Addendum. Pre-drilling site-specific benthic survey within State of Alabama Oil and Gas Lease Tract 112. Report submitted to Exxon Company, U.S.A. 13 pp.

Dames and Moore. 1979. The Mississippi, Alabama, Florida, Outer Continental Shelf Baseline Environmental Survey, Interior, Bureau of Land Management, New Orleans OCS Office. Contract No. AA550-CT7-34.

Doyle, L. J. and T. N. Sparks. 1980. Sediments of the Mississippi, Alabama and Florida (MAFLA) Continental Shelf. Journ. Sed. Petr., 50(3):905-916.

Florida Coastal Coordinating Council. 1973. ESCAROSA I. An oceanographic survey of the Florida Territorial sea of Escambia and Santa Rosa counties. State University System Institute of Oceanography, in cooperation with the Florida Coordinating Council. 366 pp.

Folk, R. L. 1980. Petrology of sedimentary rocks. Hemphill Publishing Company, Austin, Texas. ii + 182 pp.

Harmon Engineering & Testing. 1984. Final Report: Report on offshore disposal site designation for two areas southwest of Mobile Bay, Alabama. Contract No. DACW01-83-C-0009, Harmon Engineering & Testing, Auburn, AL. Prepared for Mobile District, U.S. Army Corps of Engineers, Mobile, AL.

Kjerfve, B. and J. E. Sneed. 1984. Final Report: Analysis and synthesis of oceanographic conditions in the Mississippi Sound offshore region. Contract No. DACW01-83-R-0014, B. J. Kjerfve, Dept. of Geclogy, University of South Carolina, Columbia, S.C. Prepared for Mobile District, U.S. Army Corps of Engineers, Mobile, AL.

Johnson, P. G. 1980. Seasonal variation in benthic community structure in Mobile Bay, Alabama. M.S. Thesis. University of Alabama at Birmingham. Birmingham, Alabama. 112 pp.

Ludwick, J. C. 1964. Sediments in northeastern Gulf of Mexico. Papers in Marine Geology. MacMillan Company, New York. p. 204-238.

McCall, P. L. 1978. Spatial-temporal distribution of Long Island Sound infauna: The role of bottom disturbance in a nearshore habitat. In: Estuarine Interactions, M. L. Wiley (ed.), pp. 191-219. Academic Press, N.Y.

Racal-Decca Survey, Inc. 1982. Pre-drilling site-specific benthic survey within State of Alabama Lease Tract 115. Report submitted to Exxon Company, U.S.A.

Reish, D. J. 1972. The use of marine invertebrates as indicators of varying degrees of marine pollution, pp. 203-207. In: M. Ruivo (ed.) Marine pollution and sea life. Fishing News (Books) Ltd., Surrey, England.

________. 1973. The use of benthic animals in monitoring the marine environment. J. Environ. Planning and Poll. Control. 1(3):32-38.

Shaw, J. K., P. G. Johnson, R. M. Ewing, C. E. Comiskey, C. C. Brandt and T. A. Farmer. 1982. Final Report: Benthic macroinfauna community characterizations in Mississippi Sound and adjacent waters. Contract No. DACW01-80-C-0427, Barry A. Vittor & Associates, Inc., Mobile, AL. Prepared for Mobile District, U.S. Army Corps of Engineers, Mobile, AL.

TechCon, Inc. 1980. Environmental monitoring program of MOEPSI Well No. 1-76 (Mobile Bay State lease 347 no. 1) in Mobile Bay, Alabama, vol. 1: Environmental effects. Final Report to Mobil Oil Exploration and Producing Southeast, Inc., New Orleans, Louisiana.

TerEco Corporation. 1979. Literature review of Mississippi Sound and adjacent areas. A report to the Department of the Army, Mobile District, Corps of Engineers. Contract No. DACW1-78-C-0244.

Turner, W. R. 1969. Life history of menhaden in the eastern Gulf of Mexico. Trans. Amer. Fish. Soc., 98:216-224.

Upshaw, C. F., W. B. Creath and F. L. Brooks. 1966. Sediments and microinfauna off the coast of Mississppi and adjacent states. Mississippi Geol. Survey Bull., 106:127.

U.S. Environmental Protection Agency. 1982. Draft environmental impact statement (EIS) for the Pensacola, FL., Mobile, AL., and Gulfport, MS. dredged material disposal site designation. Washington, D.C. Appendix A.

Vittor, B. A. 1977. Characterization of benthic habitats on the Mississippi-Alabama shelf, adjacent to Mobile Bay, Alabama. Report for Mobile District, U.S. Army Corps of Engineers. 19 pp.

Vittor & Associates. 1983. Characterization and development of valuation methodology for Mobile Bay and offshore area. Final Report to U.S. Army Corps of Engineers Mobile District, Contract No. DACW01-82-M-A880. 119 pp.

Wass, M. L. 1967. Biological and physiological basis of indicator organisms and communities. Section II. Indicators of pollution, marine ecology. Interscience Publ., N.Y.

APPENDIX A

EPA PENSACOLA BENTHIC MACROINFAUNAL
ANALYSIS - FAUNAL DATA, 1983

EPA PENSACCLA BENTHIC MACRCINFAUNAL ANALYSIS

SAMPLE DATE: NCVEMBER 16,19[illegible] STATICN: 1
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACRCFAUNA

CCMMENT.EPA PENSACCLA.

TAXCN	REPA	REPB	REPC	TAXCN TCT.	% CF TCT.
RHYNCHCCCELA					
RHYNCHCCCELA (LPIL)	0	2	1	3	1.6
ANNELIDA					
PCLYCHAETA					
CAPITELLIDAE					
MASTCBRANCHUS SP.A	0	0	1	1	0.5
GLYCERIDAE					
GLYCERA SP.I	1	2	0	3	1.6
MAGELCNIDAE					
MAGELCNA SP.B	0	1	1	2	1.1
NEPHTYIDAE					
NEPHTYS PICTA	1	1	1	3	1.6
NEREIDAE					
EUNEREIS SP.A	0	1	2	3	1.6
CPHELIIDAE					
ARMANDIA MACULATA	2	4	2	8	4.4
CRBINIIDAE					
SCCLCPLCS RUBRA	0	0	1	1	0.5
LEITCSCCLCPLCS FRAGILIS	0	2	2	4	2.2
PARACNIDAE					
ARICIDEA SP.H	0	5	15	20	10.9
CIRRCPHCRUS (LPIL)	0	1	0	1	0.5
PARACNIS PYGCENIGMATICA	1	14	40	55	30.1
PILARGIDAE					
SYNELMIS SP.B	0	0	1	1	0.5
SPICNIDAE					
PRICNCSPIC CRISTATA	0	3	1	4	2.2
SYLLIDAE					
PARAPICNCSYLLIS LCNGICIRRAT	0	1	1	2	1.1
BRANIA WELLFLEETENSIS	0	1	0	1	0.5
EXCGCNE LCUREI	0	1	0	1	0.5
PSAMMCDRILIDAE					
PSAMMCDRILUS BALANCGLCSSCID	0	0	1	1	0.5
CLIGCCHAETA					
CLIGCCHAETA (LPIL)	1	5	8	14	7.7
MCLLUSCA					
PELECYPCDA					
PELECYPCDA (LPIL)	0	1	1	2	1.
UNGULINIDAE					
DIPLCDCNTA PUNCTATA	0	0	1	1	0.5
TELLINIDAE					
TELLINA TEXANA	2	12	8	22	12.
STRIGILLA MIRABILIS	0	3	3	6	3.
VENERIDAE					
VENERIDAE (LPIL)	0	0	1	1	0.
CHICNE INTAPURPUREA	0	1	0	1	0.
GASTRCPCDA					

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION:
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUN

COMMENT.EPA PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT
NATICIDAE					
NATICA PUSILLA	0	1	0	1	0.
COLUMBELLIDAE					
ANACHIS OBESA	0	1	0	1	0.
ACTEOCINIDAE					
ACTEOCINA CANDEI	0	1	0	1	0.
CAECIDAE					
CAECUM IMBRICATUM	0	3	1	4	2.
OLIVIDAE					
OLIVELLA SP.A	2	1	0	3	1.
OLIVELLA SP.B	5	3	0	8	4.
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
HAUSTORIIDAE					
PARAHAUSTORIUS OBLIQUUS	0	0	1	1	0.
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	1	2	0	3	.

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE:	16	73	94
NUMBER TAXA PER REPLICATE:	9	26	22

TOTAL NUMBER TAXA FOR STATION: 33
TOTAL NUMBER INDIVIDUALS FOR STATION: 183
MEAN NUMBER INDIVIDUALS PER SQ. M: 1017 STD. DEVIATION: 673

EPA PENSACCLA BENTHIC MACRCINFAUNAL ANALYSIS

SAMPLE DATE: NCVEMBER 16,1983 STATICN: 1
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACRCFAUNA

CCMMENT.EPA PENSACCLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNCN WIENER INDEX) H'E= 2.6419

SPECIES EVENNESS (PIELCUS EVENNESS INDEX) J= 0.7556

SPECIES RICHNESS (MARGALEF'S INDEX) D= 6.143

SPECIES-AREA RELATICNSHIPS
S=CUMULATIVE NUMBER CF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	9	*	C	22	*	B	26	*	A	9
B	26	*	A	26	*	C	33	*	C	26
C	33	*	B	33	*	A	33	*	B	33

FAUNAL ANALYSIS AND REPCRT PREPARED FCR:
ENVIRCNMENTAL PRCTECTICN AGENCY

PREPARED BY:
BARRY A. VITTCR & ASSCC., INC.
8100 CCTTAGE HILL RCAD
MCBILE, ALABAMA [illegible]

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: NOVEMBER 16, 1985
AMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFAUN

COMMENT.EPA.PENSACCLA.

TAXCN	REPA	REPB	REPC	TAXON TOT.	% C TCT
ANNELIDA					
POLYCHAETA					
EUNICIDAE					
EUNICIDAE (LPIL)	0	0	1	1	0.
GLYCERIDAE					
GLYCERA SP.I	0	1	0	1	0.
GLYCERA SP.D	0	0	1	1	0.
HESICNIDAE					
HETERCPCDARKE CF HETERCMCRP	0	1	0	1	0.
MAGELCNIDAE					
MAGELCNA SP.B	0	0	1	1	0.
NEPHTYIDAE					
NEPHTYS PICTA	1	2	0	3	2.
CPHELIIDAE					
CPHELIA DENTICULATA	1	0	0	1	0.
CNUPHIDAE					
MCCRECNUPHIS PALLIDULA	0	1	0	1	0.
MCCRECNUPHIS CF. NEBULCSA	0	0	1	1	0.
CRBINIIDAE					
LEITCSCCLCPLCS FRAGILIS	1	0	0	1	0.
PARACNIDAE					
ARICIDEA SP.H	2	2	2	6	4.
PARACNIS PYGCENIGMATICA	9	0	3	12	9
SYLLIDAE					
PARAPICNCSYLLIS LCNGICIRRAT	0	1	0	1	0.
BRANIA WELLFLEETENSIS	0	0	2	2	1
STREPTCSYLLIS PETTIBCNEAE	0	0	1	1	0.
EXCGCNE LCUREI	1	4	0	5	4
OLIGCCHAETA					
CLIGCCHAETA (LPIL)	24	6	8	38	30
MCLLUSCA					
PELECYPCDA					
PELECYPCDA (LPIL)	1	0	0	1	0
LUCINIDAE					
LUCINA SCMBRERENSIS	0	1	0	1	0
TELLINIDAE					
TELLINA TEXANA	1	2	0	3	2
STRIGILLA MIRABILIS	0	0	3	3	2
VENERIDAE					
CHICNE INTAPURPUREA	0	1	0	1	0
GASTRCPCDA					
NATICIDAE					
NATICA PUSILLA	0	1	0	1	0
ACTECCINIDAE					
ACTECCINA CANDEI	0	1	2	3	2
CAECIDAE					
CAECUM PULCHELLUM	0	2	0	2	[illegible]
CAECUM IMBRICATUM	0	2	0	2	[illegible]

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION: 2
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
OLIVIDAE					
OLIVELLA SP.B	3	7	2	12	9.8
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
HAUSTORIDAE					
PARAHAUSTORIUS OBLIQUUS	1	4	0	5	4.1
PLATYISCHNOPIDAE					
PLATYISCHNOPIS SP.A	0	0	1	1	0.8
CUMACEA					
BODOTRIIDAE					
CYCLASPIS SP.D	0	0	2	2	1.6
DECAPODA (NATANTIA)					
DECAPODA NATANTIA (LPIL)	1	0	0	1	0.8
DECAPODA (REPTANTIA)					
ALBUNEIDAE					
ALBUNEA GIBBESII	1	0	0	1	0.8
ECHINODERMATA					
ECHINOIDEA					
ECHINOIDEA (LPIL)	0	2	0	2	1.6
MELLITIDAE					
MELLITIDAE (LPIL)	0	0	1	1	0.8
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	0	4	0	4	3.3

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE: 47 45 31
NUMBER TAXA PER REPLICATE: 13 19 15

TOTAL NUMBER TAXA FOR STATION: 35
TOTAL NUMBER INDIVIDUALS FOR STATION: 123
MEAN NUMBER INDIVIDUALS PER SQ. M: 684 STD. DEVIATION: 145

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,19[illegible] STATION: 2
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACCLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNCN WIENER INDEX) H'E= 2.7766

SPECIES EVENNESS (PIELCUS EVENNESS INDEX) J= 0.7810

SPECIES RICHNESS (MARGALEF'S INDEX) D= 7.065

SPECIES-AREA RELATICNSHIPS
S=CUMULATIVE NUMBER CF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	13	*	C	15	*	B	19	*	A	13
B	25	*	A	24	*	C	30	*	C	24
C	35	*	B	35	*	A	35	*	B	35

FAUNAL ANALYSIS AND REPCRT PREPARED FCR:
ENVIRCNMENTAL PRCTECTICN AGENCY

PREPARED BY:
BARRY A. VITTCR & ASSCC., INC.
8100 CCTTAGE HILL RCAD
MCBILE, ALABAMA [illegible]

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: 3
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
RHYNCHOCOELA					
RHYNCHOCOELA SP.A	0	1	2	3	0.6
RHYNCHOCOELA SP.I	0	0	1	1	0.2
RHYNCHOCOELA (LPIL)	1	0	1	2	0.4
BRACHIOPODA					
GLOTTIDIA PYRAMIDATA	0	0	1	1	0.2
SIPUNCULA					
GOLFINGIIDAE					
PHASCOLION STROMBI	0	0	1	1	0.2
ASPIDOSIPHONIDAE					
ASPIDOSIPHON ALBUS	1	0	1	2	0.4
ANNELIDA					
POLYCHAETA					
AMPHINOMIDAE					
CHLOEIA VIRIDIS	0	0	1	1	0.2
CAPITELLIDAE					
MEDIOMASTUS CALIFORNIENSIS	0	0	1	1	0.2
CIRRATULIDAE					
CAULLERIELLA CF. ALATA	1	2	0	3	0.6
GLYCERIDAE					
GLYCERA SP.A	0	0	2	2	0.4
GLYCERA SP.I	3	1	3	7	1.3
GLYCERA (LPIL)	0	1	0	1	0.2
HESIONIDAE					
HETEROPODARKE CF HETEROMORP	0	0	1	1	0.2
LUMBRINERIDAE					
LUMBRINERIS SP.D	0	3	1	4	0.7
MALDANIDAE					
BOGUEA ENIGMATICA	0	0	13	13	2.4
MAGELONIDAE					
MAGELONA SP.B	2	0	0	2	0.4
MAGELONA SP.C	1	0	1	2	0.4
NEREIDAE					
NEREIS MICROMMA	0	0	2	2	0.4
EUNEREIS SP.A	4	0	1	5	0.9
OPHELIIDAE					
OPHELIIDAE (LPIL)	0	0	1	1	0.2
ARMANDIA MACULATA	15	0	3	18	3.3
OPHELIA DENTICULATA	7	5	4	16	3.0
OWENIIDAE					
OWENIA SP.A	0	0	1	1	0.2
ORBINIIDAE					
SCOLOPLOS RUBRA	0	0	1	1	0.2
LEITOSCOLOPLOS FRAGILIS	1	0	0	1	0.2
PARAONIDAE					
ARICIDEA WASSI	[illegible]	[illegible]	[illegible]	4	0.7

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFAUN

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% O TOT
ARICIDEA SP.H	46	10	4	60	1.
CIRROPHORUS (LPIL)	0	0	1	1	0.
PARAONIS PYGOENIGMATICA	28	4	1	33	6.
PILARGIDAE					
ANCISTROSYLLIS SP.C	0	0	1	1	0.
SYNELMIS SP.B	3	2	5	10	1.
SPIONIDAE					
SPIONIDAE (LPIL)	0	1	0	1	0.
PRIONOSPIO CRISTATA	23	15	15	53	9.
PRIONOSPIO (LPIL)	0	0	2	2	0.
SPIOPHANES BOMBYX	0	0	1	1	0.
AONIDES CF. PAUCIBRANCHIATA	0	0	1	1	0.
SYLLIDAE					
PARAPIONOSYLLIS LONGICIRRAT	1	0	3	4	0.
BRANIA WELLFLEETENSIS	2	4	2	8	1.
STREPTOSYLLIS PETTIBONEAE	2	0	0	2	0.
EXOGONE LOUREI	11	4	1	16	3.
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	9	2	16	27	5.
MOLLUSCA					
PELECYPODA					
PELECYPODA (LPIL)	3	0	0	3	0.
UNGULINIDAE					
DIPLODONTA PUNCTATA	0	0	1	1	0.
LUCINIDAE					
LUCINA SOMBRERENSIS	0	0	4	4	0.
TELLINIDAE					
TELLINA TEXANA	8	5	13	26	4.
STRIGILLA MIRABILIS	4	4	0	8	1
GASTROPODA					
ACTEOCINIDAE					
ACTEOCINA CANDEI	1	0	0	1	0
CAECIDAE					
CAECUM PULCHELLUM	1	0	7	8	1
CAECUM IMBRICATUM	9	30	52	91	16
PARAMIDELLIDAE					
TURBONILLA (LPIL)	1	0	0	1	0
OLIVIDAE					
OLIVIDAE (LPIL)	0	1	0	1	0
OLIVELLA SP.B	4	1	2	7	1
ARTHROPODA (CRUSTACEA)					
ISOPODA					
IDOTEIDAE					
EDOTEA LYONSI	0	1	0	1	0
AMPHIPODA					
AMPHIPODA (LPIL)	0	0	2	2	0
AMPELISCIDAE					
AMPELISCA A[illegible]	0	0	[illegible]	[illegible]	0

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NCVEMBER 16,1983 STATICN: 3
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACRCFAUNA

:CMMENT.EPA.PENSACCLA.

TAXCN	REPA	REPB	REPC	TAXCN TCT.	% CF TCT.
AMPELISCA (LPIL)	0	0	1	1	0.2
PHCXCCEPHALIDAE					
METHARPINA FLCRIDANA	1	0	1	2	0.4
HAUSTCRIDAE					
HAUSTCRIDAE (LPIL)	0	0	1	1	0.2
PLATYISCHNCPIDAE					
PLATYISCHNCPIS SP.A	0	5	11	16	3.0
:UMACEA					
BCDCTRIIDAE					
CYCLASPIS SP.D	0	0	1	1	0.2
ECHINCDERMATA					
CCHINCIDEA					
ECHINCIDEA (LPIL)	0	2	10	12	2.2
CEPHALCCHCTDATA					
BRANCHICSTCMA FLCRIDAE	9	3	22	34	6.3

:CTE--LPIL-LCWEST PRACTICAL IDENTIFICATICN LEVEL

NUMBER INDIV. PER REPLICATE:	204	108	226
NUMBER TAXA PER REPLICATE:	30	24	50

CTAL NUMBER TAXA FCR STATICN: 62
TCTAL NUMBER INDIVIDUALS FCR STATICN: 538
EAN NUMBER INDIVIDUALS PER SQ. M: 2989 STD. DEVIATICN: 1046

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: NOVEMBER 16, 1983 STATION: 3
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 3.1689

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.7678

SPECIES RICHNESS (MARGALEF'S INDEX) D= 9.701

SPECIES-AREA RELATIONSHIPS

S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	30	*	C	50	*	B	24	*	A	30
B	38	*	A	58	*	C	56	*	C	58
C	62	*	B	62	*	A	62	*	B	62

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

END OF REPORT

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: 4
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
RHYNCHOCOELA					
RHYNCHOCOELA (LPIL)	0	2	5	7	0.9
CEREBRATULUS LACTEUS	1	0	1	2	0.2
ANNELIDA					
POLYCHAETA					
AMPHARETIDAE					
AMPHARETIDAE (LPIL)	0	0	1	1	0.1
CAPITELLIDAE					
CAPITELLIDAE (LPIL)	0	1	0	1	0.1
MEDIOMASTUS (LPIL)	0	1	1	2	0.2
NOTOMASTUS (LPIL)	0	0	2	2	0.2
CIRRATULIDAE					
CAULLERIELLA CF. ALATA	1	4	4	9	1.1
FLABELLIGERIDAE					
THEROCHAETA SP.A	0	0	1	1	0.1
GLYCERIDAE					
GLYCERA SP.I	1	0	0	1	0.1
HESIONIDAE					
GYPTIS BREVIPALPA	1	1	2	4	0.5
LUMBRINERIDAE					
LUMBRINERIS VERRILLI	1	1	2	4	0.5
LUMBRINERIS SP.D	4	3	2	9	1.1
MALDANIDAE					
BOGUEA ENIGMATICA	0	1	0	1	0.1
MAGELONIDAE					
MAGELONA SP.B	0	0	1	1	0.1
NEPHTYIDAE					
NEPHTYS PICTA	0	1	1	2	0.2
NEREIDAE					
NEREIDAE (LPIL)	0	0	1	1	0.1
NEREIS LAMELLOSA	0	0	1	1	0.1
NEREIS MICROMMA	0	1	2	3	0.4
EUNEREIS SP.A	0	3	0	3	0.4
OPHELIIDAE					
ARMANDIA MACULATA	4	10	2	16	2.0
OPHELIA DENTICULATA	5	6	16	27	3.3
ONUPHIDAE					
DIOPATRA CUPREA	0	0	4	4	0.5
ORBINIIDAE					
LEITOSCOLOPLOS FRAGILIS	0	3	0	3	0.4
PARAONIDAE					
PARAONIDAE (LPIL)	0	0	1	1	0.1
ARICIDEA SP.A	0	1	0	1	0.1
ARICIDEA WASSI	1	3	0	4	0.5
ARICIDEA SP.H	2	16	5	23	2.8
ARICIDEA (LPIL)	0	0	1	1	0.1
CIRROPHORUS (LPIL)	1	0	[illegible]	2	0.2
PARAONIS PYGOENIGMATICA	[illegible]	8	[illegible]	9	[illegible]

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: NOVEMBER 16,1983 STATION: 4
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
PILARGIDAE					
ANCISTROSYLLIS SP.C	1	1	3	5	0.6
SIGAMBRA BASSI	1	0	0	1	0.1
SIGAMBRA TENTACULATA	1	0	0	1	0.
SIGAMBRA (LPIL)	0	0	1	1	0.
SYNELMIS SP.B	2	2	1	5	0.6
PHYLLODOCIDAE					
PHYLLODOCIDAE (LPIL)	0	0	1	1	0.1
ETEONE LACTEA	1	0	2	3	0.4
PHYLLODOCE ARENAE	0	0	1	1	0.1
SPIONIDAE					
PARAPRIONOSPIO PINNATA	0	1	1	2	0.2
PRIONOSPIO CRISTATA	3	23	17	43	5.3
PRIONOSPIO (LPIL)	5	3	0	8	1.0
SPIO PETTIBONEAE	0	4	0	4	0.5
SPIOPHANES BOMBYX	0	0	2	2	0.2
SCOLELEPIS SQUAMATA	0	0	1	1	0.1
SYLLIDAE					
PARAPIONOSYLLIS LONGICIRRAT	0	1	1	2	0.2
BRANIA WELLFLEETENSIS	3	10	10	23	2.9
STREPTOSYLLIS PETTIBONEAE	2	2	1	5	0.6
EULEPETHIDAE					
EULEPETHIDAE (LPIL)	0	0	1	1	0.1
POLYGORDIIDAE					
POLYGORDIUS (LPIL)	45	4	196	245	30.3
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	20	16	9	45	5.5
MOLLUSCA					
PELECYPODA					
PELECYPODA (LPIL)	0	2	0	2	0.2
LUCINIDAE					
LUCINA SOMBRERENSIS	0	0	1	1	0.
TELLINIDAE					
TELLINA VERSICOLOR	2	2	2	6	0.
TELLINA TEXANA	3	4	4	11	1.
STRIGILLA MIRABILIS	0	2	2	4	0.
VENERIDAE					
MACROCALLISTA NIMBOSA	0	0	1	1	0.
MESODESMATIDAE					
ERVILIA CONCENTRICA	0	0	2	2	0.
GASTROPODA					
ACTEOCINIDAE					
ACTEOCINA CANDEI	0	1	0	1	0.
NASSARIIDAE					
NASSARIUS ACUTUS	0	0	2	2	0.
CAECIDAE					
CAECUM PULCHELLUM	3	2	15	20	2.
CAECUM IMBRICATUM	7	29	32	68	8.
CAECUM (LPIL)	1	0	0	1	0.

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION: 4
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
OLIVIDAE					
OLIVELLA SP.A	2	1	1	4	0.5
OLIVELLA SP.B	0	6	0	6	0.7
OLIVELLA (LPIL)	2	0	0	2	0.2
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
AMPHIPODA (LPIL)	0	2	0	2	0.2
AMPELISCIDAE					
AMPELISCA AGASSIZI	0	2	2	4	0.5
PHOXOCEPHALIDAE					
METHARPINA FLORIDANA	0	0	2	2	0.2
HAUSTORIIDAE					
PARAHAUSTORIUS OBLIQUUS	0	1	0	1	0.1
PLATYISCHNOPIDAE					
EUDEVENOPUS HONDURANUS	0	7	5	12	1.5
PLATYISCHNOPIS SP.A	6	0	0	6	0.7
MELITIDAE					
ELASMOPUS LEVIS	0	0	2	2	0.2
DECAPODA (REPTANTIA)					
ALBUNEIDAE					
ALBUNEA PARETII	0	0	1	1	0.1
ECHINODERMATA					
OPHIUROIDEA					
AMPHIURIDAE					
AMPHIURIDAE (LPIL)	0	1	0	1	0.1
ECHINOIDEA					
ECHINOIDEA (LPIL)	1	4	4	9	1.1
MELLITIDAE					
MELLITIDAE (LPIL)	0	10	3	13	1.6
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	31	15	34	80	9.9

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE: 164 224 421
NUMBER TAXA PER REPLICATE: 32 46 57

TOTAL NUMBER TAXA FOR STATION: 77
TOTAL NUMBER INDIVIDUALS FOR STATION: 809
MEAN NUMBER INDIVIDUALS PER SQ. M: 4495 STD. DEVIATION: 2241

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION: 4
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 3.0005

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.6908

SPECIES RICHNESS (MARGALEF'S INDEX) D= 11.350

SPECIES-AREA RELATIONSHIPS
S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	32	*	C	57	*	B	46	*	A	32
B	55	*	A	65	*	C	71	*	C	65
C	77	*	B	77	*	A	77	*	B	77

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

END OF REPORT

EPA PENSACCLA BENTHIC MACRCINFAUNAL ANALYSIS

SAMPLE DATE: NCVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATICN: 5
SAMPLE TYPE: MACRCFAUNA

CCMMENT.EPA.PENSACCLA.

TAXCN	REPA	REPB	REPC	TAXCN TCT.	% CF TCT.
RHYNCHCCCELA					
RHYNCHCCCELA SP.C	1	0	0	1	0.3
BRACHICPCDA					
GLCTTIDIA PYRAMIDATA	0	0	1	1	0.3
SIPUNCULA					
GCLFINGIIDAE					
GCLFINGIA (LPIL)	1	1	0	2	0.6
PHASCCLICN STRCMBI	1	0	0	1	0.3
ASPIDCSIPHCNIDAE					
ASPIDCSIPHCN ALBUS	1	0	0	1	0.3
ASPIDCSIPHCN GCSNCLDI	1	0	0	1	0.3
ANNELIDA					
PCLYCHAETA					
GLYCERIDAE					
GLYCERA SP.A	1	2	0	3	0.8
GLYCERA (LPIL)	1	0	3	4	1.
HESICNIDAE					
GYPTIS BREVIPALPA	0	2	0	2	0.6
HETERCPCDARKE CF HETERCMCRP	0	2	0	2	0.6
MALDANIDAE					
BCGUEA ENIGMATICA	2	5	7	14	3.
BCGUEA (LPIL)	3	0	0	3	0.8
NEPHTYIDAE					
NEPHTYS PICTA	0	0	2	2	0.
NEREIDAE					
NEREIDAE (LPIL)	0	1	3	4	1.1
CPHELIIDAE					
ARMANDIA MACULATA	1	1	2	4	1.1
CPHELIA DENTICULATA	1	2	1	4	1.1
CWENIIDAE					
CWENIA SP.A	1	0	1	2	0.6
CRBINIIDAE					
CRBINIIDAE (LPIL)	1	0	0	1	0.3
PARACNIDAE					
ARICIDEA SP.A	4	0	0	4	1.
ARICIDEA SP.H	0	4	0	4	1.
ARICIDEA (LPIL)	0	1	2	3	0.
PILARGIDAE					
ANCISTRCSYLLIS HARTMANAE	0	0	1	1	0.3
ANCISTRCSYLLIS SP.C	0	1	0	1	0.3
SIGAMBRA TENTACULATA	0	0	1	1	0.
SYNELMIS SP.B	2	0	0	2	0.
SPICNIDAE					
SPICNIDAE (LPIL)	4	0	0	4	1.
PRICNCSPIC CRISTATA	8	7	6	21	5.
SCCLELEPIS SCUAMATA	0	0	1	1	0.

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION:
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAU

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% TO
SYLLIDAE					
PARAPIONOSYLLIS LONGICIRRAT	2	0	0	2	0
BRANIA WELLFLEETENSIS	7	0	0	7	1
EXOGONE LOUREI	0	1	0	1	0
EULEPETHIDAE					
EULEPETHIDAE (LPIL)	0	0	1	1	0
PECTINARIIDAE					
AMPHICTENE SP.A	0	0	1	1	0
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	67	5	9	81	22
MOLLUSCA					
PELECYPODA					
UNGULINIDAE					
DIPLODONTA PUNCTATA	1	1	2	4	1
LUCINIDAE					
PARVILUCINA MULTILINEATA	1	0	1	2	0
LUCINA SOMBRERENSIS	2	0	0	2	0
TELLINIDAE					
TELLINA VERSICOLOR	1	3	6	10	2
TELLINA TEXANA	2	1	1	4	1
CRASSATELLIDAE					
CRASSINELLA LUNULATA	2	0	0	2	0
MESODESMATIDAE					
ERVILIA CONCENTRICA	1	1	1	3	0
GASTROPODA					
NATICIDAE					
NATICA PUSILLA	0	0	1	1	0
CAECIDAE					
CAECUM PULCHELLUM	0	1	13	14	
CAECUM IMBRICATUM	1	31	23	55	1
OLIVIDAE					
OLIVELLA SP.B	1	0	1	2	
SCAPHOPODA					
DENTALIIDAE					
DENTALIUM (LPIL)	0	0	1	1	
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
AMPHIPODA (LPIL)	1	0	0	1	
AMPELISCIDAE					
AMPELISCA AGASSIZI	0	2	0	2	
PHOXOCEPHALIDAE					
METHARPINA FLORIDANA	1	0	1	2	
HAUSTORIIDAE					
PARAHAUSTORIUS OBLIQUUS	0	0	1	1	
PLATYISCHNOPIDAE					
EUDEVENOPUS HONDURANUS	7	2	1	10	
DECAPODA (NATANTIA)					
PROCESSIDAE					

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1985 STATION: 5
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
PROCESSA HEMPHILLI	0	1	0	1	0.3
DECAPODA (REPTANTIA)					
ALBUNEIDAE					
ALBUNEA GIBBESII	0	1	0	1	0.3
ECHINODERMATA					
ECHINOIDEA					
ECHINOIDEA (LPIL)	2	1	6	9	2.5
MELLITIDAE					
MELLITIDAE (LPIL)	2	0	0	2	0.6
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	6	24	15	45	12.5

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE: 141 104 116
NUMBER TAXA PER REPLICATE: 35 26 31

TOTAL NUMBER TAXA FOR STATION: 56
TOTAL NUMBER INDIVIDUALS FOR STATION: 361
MEAN NUMBER INDIVIDUALS PER SQ. M: 2006 STD. DEVIATION: 315

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION: 5
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 2.9874

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.7421

SPECIES RICHNESS (MARGALEF'S INDEX) D= 9.340

SPECIES-AREA RELATIONSHIPS

S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	35	*	C	31	*	B	26	*	A	35
B	46	*	A	48	*	C	41	*	C	48
C	56	*	B	56	*	A	56	*	B	56

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

[illegible] OF REPORT

EPA PENSACCLA BENTHIC MACRCINFAUNAL ANALYSIS

SAMPLE DATE: NCVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATICN: 6
SAMPLE TYPE: MACRCFAUNA

CCMMENT.EPA.PENSACCLA.

TAXCN	REPA	REPB	REPC	TAXCN TCT.	% CF TCT.
RHYNCHCCCELA					
RHYNCHCCCELA SP.I	1	0	0	1	0.2
CEREBRATULUS LACTEUS	1	0	0	1	0.2
BRACHICPCDA					
GLCTTIDIA PYRAMIDATA	0	0	3	3	0.5
SIPUNCULA					
SIPUNCULA (LPIL)	2	0	0	2	0.3
GCLFINGIIDAE					
GCLFINGIA (LPIL)	1	0	0	1	0.2
PHASCCLICN STRCMBI	5	0	0	5	0.8
ASPIDCSIPHCNIDAE					
ASPIDCSIPHCN ALBUS	7	2	3	12	2.0
ASPIDCSIPHCN GCSNCLDI	3	6	1	10	1.7
ASPIDCSIPHCN (LPIL)	0	0	1	1	0.2
ANNELIDA					
PCLYCHAETA					
AMPHINCMIDAE					
PARAMPHINCME SP.B	0	1	0	1	0.2
CAPITELLIDAE					
CAPITELLIDAE (LPIL)	0	1	0	1	0.2
CAPITELLA CAPITATA	0	1	0	1	0.2
MEDICMASTUS (LPIL)	0	2	0	2	0.3
DCRVILLEIDAE					
SCHISTCMERINGCS PECTINATA	0	1	0	1	0.2
GLYCERIDAE					
GLYCERA SP.I	1	0	0	1	0.2
GLYCERA (LPIL)	3	0	0	3	0.5
GCNIADIDAE					
GCNIADIDES CARCLINAE	2	0	0	2	0.3
HESICNIDAE					
GYPTIS BREVIPALPA	2	1	0	3	0.5
LUMBRINERIDAE					
LUMBRINERIS VERRILLI	1	0	1	2	0.3
LUMBRINERIS SP.D	0	0	1	1	0.2
LUMBRINERIS (LPIL)	0	1	0	1	0.2
MAGELCNIDAE					
MAGELCNA SP.C	1	1	1	3	0.5
MAGELCNA (LPIL)	0	0	1	1	0.2
NEPHTYIDAE					
NEPHTYS PICTA	0	1	3	4	0.7
NEREIDAE					
NEREIDAE (LPIL)	0	2	1	3	0.5
NEREIS MICRCMMA	1	0	0	1	0.2
CPHELIIDAE					
ARMANDIA MACULATA	5	0	0	5	0.8
CPHELIA DENTICULATA	2	0	0	2	0.3

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: 6
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
ONUPHIDAE					
AMERICONUPHIS MAGNA	0	0	1	1	0.2
OWENIIDAE					
OWENIA SP.A	0	1	0	1	0.2
ORBINIIDAE					
ORBINIIDAE (LPIL)	1	1	0	2	0.3
PARAONIDAE					
ARICIDEA SP.H	4	0	0	4	0.7
ARICIDEA SP.C	0	1	0	1	0.2
ARICIDEA (LPIL)	2	0	0	2	0.[illegible]
CIRROPHORUS (LPIL)	2	2	0	4	0.7
PILARGIDAE					
ANCISTROSYLLIS HARTMANAE	3	0	0	3	0.
ANCISTROSYLLIS SP.C	0	1	0	1	0.
SIGAMBRA BASSI	0	1	0	1	0.
SIGAMBRA TENTACULATA	0	7	0	7	1.
SYNELMIS SP.B	1	1	0	2	0.
SPIONIDAE					
SPIONIDAE (LPIL)	16	1	0	17	2.
PRIONOSPIO CRISTATA	47	5	1	53	8.
SPIOPHANES BOMBYX	0	0	1	1	0.
AONIDES CF. PAUCIBRANCHIATA	4	0	0	4	0.
MICROSPIO PIGMENTATA	0	1	0	1	0.
SYLLIDAE					
PARAPIONOSYLLIS LONGICIRRAT	1	0	0	1	0.
BRANIA WELLFLEETENSIS	4	0	0	4	0.
STREPTOSYLLIS PETTIBONEAE	1	0	0	1	0.
TEREBELLIDAE					
POLYCIRRUS (LPIL)	1	0	0	1	0.
TYPHLOSCOLECIDAE					
TYPHLOSCOLECIDAE (LPIL)	0	1	0	1	0.
PECTINARIIDAE					
PECTINARIA REGALIS	1	0	0	1	0.
AMPHICTENE SP.A	0	0	1	1	0.
POLYGORDIIDAE					
POLYGORDIUS (LPIL)	1	0	20	21	3.
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	8	146	0	154	25
MOLLUSCA					
PELECYPODA					
PELECYPODA (LPIL)	2	0	0	2	0
UNGULINIDAE					
DIPLODONTA PUNCTATA	2	0	0	2	0
LUCINIDAE					
PARVILUCINA MULTILINEATA	0	2	0	2	0
LUCINA SOMBRERENSIS	1	1	0	2	0
TELLINIDAE					
TELLINA VERSICOLOR	2	0	0	2	0
TELLINA TEXANA	[illegible]	0	[illegible]	6	[illegible]

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION: 6
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
MESODESMATIDAE					
ERVILIA CONCENTRICA	4	0	0	4	0.7
GASTROPODA					
NATICIDAE					
NATICA PUSILLA	2	0	0	2	0.3
COLUMBELLIDAE					
ANACHIS OBESA	0	0	2	2	0.3
CAECIDAE					
CAECUM PULCHELLUM	18	41	2	61	10.1
CAECUM IMBRICATUM	18	53	15	86	14.3
PYRAMIDELLIDAE					
PYRAMIDELLIDAE (LPIL)	1	0	0	1	0.2
TURBONILLA (LPIL)	3	0	0	3	0.5
OLIVIDAE					
OLIVELLA SP.A	0	0	1	1	0.2
OLIVELLA SP.B	1	0	0	1	0.2
OLIVELLA (LPIL)	1	0	1	2	0.3
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
PHOXOCEPHALIDAE					
METHARPINA FLORIDANA	2	0	0	2	0.3
DECAPODA (REPTANTIA)					
ALBUNEIDAE					
ALBUNEA PARETII	0	0	1	1	0.2
ECHINODERMATA					
OPHIUROIDEA					
AMPHIURIDAE					
AMPHIURIDAE (LPIL)	1	0	0	1	0.2
ECHINOIDEA					
ECHINOIDEA (LPIL)	4	0	0	4	0.7
MELLITIDAE					
MELLITIDAE (LPIL)	1	0	1	2	0.3
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	48	0	0	48	8.0

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE: 248 286 69
NUMBER TAXA PER REPLICATE: 50 29 23

TOTAL NUMBER TAXA FOR STATION: 76
TOTAL NUMBER INDIVIDUALS FOR STATION: 603
MEAN NUMBER INDIVIDUALS PER SQ. M: 3350 STD. DEVIATION: 1931

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16, 1985 STATION: 6
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 2.9128

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.6726

SPECIES RICHNESS (MARGALEF'S INDEX) D= 11.715

SPECIES-AREA RELATIONSHIPS

S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	50	*	C	23	*	B	29	*	A	50
B	66	*	A	62	*	C	44	*	C	62
C	76	*	B	76	*	A	76	*	B	76

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

END OF REPORT

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: 7
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
RHYNCHOCOELA					
RHYNCHOCOELA SP.A	0	0	1	1	0.4
RHYNCHOCOELA (LPIL)	0	1	0	1	0.4
SIPUNCULA					
SIPUNCULA (LPIL)	1	0	0	1	0.4
ANNELIDA					
POLYCHAETA					
DORVILLEIDAE					
SCHISTOMERINGOS PECTINATA	0	0	1	1	0.4
GLYCERIDAE					
GLYCERIDAE (LPIL)	3	0	0	3	1.3
GLYCERA SP.A	0	0	2	2	0.9
MALDANIDAE					
BOGUEA ENIGMATICA	4	5	9	18	7.9
NEPHTYIDAE					
NEPHTYS PICTA	1	1	1	3	1.3
NEREIDAE					
NEREIDAE (LPIL)	1	0	1	2	0.9
NEREIS MICROMMA	0	0	2	2	0.9
EUNEREIS SP.A	0	5	0	5	2.2
OPHELIIDAE					
ARMANDIA MACULATA	1	4	2	7	3.1
OPHELIA DENTICULATA	2	5	1	8	3.5
ORBINIIDAE					
LEITOSCOLOPLOS (LPIL)	3	0	0	3	1.3
PARAONIDAE					
PARAONIDAE (LPIL)	1	0	2	3	1.3
ARICIDEA SP.H	0	9	0	9	3.9
PARAONIS PYGOENIGMATICA	1	0	0	1	0.4
SPIONIDAE					
PRIONOSPIO CRISTATA	24	4	5	33	14.4
SPIOPHANES BOMBYX	0	0	1	1	0.4
SYLLIDAE					
BRANIA WELLFLEETENSIS	2	1	0	3	1.3
EXOGONE LOUREI	5	1	4	10	4.4
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	34	7	24	65	28.4
MOLLUSCA					
PELECYPODA					
PELECYPODA (LPIL)	0	0	1	1	0.4
LUCINIDAE					
LUCINIDAE (LPIL)	2	0	0	2	0.9
LUCINA SOMBRERENSIS	0	0	5	5	2.2
TELLINIDAE					
TELLINA VERSICOLOR	2	2	3	7	3.1
STRIGILLA MIRABILIS	3	1	0	4	1.7

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: NOVEMBER 16,1983 STATION: 7
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
VENERIDAE					
VENERIDAE (LPIL)	2	0	0	2	0.9
PANDORIDAE					
PANDORA TRILINEATA	0	0	1	1	0.4
ASTROPODA					
CAECIDAE					
CAECUM (LPIL)	0	2	0	2	0.9
OLIVIDAE					
OLIVELLA SP.A	2	1	0	3	1.3
OLIVELLA SP.B	1	0	0	1	0.4
OLIVELLA (LPIL)	1	0	0	1	0.4
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
AMPELISCIDAE					
AMPELISCA AGASSIZI	0	0	2	2	0.[illegible]
HAUSTORIIDAE					
PARAHAUSTORIUS OBLIQUUS	0	0	3	3	1.[illegible]
PLATYISCHNOPIDAE					
PLATYISCHNOPIS SP.A	0	0	2	2	0.[illegible]
ECHINODERMATA					
ECHINOIDEA					
ECHINOIDEA (LPIL)	0	0	1	1	0.[illegible]
MELLITIDAE					
MELLITIDAE (LPIL)	1	1	0	2	0.[illegible]
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	1	0	6	7	3.[illegible]
BRANCHIOSTOMA (LPIL)	0	1	0	1	0.[illegible]

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE:	98	51	80
NUMBER TAXA PER REPLICATE:	23	17	23

TOTAL NUMBER TAXA FOR STATION: 40
TOTAL NUMBER INDIVIDUALS FOR STATION: 229
MEAN NUMBER INDIVIDUALS PER SQ. M: 1273 STD. DEVIATION: 395

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION: 7
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 2.8301

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.7672

SPECIES RICHNESS (MARGALEF'S INDEX) D= 7.177

SPECIES-AREA RELATIONSHIPS

S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W		*	X		*	Y		*	Z	
R	S	*	R	S	*	R	S	*	R	S
A	23	*	C	23	*	B	17	*	A	23
B	28	*	A	35	*	C	32	*	C	35
C	40	*	B	40	*	A	40	*	B	40

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

END OF REPORT

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 10,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: 5
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
RHYNCHOCOELA					
RHYNCHOCOELA (LPIL)	1	0	0	1	0.4
BRACHIOPODA					
GLOTTIDIA PYRAMIDATA	0	0	2	2	0.8
SIPUNCULA					
GOLFINGIIDAE					
GOLFINGIA (LPIL)	0	3	3	6	2.3
ASPIDOSIPHONIDAE					
ASPIDOSIPHON ALBUS	1	0	3	4	1.5
ASPIDOSIPHON (LPIL)	0	1	0	1	0.4
ANNELIDA					
POLYCHAETA					
CAPITELLIDAE					
CAPITELLIDAE (LPIL)	0	0	1	1	0.4
MEDIOMASTUS CALIFORNIENSIS	0	0	3	3	1.
MEDIOMASTUS (LPIL)	1	4	2	7	2.
CIRRATULIDAE					
CIRRIFORMIA (LPIL)	0	0	1	1	0.4
EUNICIDAE					
EUNICIDAE (LPIL)	0	0	1	1	0.4
FLABELLIGERIDAE					
THEROCHAETA SP.A	0	0	1	1	0.4
GLYCERIDAE					
GLYCERA SP.I	1	0	1	2	0.8
GLYCERA (LPIL)	0	0	1	1	0.4
HESIONIDAE					
GYPTIS BREVIPALPA	0	0	3	3	1.
HETEROPODARKE CF HETEROMORP	0	1	0	1	0.
LUMBRINERIDAE					
LUMBRINERIS VERRILLI	1	3	6	10	3.
LUMBRINERIS SP.D	0	3	4	7	2.
MALDANIDAE					
ASYCHIS ELONGATUS	0	0	1	1	0.
CLYMENELLA TORQUATA	0	0	1	1	0.
BOGUEA ENIGMATICA	1	0	0	1	0.
MAGELONIDAE					
MAGELONA SP.C	0	1	1	2	0.
NEPHTYIDAE					
NEPHTYS PICTA	2	0	2	4	1.
NEREIDAE					
NEREIDAE (LPIL)	1	1	13	15	5.
CERATONEREIS SP.A	0	0	2	2	0.
NEREIS LAMELLOSA	0	0	1	1	0.
NEREIS MICROMMA	0	1	2	3	1.
NEREIS RIISEI	0	0	1	1	0.
NEREIS (LPIL)	0	0	1	1	0.

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: 7
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
OPHELIIDAE					
ARMANDIA MACULATA	1	0	0	1	0.4
OPHELIA DENTICULATA	0	1	1	2	0.8
ONUPHIDAE					
DIOPATRA CUPREA	0	0	3	3	1.1
DIOPATRA (LPIL)	0	0	2	2	0.8
OWENIIDAE					
OWENIA SP.A	1	0	2	3	1.1
ORBINIIDAE					
ORBINIIDAE (LPIL)	1	0	0	1	0.4
PARAONIDAE					
PARAONIDAE (LPIL)	1	0	0	1	0.4
ARICIDEA SP.C	1	0	2	3	1.1
ARICIDEA SP.E	0	1	0	1	0.4
ARICIDEA SP.H	0	0	1	1	0.4
CIRROPHORUS (LPIL)	0	1	4	5	1.9
PILARGIDAE					
SIGAMBRA TENTACULATA	0	3	0	3	1.1
SYNELMIS SP.B	0	0	1	1	0.4
SIGALIONIDAE					
FIMBRIOSTHENELAIS MINOR	0	0	2	2	0.8
SPIONIDAE					
SPIONIDAE (LPIL)	1	0	0	1	0.4
PARAPRIONOSPIO PINNATA	0	1	0	1	0.4
PRIONOSPIO CRISTATA	3	6	5	14	5.3
LAONICE CIRRATA	0	0	2	2	0.8
SYLLIDAE					
TYPOSYLLIS AMICA	1	0	0	1	0.4
TEREBELLIDAE					
TEREBELLIDAE (LPIL)	0	0	2	2	0.8
PECTINARIIDAE					
AMPHICTENE SP.A	0	0	1	1	0.4
POLYGORDIIDAE					
POLYGORDIUS (LPIL)	15	0	3	18	6.8
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	2	2	1	5	1.9
MOLLUSCA					
PELECYPODA					
LUCINIDAE					
LUCINIDAE (LPIL)	1	0	2	3	1.1
LUCINA SOMBRERENSIS	0	1	0	1	0.4
TELLINIDAE					
TELLINIDAE (LPIL)	0	0	1	1	0.4
TELLINA TEXANA	3	2	0	5	1.9
STRIGILLA MIRABILIS	1	0	0	1	0.4
CORBULIDAE					
VARICORBULA OPERCULATA	0	0	1	1	0.4
VENERIDAE					
PITAR FULMINATUS	0	1	0	1	0.4

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFAUN

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT
CRASSATELLIDAE					
CRASSINELLA LUNULATA	0	1	0	1	0.
GASTROPODA					
NATICIDAE					
NATICA PUSILLA	1	0	0	1	0.
COLUMBELLIDAE					
ANACHIS OBESA	0	0	1	1	0.
BUCCINIDAE					
CANTHARUS CANCELLARIUS	0	0	1	1	0.
CAECIDAE					
CAECUM PULCHELLUM	4	1	2	7	2.
CAECUM IMBRICATUM	24	15	9	48	13.
PYRAMIDELLIDAE					
PYRAMIDELLIDAE (LPIL)	1	0	0	1	0.
OLIVIDAE					
OLIVA SAYANA	1	1	0	2	0.
OLIVELLA SP.C	1	0	0	1	0.
OLIVELLA (LPIL)	1	0	0	1	0.
SCAPHOPODA					
DENTALIIDAE					
DENTALIUM (LPIL)	0	1	1	2	0.
SIPHONODENTALIIDAE					
CADULUS TETRADON	0	1	0	1	0.
ARTHROPODA (CRUSTACEA)					
ISOPODA					
IDOTEIDAE					
EDOTEA MONTOSA	0	0	1	1	0.
AMPHIPODA					
AMPELISCIDAE					
AMPELISCA AGASSIZI	0	0	1	1	0.
AMPELISCA SP.C	0	0	1	1	0.
PHOXOCEPHALIDAE					
METHARPINA FLORIDANA	1	0	0	1	0.
HAUSTORIIDAE					
HAUSTORIIDAE (LPIL)	1	1	0	2	0.
PLATYISCHNOPIDAE					
EUDEVENOPUS HONDURANUS	1	1	0	2	0.
TANAIDACEA					
PARATANAIDAE					
LEPTOCHELIA SP.A	0	0	1	1	0.
DECAPODA (NATANTIA)					
PROCESSIDAE					
PROCESSA HEMPHILLI	0	0	1	1	0.
DECAPODA (REPTANTIA)					
PINNOTHERIDAE					
DISSODACTYLUS MELLITAE	1	0	0	1	0.
ALBUNEIDAE					
ALBUNEA GIBBESII	1	0	0	1	0.
THRACODA					

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1985 STATION: 9
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
OSTRACODA (LPIL)	0	1	1	2	0.8
ECHINODERMATA					
OPHIUROIDEA					
OPHIUROIDEA (LPIL)	0	0	1	1	0.4
ECHINOIDEA					
ECHINOIDEA (LPIL)	1	0	3	4	1.5
MELLITIDAE					
ENCOPE MICHELINI	1	0	0	1	0.4
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	2	1	3	6	2.3

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE: 83 61 120
NUMBER TAXA PER REPLICATE: 36 29 56

TOTAL NUMBER TAXA FOR STATION: 85
TOTAL NUMBER INDIVIDUALS FOR STATION: 264
MEAN NUMBER INDIVIDUALS PER SQ. M: 1467 STD. DEVIATION: 497

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: NOVEMBER 10,1989 STATION:
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAU

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 3.7299

PECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.8396

PECIES RICHNESS (MARGALEF'S INDEX) D= 15.065

SPECIES-AREA RELATIONSHIPS

S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	36	*	C	56	*	B	29	*	A	36
B	53	*	A	76	*	C	69	*	C	76
C	85	*	B	85	*	A	85	*	B	85

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

END OF REPORT

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M
STATION:
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
RHYNCHOCOELA					
RHYNCHOCOELA SP.C	0	1	0	1	0.2
ANNELIDA					
POLYCHAETA					
AMPHINOMIDAE					
PARAMPHINOME SP.B	0	0	1	1	0.2
CAPITELLIDAE					
NOTOMASTUS (LPIL)	1	0	2	3	0.6
CIRRATULIDAE					
CIRRIFORMIA (LPIL)	0	1	0	1	0.2
CAULLERIELLA CF. ALATA	0	1	0	1	0.2
HESIONIDAE					
GYPTIS BREVIPALPA	1	1	0	2	0.4
LUMBRINERIDAE					
LUMBRINERIS VERRILLI	1	3	3	7	1.4
MALDANIDAE					
MALDANIDAE (LPIL)	0	0	1	1	0.2
MAGELONIDAE					
MAGELONA SP.C	0	1	0	1	0.2
NEREIDAE					
NEREIDAE (LPIL)	0	0	2	2	0.4
NEREIS MICROMMA	0	0	1	1	0.2
OPHELIIDAE					
ARMANDIA MACULATA	1	4	0	5	1.0
ARMANDIA AGILIS	0	1	0	1	0.2
OPHELIA DENTICULATA	1	11	0	12	2.5
ONUPHIDAE					
DIOPATRA CUPREA	0	0	1	1	0.2
ORBINIIDAE					
SCOLOPLOS RUBRA	0	2	0	2	0.4
PARAONIDAE					
ARICIDEA SP.H	11	41	1	53	11.0
ARICIDEA (LPIL)	2	4	1	7	1.4
PARAONIS PYGOENIGMATICA	1	0	0	1	0.2
PILARGIDAE					
ANCISTROSYLLIS SP.C	0	2	0	2	0.4
SIGAMBRA TENTACULATA	0	1	0	1	0.2
SYNELMIS SP.B	1	1	0	2	0.4
PHYLLODOCIDAE					
ETEONE LACTEA	1	1	0	2	0.4
SPIONIDAE					
SPIONIDAE (LPIL)	0	1	0	1	0.2
PRIONOSPIO CRISTATA	2	12	4	18	3.7
SCOLELEPIS SQUAMATA	0	1	0	1	0.2
SYLLIDAE					
BRANIA WELLFLEETENSIS	0	7	0	7	1.4
TEREBELLIDAE					
TEREBELLIDAE (LPIL)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% TOT.
EULEPETHIDAE					
EULEPETHIDAE (LPIL)	0	1	0	1	0.
PECTINARIIDAE					
AMPHICTENE SP.A	0	0	1	1	0.
POLYGORDIIDAE					
POLYGORDIUS (LPIL)	10	207	0	217	44.
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	1	12	11	24	5.
MOLLUSCA					
PELECYPODA					
LUCINIDAE					
PARVILUCINA (LPIL)	0	1	1	2	0.
TELLINIDAE					
TELLINA TEXANA	2	0	0	2	0.
TELLINA (LPIL)	1	6	0	7	1.
STRIGILLA MIRABILIS	1	1	1	3	0.
GASTROPODA					
NATICIDAE					
NATICA PUSILLA	0	2	0	2	0.
NASSARIIDAE					
NASSARIUS ACUTUS	0	3	1	4	0.
CAECIDAE					
CAECUM PULCHELLUM	0	0	2	2	0.
CAECUM IMBRICATUM	1	0	5	6	1.
PYRAMIDELLIDAE					
PYRAMIDELLIDAE (LPIL)	0	1	0	1	0.
OLIVIDAE					
OLIVELLA SP.A	0	3	0	3	0.
OLIVELLA SP.B	3	3	0	6	1.
OLIVELLA (LPIL)	0	4	4	8	1.
GASTROCHAENIDAE					
GASTROCHAENA HIANS	0	1	0	1	0.
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
OEDICEROTIDAE					
SYNCHELIDIUM AMERICANUM	0	1	0	1	0.
LILJEBORGIIDAE					
LISTRIELLA BARNARDI	0	2	0	2	0.
PHOXOCEPHALIDAE					
METHARPINA FLORIDANA	0	1	0	1	0.
HAUSTORIIDAE					
ACANTHOHAUSTORIUS SP.B	0	4	0	4	0.
PROTOHAUSTORIUS SP.B	1	5	0	6	1.
PLATYISCHNOPIDAE					
EUDEVENOPUS HONDURANUS	2	4	0	6	1.
MELITIDAE					
ELASMOPUS (LPIL)	0	0	1	1	0.
DECAPODA (REPTANTIA)					

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1965 STATION: ?
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
ALBUNEIDAE					
ALBUNEA PARETII	1	2	0	3	0.6
PAGURIDAE					
PAGURIDAE (LPIL)	0	0	8	8	1.7
ECHINODERMATA					
OPHIUROIDEA					
AMPHIURIDAE					
AMPHIURIDAE (LPIL)	0	3	0	3	0.6
ECHINOIDEA					
ECHINOIDEA (LPIL)	2	2	0	4	0.8
MELLITIDAE					
MELLITIDAE (LPIL)	5	4	0	9	1.9
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	0	7	0	7	1.4
BRANCHIOSTOMA (LPIL)	1	0	0	1	0.2

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE: 54 378 52
NUMBER TAXA PER REPLICATE: 24 45 20

TOTAL NUMBER TAXA FOR STATION: 59
TOTAL NUMBER INDIVIDUALS FOR STATION: 484
MEAN NUMBER INDIVIDUALS PER SQ. M: 2689 STD. DEVIATION: 3127

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: NOVEMBER 16,1983 STATION:
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 2.5528

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.6261

PECIES RICHNESS (MARGALEF'S INDEX) D= 9.382

SPECIES-AREA RELATIONSHIPS

S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	24	*	C	20	*	B	45	*	A	24
B	50	*	A	36	*	C	56	*	C	36
C	59	*	B	59	*	A	59	*	B	59

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA [illegible]

END OF REPORT

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: 10
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
RHYNCHOCOELA					
RHYNCHOCOELA (LPIL)	1	0	0	1	0.9
SIPUNCULA					
GOLFINGIIDAE					
PHASCOLION STROMBI	1	0	0	1	0.9
ASPIDOSIPHONIDAE					
ASPIDOSIPHON ALBUS	0	1	0	1	0.9
ANNELIDA					
POLYCHAETA					
DORVILLEIDAE					
PROTODORVILLEA KEFERSTEINI	1	0	0	1	0.9
GLYCERIDAE					
GLYCERA SP.I	1	0	0	1	0.9
LUMBRINERIDAE					
LUMBRINERIS SP.D	1	0	0	1	0.9
NEPHTYIDAE					
NEPHTYS PICTA	1	2	0	3	2.7
OPHELIIDAE					
ARMANDIA MACULATA	0	0	1	1	0.9
PARAONIDAE					
ARICIDEA SP.A	2	0	0	2	1.8
ARICIDEA SP.H	3	4	3	10	9.1
ARICIDEA (LPIL)	1	1	0	2	1.8
PARAONIS PYGOENIGMATICA	6	5	14	25	22.7
PILARGIDAE					
SYNELMIS SP.B	3	1	0	4	3.6
SPIONIDAE					
SPIONIDAE (LPIL)	1	0	0	1	0.9
SYLLIDAE					
PARAPIONOSYLLIS LONGICIRRAT	0	1	0	1	0.9
BRANIA WELLFLEETENSIS	1	0	0	1	0.9
EXOGONE LOUREI	1	0	2	3	2.7
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	1	7	2	10	9.1
MOLLUSCA					
PELECYPODA					
PELECYPODA (LPIL)	1	0	3	4	3.6
LUCINIDAE					
LUCINA SOMBRERENSIS	2	1	2	5	4.5
TELLINIDAE					
TELLINIDAE (LPIL)	4	0	0	4	3.6
TELLINA TEXANA	0	3	0	3	2.7
STRIGILLA MIRABILIS	0	0	1	1	0.9
GASTROPODA					
CAECIDAE					
CAECUM JOHNSONI	1	0	0	1	0.9

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16, 1983 STATION:
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAU[illegible]

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% TOT
OLIVIDAE					
OLIVELLA SP.D	0	0	2	2	[illegible]
OLIVELLA (LPIL)	0	0	1	[illegible]	0.
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
AMPELISCIDAE					
AMPELISCA AGASSIZI	0	1	0	[illegible]	0.
HAUSTORIIDAE					
ACANTHOHAUSTORIUS SIMILIS	0	1	0	1	0.
PARAHAUSTORIUS OBLIQUUS	0	0	1	1	0.
CUMACEA					
CUMACEA (LPIL)	0	0	1	1	0.
DECAPODA (NATANTIA)					
PROCESSIDAE					
PROCESSA HEMPHILLI	1	0	0	1	0.
ECHINODERMATA					
OPHIUROIDEA					
ECHINOIDEA (LPIL)	3	0	0	3	2.
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	8	2	2	12	10.

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL.

NUMBER INDIV. PER REPLICATE: 45 30 35
NUMBER TAXA PER REPLICATE: 22 13 13

TOTAL NUMBER TAXA FOR STATION: 33
TOTAL NUMBER INDIVIDUALS FOR STATION: 110
MEAN NUMBER INDIVIDUALS PER SQ. M: 612 STD. DEVIATION: 127

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: 10
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 2.8971

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.8286

SPECIES RICHNESS (MARGALEF'S INDEX) D= 6.808

SPECIES-AREA RELATIONSHIPS

S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	22	*	C	13	*	B	13	*	A	22
B	27	*	A	28	*	C	21	*	C	28
C	33	*	B	33	*	A	33	*	B	33

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36...

END OF REPORT

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: NOVEMBER 16, 1983
AMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFAU

CMMENT.EPA.PENSACCLA.

TAXCN	REPA	REPB	REPC	TAXCN TCT.	% C TCT
CNIDARIA					
ANTHCZCA					
ACTINIARIA (LPIL)	0	0	2	2	0.
PLATYHELMINTHES					
TURBELLARIA					
TURBELLARIA (LPIL)	1	0	0	1	0.
RHYNCHCCCELA					
RHYNCHOCCELA SP.A	1	0	0	1	0.
RHYNCHCCCELA SP.C	1	0	0	1	0.
RHYNCHCCCELA (LPIL)	0	0	2	2	0.
CEREBRATULUS LACTEUS	1	0	0	1	0.
BRACHICPCDA					
GLCTTIDIA PYRAMIDATA	1	0	0	1	0.
PHCRCNIDA					
PHCRCNIS (LPIL)	0	0	1	1	0.
ANNELIDA					
PCLYCHAETA					
CAPITELLIDAE					
NCTCMASTUS (LPIL)	0	0	1	1	0.
MASTCBRANCHUS SP.A	2	0	0	2	0.
GLYCERIDAE					
GLYCERA SP.A	1	0	0	1	0.
GLYCERA (LPIL)	0	0	1	1	0.
HESICNIDAE					
HESICNIDAE (LPIL)	4	0	0	4	0.
LUMBRINERIDAE					
LUMBRINERIS VERRILLI	3	0	0	3	0.
MALDANIDAE					
MALDANIDAE (LPIL)	1	0	0	1	0.
MAGELCNIDAE					
MAGELCNA SP.B	0	0	2	2	0.
NEPHTYIDAE					
NEPHTYS PICTA	0	2	2	4	0.
NEREIDAE					
NEREIDAE (LPIL)	2	2	0	4	0.
CPHELIIDAE					
ARMANDIA MACULATA	0	0	2	2	0.
CPHELIA DENTICULATA	14	1	4	19	3.
CNUPHIDAE					
CNUPHIDAE (LPIL)	0	0	1	1	0.
CRBINIIDAE					
LEITCSCCLCPLCS (LPIL)	1	0	0	1	0.
PARACNIDAE					
ARICIDEA SP.A	[illegible]	0	[illegible]	[illegible]	0.

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: 1
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
ARICIDEA WASSI	1	0	1	2	0.4
ARICIDEA SP.H	10	10	8	28	5.6
PARAONIS PYGOENIGMATICA	20	8	5	33	6.6
PILARGIDAE					
SYNELMIS SP.B	1	3	2	6	1.2
SPIONIDAE					
SPIONIDAE (LPIL)	1	0	0	1	0.2
POLYDORA LIGNI	1	0	0	1	0.2
PRIONOSPIO CRISTATA	61	8	12	81	16.3
SYLLIDAE					
PARAPIONOSYLLIS LONGICIRRAT	0	0	1	1	0.2
BRANIA WELLFLEETENSIS	14	1	2	17	3.4
STREPTOSYLLIS PETTIBONEAE	0	0	2	2	0.4
EXOGONE LOUREI	35	7	23	65	13.1
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	45	18	1	64	12.9
MOLLUSCA					
PELECYPODA					
PELECYPODA (LPIL)	1	0	2	3	0.6
LUCINIDAE					
LUCINIDAE (LPIL)	0	2	0	2	0.4
LUCINA SOMBRERENSIS	1	0	4	5	1.0
TELLINIDAE					
TELLINA VERSICOLOR	0	0	3	3	0.6
TELLINA TEXANA	0	0	3	3	0.6
TELLINA (LPIL)	2	0	0	2	0.4
VENERIDAE					
CHIONE (LPIL)	2	0	1	3	0.6
MESOMESMATIDAE					
ERVILIA CONCENTRICA	7	0	9	16	3.2
GASTROPODA					
NATICIDAE					
NATICA PUSILLA	1	0	0	1	0.2
ACTEOCINIDAE					
ACTEOCINA CANDEI	1	0	2	3	0.6
CAECIDAE					
CAECUM JOHNSONI	0	0	1	1	0.2
CAECUM PULCHELLUM	2	6	6	14	2.8
CAECUM IMBRICATUM	4	2	20	26	5.2
OLIVIDAE					
OLIVELLA SP.B	1	0	2	3	0.6
SCAPHOPODA					
DENTALIIDAE					
DENTALIUM (LPIL)	2	0	0	2	0.4
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
AMPELISCIDAE					
AMPELISCA AGASSIZI	2	0	2	4	0.8

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION:
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAU

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% TO
OEDICEROTIDAE					
OEDICEROTIDAE (LPIL)	1	0	0	1	0.
LILJEBORGIIDAE					
LISTRIELLA BARNARDI	1	0	0	1	0.
PHOXOCEPHALIDAE					
METHARPINA FLORIDANA	1	0	0	1	0.
HAUSTORIIDAE					
HAUSTORIIDAE (LPIL)	2	0	0	2	0.
ACANTHOHAUSTORIUS SIMILIS	2	0	0	2	0.
PROTOHAUSTORIUS BOUSFIELDI	2	0	0	2	0.
PLATYISCHNOPIDAE					
EUDEVENOPUS HONDURANUS	9	1	4	14	2.
DECAPODA (REPTANTIA)					
ALBUNEIDAE					
ALBUNEA GIBBESII	0	1	0	1	0
ECHINODERMATA					
ECHINOIDEA					
ECHINOIDEA (LPIL)	6	0	2	8	.
CEPHALOCHORDATA					
BRANCHIOSTOMA FLORIDAE	14	2	1	17	3.

OTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE: 286 74 138
NUMBER TAXA PER REPLICATE: 44 16 36

TOTAL NUMBER TAXA FOR STATION: 61
TOTAL NUMBER INDIVIDUALS FOR STATION: 498
MEAN NUMBER INDIVIDUALS PER SQ. M: 2767 STD. DEVIATION: 1812

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: NOVEMBER 16,1983 STATION: 11
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

CMMENT.EPA.PENSACCLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 3.0859

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.7507

PECIES RICHNESS (MARGALEF'S INDEX) D= 9.661

SPECIES-AREA RELATIONSHIPS
S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W		*	X		*	Y		*	Z	
R	S	*	R	S	*	R	S	*	R	S
A	44	*	C	36	*	B	16	*	A	44
B	47	*	A	59	*	C	39	*	C	59
C	61	*	B	61	*	A	61	*	B	61

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

END OF REPORT

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: [illegible]
SAMPLE TYPE: MACROFAU[illegible]

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% TOT.
RHYNCHOCOELA					
CEREBRATULUS LACTEUS	0	2	0	2	0.
BRACHIOPODA					
GLOTTIDIA PYRAMIDATA	0	1	0	1	0.
SIPUNCULA					
ASPIDOSIPHONIDAE					
ASPIDOSIPHON GOSNOLDI	2	0	0	2	0.
ANNELIDA					
POLYCHAETA					
CIRRATULIDAE					
CIRRATULIDAE (LPIL)	0	0	1	1	0.
THARYX CF. ANNULOSUS	0	0	1	1	0.
GLYCERIDAE					
GLYCERA SP.A	0	3	1	4	1.
HESIONIDAE					
HETEROPODARKE CF HETEROMORP	0	0	1	1	0.
LUMBRINERIDAE					
LUMBRINERIS SP.D	2	2	0	4	1.
MAGELONIDAE					
MAGELONA SP.B	0	0	2	2	0.
NEPHTYIDAE					
NEPHTYS PICTA	1	1	3	5	1.
NEREIDAE					
NEREIDAE (LPIL)	2	1	0	3	0.
OPHELIIDAE					
ARMANDIA MACULATA	0	2	0	2	0.
OPHELIA DENTICULATA	0	3	2	5	1.
ONUPHIDAE					
ONUPHIDAE (LPIL)	0	1	0	1	0.
PARAONIDAE					
ARICIDEA SP.H	0	1	0	1	0.
PARAONIS PYGOENIGMATICA	1	4	0	5	1.
PILARGIDAE					
SYNELMIS SP.B	0	0	6	6	1.
SPIONIDAE					
SPIONIDAE (LPIL)	0	2	0	2	0.
PRIONOSPIO CRISTATA	0	0	3	3	0.
SPIOPHANES BOMBYX	0	1	0	1	0.
SYLLIDAE					
BRANIA WELLFLEETENSIS	0	1	1	2	0.
STREPTOSYLLIS PETTIBONEAE	0	0	1	1	0.
EXOGONE LOUREI	2	0	2	4	1.
POLYGORDIIDAE					
POLYGORDIUS (LPIL)	0	0	1	1	0.
OLIGOCHAETA					
OLIGOCHAETA (LPIL)	0	1	1	2	0.

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1985 STATION: 12
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
MOLLUSCA					
PELECYPODA					
PELECYPODA (LPIL)	0	0	1	1	0.2
LUCINIDAE					
LUCINA SOMBRERENSIS	0	1	3	4	1.0
TELLINIDAE					
TELLINA VERSICOLOR	4	3	15	22	5.3
TELLINA TEXANA	1	3	6	10	2.4
STRIGILLA MIRABILIS	1	0	0	1	0.2
VENERIDAE					
VENERIDAE (LPIL)	0	1	0	1	0.2
MESODESMATIDAE					
ERVILIA CONCENTRICA	0	6	5	11	2.7
GASTROPODA					
NATICIDAE					
NATICA PUSILLA	0	0	1	1	0.2
ACTEOCINIDAE					
ACTEOCINA CANDEI	1	0	2	3	0.7
CAECIDAE					
CAECUM PULCHELLUM	0	90	94	184	44.3
CAECUM IMBRICATUM	0	15	41	56	13.5
OLIVIDAE					
OLIVIDAE (LPIL)	0	1	1	2	0.5
OLIVELLA SP.B	0	1	3	4	1.0
SCAPHOPODA					
DENTALIIDAE					
DENTALIUM (LPIL)	1	0	1	2	0.5
SIPHONODENTALIIDAE					
CADULUS TETRADON	0	2	0	2	0.5
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
AMPHIPODA (LPIL)	0	0	1	1	0.2
AMPELISCIDAE					
AMPELISCA AGASSIZI	0	1	2	3	0.7
PHOXOCEPHALIDAE					
METHARPINA FLORIDANA	0	0	2	2	0.5
PLATYISCHNOPIDAE					
EUDEVENOPUS HONDURANUS	0	2	9	11	2.7
DECAPODA (REPTANTIA)					
ALBUNEIDAE					
ALBUNEA GIBBESII	1	1	1	3	0.7
ECHINODERMATA					
ECHINOIDEA					
ECHINOIDEA (LPIL)	1	7	7	15	3.6
MELLITIDAE					
MELLITIDAE (LPIL)	0	1	0	1	0.2

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16, 1985 — STATION: [illegible]
SAMPLE SIZE: 0.06 SQ. M — SAMPLE TYPE: MACROFAU[illegible]

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON S / TOT. [illegible]
CEPHALOCHORDATA				
BRANCHIOSTOMA FLORIDAE	5	3	5	13 [illegible]

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE:	25	164	226
NUMBER TAXA PER REPLICATE:	14	31	33

TOTAL NUMBER TAXA FOR STATION: 48
TOTAL NUMBER INDIVIDUALS FOR STATION: 415
MEAN NUMBER INDIVIDUALS PER SQ. M: 2306 STD. DEVIATION: 17[illegible]5

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983 STATION: 12
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 2.4209

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.6254

SPECIES RICHNESS (MARGALEF'S INDEX) D= 7.797

SPECIES-AREA RELATIONSHIPS
S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W		*	X		*	Y		*	Z	
R	S	*	R	S	*	R	S	*	R	S
A	14	*	C	33	*	B	31	*	A	14
B	36	*	A	38	*	C	46	*	C	38
C	48	*	B	48	*	A	48	*	B	48

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA

END OF REPORT

EPA PENSACCLA BENTHIC MACRCINFAUNAL ANALYSIS

SAMPLE DATE: NCVEMBER 16,1983 STATION:
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACRCFAUN

CCMMENT.EPA.PENSACCLA.

TAXCN	REPA	REPB	REPC	TAXCN TCT.	% C TCT
RHYNCHCCOELA					
RHYNCHCCCELA (LPIL)	0	1	0	1	0.
SIPUNCULA					
ASPIDCSIPHCNIDAE					
ASPIDCSIPHCN ALBUS	1	0	0	1	0.
ANNELIDA					
PCLYCHAETA					
GLYCERIDAE					
GLYCERA SP.A	1	1	0	2	1.
LUMBRINERIDAE					
LUMBRINERIS SP.D	0	1	0	1	0.
MAGELCNIDAE					
MAGELCNA SP.B	1	0	0	1	0.
NEREIDAE					
NEREIDAE (LPIL)	0	1	1	2	1.
NEREIS MICRCMMA	0	0	1	1	0.
CPHELIIDAE					
ARMANDIA MACULATA	1	1	0	2	1.
CPHELIA DENTICULATA	1	0	0	1	0.
CNUPHIDAE					
CNUPHIS EREMITA	0	1	0	1	0.
PARACNIDAE					
ARICIDEA WASSI	1	0	0	1	0.
ARICIDEA SP.H	2	1	0	3	1.
CIRRCPHCRUS (LPIL)	1	0	0	1	0.
PARACNIS PYGCENIGMATICA	3	0	0	3	1.
PILARGIDAE					
SYNELMIS SP.B	2	0	0	2	1.
SPICNIDAE					
PRICNCSPIC CRISTATA	12	6	1	19	10.
ACNIDES CF. PAUCIBRANCHIATA	1	0	0	1	0.
SYLLIDAE					
PARAPICNCSYLLIS LCNGICIRRAT	1	0	0	1	0.
BRANIA WELLFLEETENSIS	1	0	0	1	0
STREPTCSYLLIS PETTIBCNEAE	0	0	1	1	0.
EXCGCNE LCUREI	1	0	1	2	1
PECTINARIIDAE					
AMPHICTENE SP.A	0	1	0	1	0
CLIGCCHAETA					
CLIGCCHAETA (LPIL)	20	3	0	23	13
MCLLUSCA					
PELECYPCDA					
LUCINIDAE					
LUCINA SCMBRERENSIS	1	2	0	3	1
TELLINIDAE					
TELLINA VERSICCLCR	2	2	0	4	2

EPA PENSACCLA BENTHIC MACRCINFAUNAL ANALYSIS

AMPLE DATE: NCVEMBER 16,1983 STATICN: [illegible]3
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACRCFAUNA

.CMMENT.EPA.PENSACCLA.

TAXCN	REPA	REPB	REPC	TAXCN TOT.	% OF TOT.
TELLINA TEXANA	2	3	1	6	3.4
TELLINA (LPIL)	0	0	2	2	1.[illegible]
STRIGILLA MIRABILIS	0	1	3	4	2.3
MESCMESMATIDAE					
ERVILIA CCNCENTRICA	9	1	2	12	6.8
GASTRCPCDA					
NATICIDAE					
NATICA PUSILLA	1	0	1	2	[illegible]
ACTECCINIDAE					
ACTECCINA CANDEI	0	1	1	2	[illegible]
CAECIDAE					
CAECUM PULCHELLUM	14	2	0	16	9.0
CAECUM IMBRICATUM	6	3	0	9	5.[illegible]
CLIVIDAE					
CLIVELLA SP.B	4	3	0	7	4.0
CLIVELLA (LPIL)	1	0	0	1	0.6
ARTHRCPCDA (CRUSTACEA)					
AMPHIPCDA					
PHCXOCEPHALIDAE					
METHARPINA FLCRIDANA	0	1	0	1	0.6
PLATYISCHNCPIDAE					
EUDEVENCPUS HCNDURANUS	7	1	4	12	6.[illegible]
DECAPCDA (REPTANTIA)					
ALBUNEIDAE					
ALBUNEA GIBBESII	0	0	1	1	0.6
ECHINCDERMATA					
ECHINCIDEA					
ECHINCIDEA (LPIL)	1	0	0	1	0.6
MELLITIDAE					
ENCCPE (LPIL)	0	0	1	1	0.6
CEPHALCCHCRDATA					
BRANCHICSTCMA FLCRIDAE	9	7	5	21	[illegible]

CTE--LPIL-LCWEST PRACTICAL IDENTIFICATICN LEVEL

NUMBER INDIV. PER REPLICATE:	107	44	26
NUMBER TAXA PER REPLICATE:	28	22	15

TCTAL NUMBER TAXA FCR STATICN: 41
TCTAL NUMBER INDIVIDUALS FCR STATICN: 177
MEAN NUMBER INDIVIDUALS PER SQ. M: 984 STD. DEVIATICN: 709

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1982 STATION:
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUN

COMMENT.EPA.PENSACOLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 3.0733

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.8276

SPECIES RICHNESS (MARGALEF'S INDEX) D= 7.728

SPECIES-AREA RELATIONSHIPS
S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	28	*	C	15	*	B	22	*	A	28
B	36	*	A	36	*	C	29	*	C	36
C	41	*	B	41	*	A	41	*	B	41

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA [illegible]

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1983
SAMPLE SIZE: 0.06 SQ. M

STATION: [illegible]
SAMPLE TYPE: MACROFAUNA

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% OF TOT.
BRACHIOPODA					
GLOTTIDIA PYRAMIDATA	6	14	0	20	10.9
SIPUNCULA					
GOLFINGIIDAE					
PHASCOLION STROMBI	2	0	0	2	1.[illegible]
ASPIDOSIPHONIDAE					
ASPIDOSIPHON ALBUS	0	0	2	2	1.[illegible]
ANNELIDA					
POLYCHAETA					
AMPHINOMIDAE					
CHLOEIA VIRIDIS	0	0	1	1	0.5
CAPITELLIDAE					
NOTOMASTUS (LPIL)	2	0	0	2	1.1
CIRRATULIDAE					
CIRRATULIDAE (LPIL)	0	1	0	1	0.5
GLYCERIDAE					
GLYCERA SP.A	0	3	2	5	2.7
HESIONIDAE					
HETEROPODARKE CF HETEROMORP	0	0	2	2	1.[illegible]
NEPHTYIDAE					
AGLAOPHAMUS VERRILLI	0	1	0	1	0.5
NEPHTYS PICTA	3	1	1	5	2.7
NEREIDAE					
NEREIDAE (LPIL)	1	3	2	6	3.3
NEREIS MICROMMA	0	1	1	2	1.[illegible]
OPHELIIDAE					
ARMANDIA MACULATA	1	0	0	1	0.5
OPHELIA DENTICULATA	0	1	0	1	0.5
ONUPHIDAE					
DIOPATRA NEOTRIDENS	1	0	0	1	0.5
DIOPATRA (LPIL)	1	0	0	1	0.5
OWENIIDAE					
OWENIA SP.A	1	2	1	4	2.2
PARAONIDAE					
ARICIDEA SP.H	1	0	0	1	0.5
SPIONIDAE					
APOPRIONOSPIO (LPIL)	1	0	0	1	0.5
PRIONOSPIO CRISTATA	0	1	1	2	1.1
SPIOPHANES BOMBYX	0	1	0	1	0.5
TEREBELLIDAE					
TEREBELLIDAE (LPIL)	0	0	1	1	0.5
PECTINARIIDAE					
AMPHICTENE SP.A	0	1	1	2	1.[illegible]
MOLLUSCA					
PELECYPODA					
PELECYPODA (LPIL)	0	1	1		

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: NOVEMBER 16,1985
SAMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFAUN

COMMENT.EPA.PENSACOLA.

TAXON	REPA	REPB	REPC	TAXON TOT.	% TOT
LUCINIDAE					
LUCINA SOMBRERENSIS	1	1	0	2	1.
TELLINIDAE					
TELLINA VERSICOLOR	0	1	4	5	2.
TELLINA TEXANA	0	1	2	3	1.
MESODESMATIDAE					
ERVILIA CONCENTRICA	0	0	1	1	0.
GASTROPODA					
COLUMBELLIDAE					
ANACHIS OBESA	2	0	0	2	1.
CAECIDAE					
CAECUM PULCHELLUM	9	2	0	11	6.
CAECUM IMBRICATUM	4	4	4	12	6.
OLIVIDAE					
OLIVELLA SP.A	1	0	0	1	0.
OLIVELLA SP.B	0	0	1	1	0.
CYLICHNIDAE					
CYLICHNELLA BIDENTATA	1	0	0	1	0.
SCAPHOPODA					
DENTALIIDAE					
DENTALIUM (LPIL)	2	0	0	2	1.
ARTHROPODA (CRUSTACEA)					
AMPHIPODA					
AMPELISCIDAE					
AMPELISCA SP.C	0	1	0	1	0.
AMPELISCA (LPIL)	0	1	3	4	2.
PHOXOCEPHALIDAE					
METHARPINA FLORIDANA	0	0	3	3	1.
HAUSTORIIDAE					
ACANTHOHAUSTORIUS (LPIL)	0	0	1	1	0.
PLATYISCHNOPIDAE					
EUDEVENOPUS HONDURANUS	3	6	2	11	5.
MYSIDACEA					
MYSIDAE					
BOWMANIELLA SPP.	1	0	0	1	0.
DECAPODA (REPTANTIA)					
PINNOTHERIDAE					
PINNIXA (LPIL)	0	0	1	1	0.
ALBUNEIDAE					
ALBUNEA PARETII	1	0	0	1	0.
ECHINODERMATA					
OPHIUROIDEA					
AMPHIURIDAE					
AMPHIURIDAE (LPIL)	0	1	0	1	0.
ECHINOIDEA					
ECHINOIDEA (LPIL)	0	2	3	5	2.
CEPHALOCHORDATA					

EPA PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: NCVEMBER 16, 1983 STATICN: 14
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

CMMENT.EPA.PENSACCLA.

TAXCN	REPA	REPB	REPC	TAXCN TCT.	% CF TCT.
BRANCHIOSTCMA FLCRIDAE	13	7	26	46	25.1

CTE--LPIL-LCWEST PRACTICAL IDENTIFICATICN LEVEL

NUMBER INDIV. PER REPLICATE:	58	58	67
UMBER TAXA PER REPLICATE:	22	24	24

TCTAL NUMBER TAXA FOR STATICN: 46
CTAL NUMBER INDIVIDUALS FCR STATICN: 183
EAN NUMBER INDIVIDUALS PER SQ. M: 1017 STD. DEVIATICN: 87

AMPLE DATE: NOVEMBER 16,1983 STATION:
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUN

CMMENT.EPA.PENSACCLA.

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNCN WIENER INDEX) H'E= 3.0539

SPECIES EVENNESS (PIELCUS EVENNESS INDEX) J= 0.7976

SPECIES RICHNESS (MARGALEF'S INDEX) D= 8.638

SPECIES-AREA RELATICNSHIPS
S=CUMULATIVE NUMBER CF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	22	*	C	24	*	B	24	*	A	22
B	37	*	A	40	*	C	33	*	C	40
C	46	*	B	46	*	A	46	*	B	46

FAUNAL ANALYSIS AND REPCRT PREPARED FCR:
ENVIRCNMENTAL PRCTECTICN AGENCY

PREPARED BY:
BARRY A. VITTCR & ASSCC., INC.
8100 CCTTAGE HILL RCAD
MCBILE, ALABAMA 36609

END CF REPORT

APPENDIX B

PHYLOGENETIC LISTING FOR EPA PENSACOLA DREDGED MATERIAL DISPOSAL AND CONTROL SITES, 1983

PHYLOGENTIC LISTING FOR EPA PENSACOLA DREDGED MATERIAL DISPOSAL AND CONTROL SITES, 1983

CNIDARIA

ANTHOZOA

ACTINIARIA (LPIL)

PLATYHELMINTHES

TURBELLARIA

TURBELLARIA (LPIL)

RHYNCHOCOELA

RHYNCHOCOELA SP.A
RHYNCHOCOELA SP.C
RHYNCHOCOELA SP.I
RHYNCHOCOELA (LPIL)
CEREBRATULUS LACTEUS

BRACHIOPODA

GLOTTIDIA PYRAMIDATA

PHORONIDA

PHORONIS (LPIL)

SIPUNCULA

SIPUNCULA (LPIL)
GOLFINGIIDAE
GOLFINGIA (LPIL)
PHASCOLION STROMBI
ASPIDOSIPHONIDAE
ASPIDOSIPHON ALBUS
ASPIDOSIPHON GOSNOLDI
ASPIDOSIPHON (LPIL)

ANNELIDA

POLYCHAETA

AMPHINOMIDAE
PARAMPHINOME SP.B
CHLOEIA VIRIDIS
AMPHARETIDAE
AMPHARETIDAE (LPIL)

PHYLOGENTIC LISTING FOR EPA PENSACOLA DREDGED MATERIAL DISPOSAL
AND CONTROL SITES, 1983

CAPITELLIDAE
- CAPITELLIDAE (LPIL)
- CAPITELLA CAPITATA
- MEDIOMASTUS CALIFORNIENSIS
- MEDIOMASTUS (LPIL)
- NOTOMASTUS (LPIL)
- MASTOBRANCHUS SP.A

CIRRATULIDAE
- CIRRATULIDAE (LPIL)
- CIRRIFORMIA (LPIL)
- THARYX CF. ANNULOSUS
- CAULLERIELLA CF. ALATA

DORVILLEIDAE
- SCHISTOMERINGOS PECTINATA
- PROTODORVILLEA KEFERSTEINI

EUNICIDAE
- EUNICIDAE (LPIL)

FLABELLIGERIDAE
- THEROCHAETA SP.A

GLYCERIDAE
- GLYCERIDAE (LPIL)
- GLYCERA SP.A
- GLYCERA SP.I
- GLYCERA SP.D
- GLYCERA (LPIL)

GONIADIDAE
- GONIADIDES CAROLINAE

HESIONIDAE
- HESIONIDAE (LPIL)
- GYPTIS BREVIPALPA
- HETEROPODARKE CF HETEROMORPHA

LUMBRINERIDAE
- LUMBRINERIS VERRILLI
- LUMBRINERIS SP.D
- LUMBRINERIS (LPIL)

MALDANIDAE
- MALDANIDAE (LPIL)
- ASYCHIS ELONGATUS
- CLYMENELLA TORQUATA
- BOGUEA ENIGMATICA
- BOGUEA (LPIL)

MAGELONIDAE
- MAGELONA SP.B
- MAGELONA SP.C
- MAGELONA (LPIL)

NEPHTYIDAE
- AGLAOPHAMUS VERRILLI
- NEPHTYS PICTA

NEREIDAE
- NEREIDAE (LPIL)

PHYLCGENTIC LISTING FCR EPA PENSACCLA DREDGED MATERIAL DISPCSAL
AND CONTROL SITES, 1983

CERATCNEREIS SP.A
NEREIS LAMELLCSA
NEREIS MICRCMMA
NEREIS RIISEI
NEREIS (LPIL)
EUNEREIS SP.A
CPHELIIDAE
CPHELIIDAE (LPIL)
ARMANDIA MACULATA
ARMANDIA AGILIS
CPHELIA DENTICULATA
CNUPHIDAE
CNUPHIDAE (LPIL)
DICPATRA CUPREA
DICPATRA NECTRIDENS
DICPATRA (LPIL)
CNUPHIS EREMITA OCULATA
MCCRECNUPHIS PALLIDULA
MCCRECNUPHIS CF. NEBULCSA
AMERICCNUPHIS MAGNA
CWENIIDAE
CWENIA SP.A
CRBINIIDAE
CRBINIIDAE (LPIL)
SCCLCPLCS RUBRA
LEITCSCCLCPLCS FRAGILIS
LEITCSCCLCPLCS (LPIL)
PARACNIDAE
PARACNIDAE (LPIL)
ARICIDEA SP.A
ARICIDEA SP.C
ARICIDEA WASSI
ARICIDEA SP.E
ARICIDEA SP.H
ARICIDEA SP.C
ARICIDEA (LPIL)
CIRRCPHCRUS (LPIL)
PARACNIS PYGCENIGMATICA
PILARGIDAE
ANCISTRCSYLLIS HARTMANAE
ANCISTRCSYLLIS SP.C
SIGAMBRA BASSI
SIGAMBRA TENTACULATA
SIGAMBRA (LPIL)
SYNELMIS SP.B
PHYLLCDCCIDAE
PHYLLCDCCIDAE (LPIL)
ETECNE LACTEA
PHYLLCDCCE ARENAE

PHYLCGENTIC LISTING FCR EPA PENSACCLA DREDGED MATERIAL DISPCSAL

AND CONTROL SITES, 1983

- SIGALICNIDAE
  - FIMBRICSTHENELAIS MINCR
- SPICNIDAE
  - SPICNIDAE (LPIL)
  - APCPRICNCSPIC (LPIL)
  - PARAPRICNCSPIC PINNATA
  - PCLYDCRA LIGNI
  - PRICNCSPIC CRISTATA
  - PRICNCSPIC (LPIL)
  - SPIC PETTIBCNEAE
  - SPICPHANES BCMBYX
  - SCCLELEPIS SQUAMATA
  - ACNIDES CF. PAUCIBRANCHIATA
  - LACNICE CIRRATA
  - MICRCSPIC PIGMENTATA
- SYLLIDAE
  - PARAPICNCSYLLIS LCNGICIRRATA
  - BRANIA WELLFLEETENSIS
  - STREPTCSYLLIS PETTIBCNEAE
  - TYPCSYLLIS AMICA
  - EXCGCNE LCUREI
- TEREBELLIDAE
  - TEREBELLIDAE (LPIL)
  - PCLYCIRRUS (LPIL)
- TYPHLCSCCLECIDAE
  - TYPHLCSCCLECIDAE (LPIL)
- EULEPETHIDAE
  - EULEPETHIDAE (LPIL)
- PECTINARIIDAE
  - PECTINARIA REGALIS
  - AMPHICTENE SP.A
- PSAMMCDRILIDAE
  - PSAMMCDRILUS BALANCGLCSSCIDES
- PCLYGCRDIDAE
  - PCLYGCRDIUS (LPIL)

<u>CLIGCCHAETA</u>

CLIGCCHAETA (LPIL)

MCLLUSCA

<u>PELECYPCDA</u>

PELECYPCDA (LPIL)

- UNGULINIDAE
  - DIPLCDCNTA PUNCTATA
- LUCINIDAE
  - LUCINIDAE (LPIL)
  - PARVILUCINA MULTILINEATA
  - PARVILUCINA (LPIL)

PHYLOGENTIC LISTING FOR EPA PENSACOLA DREDGED MATERIAL DISPOSAL
AND CONTROL SITES, 1983

LUCINA SOMBRERENSIS
TELLINIDAE
TELLINIDAE (LPIL)
TELLINA VERSICOLOR
TELLINA TEXANA
TELLINA (LPIL)
STRIGILLA MIRABILIS
CORBULIDAE
VARICORBULA OPERCULATA
VENERIDAE
VENERIDAE (LPIL)
CHIONE INTAPURPUREA
CHIONE (LPIL)
MACROCALLISTA NIMBOSA
PITAR FULMINATUS
CRASSATELLIDAE
CRASSINELLA LUNULATA
PANDORIDAE
PANDORA TRILINEATA
MESODESMATIDAE
ERVILIA CONCENTRICA
<u>GASTROPODA</u>
NATICIDAE
NATICA PUSILLA
COLUMBELLIDAE
ANACHIS OBESA
ACTEOCINIDAE
ACTEOCINA CANDEI
NASSARIIDAE
NASSARIUS ACUTUS
BUCCINIDAE
CANTHARUS CANCELLARIUS
CAECIDAE
CAECUM JOHNSONI
CAECUM PULCHELLUM
CAECUM IMBRICATUM
CAECUM (LPIL)
PYRAMIDELLIDAE
PYRAMIDELLIDAE (LPIL)
TURBONILLA (LPIL)
OLIVIDAE
OLIVIDAE (LPIL)
OLIVA SAYANA
OLIVELLA SP.A
OLIVELLA SP.B
OLIVELLA SP.C
OLIVELLA SP.D
OLIVELLA (LPIL)
CYLICHNIDAE
CYLICHNELLA BIDENTATA

PHYLOGENTIC LISTING FOR EPA PENSACOLA DREDGED MATERIAL DISPOSAL
AND CONTROL SITES, 1983

GASTROCHAENIDAE
GASTROCHAENA HIANS
SCAPHOPODA
DENTALIIDAE
DENTALIUM (LPIL)
SIPHONODENTALIIDAE
CADULUS TETRADON

ARTHROPODA (CRUSTACEA)
ISOPODA
IDOTEIDAE
EDOTEA MONTOSA
EDOTEA LYONSI
AMPHIPODA

AMPHIPODA (LPIL)
AMPELISCIDAE
AMPELISCA AGASSIZI
AMPELISCA SP.C
AMPELISCA (LPIL)
OEDICEROTIDAE
OEDICEROTIDAE (LPIL)
SYNCHELIDIUM AMERICANUM
LILJEBORGIIDAE
LISTRIELLA BARNARDI
PHOXOCEPHALIDAE
METHARPINA FLORIDANA
HAUSTORIIDAE
HAUSTORIIDAE (LPIL)
ACANTHOHAUSTORIUS SIMILIS
ACANTHOHAUSTORIUS SP.B
ACANTHOHAUSTORIUS (LPIL)
PROTOHAUSTORIUS SP.B
PROTOHAUSTORIUS BOUSFIELDI
PARAHAUSTORIUS OBLIQUUS
PLATYISCHNOPIDAE
EUDEVENOPUS HONDURANUS
PLATYISCHNOPIS SP.A
MELITIDAE
ELASMOPUS LEVIS
ELASMOPUS (LPIL)
CUMACEA

CUMACEA (LPIL)
BODOTRIIDAE
CYCLASPIS SP.D
MYSIDACEA
MYSIDAE
BOWMANIELLA SPP.

PHYLOGENTIC LISTING FOR EPA PENSACOLA DREDGED MATERIAL DISPOSAL
AND CONTROL SITES, 1983

TANAIDACEA

PARATANAIDAE

LEPTOCHELIA SP.A

DECAPODA (NATANTIA)

DECAPODA NATANTIA (LPIL)

PROCESSIDAE

PROCESSA HEMPHILLI

DECAPODA (REPTANTIA)

PINNOTHERIDAE

PINNIXA (LPIL)

DISSODACTYLUS MELLITAE

ALBUNEIDAE

ALBUNEA GIBBESII

ALBUNEA PARETII

PAGURIDAE

PAGURIDAE (LPIL)

OSTRACODA

OSTRACODA (LPIL)

ECHINODERMATA

OPHIUROIDEA

OPHIUROIDEA (LPIL)

AMPHIURIDAE

AMPHIURIDAE (LPIL)

ECHINOIDEA

ECHINOIDEA (LPIL)

MELLITIDAE

MELLITIDAE (LPIL)

ENCOPE MICHELINI

ENCOPE (LPIL)

CEPHALOCHORDATA

LEPTOCARDII

BRANCHIOSTOMIDAE

BRANCHIOSTOMA FLORIDAE

BRANCHIOSTOMA (LPIL)

APPENDIX C

IEC (EPA) PENSACOLA BENTHIC
MACROINFAUNAL ANALYSIS -
FAUNAL DATA, 1980

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: JANUARY 16,1980
AMPLE SIZE: 0.06 SQ. M

STATION: [illegible]
SAMPLE TYPE: MACROFAUNA

COMMENT. IEC.MC.722

TAXCN	REPA	REPB	REPC	REPD	REPE	TAXCN TOT.	% OF TOT.
CNIDARIA							
ANTHOZOA							
ACTINIARIA (LPIL)	0	0	0	0	1	1	0.3
PLATYHELMINTHES							
TURBELLARIA							
TURBELLARIA (LPIL)	0	0	1	0	0	1	0.3
RHYNCHOCOELA							
RHYNCHOCOELA SP.C	0	0	0	2	0	2	0.5
PHORONIDA							
PHORONIS SP.A	0	2	0	0	0	2	0.5
SIPUNCULA							
ASPIDOSIPHONIDAE							
ASPIDOSIPHON ALBUS	2	0	0	0	0	2	0.5
ANNELIDA							
POLYCHAETA							
AMPHARETIDAE							
AMPHARETIDAE (LPIL)	0	0	0	0	1	[illegible]	0.3
AMPHARETE SP.A	0	1	0	0	0	[illegible]	0.3
CIRRATULIDAE							
CIRRATULIDAE (LPIL)	0	0	0	0	1	[illegible]	0.3
GLYCERIDAE							
GLYCERA SP.A	2	2	0	1	0	5	1.3
GLYCERA (LPIL)	0	1	4	0	0	5	1.3
LUMBRINERIDAE							
LUMBRINERIS CRUZENSIS	0	0	0	0	1	1	0.3
LUMBRINERIS VERRILLI	1	0	0	0	0	1	0.3
MALDANIDAE							
MALDANIDAE (LPIL)	0	1	0	3	1	5	1.3
MAGELONIDAE							
MAGELONA PETTIBONEAE	0	2	1	0	1	4	1.0
NEPHTYIDAE							
NEPHTYS PICTA	1	0	0	0	0	1	0.3
OPHELIIDAE							
ARMANDIA MACULATA	8	5	6	2	1	22	5.6
ONUPHIDAE							
ONUPHIS EREMITA OCULATA	0	2	0	1	2	5	1.3
ORBINIIDAE							
LEITOSCOLOPLOS FOLIOSUS	0	0	1	0	0	1	0.3
LEITOSCOLOPLOS (LPIL)	1	0	0	0	0	1	0.3
PARAONIDAE							
ARICIDEA SP.E	2	0	3	[illegible]	[illegible]	7	[illegible]
PILARGIDAE							
ANCISTROSYLLIS JONESI	[illegible]	0	[illegible]	[illegible]	[illegible]	2	[illegible].5
CABIRA INCERTA	[illegible]	0	0	[illegible]	[illegible]	[illegible]	[illegible]

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JANUARY 18,1980 STATION:
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUN

COMMENT. IEC.MC.722

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% TOT
SPIONIDAE							
APOPRIONOSPIO PYGMAEA	0	0	0	2	0	2	0.
MALACOCEROS VANDERHORSTI	1	0	0	0	0	1	0.
PRIONOSPIO CRISTATA	3	1	1	0	0	5	1.
SPIO PETTIBONEAE	0	0	1	0	0	1	0.
SPIOPHANES BOMBYX	12	8	4	10	9	43	10.
DISPIO UNCINATA	0	0	1	1	0	2	0.
SYLLIDAE							
BRANIA WELLFLEETENSIS	2	1	9	0	0	12	3.
TEREBELLIDAE							
TEREBELLIDAE (LPIL)	0	0	0	0	1	1	0.
POECILOCHAETIDAE							
POECILOCHAETUS JOHNSONI	0	0	0	0	1	1	0.
POLYGORDIDAE							
POLYGORDIUS (LPIL)	3	9	40	0	0	52	13.
MOLLUSCA							
PELECYPODA							
LUCINIDAE							
PARVILUCINA MULTILINEATA	0	0	2	0	1	3	0.
PARVILUCINA AMIANTUS	0	1	0	0	0	1	0.
TELLINIDAE							
MACOMA MITCHELLI	0	1	0	0	1	2	0.
STRIGILLA MIRABILIS	2	0	0	0	2	4	1.
DONACIDAE							
DONAX DOROTHEAE	1	0	0	0	0	1	0.
GASTROPODA							
OLIVIDAE							
OLIVELLA DEALBATA	0	0	0	1	0	1	0.
ARTHROPODA (CRUSTACEA)							
AMPHIPODA							
BATEIDAE							
BATEA CATHARINENSIS	0	0	0	1	1	2	0.
OEDICEROTIDAE							
SYNCHELIDIUM AMERICANUM	1	5	0	0	1	7	1.
MONOCULODES (LPIL)	0	1	1	1	1	4	1.
HAUSTORIIDAE							
LEPIDACTYLUS SP.A	1	2	7	6	4	20	5.
PROTOHAUSTORIUS SP.A	0	0	0	2	0	2	0.
PLATYISCHNOPIDAE							
PLATYISCHNOPIDAE (LPIL)	17	19	9	40	10	95	24.
CUMACEA							
BODOTRIIDAE							
CYCLASPIS SP.A	1	0	1	1	5	8	2.
DIASTYLIDAE							
OXYUROSTYLIS SMITHI	0	0	1	0	0	1	0.
MYSIDACEA							
MYSIDAE							
MYSIDOPSIS BIGELOWI	0	0	0	0	1	1	0.

IEC PENSACOLA BENTHIC MACRCINFAUNAL ANALYSIS

SAMPLE DATE: JANUARY 18,1980 STATICN: 11
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACRCFAUNA

CMMENT. IEC.MC.722

TAXCN	REPA	REPB	REPC	REPD	REPE	TAXCN TCT.	% CF TCT.
ECHINCDERMATA							
ECHINCIDEA							
MELLITIDAE							
MELLITA QUINQUIESPERFCRATA	8	9	9	1	12	39	9.9
CEPHALCCHCTDATA							
BRANCHICSTCMA FLCRIDAE	2	3	0	3	2	10	2.5

NCTE--LPIL-LCWEST PRACTICAL IDENTIFICATICN LEVEL

NUMBER INDIV. PER REPLICATE:	72	76	102	81	62
NUMBER TAXA PER REPLICATE:	21	20	19	20	24

TCTAL NUMBER TAXA FCR STATICN: 49
TCTAL NUMBER INDIVIDUALS FCR STATICN: 393
MEAN NUMBER INDIVIDUALS PER SQ. M: 1258 STD. DEVIATICN: 237

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JANUARY 18,1980 STATION:
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUN

COMMENT. IEC.MC.722

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 2.8186

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.7242

SPECIES RICHNESS (MARGALEF'S INDEX) D= 8.035

SPECIES-AREA RELATIONSHIPS

S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W		*	X		*	Y		*	Z	
R	S	*	R	S	*	R	S	*	R	S
A	21	*	B	20	*	B	20	*	E	24
B	30	*	E	32	*	A	30	*	D	32
C	36	*	C	37	*	E	39	*	B	39
D	42	*	A	44	*	D	45	*	C	43
E	49	*	D	49	*	C	49	*	A	49

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

END OF REPORT

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: JANUARY 18,1980 — STATION: 12
SAMPLE SIZE: 0.06 SQ. M — SAMPLE TYPE: MACROFAUNA

CMMENT. IEC.MO.722

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% OF TOT.
SIPUNCULA							
ASPIDOSIPHONIDAE							
ASPIDOSIPHON ALBUS	2	2	1	0	0	5	1.0
ANNELIDA							
POLYCHAETA							
AMPHINOMIDAE							
CHLOEIA VIRIDIS	1	0	0	0	0	1	0.2
CAPITELLIDAE							
MEDIOMASTUS AMBISETA	6	0	0	0	0	6	1.2
CIRRATULIDAE							
CIRRATULIDAE (LPIL)	2	1	0	1	0	4	0.8
GLYCERIDAE							
GLYCERA SP.A	1	4	3	3	3	14	2.9
GLYCERA (LPIL)	0	1	0	0	0	1	0.2
LUMBRINERIDAE							
LUMBRINERIS VERRILLI	0	0	0	1	0	1	0.2
MALDANIDAE							
MALDANIDAE (LPIL)	4	0	1	0	0	5	1.0
MAGELONIDAE							
MAGELONA SP.B	0	1	0	0	0	1	0.2
NEPHTYIDAE							
NEPHTYS PICTA	0	0	0	4	0	4	0.8
NEPHTYS SIMONI	0	1	3	0	0	4	0.8
OPHELIIDAE							
ARMANDIA MACULATA	2	2	1	5	3	13	2.7
ARMANDIA AGILIS	0	0	0	1	0	1	0.2
ONUPHIDAE							
ONUPHIS EREMITA OCULATA	6	2	0	1	0	9	1.9
ORBINIIDAE							
SCOLOPLOS RUBRA	2	0	0	0	0	2	0.4
PARAONIDAE							
ARICIDEA SP.A	0	0	1	0	2	3	0.6
ARICIDEA SP.A	0	0	0	0	1	1	0.2
ARICIDEA SP.E	3	3	0	0	4	10	2.1
PARAONIS (LPIL)	0	1	0	0	0	1	0.2
PILARGIDAE							
ANCISTROSYLLIS JONESI	0	1	0	0	0	1	0.2
CABIRA INCERTA	2	0	0	0	0	2	0.4
SIGAMBRA BASSI	0	0	0	1	0	1	0.2
SYNELMIS SP.B	0	1	0	0	0	1	0.2
SPIONIDAE							
APOPRIONOSPIO PYGMAEA	0	0	8	5	0	13	2.7
PRIONOSPIO CRISTATA	1	0	0	0	0	1	0.2
SPIOPHANES BOMBYX	8	10	9	7	5	39	8.1
DISPIO UNCINATA	0	1	1	0	0	2	0.4
SCOLELEPIS CF TEXANA	0	0	1	0	0	1	0.2
SYLLIDAE							
PARAPIONOSYLLIS LONGICIRRAT	0	1	0	0	0	1	0.2

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JANUARY 18,1980
SAMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFAUN

COMMENT. IEC.MC.722

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% OF TOT
BRANIA WELLFLEETENSIS	1	7	0	0	0	8	[illegible]
EULEPETHIDAE							
GRUBEULEPIS CF. MEXICANA	0	0	0	1	0	1	0.
POLYGORDIIDAE							
POLYGORDIUS (LPIL)	0	32	1	0	0	33	6.
OLIGOCHAETA							
OLIGOCHAETA (LPIL)	0	2	0	0	0	2	0.
MOLLUSCA							
PELECYPODA							
PELECYPODA (LPIL)	0	2	0	0	0	2	0.
LUCINIDAE							
LUCINIDAE (LPIL)	0	0	0	1	1	2	0.
PARVILUCINA MULTILINEATA	1	0	0	0	0	1	0.
TELLINIDAE							
TELLINA (LPIL)	1	0	0	0	0	1	0.
MACOMA MITCHELLI	2	0	0	0	1	3	0.
STRIGILLA MIRABILIS	1	0	2	1	1	5	[illegible]
CRASSATELLIDAE							
CRASSINELLA (LPIL)	0	1	0	0	0	1	0.
GASTROPODA							
GASTROPODA (LPIL)	0	1	0	0	0	1	0.
OLIVIDAE							
OLIVA SAYANA	0	0	0	1	0	1	0.
OLIVELLA DEALBATA	0	0	0	4	0	4	0.
ARTHROPODA (CRUSTACEA)							
AMPHIPODA							
BATEIDAE							
BATEA CATHERINENSIS	0	2	0	0	0	2	0.
OEDICEROTIDAE							
SYNCHELIDIUM AMERICANUM	1	0	0	0	0	1	0.
MONOCULODES EDWARDSI	0	1	0	0	0	1	0.
LILJEBORGIIDAE							
LISTRIELLA SP.A	0	4	1	0	0	5	[illegible]
PHOXOCEPHALIDAE							
METHARPINIA FLORIDANA	0	1	0	0	0	1	0.
HAUSTORIIDAE							
LEPIDACTYLUS SP.A	3	5	1	10	7	26	5.
PROTOHAUSTORIUS SP.A	0	4	1	18	7	30	6.
PLATYISCHNOPIDAE							
EUDEVENOPUS HONDURANUS	42	31	15	41	23	152	31.
SYNOPIIDAE							
TIRON TROPAKIS	0	2	0	0	0	2	0
CUMACEA							
BODOTRIIDAE							
CYCLASPIS SP.A	2	0	0	0	3	5	[illegible]
DECAPODA (REPTANTIA)							
PINNOTHERIDAE							
PINNIXA CHAETOPTERANA	[illegible]	[illegible]	0	[illegible]	[illegible]	3	0

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: JANUARY 18,1980 STATION: 12
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT. IEC.MC.722

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% OF TOT.
PINNIXA CRISTATA	4	0	0	0	0	4	0.8
ECHINODERMATA							
ECHINOIDEA							
MELLITIDAE							
MELLITA QUINQUIESPERFORATA	3	2	1	0	4	10	2.1
CEPHALOCHORDATA							
BRANCHIOSTOMA FLORIDAE	10	6	2	4	3	25	5.2

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE:	112	136	53	111	68
NUMBER TAXA PER REPLICATE:	26	32	18	20	15

TOTAL NUMBER TAXA FOR STATION: 57
TOTAL NUMBER INDIVIDUALS FOR STATION: 480
MEAN NUMBER INDIVIDUALS PER SQ. M: 1561 STD. DEVIATION: 558

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JANUARY 18,1980 STATION: .
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAU..

COMMENT. IEC.MC.722

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 2.8927

SPECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.7155

SPECIES RICHNESS (MARGALEF'S INDEX) D= 9.071

SPECIES-AREA RELATIONSHIPS
S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W			X			Y			Z	
R	S	*	R	S	*	R	S	*	R	S
A	26	*	B	32	*	B	32	*	E	15
B	45	*	E	38	*	A	45	*	D	26
C	48	*	C	41	*	E	48	*	B	46
D	56	*	A	50	*	D	56	*	C	48
E	57	*	D	57	*	C	57	*	A	57

FAUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

END OF REPORT

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JUNE 27,1980 STATION: [illegible]
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT. IEC.MC.732

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% OF TOT.
CNIDARIA							
ANTHOZOA							
ACTINIARIA (LPIL)	0	0	0	2	3	5	0.6
PLATYHELMINTHES							
TURBELLARIA							
TURBELLARIA (LPIL)	0	0	0	0	4	4	0.5
RHYNCHOCOELA							
CEREBRATULUS LACTEUS	2	0	3	2	2	9	1.0
BRACHIOPODA							
GLOTTIDIA PYRAMIDATA	2	1	2	1	1	7	0.8
PHORONIDA							
PHORONIS SP.A	1	0	0	0	0	1	0.1
ANNELIDA							
POLYCHAETA							
AMPHARETIDAE							
AMPHARETIDAE (LPIL)	0	1	2	0	0	3	0.3
AMPHARETE SP.A	0	0	3	0	3	6	0.7
ASABELLIDES SP.A	0	0	2	0	0	2	0.2
CAPITELLIDAE							
MEDIOMASTUS CALIFORNIENSIS	0	0	4	0	14	18	2.[illegible]
CHAETOPTERIDAE							
CHAETOPTERIDAE (LPIL)	0	0	0	0	1	1	0.1
MESOCHAETOPTERUS TAYLORI	0	0	2	0	2	4	0.5
SPIOCHAETOPTERUS OCULATUS	0	0	1	0	0	1	0.[illegible]
CIRRATULIDAE							
CHAETOZONE SP.D	0	0	1	0	0	1	0.[illegible]
GLYCERIDAE							
GLYCERA SP.A	0	0	0	0	11	[illegible]	[illegible]
GLYCERA SP.H	0	0	0	0	2	2	0.2
GLYCERA (LPIL)	0	0	0	1	0	1	0.1
HESIONIDAE							
HETEROPODARKE CF HETEROMORP	0	1	0	0	0	1	0.1
LUMBRINERIDAE							
LUMBRINERIS SP.A	0	1	1	0	0	2	0.2
LUMBRINERIS (LPIL)	5	1	4	4	9	23	2.7
MALDANIDAE							
MALDANIDAE (LPIL)	0	1	0	0	0	1	0.1
MAGELONIDAE							
MAGELONA SP.B	6	1	5	5	2	19	2.2
NEPHTYIDAE							
NEPHTYIDAE (LPIL)	0	1	0	0	0	1	0.[illegible]
NEPHTYS PICTA	2	0	9	1	18	30	3.5
NEPHTYS SIMONI	1	0	0	0	0	1	0.[illegible]
NEREIDAE							

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: JUNE 27,1980
AMPLE SIZE: 0.06 SQ. M

STATION: [illegible]
SAMPLE TYPE: MACROFAUN

CMMENT. IEC.MC.732

TAXCN	REPA	REPB	REPC	REPD	REPE	TAXCN TCT.	% C TCT
NEREIDAE (LPIL)	0	0	2	0	1	3	0.
CPHELIIDAE							
ARMANDIA MACULATA	1	0	0	4	2	7	0.
CNUPHIDAE							
CNUPHIDAE (LPIL)	0	0	1	0	1	2	0.
DICPATRA CUPREA	0	0	0	0	2	2	0.
CNUPHIS EREMITA CCULATA	0	0	0	0	1	1	0.
CWENIIDAE							
CWENIA SP.A	1	0	0	0	1	2	0.
CRBINIIDAE							
CRBINIIDAE (LPIL)	0	0	0	0	2	2	0.
PARACNIDAE							
PARACNIDAE (LPIL)	1	1	1	0	0	3	0.
ARICIDEA SP.A	0	1	0	0	0	1	0.
ARICIDEA SP.C	1	1	0	3	0	5	0.
ARICIDEA WASSI	0	0	0	1	0	1	0.
ARICIDEA SP.E	0	0	0	0	2	2	0.
PILARGIDAE							
ANCISTRCSYLLIS HARTMANAE	2	0	1	0	0	3	0.
SIGAMBRA TENTACULATA	0	0	0	0	1	1	0.
SYNELMIS SP.B	0	2	0	1	1	4	0.
PHYLLCDCCIDAE							
PHYLLCDCCE ARENAE	0	0	0	0	1	1	0.
PCLYNCIDAE							
PCLYNCIDAE (LPIL)	0	0	1	1	0	2	0.
SPICNIDAE							
SPICNIDAE (LPIL)	0	0	0	0	1	1	0.
APCPRICNCSPIC PYGMAEA	2	0	28	1	9	40	4.
PARAPRICNCSPIC PINNATA	1	0	8	1	10	20	2.
SPIC PETTIBCNEAE	0	0	0	1	0	1	0.
SPICPHANES BCMBYX	2	0	6	0	10	18	2.
DISPIC UNCINATA	3	0	2	2	2	9	1.
SABELLIDAE							
SABELLIDAE (LPIL)	2	0	1	0	2	5	0.
TEREBELLIDAE							
TEREBELLIDAE (LPIL)	0	0	1	2	1	4	0.
LCIMIA SP.A	0	0	1	0	8	9	1.
PECTINARIIDAE							
PECTINARIIDAE (LPIL)	0	0	0	0	1	1	0.
PCLYGCRDIDAE							
PCLYGCRDIUS (LPIL)	0	0	0	0	2	2	0.
LIGCCHAETA							
CLIGCCHAETA (LPIL)	0	0	0	0	1	1	0.
MCLLUSCA							
ELECYPCDA							
PELECYPCDA (LPIL)	15	0	8	10	1	34	3.
SEMELIDAE							
ABRA AEQUALIS	1	1	7	0	19	28	3.
SEMELE PRCFICUA	9	1	0	1	0	11	1.

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JUNE 27,1980
SAMPLE SIZE: 0.06 SQ. M

STATION: 11
SAMPLE TYPE: MACROFAUNA

COMMENT. IEC.MC.732

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% OF TOT.
SEMELE (LPIL)	0	0	0	5	0	5	0.6
TELLINIDAE							
TELLINA ALTERNATA	27	20	44	26	31	148	17.2
TELLINA (LPIL)	2	0	20	0	0	22	2.6
STRIGILLA MIRABILIS	5	1	0	0	0	6	0.7
VENERIDAE							
DOSINIA ELEGANS	0	1	0	0	0	1	0.1
MERCENARIA CAMPECHIENSIS	0	3	0	0	0	3	0.3
CRASSATELLIDAE							
CRASSINELLA LUNULATA	0	1	0	0	0	1	0.1
MACTRIDAE							
MULINIA LATERALIS	1	0	1	0	0	2	0.2
CUSPIDARIIDAE							
CARDIOMYA ORNATISSIMA	0	0	0	0	1	1	0.1
NUCULANIDAE							
NUCULANA CONCENTRICA	0	0	0	1	0	1	0.1
PANDORIDAE							
PANDORA TRILINEATA	0	1	2	0	1	4	0.5
GASTROPODA							
GASTROPODA (LPIL)	4	0	7	0	0	11	1.3
NATICIDAE							
NATICA PUSILLA	8	3	9	4	1	25	2.9
ACTEOCINIDAE							
ACTEOCINA CANALICULATA	0	4	0	4	1	9	1.0
OLIVIDAE							
OLIVA SAYANA	2	0	1	0	1	4	0.5
ARTHROPODA (CRUSTACEA)							
ISOPODA							
IDOTEIDAE							
EDOTEA SP.A	0	0	0	1	0	1	0.1
MUNNIDAE							
MUNNA HAYESI	0	0	0	5	1	6	0.7
AMPHIPODA							
AMPHIPODA (LPIL)	0	0	0	0	2	2	0.2
HYPERIIDAE							
HYPERIIDAE (LPIL)	0	0	0	1	0	1	0.1
AMPELISCIDAE							
AMPELISCA AGASSIZI	0	0	0	2	0	2	0.2
OEDICEROTIDAE							
SYNCHELIDIUM AMERICANUM	0	0	2	3	0	5	0.6
LILJEBORGIIDAE							
LISTRIELLA BARNARDI	0	1	1	0	1	3	0.3
LISTRIELLA SP.C	0	0	0	0	2	2	0.2
PHOTIDAE							
PHOTIS MACROMANUS	0	0	0	0	1	1	0.1
ARGISSIDAE							
ARGISSA HAMATIPES	0	0	0	0	5	5	[illegible]
HAUSTORIIDAE							
ACANTHOHAUSTORIUS SP.A	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JUNE 27, 1980
SAMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFAUN

COMMENT. IEC.MC.732

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% OF TOT
LEPIDACTYLUS SP.A	0	0	0	0	1	1	0.
PROTOHAUSTORIUS SP.A	0	1	0	0	1	2	0.
PLATYISCHNOPIDAE							
TITTAKUNARA SP.A	0	7	4	26	4	41	4.
CUMACEA							
BODOTRIIDAE							
CYCLASPIS SP.A	0	16	7	44	10	77	8.
DIASTYLIDAE							
OXYUROSTYLIS SMITHI	0	0	0	0	4	4	0.
STOMATOPODA							
SQUILLIDAE							
SQUILLIDAE (LPIL)	0	0	0	1	0	1	0.
MYSIDACEA							
MYSIDAE							
MYSIDOPSIS FURCA	0	0	3	0	1	4	0.
DECAPODA (NATANTIA)							
SERGESTIDAE							
ACETES AMERICANUS	0	1	1	0	0	2	0.
PROCESSIDAE							
PROCESSA HEMPHILLI	0	0	0	0	2	2	0.
DECAPODA (REPTANTIA)							
PINNOTHERIDAE							
PINNIXA PEARSEI	0	0	0	0	1	1	0.
ALBUNEIDAE							
ALBUNEA PARETII	0	0	1	0	0	1	0.
PORCELLANIDAE							
EUCERAMUS PRAELONGUS	0	0	0	0	1	1	0.
ECHINODERMATA							
ECHINOIDEA							
ECHINOIDEA (LPIL)	0	1	0	0	0	1	0.
MELLITIDAE							
MELLITA QUINQUIESPERFORATA	5	0	0	7	0	12	1.
CEPHALOCHORDATA							
BRANCHIOSTOMA FLORIDAE	12	5	1	28	1	47	5.

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE:	126	85	215	206	230
NUMBER TAXA PER REPLICATE:	29	30	43	35	60

TOTAL NUMBER TAXA FOR STATION: 97
TOTAL NUMBER INDIVIDUALS FOR STATION: 862
MEAN NUMBER INDIVIDUALS PER SQ. M: 2759 STD. DEVIATION: 1014

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: JUNE 27,1980 STATION: ..
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

CMMENT. IEC.MC.732

FAUNAL CHARACTERISTICS

PECIES DIVERSITY (SHANNCN WIENER INDEX) H'E= 3.5910

PECIES EVENNESS (PIELCUS EVENNESS INDEX) J= 0.7850

PECIES RICHNESS (MARGALEF'S INDEX) D= 14.203

SPECIES-AREA RELATICNSHIPS
S=CUMULATIVE NUMBER CF SPECIES IN REPLICATE R

W		*	X		*	Y		*	Z	
R	S	*	R	S	*	R	S	*	R	S
A	29	*	B	30	*	B	30	*	E	60
B	48	*	E	75	*	A	48	*	D	74
C	62	*	C	85	*	E	82	*	B	87
D	73	*	A	88	*	D	93	*	C	95
E	97	*	D	97	*	C	97	*	A	97

FAUNAL ANALYSIS AND REPCRT PREPARED FCR:
ENVIRCNMENTAL PRCTECTICN AGENCY

PREPARED BY:
BARRY A. VITTCR & ASSCC., INC.
8100 CCTTAGE HILL RCAD
MCBILE, ALABAMA 36609

END CF REPCRT

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JUNE 27, 1980
SAMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFA

COMMENT. IEC.MC.732

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% TO
CNIDARIA							
ANTHOZOA							
ACTINIARIA (LPIL)	0	1	3	6	0	10	0
PLATYHELMINTHES							
TURBELLARIA							
TURBELLARIA (LPIL)	0	0	2	0	0	2	0
RHYNCHOCOELA							
RHYNCHOCOELA SP.A	0	1	0	2	0	3	0
RHYNCHOCOELA SP.C	0	0	0	2	0	2	0
CEREBRATULUS LACTEUS	0	0	1	3	0	4	0
BRACHIOPODA							
GLOTTIDIA PYRAMIDATA	3	9	0	3	0	15	1
SIPUNCULA							
GOLFINGIIDAE							
GOLFINGIA TRICOCEPHALA	0	0	0	3	0	3	0
ASPIDOSIPHONIDAE							
ASPIDOSIPHON ALBUS	0	1	0	2	1	4	0
ASPIDOSIPHON GOSNOLDI	0	1	0	0	0	1	<
SIPUNCULIDAE							
SIPUNCULUS NUDUS	0	1	0	0	0	1	<
ANNELIDA							
POLYCHAETA							
AMPHINOMIDAE (LPIL)	0	1	0	0	0	1	<
AMPHARETIDAE							
AMPHARETIDAE (LPIL)	2	3	1	5	2	13	0
AMPHARETE SP.A	0	0	1	1	0	2	0
CAPITELLIDAE							
MEDIOMASTUS CALIFORNIENSIS	0	17	1	44	0	62	4
NOTOMASTUS (LPIL)	0	0	1	0	0	1	<
CHAETOPTERIDAE							
MESOCHAETOPTERUS TAYLORI	0	0	1	2	0	3	0
SPIOCHAETOPTERUS OCULATUS	0	0	0	1	0	1	<
CIRRATULIDAE							
CHAETOZONE SP.D	0	1	1	0	0	2	0
GLYCERIDAE							
GLYCERA AMERICANA	0	1	0	0	1	2	0
GLYCERA SP.A	0	0	0	2	7	9	0
GLYCERA DIBRANCHIATA	0	0	2	0	0	2	0
GLYCERA SP.H	2	0	1	0	0	3	0
GLYCERA (LPIL)	1	2	5	0	0	8	0
GONIADIDAE							
GLYCINDE SOLITARIA	0	2	0	0	0	2	0
HESIONIDAE							

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JUNE 27,1980 STATION: 12
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT. IEC.MC.732

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% OF TOT.
HESIONIDAE (LPIL)	0	0	0	1	0	1	<.1
LUMBRINERIDAE							
LUMBRINERIS (LPIL)	2	4	6	2	9	23	1.6
MALDANIDAE							
MALDANIDAE (LPIL)	0	2	0	0	0	2	0.1
BOGUEA ENIGMATICA	0	1	0	0	0	1	<.1
MAGELONIDAE							
MAGELONA CF. CINCTA	0	1	0	0	0	1	<.1
MAGELONA SP.B	0	1	0	5	1	7	0.5
NEPHTYIDAE							
NEPHTYS PICTA	2	7	5	14	5	33	2.2
NEPHTYS SIMONI	1	0	0	0	0	1	<.1
OPHELIIDAE							
ARMANDIA MACULATA	2	1	7	0	6	16	1.1
ONUPHIDAE							
ONUPHIS EREMITA OCULATA	2	2	1	1	0	6	0.4
OWENIIDAE							
OWENIA SP.A	0	1	0	0	0	1	<.1
ORBINIIDAE							
LEITOSCOLOPLOS FRAGILIS	0	0	0	1	2	3	0.2
PARAONIDAE							
ARICIDEA WASSI	0	1	11	8	0	20	1.4
ARICIDEA SP.[illegible]	5	3	2	15	0	25	1.7
CIRROPHORUS (LPIL)	0	1	0	0	0	1	<.1
PILARGIDAE							
ANCISTROSYLLIS HARTMANAE	0	2	1	2	0	5	0.3
ANCISTROSYLLIS JONESI	0	1	0	1	0	2	0.1
SIGAMBRA TENTACULATA	0	0	2	0	0	2	0.1
SYNELMIS SP.B	0	0	0	11	2	13	0.9
LITOCORSA SP.A	2	1	3	0	0	6	0.4
PHYLLODOCIDAE							
PHYLLODOCIDAE (LPIL)	0	0	0	0	1	1	<.1
PHYLLODOCE ARENAE	0	0	2	1	2	5	0.3
POLYNOIDAE							
POLYNOIDAE (LPIL)	0	1	0	2	0	3	0.2
SIGALIONIDAE							
STHENELAIS SP.A	0	1	1	0	4	6	0.4
SPIONIDAE							
SPIONIDAE (LPIL)	0	0	0	0	6	6	0.4
APOPRIONOSPIO PYGMAEA	4	3	12	20	5	44	3.0
PARAPRIONOSPIO PINNATA	2	5	5	21	2	35	2.4
POLYDORA LIGNI	0	0	1	0	0	1	<.1
POLYDORA SP.A	0	0	0	1	0	1	<.1
POLYDORA (LPIL)	0	1	0	0	0	1	<.1
PRIONOSPIO CIRRIFERA	0	2	1	1	0	4	0.3
PRIONOSPIO CRISTATA	1	4	2	1	1	9	0.6
SPIO PETTIBONEAE	1	7	3	1	0	12	0.8
SPIOPHANES BOMBYX	2	0	5	2	4	13	0.9
SPIOPHANES CF. MISSIONENSIS	0	0	0	0	2	2	0.1
DISPIO UNCINATA	1	0	6	0	1	8	0.[illegible]

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JUNE 27,1980
SAMPLE SIZE: 0.06 SQ. M

STATION:
SAMPLE TYPE: MACROFAU

COMMENT. IEC.MC.732

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% OF TOT
SYLLIDAE							
BRANIA WELLFLEETENSIS	0	3	1	0	0	4	0.
TEREBELLIDAE							
LOIMIA SP.A	0	2	0	10	1	13	0.
AMAEANA ACCRAENSIS	0	0	1	0	0	1	0.
OLIGOCHAETA							
OLIGOCHAETA (LPIL)	0	1	3	0	2	6	0.
TUBIFICIDAE							
TUBIFICIDAE (LPIL)	0	0	0	3	0	3	0.
MOLLUSCA							
PELECYPODA							
PELECYPODA (LPIL)	7	1	15	34	17	74	5.
SEMELIDAE							
ABRA AEQUALIS	2	14	0	3	1	20	1.
SEMELE PROFICUA	0	6	3	3	2	14	0.
SEMELE (LPIL)	1	0	5	2	0	8	0.
TELLINIDAE							
TELLINA ALTERNATA	20	19	65	30	2	136	9.
TELLINA (LPIL)	0	2	0	0	9	11	0.
STRIGILLA MIRABILIS	2	0	0	0	0	2	0.
CRASSATELLIDAE							
CRASSINELLA LUNULATA	0	3	0	0	0	3	0.
PANDORIDAE							
PANDORA TRILINEATA	0	0	0	0	2	2	0.
GASTROPODA							
GASTROPODA (LPIL)	1	0	10	4	0	15	1.
NATICIDAE							
NATICA PUSILLA	2	1	10	2	0	15	1.
ACTEOCINIDAE							
ACTEOCINA CANALICULATA	0	0	5	0	1	6	0.
OLIVIDAE							
OLIVA SAYANA	1	1	5	0	0	7	0.
OLIVELLA DEALBATA	0	0	0	2	1	3	0.
ARTHROPODA (CRUSTACEA)							
ISOPODA							
IDOTEIDAE							
EDOTEA SP.A	0	0	0	2	5	7	0.
MUNNIDAE							
MUNNA HAYESI	0	1	0	3	0	4	0.
AMPHIPODA							
AMPELISCIDAE							
AMPELISCA AGASSIZI	3	0	0	0	0	3	0.
OEDICEROTIDAE							
SYNCHELIDIUM AMERICANUM	4	0	3	3	0	10	0.
LILJEBORGIIDAE							
LISTRIELLA BARNARDI	2	0	2	[illegible]	10	15	1.
LISTRIELLA SP.C	0	0	0	[illegible]	3	3	0.
PHOTIDAE							

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

SAMPLE DATE: JUNE 27,1980 STATION: 1?
SAMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

COMMENT. IEC.MC.732

TAXON	REPA	REPB	REPC	REPD	REP_	TAXON TOT.	% OF TOT.
PHOTIS MACROMANUS	0	2	0	0	0	2	0.1
ARIGISSIDAE							
ARGISSA HAMATIPES	0	0	0	2	0	2	0.1
PHOXOCEPHALIDAE							
METHARPINA FLORIDANA	0	1	1	0	4	6	0.4
HAUSTORIDAE							
ACANTHOHAUSTORIUS SP.A	15	8	15	4	32	74	5.0
LEPIDACTYLUS SP.A	0	0	0	0	7	7	0.5
PROTOHAUSTORIUS SP.A	8	0	28	6	23	65	4.4
PLATYISCHNOPIDAE							
TITTAKUNARA SP.A	15	30	29	23	24	121	8.2
SYNOPIIDAE							
TIRON TRIOCELLATUS	0	1	0	0	0	1	<.1
CUMACEA							
BODOTRIIDAE							
CYCLASPIS SP.A	4	51	21	25	14	115	7.8
CYCLASPIS SP.F	0	0	0	1	0	1	<.1
DIASTYLIDAE							
OXYUROSTYLIS SMITHI	0	3	0	6	0	9	0.6
MYSIDACEA							
MYSIDAE							
MYSIDOPSIS FURCA	0	0	0	0	1	1	<.1
PROMYSIS ATLANTICA	0	0	0	5	0	5	0.3
DECAPODA (NATANTIA)							
SERGESTIDAE							
LUCIFER FAXONI	0	1	0	1	0	2	0.1
ACETES AMERICANUS	0	0	0	2	0	2	0.1
OGYRIDAE							
OGYRIDES ALPHAEROSTRIS	0	0	0	1	0	1	<.1
PROCESSIDAE							
PROCESSA HEMPHILLI	1	1	1	0	1	4	0.3
DECAPODA (REPTANTIA)							
PINNOTHERIDAE							
PINNIXA (LPIL)	2	0	0	1	5	8	0.5
DISSODACTYLUS MELLITAE	0	1	0	0	0	1	<.1
ALBUNEIDAE							
ALBUNEA GIBBESII	1	1	1	1	0	4	0.3
PORCELLANIDAE							
EUCERAMUS PRAELONGUS	0	1	1	0	1	3	0.2
PAGURIDAE							
PAGURUS ANNULIPES	1	7	3	0	0	11	0.7
CALAPPIDAE							
HEPATUS EPHELITICUS	0	0	0	1	0	1	<.1
OSTRACODA							
OSTRACODA (LPIL)	0	1	2	0	1	4	0.3
ECHINODERMATA							
OPHIUROIDEA							
OPHIUROIDEA (LPIL)	0	0	0	0	1	1	<.1
AMPHIURIDAE							

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: JUNE 27,1980 STATION: [illegible]
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUN

COMMENT. IEC.MC.732

TAXON	REPA	REPB	REPC	REPD	REPE	TAXON TOT.	% OF TOT
AMPHIURIDAE (LPIL)	6	0	2	0	0	8	0.
CHINOIDEA							
ECHINOIDEA (LPIL)	0	0	6	0	0	6	0.
MELLITIDAE							
ENCOPE ABERRANS	0	0	0	1	0	1	0.
ENCOPE MICHELINI	0	2	0	0	0	2	0.
CEPHALOCHORDATA							
BRANCHIOSTOMA FLORIDAE	10	46	61	5	23	145	9.

NOTE--LPIL-LOWEST PRACTICAL IDENTIFICATION LEVEL

NUMBER INDIV. PER REPLICATE:	143	305	395	374	257
NUMBER TAXA PER REPLICATE:	38	64	57	63	46

TOTAL NUMBER TAXA FOR STATION: 115
TOTAL NUMBER INDIVIDUALS FOR STATION: 1474
MEAN NUMBER INDIVIDUALS PER SQ. M: 4717 STD. DEVIATION: 1618

IEC PENSACOLA BENTHIC MACROINFAUNAL ANALYSIS

AMPLE DATE: JUNE 27,1980 STATION: 12
AMPLE SIZE: 0.06 SQ. M SAMPLE TYPE: MACROFAUNA

OMMENT. IEC.MC.732

FAUNAL CHARACTERISTICS

SPECIES DIVERSITY (SHANNON WIENER INDEX) H'E= 3.7133

PECIES EVENNESS (PIELOUS EVENNESS INDEX) J= 0.7826

PECIES RICHNESS (MARGALEF'S INDEX) D= 15.626

SPECIES-AREA RELATIONSHIPS
S=CUMULATIVE NUMBER OF SPECIES IN REPLICATE R

W		*	X		*	Y		*	Z	
R	S	*	R	S	*	R	S	*	R	S
A	38	*	B	64	*	B	64	*	E	46
B	77	*	E	84	*	A	77	*	D	82
C	89	*	C	99	*	E	92	*	B	**
D	**	*	A	**	*	D	**	*	C	**
E	**	*	D	**	*	C	**	*	A	**

AUNAL ANALYSIS AND REPORT PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY

REPARED BY:
BARRY A. VITTOR & ASSOC., INC.
8100 COTTAGE HILL ROAD
MOBILE, ALABAMA 36609

END OF REPORT

APPENDIX D

PHYLOGENETIC LISTING FOR
IEC PENSACOLA, 1980

PHYLCGENTIC LISTING FCR IEC PENSACCLA 1980

CNIDARIA

ANTHCZCA

ACTINIARIA (LPIL)

PLATYHELMINTHES

TURBELLARIA

TURBELLARIA (LPIL)

RHYNCHCCCELA

RHYNCHCCCELA SP.A
RHYNCHCCCELA SP.C
CEREBRATULUS LACTEUS

BRACHICPCDA

GLCTTIDIA PYRAMIDATA

PHCRCNIDA

PHCRCNIS SP.A

SIPUNCULA

GCLFINGIIDAE
GCLFINGIA TRICCCEPHALA
ASPIDCSIPHCNIDAE
ASPIDCSIPHCN ALBUS
ASPIDCSIPHCN GCSNCLDI
SIPUNCULIDAE
SIPUNCULUS NUDUS

ANNELIDA

PCLYCHAETA

AMPHINCMIDAE (LPIL)
CHLCEIA VIRIDIS
AMPHARETIDAE
AMPHARETIDAE (LPIL)
AMPHARETE SP.A
ASABELLIDES SP.A
CAPITELLIDAE
MEDICMASTUS CALIFCRNIENSIS

PHYLCGENTIC LISTING FCR IEC PENSACCLA 1980

- MEDICMASTUS AMBISETA
- NCTCMASTUS (LPIL)

- CHAETCPTERIDAE
  - CHAETCPTERIDAE (LPIL)
  - MESCCHAETCPTERUS TAYLCRI
  - SPICCHAETCPTERUS CCULATUS
- CIRRATULIDAE
  - CIRRATULIDAE (LPIL)
  - CHAETCZCNE SP.D
- GLYCERIDAE
  - GLYCERA AMERICANA
  - GLYCERA SP.A
  - GLYCERA DIBRANCHIATA
  - GLYCERA SP.H
  - GLYCERA (LPIL)
- GCNIADIDAE
  - GLYCINDE SCLITARIA
- HESICNIDAE
  - HESICNIDAE (LPIL)
  - HETERCPCDARKE CF HETERCMCRPHA
- LUMBRINERIDAE
  - LUMBRINERIS CRUZENSIS
  - LUMBRINERIS VERRILLI
  - LUMBRINERIS SP.A
  - LUMBRINERIS (LPIL)
- MALDANIDAE
  - MALDANIDAE (LPIL)
  - BCGUEA ENIGMATICA
- MAGELCNIDAE
  - MAGELCNA (LPIL)
  - MAGELCNA SP.B
  - MAGELCNA PETTIBCNEAE
- NEPHTYIDAE
  - NEPHTYIDAE (LPIL)
  - NEPHTYS PICTA
  - NEPHTYS SIMCNI
- NEREIDAE
  - NEREIDAE (LPIL)
- CPHELIIDAE
  - ARMANDIA MACULATA
  - ARMANDIA AGILIS
- CNUPHIDAE
  - CNUPHIDAE (LPIL)
  - DICPATRA CUPREA
  - CNUPHIS EREMITA CCULATA
- CWENIIDAE
  - CWENIA SP.A
- CRBINIIDAE
  - CRBINIIDAE (LPIL)

PHYLCGENTIC LISTING FCR IEC PENSACCLA 1980

SCCLCPLCS RUBRA
LEITCSCCLCPLCS FRAGILIS
LEITCSCCLCPLCS FCLICSUS
LEITCSCCLCPLCS (LPIL)

PARACNIDAE
PARACNIDAE (LPIL)
ARICIDEA SP.A
ARICIDEA SP.C
ARICIDEA WASSI
ARICIDEA SP.E
ARICIDEA SP.H
CIRRCPHCRUS (LPIL)
PARACNIS (LPIL)

PILARGIDAE
ANCISTRCSYLLIS HARTMANAE
ANCISTRCSYLLIS JCNESI
CABIRA INCERTA
SIGAMBRA BASSI
SIGAMBRA TENTACULATA
SYNELMIS SP.B
LITCCCRSA SP.A

PHYLLCDCCIDAE
PHYLLCDCCIDAE (LPIL)
PHYLLCDCCE ARENAE

PCLYNCIDAE
PCLYNCIDAE (LPIL)

SIGALICNIDAE
STHENELAIS SP.A

SPICNIDAE
SPICNIDAE (LPIL)
APCPRICNCSPIC PYGMAEA
MALACCCERCS VANDERHCRSTI
PARAPRICNCSPIC PINNATA
PCLYDCRA LIGNI
PCLYDCRA SP.A
PCLYDCRA (LPIL)
PRICNCSPIC CIRRIFERA
PRICNCSPIC CRISTATA
SPIC PETTIBCNEAE
SPICPHANES BCMBYX
SPICPHANES CF. MISSICNENSIS
DISPIC UNCINATA
SCCLELEPIS CF TEXANA

SYLLIDAE
PARAPICNCSYLLIS LCNGICIRRATA
BRANIA WELLFLEETENSIS

SABELLIDAE
SABELLIDAE (LPIL)

TEREBELLIDAE
TEREBELLIDAE (LPIL)

PHYLCGENTIC LISTING FCR SEC PENSACCLA 1980

- LCIMIA SP.A
- AMAEANA ACCRAENSIS

PCECILCCHAETIDAE

- PCECILCCHAETUS JCHNSCNI

EULEPETHIDAE

- CRUBEULEPIS CF. MEXICANA

PECTINARIIDAE

- PECTINARIIDAE (LPIL)

PCLYGCRDIDAE

- PCLYGCRDIUS (LPIL)

<u>CLIGCCHAETA</u>

- CLIGCCHAETA (LPIL)

TUBIFICIDAE

- TUBIFICIDAE (LPIL)

MCLLUSCA

<u>PELECYPCDA</u>

- PELECYPCDA (LPIL)

SEMELIDAE

- ABRA AEQUALIS
- SEMELE PRCFICUA
- SEMELE (LPIL)

LUCINIDAE

- LUCINIDAE (LPIL)
- PARVILUCINA MULTILINEATA
- PARVILUCINA AMIANTUS

TELLINIDAE

- TELLINA ALTERNATA
- TELLINA (LPIL)
- MACCMA MITCHELLI
- STRIGILLA MIRABILIS

VENERIDAE

- DCSINIA ELEGANS
- MERCENARIA CAMPECHIENSIS

DCNACIDAE

- DCNAX DCRCTHEAE

CRASSATELLIDAE

- CRASSINELLA LUNULATA
- CRASSINELLA (LPIL)

MACTRIDAE

- MULINIA LATERALIS

CUSPIDARIIDAE

- CARDICMYA CRNATISSIMA

NUCULANIDAE

- NUCULANA CCNCENTRICA

PANDCRIDAE

- PANDCRA TRILINEATA

PHYLOGENETIC LISTING FOR TEC PENSACOLA 1980

GASTROPODA

* GASTROPODA (LPIL)

NATICIDAE

NATICA PUSILLA

ACTEOCINIDAE

ACTEOCINA CANALICULATA

OLIVIDAE

OLIVA SAYANA

OLIVELLA DEALBATA

ARTHROPODA (CRUSTACEA)

ISOPODA

IDOTEIDAE

EDOTEA SP.A

MUNNIDAE

MUNNA HAYESI

AMPHIPODA

AMPHIPODA (LPIL)

HYPERIIDAE

HYPERIIDAE (LPIL)

BATEIDAE

BATEA CATHERINENSIS

AMPELISCIDAE

AMPELISCA AGASSIZI

OEDICEROTIDAE

SYNCHELIDIUM AMERICANUM

MONOCULODES EDWARDSI

MONOCULODES (LPIL)

LILJEBORGIIDAE

LISTRIELLA BARNARDI

LISTRIELLA SP.A

LISTRIELLA SP.C

PHOTIDAE

PHOTIS MACROMANUS

ARGISSIDAE

ARGISSA HAMATIPES

PHOXOCEPHALIDAE

METHARPINA FLORIDANA

HAUSTORIIDAE

ACANTHOHAUSTORIUS SP.A

LEPIDACTYLUS SP.A

PROTOHAUSTORIUS SP.A

PLATYISCHNOPIDAE

PLATYISCHNOPIDAE (LPIL)

TITTAKUNARA SP.A

EUDEVENOPUS HONDURANUS

SYNOPIIDAE

TIRON TRIOCELLATUS

PHYLCGENTIC LISTING FCR IEC PENSACCLA 1980

TIRCN TRCPAKIS

CUMACEA

BCDCTRIIDAE

CYCLASPIS SP.A

CYCLASPIS SP.F

DIASTYLIDAE

CXYURCSTYLIS SMITHI

STCMATCPCDA

SQUILLIDAE

SQUILLIDAE (LPIL)

MYSIDACEA

MYSIDAE

MYSIDCPSIS BIGELCWI

MYSIDCPSIS FURCA

PRCMYSIS ATLANTICA

DECAPCDA (NATANTIA)

SERGESTIDAE

LUCIFER FAXCNI

ACETES AMERICANUS

CGYRIDAE

CGYRIDES ALPHAERCSTRIS

PRCCESSIDAE

PRCCESSA HEMPHILLI

DECAPCDA (REPTANTIA)

PINNCTHERIDAE

PINNIXA PEARSEI

PINNIXA CHAETCPTERANA

PINNIXA CRISTATA

PINNIXA (LPIL)

DISSCDACTYLUS MELLITAE

ALBUNEIDAE

ALBUNEA GIBBESII

ALBUNEA PARETII

PCRCELLANIDAE

EUCERAMUS PRAELCNGUS

PAGURIDAE

PAGURUS ANNULIPES

CALAPPIDAE

HEPATUS EPHELITICUS

CSTRACCDA

CSTRACCDA (LPIL)

ECHINCDERMATA

CPHIURCIDEA

CPHIURCIDEA (LPIL)

AMPHIURIDAE

AMPHIURIDAE (LPIL)

PHYLCGENTIC LISTING FCR IEC PENSACCLA 1980

ECHINCIDEA

ECHINCIDEA (LPIL)
MELLITIDAE
ENCCPE ABERRANS
ENCCPE MICHELINI
MELLITA QUINQUIESPERFCRATA

CEPHALCCHCTDATA
LEPTCCARDII
BRANCHICSTCMIDAE
BRANCHICSTCMA FLCRIDAE