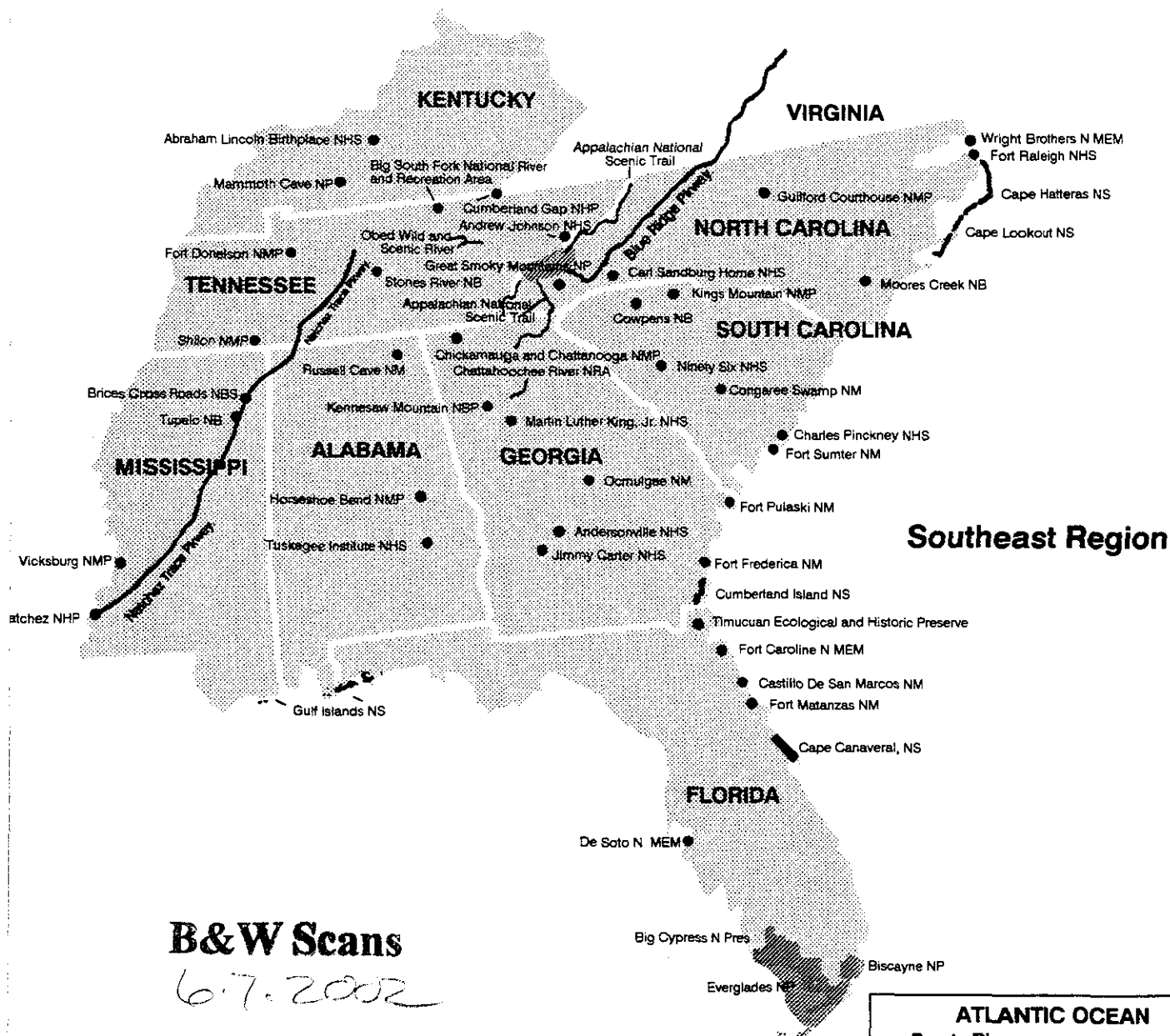
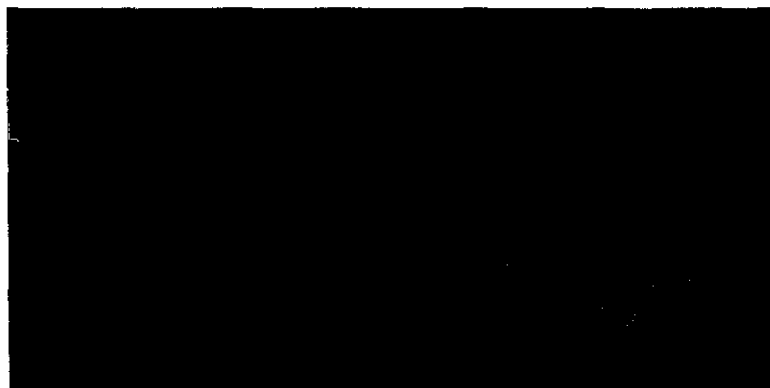


D-66
Vol. 3 of 3



B&W Scans

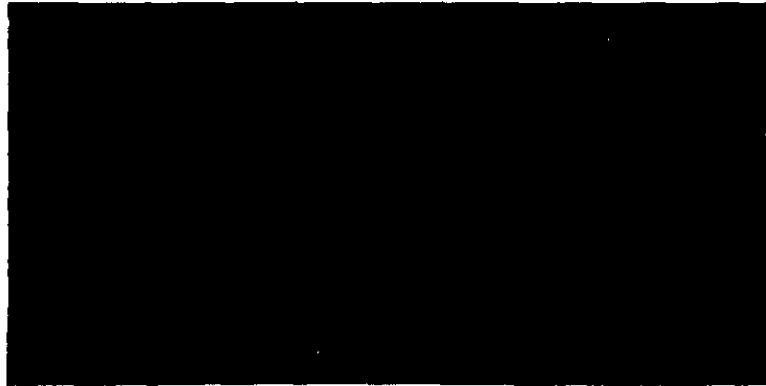
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United States Department of the Interior
National Park Service

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Southeast Region

The Southeast Region (SER) of the National Park Service (NPS) is the central administrative office for park units in eight states: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Kentucky and two United States territories, Puerto Rico and the Virgin Islands. The diversity of parks and their resources is reflected in their designations as national parks, seashores, historic parks, recreation areas, military parks and rivers. The Office of Natural Resource Management and Science, Southeast Regional Office (SERO), administers scientific research, monitoring and consultation efforts in these parks and territories, involving a wide range of biological, physical and social sciences. SERO is the established in-house medium for distributing scientific information to park superintendents, resource management specialists and other National Park Service Personnel in the parks.

The NPS disseminates the results of biological, physical, and social science through the SER Natural Resources Technical Report Series. This series supersedes the previous SER Research/Resources Management Report Series but retains a consecutive numbering system. Natural resources inventories and monitoring activities, scientific literature reviews, bibliographies, and proceedings of technical workshops and conferences are also disseminated through this series. Documents in this series usually contain information of preliminary nature and are prepared primarily for internal use within the National Park Service. This information is not intended for use in open literature. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

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Southeast Regional Office
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**National Park Service
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VOLUME II

HISTORY OF SCIENTIFIC RESEARCH
FOR GULF ISLANDS NATIONAL SEASHORE

D-66
Vol. 3 of 3

Patricia G. Claxon, Project Director
Sharon B. Worthen
Assistant Project Director

Technical Report NPS/SERGUIS/NRTR-93/02

June 1990

Supported Through

National Park Service Cooperative Research Unit
Rutgers-The State University of New Jersey
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83 4632 DI NPS CRU Resource Documents (Psuty)

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TABLE OF CONTENTS

	<u>Page</u>
Acknowledgements	i
The Barrier Islands Scientific Research Bibliography Project Description.....	iii
Maps of Gulf Islands National Seashore	v
Acronyms Used for Document Locations	x
General Keyword Categories.....	xii
Research Reviews	1
Geology, Hydrology, Soils	2
Coastal Geomorphology	13
Vegetation	20
Invertebrates	28
Fish	46
Reptiles, Amphibians	56
Birds	59
Mammals	64
Estuarine Ecology	67
Cultural, Historical	76
Management, Legislation, Recreation, Miscellaneous	88
Bibliographies	111
Maps, Charts and Aerial Photographs	113
Computerized Data Bases	127
Additional Information Sources.....	129

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This document is part of a larger project, the production of two volumes of scientific history for each park. The National Park Service has been very helpful in our effort to pull all of this information together.

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Both the Director of the Center for Coastal and Environmental Studies (CCES), Dr. Norbert P. Psuty, and Dr. P.A. Buckley, Director of the National Park Service/Rutgers University Cooperative Research Unit, have been central to the production of this series of documents.

On a park-by-park basis, we would like to thank the following people:

Gulf Island National Seashore (GUIS)

Superintendent Jerry Eubanks; R.W. (Buck) Thackeray, former Assistant Chief Ranger (FL); Thomas Muir, Jr., Supervisory Interpreter (FL); and Theodore R. Simons, Research Biologist (MS).

Fire Island National Seashore (FIIS)

Former Superintendent Jack Hauptmann; Allan O'Connell, Natural Resources Specialist; Don Weir, Chief Ranger; Neal Bullington, Assistant Chief Ranger; Richard Stavdahl, Resource Manager; Mary Laura Lamont, Interpretation; Steven Kesselman, former Curator, William Floyd Estate.

Gateway National Recreation Area (GATE)

Superintendent Robert McIntosh; Bill Shields, Assistant Superintendent; John T. Tanacredi, Natural Resources Management Specialist; John Krisko, Interpretation; Bob Cook and Mary Hake, Natural Resource Management; and Harvey Simon, Laboratory Researcher.

Cape Cod National Seashore (CACO)

Superintendent Herbert Olsen; Jim Killian, Research Coordinator; Barbara A. Samora, Resources Management Specialist; John W. Portnoy, Staff Biologist; Michael E. Whatley, Historian and Naturalist; and Dorinda Partsch, Museum Curator.

Assateague Island National Seashore (ASIS)

Superintendent Roger K. Rector; Bruce Rodgers; and Dr. Wornie K. Reed, Director, Institute for Urban Research, Morgan State University, Baltimore, MD.

Cape Hatteras National Seashore (CAHA)

Superintendent Thomas Hartman; Kent Turner, Natural Resources Management Specialist; Bebe Midgett, Cultural Resources Specialist; Clay Gifford*, Naturalist.

Cape Lookout National Seashore (CALO)

Superintendent Preston D. Riddell; Bill Springer, former Chief of Operations; Bob Patton and Skip Prange.

Cumberland Island National Seashore (CUIS)

Superintendent Kenneth Morgan; Dick Newgren, Chief Ranger; Kevin Kacer, former Chief Ranger; Don Hooker, Ranger, Interpretive; Bert Rhyne, Ranger and Library Curator, and Marcia Stout, Park Curator.

Cape Canaveral National Seashore (CANA)

Superintendent Arthur Graham.

At the Center for Coastal and Environmental Studies, our profound gratitude goes to Patricia Eager and Denise Rucci, who have unflinchingly typed and rearranged mass quantities of information in the early stages. Denise Rucci also provided editorial assistance and helped with certain stages of the production of these volumes. Srinarayani Iyer, Jay Murali, Rangarajan (Rajun) Narasimhan, and David Pantos worked extensively on the final stages of entry. Gina Bedoya, Michele Pronio, and Elaine Butterhof (Michael Siegel, Supervisor) of the CCES Cartography Laboratory did the maps. Merry Camhi offered additional suggestions for the Cumberland Island map. Les Smith and Langdon Warner have worked with the early nuts and bolts of computerizing this information; Robert Starcher worked with the intermediate stages; Krishna Murali and Anakkavur Srikanth conducted the complicated transfer of the final versions from our IBM Displaywriter to the IBM PC and MacIntosh versions.

Finally, the "Bib Team," itself is comprised of Rutgers graduate students, past and present, and others who have done the library and field research, and are writing and re-writing the two volumes for each park: Barbara Baker, Sharon Boeglin Worthen, Patricia Claxon, Helen Dudar, Steven Garber, Caroline Grant, Martha Gulick, Stephanie Hoenig, Kathleen Jagger, Vicky Lentz, Craig Liska, Enid Lotstein, Gudrun (Runa) Marteinsdottir, Anne Marie Newman, Carol Nilson, Richard Paperno, Robert Pavlowsky, Hilary Lambert Renwick, Berta Schreiber, Lisa Trecartin, Usha Vedagiri, Heidi Wearne, Linda Weldon. These researchers and writers have worked diligently and ably.

*We deeply regret that Clay Gifford passed away in the summer of 1985; we wish to acknowledge our appreciation for all the help and friendship he extended to our team members on their visits to Cape Hatteras.

THE BARRIER ISLANDS SCIENTIFIC RESEARCH BIBLIOGRAPHY PROJECT

Background

During the 1960's and 1970's, a series of National Seashores and National Recreation Areas were created by the National Park Service (NPS) along the nation's water boundaries. Unlike many of the more remote, traditional National Parks, many of these newer units are adjacent to or within major urban areas, and hence are subject to very heavy human use. In an effort to balance human and natural interests, the Center for Coastal and Environmental Studies (CCES), as part of its 1983 Cooperative Research Agreement with the NPS, in 1984 began an information-collecting project aimed at better resource management for the East Coast barrier island NPS units.

Purpose

For better resource management, the National Park Service needs a scientific data base. Much research of potential use to resource managers has been carried out in these parks, yet the results of this research have not been centrally located or coherently organized.

This project begins to fill the gap, by collecting published and unpublished research results from many fields of study, and providing a bibliographic guide to research and a narrative history of research for each park. As can be seen in Figure 1, seven NPS units were researched by the CCES group, and two by Morgan State University.

Methods

A team approach was used to review the wide-ranging literature appropriate to the parks. Research citations were obtained from over 100 journals and through library research carried out at each park and at regional and national NPS offices. Helpful park personnel provided responses to several research-related questionnaires. In addition, listings of aerial photographs, maps and charts were assembled for each park, along with information on any available computerized data bases.

Research citations were sorted into the following areas of research: Geology, Hydrology, Soils; Coastal Geomorphology; Vegetation; Invertebrates; Fish; Reptiles, Amphibians; Birds; Mammals; Estuarine Ecology; Cultural, Historical; Management, Legislation, Recreation, Miscellaneous; Bibliographies.

Library research for CACO, FIIS, GATE, CAHA, CALO, and CUIS was completed in December, 1984; library work for GUIIS was completed in January of 1987. Incidental citations for the east coast parks are being taken as they are found, but should not be considered exhaustive from 1985 to the present. These citations will be added to the Volume I Bibliography only up until the time of final publication for each park. The computerized versions will allow the updating of any bibliography with new, or newly found, citations.

Products

The history and status of scientific research will be presented in two volumes for each of the parks:

Volume I: Bibliography of Scientific Research

These volumes provide a listing of scientific studies, published and unpublished, in standard bibliographic format. For NPS use they will be available on IBM computer diskettes as well as paper copy. General and specific keywords, title, author, etc. can be used for retrieval purposes. CCES retains an annotated, descriptive and evaluative summary for each listed citation.

Volume II: History of Scientific Research

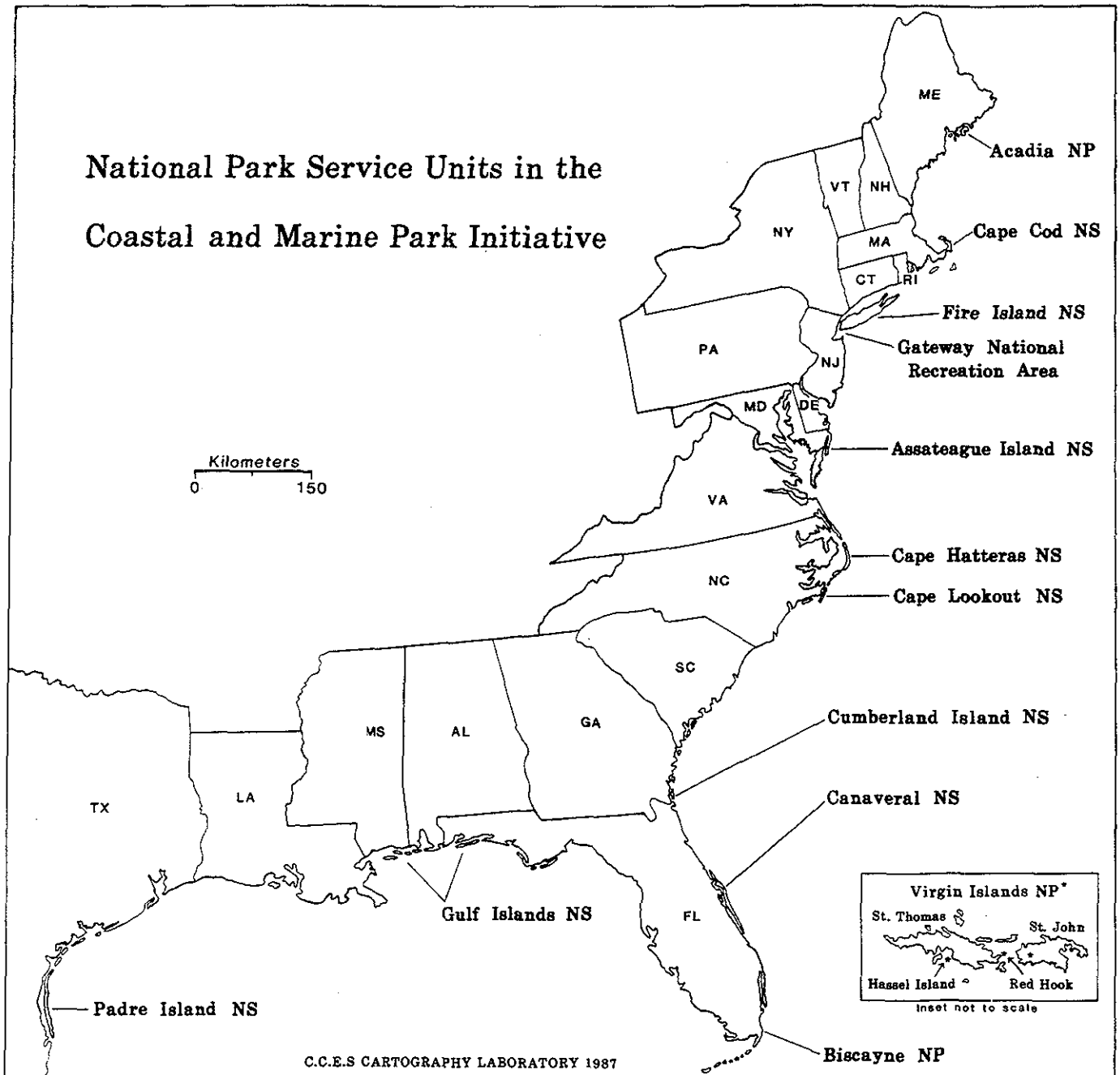
These volumes provide, first, a narrative history of scientific research in each park, organized by the categories listed above and incorporating the most significant research citations from each Volume I. Secondly, Volume II for each park provides a comprehensive listing of ongoing scientific research, environmental monitoring, and available park research facilities as of 1984.

In addition, Volume II contains a summary of maps, charts and aerial photographs available at the park and from other sources, a summary of computerized databases, and a listing of researchers, individuals, institutions, and agencies contacted in the compilation of this information.

Conclusions

This project's products will provide the basic scientific information base for any researchers working on East Coast and Gulf of Mexico barrier islands. It is hoped that these volumes will be a tool for use by both NPS resource managers and individual scientists.

Figure 1.



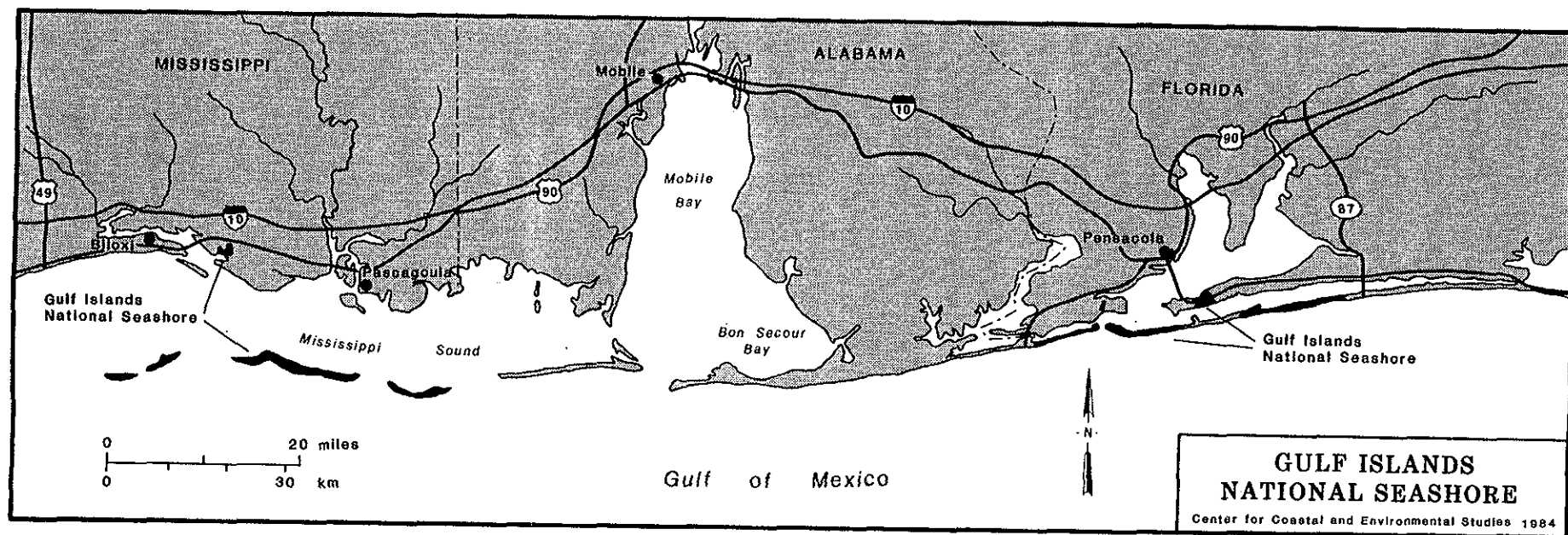


Figure 2.

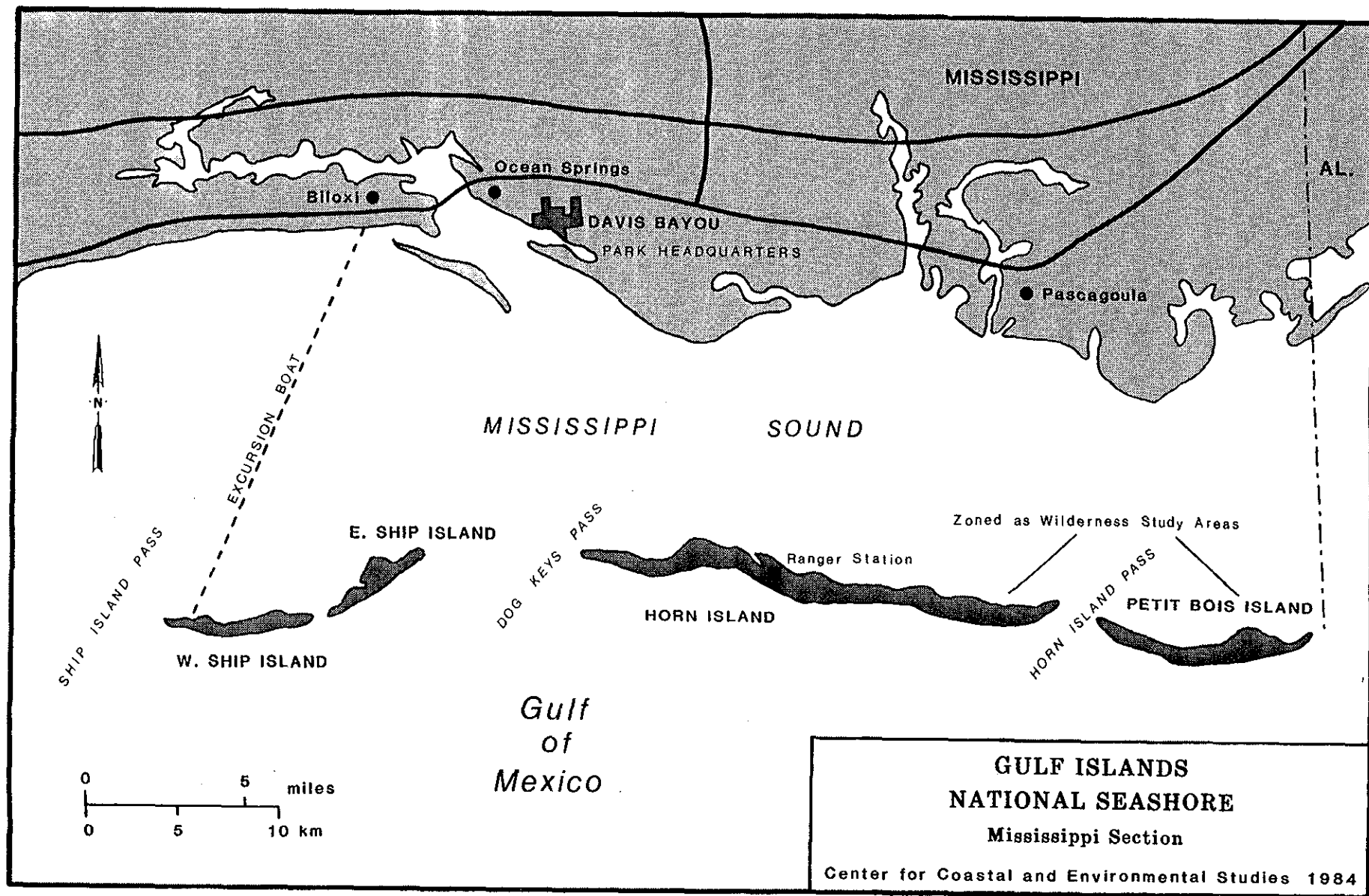
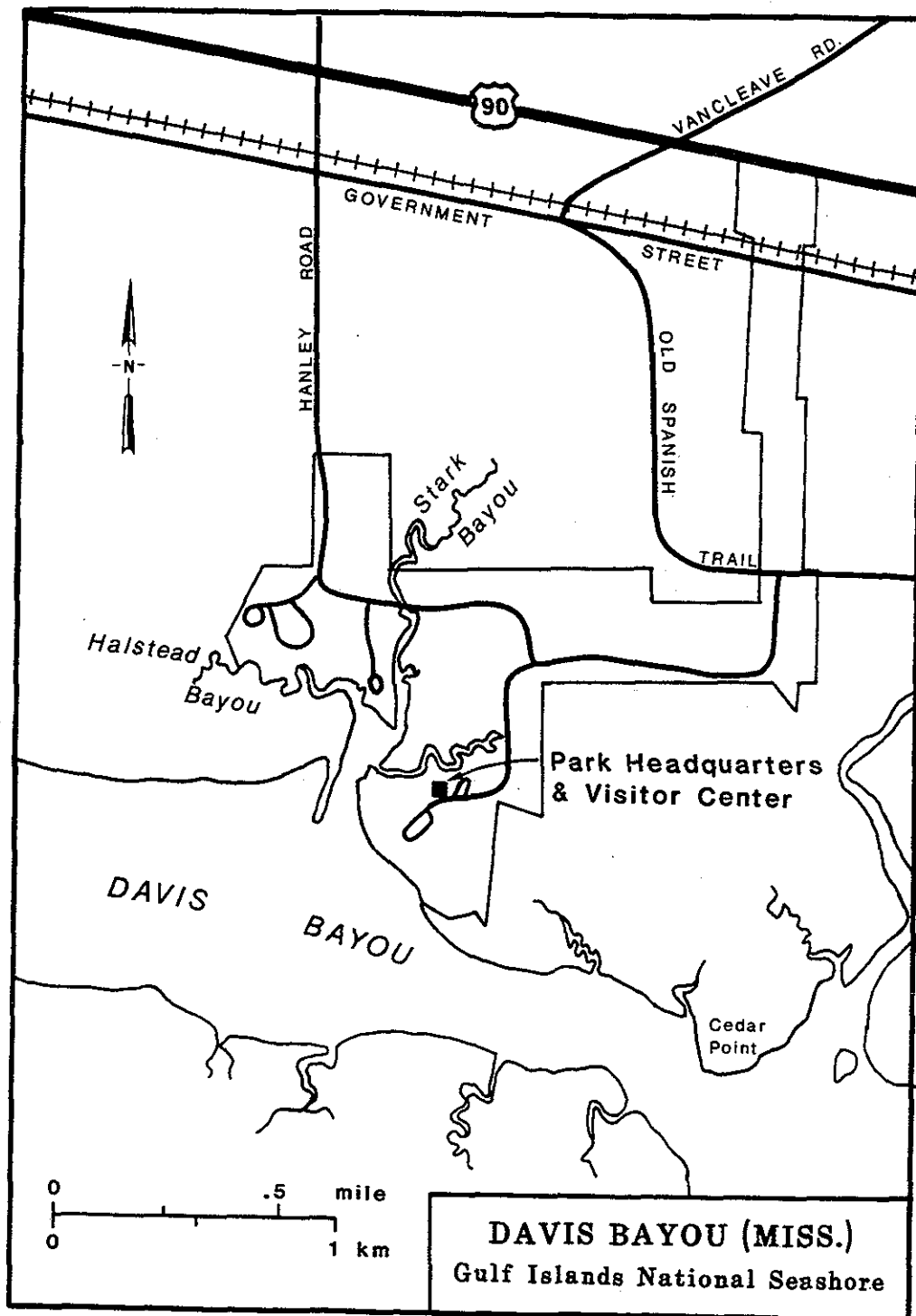


Figure 3.

Figure 4.



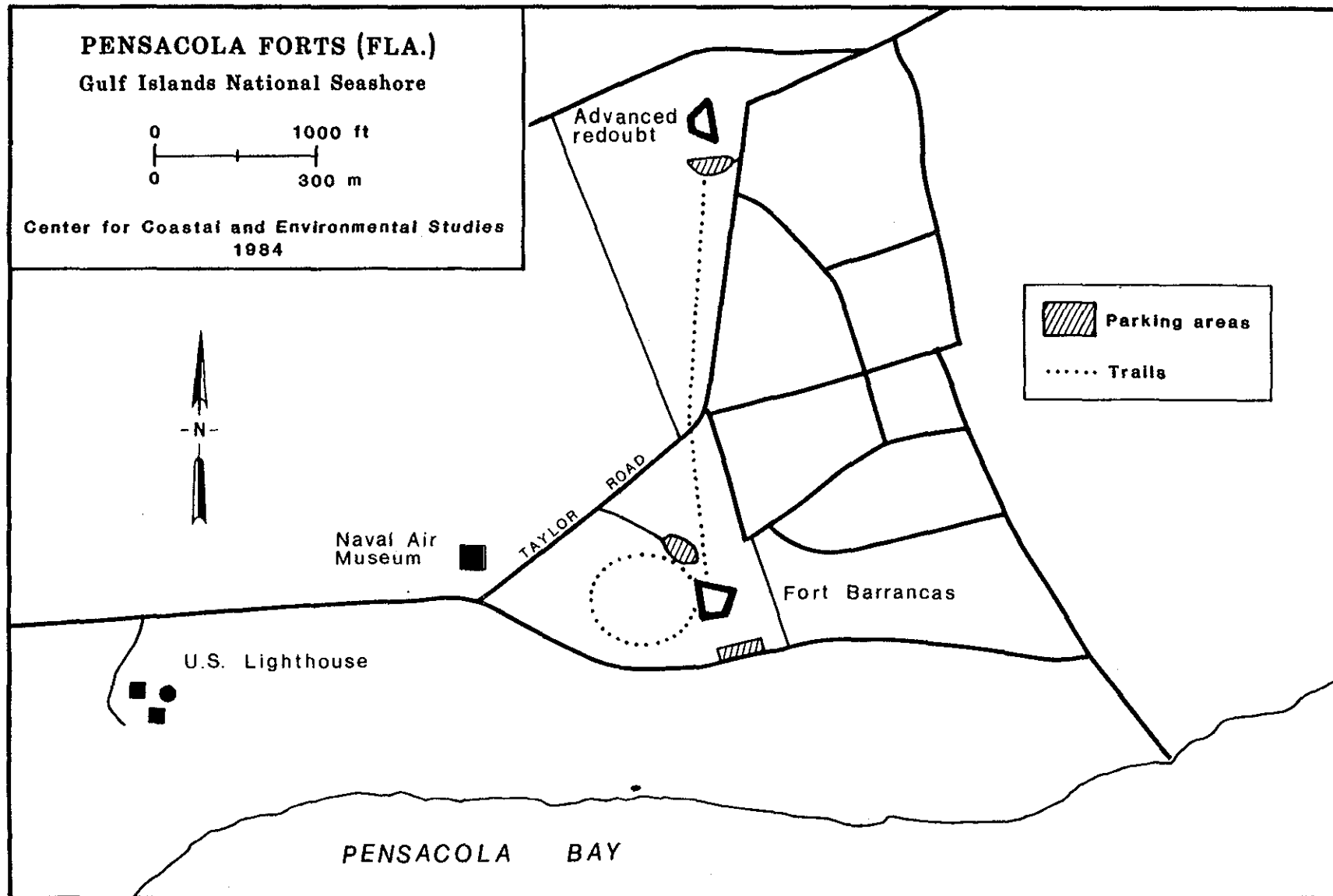


Figure 5.

ACRONYMS USED FOR DOCUMENT LOCATIONS

U.S. Department of Interior, National Park Service Locations:

ASIS: Assateague Island National Seashore, Berlin, MD.
 CACO: Cape Cod National Seashore, South Wellfleet, MA.
 CAHA: Cape Hatteras National Seashore, Manteo, NC.
 CALO: Cape Lookout National Seashore, Beaufort, NC.
 CANA: Cape Canaveral National Seashore, Titusville, FL.
 CUIS: Cumberland Island National Seashore, St. Mary's, GA.
 FIIS: Fire Island National Seashore, Patchogue, NY.
 GATE: Gateway National Recreation Area, Brooklyn, NY.
 GUISFL: Gulf Islands National Seashore, Florida Unit, Gulf Breeze, FL.
 GUISMS: Gulf Islands National Seashore, Mississippi Unit, Ocean Springs, MS.
 MARO: Mid-Atlantic Regional Office, Philadelphia, PA.
 NARO: North Atlantic Regional Office, Boston, MA.
 NPSCD: National Park Service, Washington, DC.
 NPSCDSC: National Park Service, Denver Service Center, Denver, CO.
 NPSSAC: National Park Service, Southeast Archaeological Center, Tallahassee, FL.
 SERO: Southeast Regional Office, Atlanta, GA.

Universities, Institutions, Associations, and Other U.S. Government Agencies:

ABST: citation taken from abstract.
 ADELPH: Adelphi University, Garden City, NY.
 ALEX: Alexander Library, Rutgers University, New Brunswick, NJ.
 AMNH: American Museum of Natural History, New York, NY.
 APCC: Association for the Preservation of Cape Cod, Orleans, MA.
 BIBL: citation taken from a bibliography.
 CAMCO: Camden County Library, Woodbine, GA.
 CCES: Center for Coastal and Environmental Studies, Rutgers University, New Brunswick, NJ.
 COLUM: Columbia University, New York, NY.
 DUKE: Duke University, Durham, NC.
 ECU: East Carolina University, Greenville, NC.
 ENT: Entomology Library, Cook College, New Brunswick, NJ.
 FIRE: Firestone Library, Princeton University, Princeton, NJ.
 FWS: U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.
 GADNR: Georgia Department of Natural Resources, Atlanta, GA.
 GAGS: Georgia Geologic Survey, Atlanta, GA.
 GOOD: Ralph Good's personal library, Rutgers University, Camden, NJ.
 HUSL: Science Library, Harvard University, Cambridge, MA.
 JBWR: Jamaica Bay Wildlife Refuge, Brooklyn, NY.
 LSM: Library of Science and Medicine, Rutgers University, New Brunswick, NJ.
 MABEL: Mabel Smith Douglass Library, Rutgers University, New Brunswick, NJ.
 MANN: Horace Mann Library, Cornell University, Ithaca, NY.
 N.A.: document location not available.
 NCSM: North Carolina State Museum, Raleigh, NC.
 NCSU: North Carolina State University, Raleigh, NC.
 NOAA: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Washington, DC.
 OICC: Office in Charge of Construction, Kings Bay Naval Facility, Kings Bay, GA.
 PANS: Philadelphia Academy of Natural Sciences, Philadelphia, PA.
 PCCS: Provincetown Center for Coastal Studies, Provincetown, MA.
 PEA: Pea Island National Wildlife Refuge, Cape Hatteras, NC.
 POST: C.W. Post College, Long Island University, Greenvale, NY.
 SFA: Sports Fishery Abstract.
 SKID: Georgia Marine Science Center, Skidaway Island, GA.

STICK: David Stick's personal library, Kitty Hawk, NC.
 UCT: University of Connecticut, Storrs, CT.
 UFL: University of Florida, Gainesville, FL.
 UGACPSU: University of Georgia, Cooperative Park Studies Unit, Athens, GA.
 UGAMN: University of Georgia, Main Library, Athens, GA.
 UGASCI: University of Georgia, Science Library, Athens, GA.
 UMA: University of Massachusetts, Amherst, MA.
 UVA: University of Virginia, Charlottesville, VA.
 UNC: University of North Carolina, Chapel Hill, NC.
 USC: University of South Carolina, Columbia, SC.
 USGS: U.S. Geological Survey, Washington, DC.
 UWF: University of West Florida, Pensacola, FL.
 VIMS: Virginia Institute of Marine Science, Gloucester Point, VA.
 WHOI: Woods Hole Oceanographic Institution, Woods Hole, MA.
 YALE: Yale University, New Haven, CT.

GENERAL KEYWORD CATEGORIES

BIBL:	Bibliographies
BIRDS:	Birds
CGEO:	Coastal Geomorphology -- also includes climatology, meteorology, and sea level studies
CUHI:	Cultural, Historical
ESTE:	Estuarine Ecology
FISH:	Fish
GEOS:	Geology, Hydrology, Soils -- also includes limnology, hydrography, and oceanography studies
INVRT:	Invertebrates
MAMM:	Mammals
MANL:	Management Legislation -- also includes recreation and miscellaneous studies
RPTAM:	Reptiles, Amphibians
VEGT:	Vegetation -- including fungi, phytoplankton, macroalgae, submerged aquatic vegetation, saltmarsh and terrestrial vegetation studies

RESEARCH REVIEWS

GEOLOGY/HYDROLOGY/SOILS**Hydrographic Studies****General Gulf of Mexico**

Some early general observations on the physical properties of the Gulf of Mexico were provided by Parr (1935), including data on the west Florida area. As part of a larger study on the natural history of the Gulf of Mexico, several authors contributed papers on the physical parameters of the Gulf. Leipper (1954b) analyzed the physical properties of seawater, and examined various mechanisms for the transfer and interchange of energy. Shoemaker (1954) studied light penetration in Gulf waters. R.H. Williams (1954) summarized the chemical distribution data (salinity, oxygen, phosphorus, nitrates, nitrites, pH, and carbon dioxide) of Gulf waters.

Bretschneider (1956) presented methods on obtaining hindcast statistics of wave data from the Gulf of Mexico, and methods for the generation and propagation of waves over sloping bottoms, accounting for both wind and bottom friction. B.W. Wilson (1957) reported on the results of a statistical hindcast study of the heights and periods of significant waves generated by hurricanes in the Gulf between 1900 and 1949: thirty two hurricanes were characterized.

Collier and Drummond (1958) provided data on the salinity, temperature, and levels of nitrates, nitrites, carbohydrates, and proteins in the Gulf of Mexico. J.B. Price and Priddy (1959) reported on a procedure to determine the nitrate and nitrite content of the brackish coastal waters of Mississippi. In 1961, J.B. Price and Priddy described a quick method for determining the sulphate, calcium, and magnesium content of the brackish waters of Mississippi Sound.

Tolbert and Salsman (1964) conducted a surface circulation study of the eastern Gulf of Mexico using drift bottles. The primary mechanism of surface transport in the vicinity of the release point (Panama City, FL) was wind-induced currents. David (1967) also provided observations on circulation patterns over the continental margin of the northeast Gulf of Mexico.

Drennan (1968) presented general hydrographic data on the northeast Gulf of Mexico. Major circulatory features and physical properties were described. The seasonal aspects of hydrography and circulation were also discussed, and the effects of offshore currents, river discharge, winds, and tides were also considered. Rivas (1968) compiled an atlas of seasonal and latitudinal fluctuations in surface temperature in the Gulf of Mexico. Warsh, et al. (1970) studied the relationship between surface temperatures and circulation in the Gulf of Mexico. The surface circulation of the Loop Current during the winter was characterized by strong temperature gradients.

As part of a cooperative study and inventory of the Gulf of Mexico, Christmas and Eleuterius (1973) presented hydrographic data for the coastal waters of Mississippi. The data presented established temperature and salinity characteristics for the study area, as well as general nutrient levels and the occurrence of saltwater wedges. Churgin and Halminski (1974) provided data on temperature, salinity, oxygen, and phosphate levels in the Gulf of Mexico. P.A. Thompson and Leming (1978) presented data on seasonal surface and bottom salinities and temperatures in the northern Gulf of Mexico. Seasonal variations were significantly affected by meteorological conditions and Mississippi River discharge. Blumberg and Mellor (1987) presented a three-dimensional estuarine and coastal ocean circulation model. Applications included a computation and simulation of general circulation in the Gulf of Mexico.

Mississippi Sound**Water Studies**

McPhearson (1970) provided general hydrographical data on Mobile Bay and

Mississippi Sound. Information on surface and bottom salinities, temperature, turbidity, mean low water levels, tidal range, flushing currents, and river discharge was presented.

C.K. Eleuterius (1976a) provided an in-depth description of the flow patterns, salinity, and temperature characteristics of Mississippi Sound. C.K. Eleuterius (1976b) presented data on the temporal and spatial distribution of nutrients in Mississippi Sound. Hydrographical data on the central portion of Mississippi Sound waters were also presented by C.K. Eleuterius (1976c). Using salinity data collected from April 1973 to April 1977 at 90 stations, C.K. Eleuterius (1978c) classified the Sound as a well-mixed estuary. Although data indicated local stratification, it generally fluctuated between partially mixed and well mixed.

Higgins and Eleuterius (1978) described the physical characteristics of Mississippi Sound with measurement of water volume, the area of air-sea interface, and bathymetric parameters; 99% of the total area has a depth of 20 feet or less.

C.K. Eleuterius (1983) conducted a seasonal salinity study of Mississippi Sound, comparing the effects of barrier islands, channels, reefs, and river flow on circulation patterns within the estuary. Measurements were taken at the surface and at intervals of five feet from the surface to within one and a half feet of the bottom at 95 stations. Kjerfve (1983) provided an analysis and synthesis of oceanographic conditions, such as meteorology, freshwater discharge, tidal level currents, water temperature, and salinity over a seven-month period in the Sound. In 1986, Kjerfve compared the oceanography of 10 lagoons worldwide. The Mississippi Sound estuary was characterized as follows: leaky entrance type, multiple ocean entrances, diurnal ocean tides at entrance, oceanic/estuarine salinity characteristics, mean depth of three meters, annual rainfall of 1.49 meters, and low offshore wave energy.

R.E. Turner, et al. (1987) studied the oxygen depletion of the bottom waters of Mobile Bay and adjacent shelf waters. They found that low wind speeds aided stratification and hypoxic events.

Sediment Studies

Priddy and Crisler (1952), and Priddy, et al. (1955) conducted a survey of the sediments of Mississippi Sound and inland waters to determine their physical and chemical nature with regard to the presence of oysters and other organisms. Approximately 80% of the Sound was found to consist of clay mud bottom. Data on grain size and mineral composition were provided. J.B. Price, et al. (1962) performed a chemical analysis of flocculent material found in Mississippi Sound. The flocculent was highly siliceous, and contained smaller amounts of aluminium and iron. Priddy, et al. (1964) provided a short abstract on the sulfur cycle in Mississippi Sound sediments.

Otvos (1976a) conducted an inventory of the offshore, bottom sediments of Mississippi Sound. The locations of spill areas and oyster reefs were mapped. Erosional and accretional shoreline changes on the barrier islands and mainland were recorded, as well. Isphording and Lamb (1980) provided a general description of the sediments of eastern Mississippi Sound, including information on grain size, circulation, texture, and mineral content.

J.S. Lytle and Lytle (1979, 1980), T.F. Lytle (1983), and T.F. Lytle and Lytle (1985) characterized pollutants in Mississippi Sound sediments, and clarified the processes responsible for pollutant movement. The authors provided information on regional pollutant distributions in the Pascagoula River system, the Biloxi Bay system, the St. Louis Bay system, and the Mississippi Sound system.

H.C. Carroll (1982) studied the processes involved in the deposition of sediments in central Mississippi Sound. A complex interaction between fluvial-dominated and shallow, marine coastal processes were present in the upper 20 feet of sediment. Otvos (1985) summarized information on the geology, sand resources, and geological history of Mississippi Sound.

State Specific Studies

Florida

Austin (1955) prepared an early unpublished report for the U.S. Bureau of Commercial Fisheries. Information on water currents, temperature, and salinity for Santa Rosa Sound was presented. Bohannon (1971) examined the waters and sediments of Escambia Bay for nitrogen fixation. Both anaerobic and aerobic bacteria were major nitrogen fixers. R.M. Gallagher (1971) provided a summary of hydrographic data collected in Santa Rosa Sound, Escambia Bay, Blackwater Bay, and East Bay.

L.D. Wright, et al. (1972) related patterns of bedload transport to water-mass density differences in East Pass. Bedform asymmetries indicated that bedload transport was flood dominated in the channels and ebb dominated over the shoals. A comprehensive water quality analysis and environmental impact assessment was conducted by Atlantis Scientific (1976) for Escambia River and Bay. N.C. Edwards (1976) studied circulation patterns and estuarine dynamics in Escambia Bay during a period of low, freshwater input. Ketchen (1979) conducted a hydrographic survey of Pensacola Bay, and studied flow patterns and mechanisms responsible for the transport of dissolved and suspended materials from the Bay. Moshiri, et al. (1980) studied water quality in Santa Rosa Sound. A wide variety of parameters were examined: productivity, bacteria and phytoplankton numbers, temperature, salinity, pH, transparency, dissolved oxygen, inorganic carbon, biological oxygen demand, nitrates, and ammonia. The water quality of the Sound was deemed quite good in comparison to other local estuaries.

Several dissolved oxygen surveys were conducted in the estuaries of northwestern Florida by the Florida Department of Environmental Resources, Northwest District: Blackwater-East Bay (1983a); Escambia Bay (1983b); Lower Perdido Bay (1983c); Pensacola Bay (1983d); Santa Rosa Sound (1983e); Upper Perdido Bay (1983f). McAfee (1984) conducted a 12-month study to determine the environmental impacts of treated effluent from Escambia County Utilities Authority dumped into Pensacola Bay. Data on physical parameters such as water temperature, tides, salinity, and pH were presented, as well as biological parameters such as chlorophyll production and phytoplankton counts.

Alabama/Mississippi

Snowden (1961) described the physical, sedimentological, and chemical parameters of Biloxi Bay, Mississippi. Some of the topics included principal water ions, pH, reducing conditions, and sediment size and quality. The estuaries of Alabama were surveyed by Bault (1972) for a variety of hydrological factors: pollution, nutrients, dissolved oxygen, nitrates, salinity, turbidity, and temperature. May (1973c) studied the flushing rate of Mobile Bay, Alabama in relation to river flow, bathymetry, and tidal influence. The author found that heavy metals resettled into the substrate, rather than dissipating into the waters. Schroeder (1976) compiled an atlas of the physical environment of coastal Alabama and Mississippi. Data, collected between 1973-1976, supplied information on meteorology, tides, wind, temperature, salinity, dissolved oxygen, and estuarine/river discharge. Schroeder (1978) characterized the Mobile Bay estuarine system as a moderate-sized, shallow, semi-enclosed, coastal embayment with a simple triangular shape and swell tidal amplitude.

The USACE New Orleans District (1980) recorded the highest and lowest stages of the Mississippi River and its tributaries, along with monthly and yearly mean stages, and maximum, minimum, and mean discharge of the River. Using a parametric, shallow-water, wave model, along with simulated wind fields, R.E. Jensen (1983) calculated 20 years (1956-1975) of hindcast wave data for 23 sites in Mississippi Sound. Schroeder and Wiseman (1986), and Wiseman, et al. (1988) described subtidal, shelf-estuarine exchange processes over a two-year period in Mobile Bay, together with other estuarine systems in the northern Gulf of Mexico. Southard (1989) calculated mean, annual runoff values for streams draining the eastern Gulf coastal plain of Mississippi. The runoff values of 62 continuous-record gauging stations were computed for a common, 47-year, base period. Among those rivers analyzed were the Biloxi, Wolf, and Pascagoula Rivers of Mississippi.

Groundwater Resources

Groundwater Supply

Florida

An early survey of elevations, surface features, drainage, and artesian flow was conducted by Sellards and Herman (1912) for west Florida. Jacob, et al. (1940) provided a report on the groundwater conditions in Escambia County between December, 1939 and April, 1940. Heath and Clark (1951) reported on the potential yield of test-wells drilled on the western end of Fair Point. The authors suggested that the upper aquifer could yield as much as 100,000 gallons/day without danger of saltwater intrusion. Barraclough and Marsh (1962) studied groundwater quality along the Gulf Coast of western Florida. Two problems were identified at the Fort Walton Beach area: a sharp decline in water levels (82 feet) since 1936, and saltwater intrusion at a school, brought on by the drop in water levels.

The USGS Water Resources Division (1964a) provided an index of water resource data on groundwater, surface water, and water quality, collected at various water data collection stations in Florida during 1961. Conover, et al. (1965) mapped Florida's aquifers, and discussed future management possibilities. Musgrove, Foster, and Toler (1965) reported on the water resources of the Ecofina Creek Basin area, which includes East Bay; Musgrove, Barraclough, and Grantham (1965) reported on the same for Escambia and Santa Rosa Counties. The authors covered the hydrological environment, water availability, water use, and water levels. Barraclough (1967) compiled maps and charts of available groundwater sources in Escambia and Santa Rosa Counties.

J.S. Hall, et al. (1972) conducted a ten-day waste characterization and water quality study of discharges passed into upper Perdido Bay and its tributaries. Trapp (1972, 1975) reported on the quantity and quality of groundwater available from the only sand-and-gravel, freshwater aquifer in central and south Escambia County. Healy (1974) summarized the trends and fluctuations of groundwater levels in wells by tapping the principal aquifers between 1971-1972.

Dysart, et al. (1977) conducted an inventory of the water resources of the northwest Florida counties. The authors speculated that the supply seemed adequate until 2020. Trapp, et al. (1977) reported on the decline in the water supply for Okaloosa County (Floridan aquifer), and also discussed the potential for future water resources development. Water levels declined more than 90 feet in the upper limestone of the Floridan aquifer. Healy (1978) reported a two-to-four-foot decline in water levels of the aquifers of north and central Florida, based on water level data collected from 664 wells. Merritt (1978) prepared a computerized index of water data collection activities and retrieval software. The USGS Water Resources Division (1978a) summarized the hydrologic budget under stressed conditions for the sand-and-gravel aquifer in central and south Escambia County. The Florida State University, Resources and Environmental Analysis Center (1978) conducted an inventory of unique and important physiographic, biological, cultural, and environmental elements of the water resources in the counties in northwest Florida.

Fisher and Stidham (1980) discussed the consequences of saltwater intrusion in Florida, and offered alternatives and conservation techniques. Wagner, et al. (1980) provided hydrologic and water quality data for the streams, wells, and groundwater resources of Okaloosa, Walton, and southeastern Santa Rosa Counties. The USACE Jacksonville District (1981) presented information on the scope and progress of water resource projects and studies conducted by the Corps in Florida. Various projects in northwest Florida were mentioned. Coffin (1982) provided hydrologic, geologic, and water quality data for Escambia County between 1962-1980. P.E. Meadows, et al. (1985) recorded water level and water quality data for aquifers in northwest Florida. Locations of aquifers, well characteristics, and water elevation of each site were provided. Similar data were provided in 1986 by P.E. Meadows, et al.

Mississippi

Lusk (1953) discussed water levels, and artesian pressures in wells throughout Mississippi between 1938-1952. Harvey, et al. (1965) described the texture, thickness, and transmissibility of Pascagoula area aquifers. A similar report was prepared by Newcome, et al. (1968) for Harrison County. The USACE Lower Mississippi Valley Division (1973) provided information on the scope and progress of the Corps' program for water resource development in Mississippi. Baughman, et al. (1976) reported on the status of the Pascagoula and Biloxi aquifers. The aquifers were reported to have an adequate water supply. Saltwater intrusion was mentioned as a problem in certain areas. The USGS Water Resources Division (1978b) provided records of water levels for 186 observation wells throughout Mississippi, including eight wells bordering Mississippi Sound. Similar reports were compiled by the USGS Water Resources Division (1981, 1982) and Thorpe, et al. (1986).

J.M. Wright (1983) discussed the future prospects of coastal Mississippi freshwater resources. The author touched on several topics: lack of regulation, conservation, reduction in water levels, contaminants, and poor attitude on the part of public officials toward utilization of available resources.

Alabama

R.V. Chandler and Moore (1983) described the freshwater resources of Dauphin Island. Saltwater intrusion and water quality problems were reviewed. Several reports are available concerning water resources investigations; they provide data on water levels in observation wells throughout the state, including the coastal area: USGS Water Resources Division, 1983; and Rollins, et al., 1984, 1985, 1986, and 1988.

Gulf Coast

Grubb (1984, 1985) compiled a report on the regional aquifer system of the coastal plain of the Gulf of Mexico, as part of an eight-year study. The goals were to delineate the geohydrologic framework, water chemistry, and regional groundwater flow patterns for the area.

Groundwater Contamination

General Pollution

Speed (1973) discussed the need for coastal zone water quality monitoring in the Pensacola area. Lanton and Jones (1979) edited a report on the biological aspects of water quality in northwest Florida, emphasizing the general efficiency of pollution abatement programs. Sloan (1984) discussed the various types of runoff waste sources at Pensacola Naval Air Station.

Waste Disposal

Barraclough (1966) conducted an investigation into the use of the water resources of Escambia and Santa Rosa Counties for disposal of industrial wastes from a nearby plant. For a three-month period, 70 million gallons of industrial wastes were successfully injected into a deep limestone layer. The movement of the waste was expected to run southward to the natural discharge area out in the Gulf of Mexico. Goolsby (1971), and J.B. Foster and Goolsby (1972) reported on the effects of long-term industrial waste injection into a limestone aquifer near Pensacola. No adverse effects had been noted at the time of the report.

M.I. Kaufman (1973) discussed the status of subsurface waste injection in Florida, including observed hydraulic and geochemical effects, as well as regional descriptions of the lithology and hydrochemistry of the saline aquifer system. Portions of the report covered areas in northwest Florida. Chemical analyses of sites in the Pensacola area were provided, along with maps of the study area. Pascale (1976) reported on the construction of two test-wells by the USGS to monitor a deep well injection site in northwest Florida.

Ehrlich, et al. (1979) discussed techniques needed to predict the impact of waste injection on the subsurface environment in a limestone aquifer located near Pensacola. Analyses of samples from monitor wells indicated an 80% reduction in chemical oxygen demand, and an almost complete loss of organonitrates and nitrates from waste liquid during passage from injection well to monitor well. Hull and Martin (1982) collected hydrogeologic data on the two subsurface storage systems near Pensacola containing industrial waste. The authors presented data on injection rates, geological data from core and grab samples, volume, pressure, water levels, and water quality from both injection and monitor wells. Matraw and Franks (1986) reported on the long-term contamination of aquifers near Pensacola by a creosote plant operating from 1902-1981. In 1983, the site was selected by the USGS Office of Hazardous Waste Hydrology as a national research demonstration area. The processes that affected the occurrence, transport, transformation, and fate of creosote in the environment were studied.

Geological Studies

Regional - Northeast Gulf of Mexico

Geological History

Stephenson (1928) compiled maps showing areas of marine deposits caused by submergence along the entire Gulf coastal plain. Bornhauser (1947) presented a classification of marine sedimentary cycles that caused deposition during the Tertiary in the Mississippi embayment. The author also provided a brief discussion on the principles of marine cyclic deposition. In 1958, Bornhauser described the structural types of the western Gulf Coast, and discussed possible avenues of genesis. The goal of the study was to trace the migration of oil and gas into local Gulf Coast structures. Curray and Moore (1963) reported on deposition in the portion of Mississippi Sound beyond the influence of the Mississippi River. Clay ridges indicated that small barriers were remnants of larger barriers deposited 7,000 BP. Beall (1973) discussed plate tectonics related to the origin of the Gulf Coast basin.

Toulmin (1977) reported on the distribution of Paleocene and Eocene fossils in the eastern Gulf Coast region. Fossil collections were made in beds of known stratigraphic position in Mississippi, Alabama, Georgia, and Florida. More than 700 species and subspecies were distributed through four stages: Midway Stage, Sabine Stage, Claiborne Stage, and Jackson Stage.

Salvador (1987), and Longoria (1988) discussed the structural and stratigraphic framework of the Gulf of Mexico basin, which was established during the late Triassic and the Jurassic. The Gulf was formed as the result of the southward drift of the Yucatan continental block away from the remainder of the North American plate early in the late Jurassic. Winker and Buffler (1988) described the paleobathymetric configuration of the early Gulf of Mexico.

General Geology

Lowman (1949) discussed sedimentary deposits along the Gulf Coast. From Pensacola eastward, the deposits were predominantly carbonates; westward the deposits were predominately silicates. Carsey (1950) provided a geological description of the Gulf coastal plain. S.A. Lynch (1954) discussed the origin and geology of the Gulf of Mexico.

Surveys

The University of Georgia, Marine Institute and the Skidaway Institute of Oceanography (1974) compiled a collection of existing information and data on the geology, geological history and development, and geological processes of Gulf Islands National Seashore.

Sediments

Hsu (1960) characterized recent beach sands east of the Mississippi River as mature quartz containing practically no feldspar, and a mature heavy mineral suite rich in staurolite and kyanite. Shepard (1960) discussed differences in sediment characteristics of the four facies that make up Gulf Coast barrier islands: beaches, dunes, marshes, and inlets. Ludwick (1964) provided results of extensive research on the distributional pattern of modern surficial sediment deposits in the northeastern Gulf of Mexico. Upshaw, et al. (1966) described the microfaunal, lithologic, and environmental characteristics of the depositional environment off the coast of Mississippi. Gorsline (1967) contrasted low and high energy coastal sediments between the Pacific and Gulf Coasts. The author discussed the development and formation of the coastal areas east of the Mississippi River delta.

D.K. Davies (1972) described Quaternary sediments in the Gulf of Mexico, and interpreted dominant sedimentary processes. The Gulf has undergone sedimentation by the major agents of sedimentation characteristic to deepwater areas: differential pelagic settling, turbidity currents, and bottom currents. Devine, et al. (1973) studied the distribution of minerals in the deep Gulf of Mexico, and the effects of differential settling, variable source areas, and diagenetic modification on observed mineral distribution patterns. Boone (1973) summarized available data related to coastal zone depositional environments along the Gulf coasts of Alabama, Mississippi, and western Florida. Fluvial-deltaic, estuarine, barrier island, and marine shelf systems were noted as major sources of sediment to the area. Kent, et al. (1976) characterized shoreface, inner offshore, and offshore sediments off northwest Florida and Alabama. Shoreface sediments (0-10 meters) were found to be in equilibrium with present sea level and surf base, consisting mainly of quartz grains. The inner offshore sediments (10-30 meters) were described as not being in equilibrium with daily wave action, but as being more affected by storms. The offshore sediments (>30 meters) were medium to coarse, medium to poorly sorted, and consisted of quartz grains and up to 40% fragmented organic carbonate.

Landforms

Doering (1956) reviewed geologic formations of the Gulf Coast. Otvos (1972b) conducted field investigations to document marine terraces along coastal Mississippi, Alabama, and northwest Florida; however the author was unable to confirm the presence of earlier (pre-Sangamon) Pleistocene or Citronelle (Pliocene) littoral ridges and marine deposits. Otvos (1981b) conducted surface studies of the northeastern Gulf coastal plain to explore alternatives to the littoral origin of landforms. Lineaments, partially interpreted in the past as being associated with beach ridges, barriers, spits, bars, or wave-cut scarps along the northeast Gulf Coast, appeared to be tectonic in origin. Mink, et al. (1988) discussed the geologic framework of the Norphlet Formation found both onshore and offshore of coastal Mississippi, Alabama, and west Florida.

Oil Drilling

Halvatzis (1986) summarized drilling activities in Mississippi, Alabama, Florida, and Georgia during 1985. Oil and gas were produced from formations ranging in age from early Paleozoic to early Tertiary, and from depths of 2,000 feet to >20,000 feet. In 1987, Halvatzis summarized drilling activities in 1986. Total drilling activity decreased 33.4% from 1,053 tests in 1985 to 701 tests in 1986.

Florida

Geological History

Chen (1965) conducted a reconnaissance study of the complex Paleocene and Eocene stratigraphy of the panhandle of Florida.

General Geology

C.W. Cooke and Mossom (1929) reviewed basic geological research conducted in Florida between 1927-1928. Three locations along the Gulf Coast were studied: the Alum Bluff group in Okaloosa County, the Choctawhatchee and Citronelle Formations in Escambia, Santa Rosa, and Okaloosa Counties. C.W. Cooke (1939) presented a history of the geology of Florida. The author covered the coastline, islands, beaches, lagoons, bays, and harbors. In 1945, C.W. Cooke reported on the geology of Florida, describing the composition and structure of the Floridian Plateau. Data were provided for Okaloosa, Escambia, and Santa Rosa Counties. The general features of the formations were provided including name, character, thickness, distribution, stratigraphic relations, fauna and flora, and paleogeography.

Puri and Vernon (1959, 1964) compiled a guidebook of classic Florida outcrops. The Choctawhatchee Stage was described, along with its fauna and type locality. Marsh (1966) discussed the geology of Escambia and Santa Rosa Counties. The author described the formations and fossils in the area, as well. M.W. Clark and Schmidt (1982) studied the shallow stratigraphy of Escambia, Santa Rosa, and Okaloosa Counties. Mott (1983) compiled data on the date and geographic locale of seismic events in Florida between 1727-1981.

Surveys

Carlisle and Walker (1960), and Walker, et al. (1960) surveyed the soils of Escambia County, providing characteristics of the soils, as well as discussing how the soils were formed and how they are classified. The USDA Soil Conservation Service (1969) provided a soil description of Escambia County, as well. Data included soil type, particle-size distribution, textural class, organic cations, moisture tensions, extractable cations, and soil series names.

Sediments

R.M. Harper (1910) studied peat deposits in Florida, including Santa Rosa and Escambia Counties. Bell (1924) described the use of clay deposits found in various locations in Florida. The deposits in Escambia County were described as Pliocene and Pleistocene aged sands and clays that were used for bricks, stoneware, and terra cotta. Those from Okaloosa County were also sands and clays, but had no manufacturing use. The Santa Rosa County deposits had two strata, used for stoneware, terra cotta, and roofing tiles. Mossom (1926) described the structure and stratigraphy of the Pensacola area, as well as Escambia, Santa Rosa, and Okaloosa Counties. These areas are covered by clays and sands in those regions nearest the coast. Puri (1953) studied 58 outcrops, 20 auger holes, and 2 water wells to develop a sequence of Miocene formations in western Florida.

Hyne (1965) studied the continental shelf area of Choctawhatchee Bay to define sedimentary characteristics and distribution patterns. Swanson and Palacas (1965) provided notes on the distribution and probable origin of water soluble organic material in shallow, subsurface sands of the Florida panhandle. Goldsmith (1966) conducted a study of the sedimentary environment of Choctawhatchee Bay to delineate complex physical, chemical, and biological conditions under which recent sediments have accumulated. Hyne and Goodall (1967) speculated on the origin of sediments, and the formation of the local geomorphology of the inner continental shelf off Choctawhatchee Bay. Horvath (1968) studied the bottom sediments of the Pensacola Bay system to evaluate the estuarine depositional environment. N.M. Parker (1968) conducted a sediment study of the Perdido Bay estuary. The author characterized various regions of the estuary according to the types of mineral deposits present.

Arvik (1970) studied and described the soils near Eglin Air Force Base. Van Wyk (1973) studied selected aspects of Holocene and Pleistocene sedimentation in the Pensacola area. T.M. Scott, et al. (1980) discussed the specifications, various uses, and geologic framework of the sand and gravel resources of Florida.

Alabama/Mississippi

Geological History

Otvos (1976b) discussed the various geological time units present along the Mississippi-Alabama coastal zone, and also described the mineral distribution, deposition sequence, sediment sources, and the effects of erosion. Also included were discussions of transgressions, regressions, and the effects of the interglacial Pleistocene Epoch, along with barrier island evolution and island drift. Kindinger (1988) discussed five stages of continental shelf evolution off the Mississippi-Alabama coast. The stages were controlled by glacioeustatic (sea level) changes, and were defined by the stratigraphic position of depositional and erosional episodes. The study area was located off Ship, Horn, Petit Bois, and Dauphin Islands.

General Geology

Otvos (1973a) compiled a guidebook of geologic formations of the Mississippi-Alabama coastal and nearshore zone. Nummedal and Otvos (1982) described the geological history, morphology, and bathymetry of the Mississippi-Alabama coastline.

Sediments

Milne and Earley (1958) studied the use of clay mineralogy of sediments as a tool in evaluating the stratigraphy of an area. The authors presented evidence that clay mineralogy analysis assisted in determining the origin of sediments and the type of depositional environment. Stow, et al. (1976), and Drummond (1977) studied the distribution of heavy minerals offshore Alabama and Mississippi. Each of the 110 sediment samples contained the same suite of nine heavy mineral species. Differentiation of the species appeared to be affected by hydraulic factors; settling velocity was directly related to the energy of the environment. Drummond and Stow (1979a, b) presented further information on the abundance, distribution, and transportation-concentration processes of heavy minerals in the offshore zone of Mississippi and Alabama. Abundances were interpreted as a function of the hydraulic properties of the grains and of the hydraulic regime of the area.

Mississippi

Geological History

Gagliano (1962) conducted a coastal plain survey of southern Mississippi. The author discussed the geological history, physiography, paleoecology, and archeological sites of the area. Otvos (1972a) conducted a stratigraphic and geomorphological study of the Pleistocene coastal Mississippi barrier ridge.

General Geology

Hilgard (1860) provided a general descriptive book on the geology and agricultural features of Mississippi. E.N. Lowe (1919) compiled one of the earliest accounts of the geology, geography, and soil and mineral resources of Mississippi. G.F. Brown, et al. (1944) reported on the geology and groundwater resources for Mississippi, including Cat, Horn, Ship, and Petit Bois Islands. Hahn (1962) conducted a survey of the titanium resources of Ship Island. The author also looked at the ilmenite, rutile, and associated heavy mineral content of black-sand-bearing beach sands. The western part of the island was considered a potential source of titanium.

Surveys

The USDA Soil Conservation Service (1967) provided characterizations of Mississippi soils. Information included soil series names, particle size, ion exchange properties, chemical analysis, mineralogy, and pH.

Sediments

E.N. Lowe (1911) conducted a survey of soils by physiographic regions. The author also provided a discussion on weathering, erosion, and treatment of soils. Barton and Campbell (1949) conducted marine sedimentation studies at various locations in Mississippi, including the Biloxi waterfront, both shores of Deer Island, the shallows of Biloxi Bay, and restricted areas of Horn, Ship, and Cat Islands. Sand was most abundant on barrier beaches, spits, and exposed beaches, where it has accumulated by the winnowing action of waves. Silt increased with increasing distance from shore in open bodies of water. Organic mud was found in quiet, nearly land-locked bodies of water.

Wimberley and Ludwick (1955) profiled the mineral content of surficial sediments on Horn Island. Sediments showed a high percentage of heavy minerals on the island, intermediate percentages in the Sound, and low percentages seaward. W.R. Walton (1960) examined a series of sediment samples transgressing the major environments of Horn Island. Nine environmental zones were recognized on the basis of species composition, diversity, population size, and faunal dominance. Harrison (1968, 1973) studied the composition of heavy minerals on Horn Island. The author found that the minerals were dominantly metamorphic, with a simple mineralogy. Childers (1973) conducted a preliminary analysis of the estuarine sediments of Davis Bayou for various chemical and physical parameters, and bacteria. There was a significant correlation between heterotrophic bacteria, and the carbon and nitrogen present in the sediments, as well as depth. Hoskin (1974) described size-frequency distributions for bottom sediments from three living oyster reefs in Biloxi Bay. Oyster reef sediments contained 10% gravel, 60% sand, 15% silt, and 15% clay.

J.S. Lytle and Lytle (1984) were able to determine the extent of transport of polluted sediments from their source. Most toxic substances became bound to sediments soon after discharge into the estuary. These profiles were intended to provide an accurate assessment of potential damage caused by dredging and other types of sediment disturbance. T.F. Lytle and Lytle (1984) devised an index rating system (Environmental Stress Index) to numerically rate the key factors dealing with the potential harm associated with polluted sediments. Four principal factors were evaluated in 35 regions in Mississippi Sound: sediment toxicity, suspension stability, biota susceptibility, and disturbance probability. Areas sampled near industrial zones for these factors showed a high potential for danger to the environment; however the rest of the Sound had a low potential for damage. J.S. Lytle and Lytle (1987) analyzed surface sediments and core samples in Mississippi Sound for aliphatic and aromatic hydrocarbons, fuel oil contaminants, and sewage wastes. T.F. Lytle and Lytle (1987) examined surface sediments at 45 sites in Mississippi Sound for heavy metals, petroleum hydrocarbons, and other organic pollutants.

Alabama

Geological History

Ryan and Goodell (1972) compiled a portion of a book based on presentations made at a symposium on estuaries made at the 18th Annual Meeting of the Southeastern Section of the Geological Society of America. Their portion of the book was dedicated to the geology and estuarine history of Mobile Bay. A complete characterization of sediment types present in the system was provided.

General Geology

E.A. Smith, et al. (1894) provided an early document on the coastal plain geology of Alabama. Included were topics on Tertiary formations of the coastal plain, riverine geology, Tertiary and Cretaceous formations east of the Alabama River, and geological descriptions of each county. W.E. Smith (1981) provided information on the primary geologic processes and features of Alabama's coastal area. R.B. Cook and Smith (1982) reported on the geology and mineralogy of Alabama; each county was covered in detail. Thomas and Mack (1982) studied the relationship between Hartselle Sandstone in Alabama and the Appalachian-Ouchita orogenic belt.

Surveys

Several surveys are available for the coastal counties of Alabama: Mobile County (Gustabus, 1911; B.H. Williams, et al., 1930; Hickman and Owens, 1980) and Baldwin County (McBride and Burgess, 1964). Surveys included information on soil properties and their classification. R.L. Barnett and Clarke (1983) surveyed soils in Mobile and Baldwin Counties for fuel-grade peat resources. In addition to information on geology and peat resources, the authors provided site descriptions of the study areas, and recommendations for the removal and use of the peat.

Sediments

Ingle, et al. (1955) examined the muds of Mobile Bay for nutritional value, and to determine if toxic components were harmful to fish. The muds were found to be rich in phosphorus, and contained nitrogen in forms that could be utilized by plant life. Fat and carbohydrate contents of the muds were also noted. Brannon, et al. (1976, 1977) studied the distribution of five heavy metals in Mobile Bay: manganese, nickel, zinc, cadmium, and arsenic. High concentrations of iron and manganese in the interstitial waters were recorded.

Limnological Studies

Heitmuller (1968) conducted a preliminary study of Fort Pickens Pond at Gulf Islands National Seashore. The water was sampled for water chemistry, depth, and micro and macro organisms. Shabica and Watkins (1982) assessed the physical size of all ponds and lagoons on Horn and Petit Bois Islands. 17 ponds and lagoons were evaluated on Petit Bois Island, and 63 on Horn Island. The ponds and lagoons of both islands were concentrated on the eastern, geologically oldest, and most stable portion of the islands; all had brackish water.

COASTAL GEOMORPHOLOGY

General Geomorphological Research

Gulf Coast

Surveys undertaken by the U.S. Navy (1841, 1842b) form the earliest record of surveillance research on the Gulf Coast. These two reports outline the oceanography and hydrography of the coast from Apalachicola Bay to the Mississippi River.

W.A. Price (1954) provided a shoreline classification scheme for the Gulf Coast. He attempted to apply a quantitative regional approach to his study, grouping oceanographic processes with the associated coastal and shallow bottom conditions. He also provided a brief review of previous shoreline studies and classifications. Schwartz (1973) edited a series of landmark papers on barrier island research. Leatherman (1979) edited the proceedings from the Coastal Research Symposium held in 1978. The topics focused on barrier island dynamics from the Gulf of St. Lawrence to the Gulf of Mexico, and assessed their sedimentology, morphology, and topography. Nummedal (1981, 1982b) studied long-range dynamic equilibrium in barrier islands of the Gulf Coast. Using data on the geology, stratigraphy, morphology, and sediment transport processes of these islands, he concluded that the sediment transport system could be maintained if the sand were left to freely migrate between all related components of the system. Nummedal (1983) described the dynamic nature of the barrier islands along the northern Gulf Coast by reviewing the physical processes that led to their development and the forces that modify them.

Various authors (N.A., N.A.b) have contributed to a collection of general information on the geomorphology of Gulf Coast barrier islands, consisting of journal and newspaper articles, Park Service reports, and pamphlets. They are available at the Ocean Springs Unit, Mississippi, of Gulf Islands National Seashore.

Florida

Martens (1931) conducted a survey of Florida beaches for the Florida Geological Survey. The report described the types of shoreline found along the Florida panhandle, looking in detail at the nature of the beaches and nearshore processes. Tanner (1960) described Florida's coastline based on a wave energy classification system. Atlantic beaches were classified as moderate to high energy regimes, whereas the more sheltered Gulf Coast beaches had a reduced energy level, and sandy, low profile beaches predominated. Hyne and Goodell (1967) discussed the origins of the sediments of the inner continental shelf off Choctawhatchee Bay, Florida. The authors also described the geomorphology of the submarine environment. In 1985, Tanner indicated that all sandy barrier islands along the coast of Florida were undergoing erosion and migrating landward.

Mississippi

Shabica, et al. (1978) described the barrier island system of the Mississippi Gulf Coast in general, but more specifically discussed the effects of dredging of the channel west of Petit Bois Island. The authors stated that continued dredging of the channel would impede the natural eroding and accreting processes of the island.

Barrier Island Formation

The barrier islands of the northern Gulf Coast were formed as a result of the last sea level rise during the Holocene. Shepard (1955) discussed the sedimentary units present, and suggested that some of the latest islands were built on top of older Pleistocene barriers. Kwon (1969a, b) listed possible sediment sources for Gulf Coast barrier islands. Santa Rosa Island, Florida, and all of the Alabama and Mississippi islands developed downdrift of Quaternary-age sediment sources. Littoral drift was mentioned as a primary factor in the transport of sediments from source areas, as well as initiating or sustaining the barrier islands of the northern Gulf Coast.

Otvos (1970a, b), after extensive core analysis of the northern Gulf Coast, suggested that the islands formed by upward growth and migration of submerged shoal areas. He stressed the necessity for a sediment source to maintain growth. Hoyt (1970) also provided a discussion on the formation of northern Gulf Coast barrier islands, stating that the formation of the islands at the Mississippi River delta were due to the submergence of beach and/or dune ridges. He commented on other theories describing barrier island formation, and pointed out that the lack of open marine sediments and fauna landward of the islands indicates that they did not form from bars or shoals.

Otvos (1979a) provided further information on the evolution of the Alabama-Mississippi barrier islands with the preliminary results of core drilling, which indicated that the islands evolved by shoal-bar aggradation. Otvos (1979b) described the geologic framework of the nearshore zone of Dauphin, East Ship, Petit Bois, and Cat Islands. He also discussed the formation of the islands, and where all muds and sediments originated. Information on the subsurface stratigraphy and geologic history of each island was included.

Otvos (1980b, 1982b) discussed theories on the evolution of Santa Rosa Island, and compared them to the theories on the formation of the Alabama-Mississippi barrier islands. Drilling results showed that certain areas on eastern and central Santa Rosa Island at shallow depths are underlain by Pleistocene sands. Otvos (1981a) further discussed his ideas on the formation of the barrier islands of the northern Gulf of Mexico, and provided stratigraphic information demonstrating the existence of open marine mainland shores in the area during the late Holocene up until the early forms of the present-day islands emerged. Otvos (1985b) summarized the results of core sampling from four Holocene island-lagoon complexes in the northern Gulf of Mexico. He reconstructed the evolution of the islands by comparing vertically and horizontally inter-related foraminiferal biotopes and sediment parameters. Three main platform types were identified: 1) aggradational-progradational platforms (Mississippi and Apalachicola island chains); 2) composite platforms (Dauphin and Santa Rosa Islands); and 3) transgressive platforms (Chandeleur and Derniere Islands).

Nearshore Processes

Beach Profiles

Gorsline (1966) provided monthly profiles on several west Florida beaches over a period of several years: Destin Beach, Pensacola Beach, Pensacola Shores, and Gulf Shores. The author characterized the coast as near equilibrium, with low to medium wave energy.

The annual growth of Gulf Beach on Perdido Key was studied over a 108-year period by D.J. Price (1975). Balsillie (1975) studied a 100 mile segment of the west Florida Gulf Coast to analyze and interpret littoral phenomenon and profile data. Longshore transport rates were predicted and compared to earlier studies. A physiographic review was also presented.

Vieser, et al. (1977) conducted a beach profile study of Santa Rosa Island to determine short-term changes, as well as the type and approximate amount of sediment transported along the beach face. Results showed very active beach processes. Beach width changed from a minimum of 52 feet in June 1975 to a maximum of 200 feet in January 1976. Profiles taken in 1977 showed little overall change. There were major changes of the beach face at each station with regard to slope and sediment movement. The backshore remained relatively stable. Additional raw profile data for Santa Rosa Island were provided by Morgan (1979).

Dolan, et al. (1982) described the general relationships and covariance of the shorezone of Horn Island. Zapel and Nummedal (1983) discussed the sedimentary processes of the Mississippi barrier islands. Prevailing and dominant waves cause longshore sediment transport to the west along the Gulf Coast beaches. The Mississippi Sound shoreface of Horn Island is dominated by a set of oblique transverse bars, and is maintained by a complex sediment/cell-circulation pattern.

G.W. Stone (1984a) provided information on ancient, as well as modern, coastal process-response systems in northwest Florida. The author focused on the systems of Santa Rosa Island and Perdido Key, and described and compared the wave damage and sediment transport processes of the two islands. Psuty and Jagger (1987) reported on shoreline change and sediment transport at Perdido Key. The researchers found an overall negative displacement, with the island migrating landward.

Offshore Bar Morphology

Marion (1951) discussed methods for modifying rates of supply and loss of sediments in achieving a material-energy balance in the Biloxi/Ocean Springs area of the Mississippi Gulf Coast. The author stated that offshore bars were moving seaward, due to the topography of the bottom and transverse bars. Evans (1972) discussed bar and spit formation in general, mentioning the offshore bars of the Gulf Coast. The formation of bars is caused by the transport of material from the shore toward the distal end of the bar by the swash and backwash of the waves breaking obliquely on the shore. Hardin, et al. (1976) documented shoreline change and nearshore bottom changes of coastal Alabama using remote sensing techniques.

Nummedal, et al. (1980), and Nummedal (1982a) discussed bar morphology along the Mississippi Sound margin. They described the micro-tidal, low wave energy Mississippi Sound margins as being characterized by an abundance of shoreface bars. Equilibrium bar configuration at any given time was described as time-invariant. During storms, however, the bars went through cycles of change. In response to annual changes in prevailing winds, the bars showed an increase and decrease in height.

Zapel (1983a, b; 1984) provided seasonal beach and bathymetric profiles of a transverse bar field on the sound side of Horn Island, Mississippi. Neither the form nor the orientation of the bars were effected by variations in wave conditions. The author discussed the process by which sediment was redistributed, and how the bar morphology was maintained. The persistence of the transverse bar was explained by the narrow range of "effective" wave conditions occurring in the area, and the short time interval required for the growth and decay of waves.

Transport Mechanisms

Tanner (1964) suggested low, local headlands as a probable sediment source for Florida panhandle beach ridges and barrier islands. The author found that local rivers did not supply much sediment, due to low energy deposition at river mouths and estuaries. Bruno (1971) developed an empirical predicting equation for a longshore current system from Panama City to Pensacola, Florida, using stepwise multiple regression. Wind roses, surf histograms, and current conditions were presented for each of the six sites along the transect. Sheng and Butler (1982), and Sheng (1983) constructed a three-dimensional model for coastal currents and sediment transport in Mississippi Sound and adjacent offshore waters. The authors found large spatial and temporal variations in bottom shear stress, and an increase in sediment resuspension with an increase in shear stress, decreasing salinity, and shorter time-history of bottom sediments.

Historical Shoreline Change

Using maps and charts dating from 1710 to 1948, Glezen (1951) prepared a memorandum on changes in the barrier bars of Mississippi Sound. Information on shoreline changes of the Mississippi barrier islands was provided by Malbrough and Waller (1977) through use of historical monitoring, topographic charts, and aerial photographs. Results provided insight into natural and artificial trends of sediment movement and deposition. Long-term trends, averaged over a 125-year period (1847-1973), indicated maximum rates of accretion (16-125 feet/year) on the western ends of the islands, while maximum rates of erosion averaged for the same time period (44 to 322 feet/year) occurred on the eastern ends of the islands. Major factors found to have had an effect on shoreline change were fluctuations in sediment supply, high frequency of tropical storms, and artificial change in east-west littoral drift by dredged channels.

Stapor (1975) studied long-term erosion patterns on Santa Rosa Island, Florida. Results indicated net deposition at the western tip, net erosion between the U.S. Coast Guard Station and Pensacola Beach, and no change from East Pass to Pensacola Beach. Shabica, et al. (1984) compared shoreline changes between two barrier island systems: the fine-grained deltaic barrier islands of Louisiana, and the medium to coarse-grained coastal plain barrier islands of Mississippi and Alabama. Rates of shoreline change were quantified along 300 km of coast for time intervals as long as 56.3 years. Dauphin, Petit Bois, Horn, East and West Ship, and Cat Islands were chosen for analysis.

Coastal Sedimentology

Sediments/Sands

Martens (1928) described the sand composition of Florida's beaches for the Florida Geological Survey. Several areas of the northern Gulf Coast were included: Pensacola, Gulf Beach, and Santa Rosa Island. Foxworth and Ellis (1957) conducted a preliminary study of the heavy minerals of the beach sands of Mississippi Sound. A list of the minerals identified, as well as their distribution, was included. In 1962 Foxworth, et al. provided further information on the heavy minerals of Mississippi Gulf Coast beaches, describing and identifying the heavy mineral component. Possible commercial uses were also discussed. Weidie (1968) described bar and barrier sands of the Gulf Coast. The author found them to exhibit a number of characteristic properties; among these were shape, relation to surrounding strata, mineral content, grain size and sorting, and carbonate and heavy mineral content. The properties were used to define and identify the sand bodies.

Stapor (1973) studied the internal structure of representative beaches, coastal dunes, and beach ridges of northwest Florida to identify and evaluate marine and eolian processes. Extensive coastal dune fields and heavy mineral deposits were identified and related to possible changes in coastal conditions since the early Holocene. Using the Mississippi/Alabama barrier islands, Otvos (1974) studied significant textural differences between high energy, open marine, and low energy, sound beaches. The northern beaches were composed of a coarser-grained sand than the southern beaches.

Sedimentary Environments

Priddy and Smith (1960) compiled a guidebook on the sedimentology and erosional aspects of Horn Island, Mississippi. Shepard, et al. (1960) contributed to a collection of papers summarizing the results of an American Petroleum Institute project on the sediments of the northern Gulf of Mexico. S.J. Williams (1974) studied the sedimentary environments of the barrier islands and shallow marine shelf west of Pensacola. Kent (1976) provided an assessment of the coastal sedimentary environments of Alabama and northwest Florida. The author characterized the environment as an area with low tidal range, moderately high wave energy, net westward longshore drift, and storm-generated currents and waves.

Barfus (1984) studied recent depositional environments in the western portion of Mississippi Sound. Core and seismic data revealed an unconformable contact beneath the study area; the author described how the contact was formed. Webb (1985) described in detail the depositional sub-environments of Santa Rosa Island, Florida.

Inlets

Keulegan and Hall (1950) presented a model for tidal discharge through a proposed inlet on Santa Rosa Island. A formula was derived to determine the maximum discharge to be expected through an inlet at any tidal cycle. R.G. Dean and Walton (1975) described the hydraulic and sedimentary processes that occur near inlets, and their effects on adjacent barrier islands. L.D. Wright and Sonu (1975) contrasted the flood and ebb tidal deltas in East Pass on the northwestern coast of Florida. As part of an inlet classification study, Jarrett (1976) investigated tidal prism/inlet area relationships throughout the United States, including 24 sites on the Gulf Coast. The tidal prism/inlet area relationship was not found to be a unique function for all inlets, but varied depending on the location of the inlet, and

whether it had been stabilized by a dual jetty system. C.P. Jones and Mehta (1977) discussed sand transfer systems at Florida tidal entrances, including Perdido Pass and East Pass on the Florida panhandle. Inlets were classified on the basis of six types of transfer systems. Perdido Pass and East Pass were classified as Type II: "Hydraulic dredging in the entrance vicinity from an impoundment basin, adjacent to a weir jetty."

G.W. Stone (1984c) presented a wave refraction model (WAVENRG) to evaluate the effects of jetty and channel construction on the nearshore wave regime of the proposed site of Navarre Pass in Santa Rosa Island. The author speculated that pass construction would cause a local increase in wave energy concentrated in the channel. Bruun and Adams (1988) discussed the use of hydraulic pressure to stabilize tidal inlets, and reviewed existing procedures and methods of channel stabilization and bypassing; East Pass (Santa Rosa County, Florida) was included as an example.

Shoreline Management

Bruun, et al. (1962) provided data on the topography of Florida's coastline in relation to storm tides, as a guide for coastal developers. In an early shore management study, Snetzer (1969) described the failure of the inlet jetty-weir systems of East Pass Channel (Florida) and Perdido Pass Channel (Alabama). Deposition occurred updrift of the jetty at both sites.

Waddell (1973a) investigated swash processes and beach response on Santa Rosa Island. The author also discussed the success of a newly developed monitoring system. Henry (1977) reported on the beach nourishment of Fort Massachusetts on West Ship Island. Major changes in the fill shoreline were in response to northwest and northeast storms. Net average retreat was slightly more than one meter per month during the 41 month monitoring period between April 1974 and September 1977.

The U.S. Army Corps of Engineers, Mobile District (1979a, 1980a) conducted a study on the erosion of the north shore of Santa Rosa Island near Pensacola Beach, Florida, and provided recommendations for control. Through use of shoreline monitoring and beach profile surveys, Shabica (1982) analyzed shoreline change at the western tip of Petit Bois Island. A total of 74% of the study area was removed due to the dredging of the impoundment basin, which allowed direct wave attack on the dunes of the island's western tip.

Doyle, et al. (1984) provided management and land use guidelines for homeowners and developers along Florida's west coast. Coling (1986) reported on physiographic changes at Perdido Key, Florida. As a result of the report, dune preservation and development activities were implemented. Psuty (1988) also studied erosion at Perdido Key, within a recreational context. A general negative sediment budget, in addition to nearby dredging, have added to the long-term erosion problem. The author discussed management problems and solutions.

Sea Level Fluctuations

Long-Term (or Historical) Sea Level Change

Marmer (1949) discussed sea level changes in the Pensacola area. A more or less continuous sea level rise since 1924 was reported. R.D. Ballard and Uchupi (1970) described the major features of the continental shelf off the Gulf Coast, with respect to their origins and relationship to the eustatic sea level events of the late Quaternary. Burgess (1977) reported on the submerged forests of Florida's Gulf Coast found in 18 meters of water. The trees were thought to have been continually submerged for the last 8,000 years. Pirazzoli (1986) mentioned Gulf Coast statistics in his report on relative sea level (RSL) changes recorded by tide gauge stations all over the world. The National Research Council, Committee on Engineering Implications of Changes in Relative Mean Sea Level, Marine Board (1987) compiled a series of reports on relative mean sea level with regard to engineering problems. Selected topics included assessment of relative mean sea level changes, the effects and responses of mean sea level changes in the coastal zone, and management recommendations.

Short-Term Water Level Fluctuations

Marmer (1954) conducted tidal studies at three Florida stations: 1) Miami Beach, 2) Cedar Key, and 3) Pensacola. After an eight-day study, tidal curves were assembled for Pensacola. Periods of tidal rise and fall were approximately 12 hours, resulting in one high and one low tide per day. Reasons for diurnal tides were discussed. F. Chew (1964) reported on sea level changes along the northern Gulf of Mexico. The author correlated the sea level changes with changes in the winds producing net onshore and offshore water transport. Zetler and Hansen (1970) provided a review of a panel study on Gulf of Mexico tides.

Culp, et al. (1982) analyzed tidal observations collected from 21 tidal stations in Mississippi Sound. Marmorino (1982) studied sea level fluctuations along the West Florida Shelf. The author presented sea level data from January through April, 1978, and discussed the relationship between climatic factors and variations in sea level. In 1987 Seim, et al. presented further information on the tides of Mississippi Sound.

Storms

Pre-Storm Hazard Assessment

Using hurricane surveys taken between 1711 and 1965, Resor (1967) compiled a guide for Mississippi officials to aid in planning for the protection of lives and property, and to designate hazardous areas during dangerous storms. Golden (1977) provided an assessment of the threat posed by waterspouts to existing and proposed, floating, offshore nuclear power plants along the Atlantic and Gulf Coasts. Morgan and Stone (1985) reported on a technique for quantifying the coastal geomorphology of Florida by developing a storm wave susceptibility quotient. Ho, et al. (1987) provided a climatological assessment of the Gulf and Atlantic Coasts of the United States to aid in establishing flood insurance criteria for coastal communities. G.W. Stone and Salmon (1988) integrated planning criteria with data describing the morphological response of Perdido Key and Dauphin Island to two recent hurricanes (Frederic, 1979 and Elena, 1985). The authors advocated a "window of opportunity" concept as a necessary approach to mitigative planning. Godschalk, et al. (1989) provided information on planning and hazard mitigation policies for possible catastrophic coastal storms of the Gulf and Atlantic Coasts. Local mitigation tools, influences on mitigation, and alternate approaches to mitigation were discussed.

Post-Storm Assessment

Damage assessments for both property and shorelines as the result of several hurricanes are available: the Caribbean Sea Storm of 1906 (Anonymous, 1906); Hurricane Hilda (Leipper, 1965); Hurricane Camille (Sonu, 1970; Tanner, 1970; and U.S. Army Corps of Engineers, Mobile District, 1970b); Hurricane Eloise (Morton, 1976; Chiu, 1977); Hurricane Frederic (U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, 1979; Franklin and Bohman, 1980a, b; Franklin and Scott, 1980; Nummedal, 1980; D.W. Parker, et al. 1981; Nummedal, 1982d; and Shay and Elsberry, 1987).

Bruun, et al. (1962) reviewed the status of beach erosion due to storm tides in Florida between 1961-1962. The northwest coast from Gulf Beach to Cedar Key was included in the report. The U.S. Army Corps of Engineers, Mobile District (1966) conducted a hurricane survey of past storms affecting northwest Florida. The nature of hurricane problems, the direct solutions, and the economics of the solutions were discussed. Balsillie (1986) provided a review of the major storms between 1959-1985, along with associated data on beach erosion. B. et al. (1986) presented an analysis of the meteorological data for storms, and the distribution of rainfall for the floods of April 1979 in Mississippi, Alabama, and Georgia. Summaries of flood stages and discharges at 221 streamflow gauging stations were provided. Additional information, such as flood crest stages, hydrological data, water salinity, and water temperature were compiled for 22 sites along the Intracoastal Waterway in Mobile Bay, Alabama.

Storm Surge Modeling

G.W. Stone and Morgan (1983), and G.W. Stone, et al. (1985) presented information on a computer model capable of predicting potential storm wave damage along Florida's coastline. Jelesnianski, et al. (1984) presented a hurricane storm surge forecast model called SLOSH, using 22 basins along the East and Gulf Coasts. R.G. Dean and Chiu (1985), using measurements taken from Hurricane Camille in 1969, modeled expected hurricane storm surges for Escambia County. R.G. Dean and Chiu (1986) presented storm surge models for Escambia County, Florida.

Miscellaneous Studies

Kurz (1942) provided a brief description of dunelets and dune development on Santa Rosa Island, near Camp Walton. Leipper (1954a) discussed the regions of formation, directions of motion, and characteristics of intensification of cyclones and other storms in the Gulf of Mexico. L.D. Wright, et al. (1972) contrasted the water densities of Choctawhatchee Bay and the Gulf of Mexico. As a consequence of sharp vertical and horizontal stratification in the northern part of East Pass, flood tide currents were swiftest and of longest duration in the deeper layer of the dredged channels, while ebb tide currents attained their maximum velocity and duration in the upper portion of the water column. Sonu, et al. (1973) studied the effects of sea breezes on coastal processes at Santa Rosa Island, Florida.

C.K. Eleuterius (1978b) described the geographical boundaries of Mississippi Sound through surveying and observations of physical processes. Raynor and Hayes (1981) presented a climatological model to predict coastal winds and atmospheric diffusion to aid in planning and site selection for potential pollution causing installations. Mossa (1984) conducted wave climate studies at various sites in the northern Gulf of Mexico, comparing wave height and direction. The deepwaters of the northwestern Gulf of Mexico were dominated by waves from the southeast and south, while the northeastern waters were dominated by waves from the east and northeast. These data were collected on shipboard in established deepwater quadrants, and are not necessarily coincident with wave data taken in the nearshore zone or under high-energy circumstances.

VEGETATION

Ecological Studies

Blue-green Algae

Although blue-green algae are members of the Kingdom Protista (single-celled organisms), not the plant kingdom, they have been placed under vegetation because, until relatively recently, they have been included with the study of botany.

Sage and Sullivan (1978) described the taxonomic composition of edaphic blue-green algal communities in Graveline Bay Marsh, Mississippi. The number of individuals in all sampling zones were greatest in the summer and lowest in the winter. Light intensity was apparently the major factor affecting distribution. L.N. Eleuterius, et al. (1981) profiled the physical, chemical, and biological characteristics which preceded and caused an *Oscillatoria erythraea* bloom in the northern Gulf of Mexico.

Diatoms

Conger (1954) reviewed previous diatom research conducted in the Gulf of Mexico. Davis (1954) discussed phytoplankton production in the Gulf. Woodmansee (1962) reported on the distribution of the diatom genus *Rhizosolenia* in Mississippi Sound and Biloxi Bay. Diatoms were transported toward the sea in surface waters and toward land in bottom waters. Maximum numbers were found at intermediate salinities in Biloxi Bay. Sullivan (1977) studied the distribution of diatoms in Graveline Bay Marsh, Mississippi over a one-year period. The author found little evidence of seasonality, and attributed differences in distribution between spermatophyte communities to physical parameters.

In 1978, Sullivan studied the community structure of diatoms in Graveline Bay Marsh. A total of 119 taxa were noted. Differences in community structure were attributed to elevation, far-red light energy, ammonia nitrogen, soil moisture, and height of spermatophyte canopy. Further research by Sullivan (1979a) on the effects of ammonia enrichment and light intensity on salt marsh diatoms revealed a more significant effect due to clipping than to nitrogen enrichment. Sullivan (1979b) also compared epiphytic diatoms from three seagrass species found along the northern shores of Cat, Ship, Horn, and Petit Bois Islands. It was found that the three seagrasses that were sampled supported a single, nearly homogeneous diatom community. Sullivan (1988a) conducted additional community studies on the diatoms found on monospecific stands of vascular plants in Graveline Bay Marsh. A total of 155 diatom taxa in 30 genera were identified. More than half of those taxa belonged to two genera: *Navicula* and *Nitzschia*.

Algae

A general species list of the marine algae found in the Gulf of Mexico was provided by W.R. Taylor (1954). S.E. Taylor (1966) discussed the ecology and distribution of brown algae (Phaeophyta) in the eastern Gulf of Mexico. More detailed information of the brown algae of this area was presented by Earler (1969).

Mueller (1976) studied the seasonality and distribution of marine algae off the coast of Louisiana. Hollister, et al. (1978) investigated the effects of the pesticide Mirex on marine algae. Mirex had no effect on the growth or productivity of the algae, however it was rapidly accumulated in the algal tissue, thereby posing a threat to the food web.

The Florida Department of Environmental Regulation, Bureau of Water Analysis (1979) conducted limiting nutrient algal assays on water samples taken near the outfall of the Main Street Pensacola Wastewater Facility into Pensacola Bay. Pecora (1980) studied species composition of algal mats sampled from several locations along the Gulf Coast. Habitat preference, distribution, and morphology were reported for nine species and one variety of *Vaucheria*. Sullivan and Moncreiff (1988b) studied the edaphic algal flora of a Mississippi salt marsh. Algal production was highest in spring and early summer. The algal flora was dominated by motile, pennate diatoms.

Seagrasses

Phillips (1960) provided a general look at the ecology and distribution of the seagrasses of Florida. Several researchers have studied the ecology of turtlegrass, *Thalassia*. Moore (1963) found a correlation between physical conditions of the water and the distribution of turtlegrass throughout the United States, including several specific areas along the northern Gulf Coast. The author found several factors to be limiting in its distribution: water temperature, water depth, turbidity, salinity, and wave action. Humm (1964) studied the life cycle of turtlegrass epiphytes. Most rapid growth of epiphytes occurred in early summer, with peak abundance in February. A lengthy key was also provided to the 92 species of marine algal epiphytes. Stephens (1966) provided a general account of the life history and ecology of turtlegrass. Walsh and Grow (1972) compared the nutrient content of *Thalassia testudinum* and *Ruppia maritima* in relation to other aquatic plants and food crops. Both species were found to contain significant amounts of protein, carbohydrates, and minerals. Preliminary results indicated a seasonal change in annual chemical composition of both species.

L.N. Eleuterius (1972c), and L.N. Eleuterius and Miller (1976) mapped both the vascular and algal submerged aquatic vegetation in Mississippi Sound. Areas that were denuded in 1969 by Hurricane Camille exhibited signs of re-establishment and vigorous growth. No attached plants were found south of the barrier islands. L.N. Eleuterius (1975a) investigated the possible use of *Thalassia testudinum*, *Cymodocea manatorum*, and *Diplanthera wrightii* as stabilization for dredge spoil islands. Use of *Diplanthera* proved most successful.

Winter (1978) evaluated the seagrass beds located between a sewage treatment plant and Range Point on Santa Rosa Island. The bed was composed of three species: *Thalassia testudinum*, *Halodule wrightii*, and *Syringodium filiforme*. Increase in water turbidity posed the greatest threat to the future of the seagrass beds. The author also discussed costs and methods for transplanting dying seagrass beds.

McMillan and Phillips (1979) compared the environmental flexibility between different populations of new world seagrasses in the Gulf of Mexico. Knight, et al. (1980) compiled an annotated bibliography on historic, as well as recently published research reports on several seagrasses; *Halodule*, *Ruppia*, *Thalassia*, and *Zostera*. Williams (1982) conducted an aerial photographic inventory of the seagrass beds of the Breton National Wildlife Refuge and the barrier islands of Mississippi to serve as a baseline for planning purposes.

Lowden (1982) reported on the taxonomy of *Vallisneria*, and provided distribution maps. Durako, et al. (1985) edited the proceedings of a symposium on subtropical and tropical seagrasses of the southeast United States. Included was a synthesis of over 25 years of research on seagrasses. Future research recommendations were also presented.

Marsh Vegetation

General Ecology

Allan (1950) discussed land-use planning for Gulf Coast marshlands, and described in detail the various stages of salt marsh succession as related to management planning. Niering (1966) authored a general book on marsh ecology, discussing such topics as the dynamics of wetlands, energy flow, and pollution. Brief mentions were made of several Gulf Coast areas. De la Cruz (1979) compared Atlantic and Gulf Coast marshes. Gulf Coast marshes were described as deltaic formations that have grown on alluvial deposits, whereas Atlantic marshes have developed from estuarine and lagoonal sediments. Gulf Coast salt marshes were also described as having a more diverse vegetative structure.

Kruczynski (1982) characterized the salt marshes of the northeastern Gulf of Mexico from Tarpon Springs, Florida to Mississippi. The author provided a summary of various studies on the establishment of marsh communities on dredge spoil. Baird (1983) described the flora of the high marsh zone of the Atlantic and Gulf Coasts. The silica content of *Juncus roemerianus* was examined by L.N. Eleuterius and Lanning (1987) in relation to the age of living and dead-standing leaves. The percentage of silica increased as the leaf decomposed.

Communities/Zonation

L.N. Eleuterius (1972d, 1973b) provided extensive data on the ecology of Mississippi salt marshes. Profile diagrams were prepared to illustrate lateral zonation of plant communities. Organic production of vascular plants was estimated. *Juncus roemerianus* was the dominant plant species. Total standing crop and annual production was estimated at 3 million tons. L.N. Eleuterius (1976b) further discussed the distribution of the rush, *Juncus roemerianus* using inventory data collected on Atlantic and Gulf Coast marshes. Approximately 320,000 hectares of salt marsh in North America are dominated by *J. roemerianus*.

L.N. Eleuterius and C.K. Eleuterius (1979) investigated the relationship between inconspicuous tidal phenomena and zonation of salt marsh vegetation. Results indicated that frequency and duration of tidal flooding was not related to abrupt changes in plant zonation. It was suggested that other environmental factors were involved, such as edaphic conditions or biotic interactions. L.N. Eleuterius and Caldwell (1985) studied the soil characteristics of several *Juncus roemerianus* marshes in Mississippi. Results showed that tidal marsh soils vary considerably in physical and chemical characteristics among locations. *J. roemerianus* was able to flourish in a variety of soil types.

Biology/Physiology

L.N. Eleuterius (1970), and L.N. Eleuterius and Meyers (1974) reported on the distribution and effects of a fungal parasite, *Claviceps purpurea*, on *Spartina alterniflora* in the coastal marshes of Mississippi.

Seneca (1974) compared twelve populations of *Spartina alterniflora* from the Atlantic and Gulf Coasts for germination and seedling response to thermoperiod and photoperiod. De la Cruz and Poe (1975) determined amino acid content and crude protein content of 13 salt marsh vegetation species.

L.N. Eleuterius (1975b) provided a general look at the life history of *Juncus roemerianus*. In 1976 (c), L.N. Eleuterius described the morphology and anatomy of *J. roemerianus*. Lanning and L.N. Eleuterius (1978; 1981) provided a detailed analysis of the types and quantity of silica and ash, as well as their importance in a variety of marsh plants. Those species studied included: *Juncus roemerianus*, *Spartina alterniflora*, *Distichlis spicata*, *Scirpus validus*, *Zizania aquatica*, and *Limonium carolinianum*.

Simmers, et al. (1981) established a baseline to compare pollution concentration and uptake by plants from contaminated sediments. Results showed that marsh plants grown on contaminated dredged material in a flooded environment did not bioconcentrate significantly higher levels of toxic metals than the same plants grown in naturally occurring marshes. Faulkner and de la Cruz (1982) compared nutrient levels between field collected pre-fire vegetation, post-fire regrowth, pre-fire and post-fire sediment combustion residues, and reference materials from unburned adjacent sites. The study was conducted in an irregularly flooded Mississippi marsh. Two vegetative communities were examined, one dominated by *Juncus* and the other dominated by *Spartina*. Estimated losses of nitrogen and potassium from combustible plant matter exceeded 90 % and 50 % respectively. L.N. Eleuterius (1984) examined the relationship between *Juncus roemerianus* and its intertidal habitat, providing data on factors affecting growth and distribution. Experiments showed that *Juncus* grows best in freshwater with no competition from other species, and that it cannot tolerate salinities greater than 30 ‰. Horn Island, Mississippi was the study site location.

Primary Productivity

The annual net primary productivity of nine marsh communities was compared by de la Cruz (1974). Production values ranged from 600g/m²/yr for a *Sagittaria lancifolia* marsh to 2330g/m²/yr for a *Phragmites communis* [= *australis*] marsh. Annual net productivity in Mississippi marshes was generally slightly higher as compared to Atlantic Coast marshes. Stout (1978) compared annual growth and productivity between *Juncus roemerianus* and *Spartina alterniflora* in coastal Alabama. L.N. Eleuterius and Caldwell (1985) compared the

soil characteristics between several species of marsh vegetation in Graveline Bay Marsh Mississippi. Soil characteristics were highly variable within and among populations, reflecting the complexity of salt marsh plant populations.

Erosion/Stabilization Studies

Gifford (1978) reported on an unusual beginning for a Florida Salt marsh. Detritus collected around a breakwater of floating tires which contained seeds and plant fragments that grew into high marsh and foredune plants without planting, fertilizer, or care. Knutson and Inskeep (1982), and Knutson and Woodhouse (1983) provided a method for determining site suitability for erosion control using salt marsh vegetation. The authors also compared the costs of vegetation to structural methods of erosion control.

Mangroves

Savage (1972) provided a review of mangroves in Florida. The author described the process between establishment and mature trees. The black mangrove was described as the most cold-hardy species, surviving as isolated bushes throughout the Gulf area of Florida, including Pensacola.

Dune Vegetation

Kurz (1939) discussed the reaction of several plants to dune activity along the west coast of Florida. The effects of wind and salt spray on magnolia, scrub live oak, slash pine, and palmetto, among others, were described. Seneca (1972) reported on the germination response of *Uniola paniculata* to temperature, photoperiod, and salinity. Temperature appeared to have the most influence on growth and development; however the three study populations did not respond in the same way to variations in temperature.

Fix (1975), and V. Stewart (1979) provided layperson accounts on sea oats and how they promote dune growth and stabilization by accumulating windblown sand. Shabica and Call (1978) conducted a comparative vegetative analysis between dune areas, with and without boardwalks, on Santa Rosa Island.

Forest Vegetation

An early geological and biological inventory of Horn Island was conducted by Pessin and Burleigh (1941). Over 50 species of plants were identified. The principal forest species was slash pine; the authors discussed the ecological development of this species on the island. Hodgkins (1965) edited a report describing the habitat regions of southeastern forests in terms of topography, parent rock material, and physical properties of the soil profiles.

L.N. Eleuterius (1976a) provided observations on a heavy infestation of mistletoe, *Phoradendron flavescens*, on *Quercus nigra* in southern Mississippi. Teskey and Hinckley (1977) studied the impact of changes in water level on various forest types of the southern United States. The authors listed each species' tolerance level, and response to water level changes for the beech/sweet gum/magnolia/pine/oak forests of Florida, Louisiana, and Mississippi. Also included was information on the climate, topography, site characteristics, dominant species, and colonization and successional stages.

Burgess (1977) reviewed research on submerged slash pine forests on the continental shelf off Panama City. The author also made note of similar observations made at the entrance of Pensacola Bay. An evaluation of slash pine mortality by beetles at the Fort Pickens Unit of Gulf Islands National Seashore was presented by Hoffard and Oak (1980). The pines were initially damaged by saltwater overwash during Hurricane Frederic (1979) and by campground use. The initial damage allowed beetles to easily infest the trees.

Cousens, et al. (1988) studied the life history of the fern, *Lorinseria areolata*, along the Escambia River and Pensacola Bay. J.A. Jackson (1988) discussed pine forest ecosystems of the southeast, including the loblolly pines of the Gulf Coast. Exploitation of the forest was

discussed and conservation measures were reviewed.

Dredge Spoil Vegetation

The U.S. Army Corps of Engineers published two preliminary reports (L.N. Eleuterius, 1972a, b) and a final report (L.N. Eleuterius, 1974a) on plant establishment on dredge spoil in Mississippi and adjacent waters. Both seagrasses and emergent vascular plants were used as transplants. *Halodule beaudetti* was the most successful seagrass species, while *Panicum amarum* var. *amarulum* and *Panicum repens* were the most successful vascular species.

L.N. Eleuterius and McClellan (1976) reported on the ecology of dredge spoil transplants in Mississippi waters. Several factors contributed to transplant mortality: hypersaline conditions, erosion by wind and/or water, availability of soil water, soil water salinity, and soil nutrients. In 1981, L.N. Eleuterius and Caldwell discussed vegetational succession and patterns of colonization of tidal marsh plants on dredge spoil in Mississippi.

Storm Effects on Vegetation

Gunter and L.N. Eleuterius (1973) studied the effects of Hurricane Betsy (1965) and Hurricane Camille (1969) on coastal Mississippi. Miller (1974) also studied the effects of hurricanes on vegetation, but specifically researched Ship Island, Mississippi. After observing an unusual plant distribution, the author concluded that the plant communities of the Mississippi barrier islands were controlled by abiotic factors. In 1976, G.J. Miller and Stoneburner looked at the effects of hurricanes on insular tree species, they concluded that hurricanes, rather than fire, resulted in the dominance of *Pinus* over *Quercus*, as well as distinct age groupings. Further research on the contribution of hurricanes to the structure of vegetation communities was conducted by Stoneburner (1978). The study was done on Petit Bois, Horn, East Ship, and Cat Islands. The author stated that the slash pine forests on the barrier islands were maintained by the repeated occurrence of hurricane-generated overwash. Cousens, et al. (1983) studied a series of plant communities on Perdido Key following Hurricane Frederic in September, 1979. The report emphasized the revegetation of the least disturbed and the most disturbed transects.

Miscellaneous Ecological Studies

Oosting (1954) provided a review of articles concerning the vegetation and ecological processes of barrier islands from North Carolina to Texas. The U.S. Army Corps of Engineers, Rivers and Harbors Division, and the U.S. Department of Commerce, Maritime Administration (1957b) published a report on the extermination and removal of water hyacinth plants from Gulf waters.

G.J. Miller (1973) studied the effects of continual physiographic changes, such as longshore drift and storms, on the vegetation of Ship Island. J.F. Hall (1978) determined the aboveground biomass and percent cover for eleven plant species at five beach locations on Horn Island.

Gallagher (1978) discussed the importance of detritus within the estuarine food web, as well as the general ecology of the estuarine system of Santa Rosa Sound. Baron (1979, 1982) reported on the effects of feral hogs on the vegetation of Horn Island. She found that the hogs had little or no permanent impacts on the vegetation, in contrast with other studies that had shown hogs to inflict serious damage to vegetation.

Surveys, Inventories and Field Guides

Florida

Mapping Surveys

Distribution maps for the Florida species of *Ilex* were compiled by Wunderlin and Poppleton (1977). The vegetation of the Fort Pickens area was mapped by K. Hansen (1977). He

also provided a discussion of the geology, soils, climate, and physical stress of the area.

Field Guides

A variety of guides to the vegetation of Florida are available to researchers:

<u>Subject</u>	<u>Author</u>
trees	Kurz and Godfrey, 1962
mosses	Breen, 1963
orchids	Luer, 1972
wildflowers	M.F. Baker, 1972
saltmarsh and mangrove	Carlton, 1975
vegetation	
seagrasses	Hanlon and Voss, 1975
ferns	Lakela and Long, 1976
poisonous plants	Perkins and Payne, 1978
aquatic and wetland plants	Tarver, et al., 1979; Bullard and Harrell, 1979

Species Lists

<u>Subject</u>	<u>Author</u>
vegetation of Santa Rosa Island	McFarlin, 1941
endemic flowering plants I, II, III	Harper, 1949a, b, c
tidal marshes	Kurz, 1953
marine Chlorophyta	Humm and Taylor 1959, 1961
endangered species	Florida Senate, 1973; D.B. Ward, 1978; Florida Committee on Rare and Endangered Plants and Animals, 1979
<i>Vaccinium</i>	D.B. Ward, 1974
plant diseases	Wehlburg, et al., 1975
coastal vegetation communities	Carlton, 1977; Burkhalter, 1978a, b
ferns	Burkhalter, 1980
vegetation of Peridido Key	Cousens, 1981a, b
aquatic vegetation	Schardt, 1983

Alabama

<u>Subject</u>	<u>Author</u>
vegetation of Dauphin Island	Deramus, 1970
wildflowers	B.E. Dean, et al., 1973
wetland habitats	Alabama Marine Environmental Sciences Consortium, 1981

Mississippi

Mapping

Several mapping studies have been conducted in Mississippi. S.B. Jones (1974b; 1975b) mapped the distribution of the evening primrose family, and aquatic and wetland dicotyledon families. L.N. Eleuterius (1979) prepared vegetation maps for Horn and Petit Bois Islands. A total of 283 species of vascular plants were collected from the two islands. The author compared and contrasted plant communities from each island.

Field Guides

Evans (1978) compiled a guide and key to the ferns and equisetum of Mississippi by county and physiographic region. L.N. Eleuterius (1980) provided an illustrated guide to the tidal marsh plants of Mississippi and adjacent states.

Species Lists

<u>Subject</u>	<u>Author</u>
fungi	Tracey and Earle, 1895
insular flora	Lloyd and Tracy, 1901
flowering plants and ferns	Lowe, 1921; S.B. Jones, 1976b; K. Rogers, 1979
Cat Island vegetation	Penfound and O'Neill, 1934
marine flora	Humm and Caylor, 1955, 1957
orchids	Pullen, 1966
Ship Island vegetation	G.J. Miller and Jones, 1967; G.J. Miller, 1975
ferns	S.B. Jones, et al., 1969
arborescent flora	Watson, 1969
submerged aquatic vegetation	L.N. Eleuterius, 1973a; 1977a, b
aquatic monocot families	S.B. Jones, 1974a
Horn and Petit Bois Island vegetation	Bradburn, 1974
coastal area vegetation	L.N. Eleuterius, 1975c
mint family	S.B. Jones, 1976a
dune vegetation	Huguley and L.N. Eleuterius, 1976
salt marsh flora	L.N. Eleuterius and McDaniel, 1978
diatoms	Sullivan, 1981
Davis Bayou vegetation	USDOINPSGUISMS, 1982

General Gulf Coast

<u>Subject</u>	<u>Author</u>
coastal flowering plants	Thorne, 1954
seagrasses	Humm, 1956; Phillips and Meñez, 1988
liverworts	Breil, 1970
poisonous plants	Lopez, 1977

Southeastern United States

The following are species lists and field guides that may prove useful to researchers along the Gulf Coast.

<u>Subject</u>	<u>Author</u>
flowering plants and ferns	Chapman, 1809; Small, 1933
woody vines	Duncan, 1967
aquatic vegetation	Hotchkiss, 1972
ferns	Wherry, 1972
Oleaceae	Hardin, 1974
wildflowers	Duncan and Foote, 1975; Ricket, 1975
Lythraceae	Graham, 1975
Ranunculaceae (<i>Clematis</i>)	Keener, 1975, 1976
wetland plants	USACENAD, 1977; Godfrey and Wooten, 1979, 1981

lichens
 orchids
 mushrooms
 Asteraceae
 poisonous plants

Hale, 1979
 Luer, 1979
 O.K. Miller, 1979
 Cronquist, 1980
 Cooperative Extension Service,
 University of Georgia, N.A.

NPFLORA

A computerized data base (NPFLORA) on the vegetation of the National Parks is available to researchers. Information for Gulf Islands National Seashore is lumped together for both units, and for all islands. The data base is a computerized inventory of all vascular plants found in the park. (Bratton, et al., 1982; Waggoner, 1986).

Miscellaneous Studies

D.B. Ward and Chapman (1973) conducted an experiment on the aerial spraying of herbicides at Eglin Air Force Base, using Agents Purple, White, Orange, and Blue. They noted an increase in weedy species after spraying.

Gunn and Dennis (1973) collected disseminules of tropical plants that were carried by currents and wind, and then washed ashore on barrier beaches (Santa Rosa Island) in the Gulf of Mexico. R.R. Johnson (1979) also studied drift disseminules on Mississippi and east Louisiana's barrier islands. The author found that the influx of seeds and fruits onto barrier islands varied seasonally due to both biological and physical factors.

INVERTEBRATES

General Species Studies

Protozoans

Introduction

Although protozoans are members of the Kingdom Protista (single-celled organisms), not the animal kingdom, they have been placed under invertebrates because, until relatively recently, they had been included with the study of invertebrates.

Dinoflagellates

Several of the studies conducted concerning dinoflagellates are descriptive in nature, and discuss locations for outbreaks of red tide (Feinstein, et al., 1955; Anonymous, 1975; Perry, et al., 1979; Pierce, 1985; and B.A. Coleman, et al., 1986). Lawler (1980) studied the distribution of *Amyloodinium ocellatum* in Mississippi Sound in an attempt to determine natural and artificial hosts. Perry and McLelland (1981) documented the first recorded observance of the flagellate, *Prorocentrum minimum*, in Mississippi Sound.

Foraminiferans

Bandy (1954), F.L. Parker (1954), and Phleger and Parker (1954) compiled distributional information on the Foraminifera of the northern Gulf of Mexico. Phleger (1954) focused on the ecology of forams from Mississippi Sound and adjacent waters. Bandy (1956) described the habitats and zonation of forams from the continental shelf and upper part of the continental slope near Mobile, Alabama. The author also presented paleontological implications, and provided a faunal reference list. Phleger (1960a) discussed the general distribution of recent Foraminifera throughout the Gulf of Mexico, and specifically mentioned the Mississippi Sound region with regard to inshore and offshore species, and provided a comparison between the species found in Mississippi with those found in San Antonio Bay, Texas. Lindsay (1962) conducted a study on the distribution of Foraminifera along a salinity gradient through the Mississippi Sound. He found that calcareous forams increased steadily with salinity. A discussion regarding each species was provided, as well. Phleger (1964) reported on the ecology of Foraminifera in the coastal lagoons of Mississippi Sound. The author noted that different ecological habitats (marine marshes, lagoons, nearshore zone, etc.) were characterized by distinctive benthic fauna, and suggested that planktonic forams be used to characterize various offshore water masses. Pastula (1967) examined the sediments of Choctawhatchee Bay for recent Foraminifera distribution. J.B. Anderson (1968) also studied the ecology of forams in the Mississippi Sound and surrounding waters. The coastal waters of Mississippi served as a study area for Krutak (1975), as well, where environmental variations in forams were investigated. A two volume set on the distribution of recent benthic Foraminifera of the Gulf of Mexico was compiled by Culver and Buzas (1981). This extensive work was presented in the form of five computer-generated catalogs and 296 maps. A total of 1,219 taxa were recorded from 426 locations. Poag (1981) provided further information on the benthic Foraminifera of the Gulf of Mexico. The author presented the distributional patterns of benthic foram communities in the Gulf. The first part of the book focused on the various aspects of the ecology and distribution of the predominant genera, such as geology, climate, circulation, sediments, and marine biogeography. Part two provided descriptions and illustrations of diagnostic species.

Ciliates

Borror (1962) provided information on the ciliate Protozoa of the Gulf of Mexico through review of previously published material, as well as his own personal observations. A total of 219 species were reported. The author also discussed changes in nomenclature and classification.

Cnidarians and Ctenophores

Taxonomic and distributional information on a wide variety of cnidarians and ctenophores is available through an early publication of the U.S. Fishery Bulletin, *The Gulf of Mexico, Its Origin, Waters, and Marine Life*. Although somewhat outdated, some of the information may prove useful to present day researchers. The following groups were mentioned: soft corals (Bayer, 1954), anemones (Hedgpeth, 1954a; F.G.W. Smith, 1954a), hydroids (Deevey, 1954), hydromedusae (M. Sears, 1954b), siphonophores (M. Sears, 1954c), scyphozoa (Hedgpeth, 1954d), and ctenophores (M. Sears, 1954a).

Information on the range of the hydrozoan, *Nemopsis bachei*, in the northern Gulf of Mexico was provided by D.R. Moore (1962b). P.J. Phillips, et al. (1969) investigated the trophic significance of jellyfish medusae in Mississippi Sound. P.J. Phillips and Burke (1970) reported on the occurrence of two species of Cubomedusae, *Chiropsalmus quadrumanus* and *Tamoya haplonema*, from Mississippi coastal waters. Morphology of both species was discussed. Information on the zoogeography, ecology, and systematics of the pelagic Cnidaria of the Gulf of Mexico was compiled by P.J. Phillips (1971b).

The pelagic Cnidaria of Mississippi Sound were surveyed by Burke (1975). In 1976, Burke studied the biology and distribution of seven species of macrocoelenterates from the Mississippi Sound. The species included were: *Aurelia aurita*, *Chrysaora quinquecirrha*, *Pelagia noctiluca*, *Chiropsalmus quadrumanus*, *Rhopilema verrillii*, *Stomolophus meleagris*, and *Physalia physalis*. Physical parameters relevant to these species, as well as developmental histories, were described. Cairns (1977) compiled a checklist of the ahermatypic Scleractinia of the Gulf of Mexico. A brief chronology of the 54 species was presented, as well as information on distribution and overall bathymetric range. A new species, *Pourtalesmilia*, was described. J.M. Morris (1983) investigated the population characteristics and symbiotic associations of sea nettle medusae (*Chrysaora quinquecirrha*) in Mississippi Sound from June 2 - August 18, 1981. Peak abundance of the nettle for inshore waters was in July, and for offshore waters in August. Seventy three percent of individuals dip-netted to examine symbiotic relationships had some form of brachyuran symbiont. Symbionts included *Libinia dubia*, *Callinectes sapidus*, *C. similis*, *Portunus gibbesii*, and *Pinnixa* sp.

Flatworms

Portions of the extensive Gulf of Mexico ecological study, published by the U.S. Fishery Bulletin, pertain to flatworms and cestodes (Chandler, 1954b), turbellarians (Hyman, 1954), and trematodes (Manter, 1954).

Dundee and Dundee (1963) provided information on the land planarian, *Bipalium kewense* Mosely. The authors noted species' distribution along the Gulf Coast in Biloxi, Mississippi and Mobile, Alabama.

Mollusks

Gastropods

T.J. Price, et al. (1976) determined the organic content of three species of estuarine gastropods. Garrison (1978) examined the relationship between the abundance of the marsh periwinkle, *Littorina irrorata*, and the type of salt marsh vegetation it inhabited. The author found that snail density correlated with shoot density of *Spartina alterniflora*. Baird (1979) provided a general report on three types of salt marsh snails: periwinkles, coffee bean snails, and ladder-horn snails. Included was information on the life history of each species, as well as their roles in salt marsh ecology.

Heard (1979) discussed the taxonomic status of the gastropod genus *Vioscalba* Morrison 1965, which is considered a taxonomic synonym for *Probythinella* Thiele 1925; also reported were limited observations on the habitat and reproductive biology of *P. louisianae*. Wilder (1979) studied the distributional ecology of the salt marsh snail, *Melampus bidentatus*, in a

Mississippi salt marsh. Through a review of literature between 1880-1980, Butler (1985) compiled information on the predatory oyster drill, *Thais haemastoma floridana*. The author presented data on the snails' biology and its distribution in the Gulf Coast states. D'Asaro (1986) provided illustrations of the egg capsules of eleven marine prosobranchs. Dobbertein and Pechenik (1987) compared the larval bioenergetics and carbon budgets of two gastropods, *Thais haemastoma canaliculata* (Gray) and *Crepidula fornicata* (L.). By studying growth, ingestion, respiration, and assimilation efficiencies for the larvae of each species, they found that during larval development of *C. fornicata*, gross and net growth efficiencies declined, while growth efficiencies were constant or increased during the early development of *T. h. canaliculata*. Paige (1988) provided information on the biology, metamorphosis, and postlarval development of the sea hare, *Bursatella leachii plei*.

Bivalves

Oyster Shellfishery Studies

In early surveys by Ritter (1896) and H.F. Moore (1913a, b), the oyster beds of Mississippi and Alabama were mapped. Butler (1952a) investigated the effect of floodwaters on the oyster populations of Mississippi Sound. The sample area was between St. Louis Bay and Cat Island. Data collection included pH, salinity, and water transparency. Waters of the western end of Mississippi Sound were found to be marginal with respect to oyster culture. Butler (1952b) discussed the importance of local environment to oyster growth. He grew oysters transplanted from Chesapeake Bay in Pensacola waters, and compared their growth to native populations. He found that the native oysters were more than twice as large as the transplanted group after one and a half years.

Through personal interviews and a review of the pertinent literature, Matthiessen (1971) provided an in-depth review of the North American oyster industry, including information specific to the Gulf Coast states. Little (1973b) summarized an oyster culture program in the Pensacola area. Live oyster seeds were planted; spatfall was negligible except for September and October of 1972. The effects of siltation, predation, and fouling organisms was slight. Little and Quick (1976) studied the rehabilitation of an oyster population in Pensacola Bay after the outbreak of a parasitic fungus (*Labyrinthomyxa marina*). They found that the potential for rehabilitation was not constant throughout the entire bay system; however, East Bay did show promise for progressive cultivation techniques. The Gulf South Research Institute (1976) presented a report on the status of the fisheries industry in the Gulf region. Management priorities, environmental impacts, and aquaculture were discussed.

C.K. Eleuterius (1977a) studied the relationship between the location of oyster reefs and salinity of bottom waters in Mississippi Sound. He found, with one exception, that the producing reefs were located in areas with an average salinity between 10.0-16.0 ‰. MacKenzie (1977) described the ecology of oyster reefs in Mississippi Sound, with relation to the oyster industry. The author concluded that the Mississippi oyster industry had a high productive potential, as well as excellent ecological conditions. He also presented information on the functional operations, economics, and sociology of the oyster industry.

Four oyster reefs in Mississippi waters were sampled by Ogle (1979). Parameters that were studied included size class, spat set, growth rate, and seasonality. He found the reef near Horn Island to be marginally harvestable, with populations that exhibited rapid growth, but high predation and mortality rates, as well. McGraw (1980) investigated the growth and survival rates of both hatchery-reared and wild seed oysters in Mississippi Sound. She found differences in growth rates to be an apparent function of environmental factors such as wave turbulence, sediment load, and water temperature. Up to 95% predation by mud crabs, blue crabs, and oyster drills, on 3 cm seeds was observed. The U.S. Fish and Wildlife Service provided life history requirements for selected shellfish in the Mississippi Sound area (Benson, 1982). Included was information on spawning, nurseries, migration, and distribution.

A study plan for the assessment of oyster populations within the boundaries of Gulf

Islands National Seashore was compiled by Cake (1982). In 1983, Cake prepared a habitat suitability index model for oysters. Supan (1983) evaluated the spatfall rate of oysters on a 600-hectare oyster lease in Mississippi Sound. Spatfall occurred from May 6 - July 31, then again from August 15 - October 24, 1979. Greatest spatfall was recorded from August 15 - September 4. K.K. Chew (1983) edited the Proceedings of the North American Oyster Workshop. Included were documents for oyster processors and producers, as well as other segments of the oyster industry. Eckmayer (1983) compared growth and survival rates of hatchery-reared oyster set on three types of cultch: nylon sheets, crushed oyster shells, and whole oyster shells. Greatest growth was observed in the oysters set on nylon. Least growth was observed on crushed oyster shells. Craig and Powell (1988) surveyed the infection of oysters by *Perkinsus marinus* in the Gulf of Mexico. The authors found the presence of the disease was related to salinity and temperature. F.O. Perkins (1987) also studied transmission of *P. marinus*, and found that the parasite was transmitted from oyster to oyster at high host densities and temperatures above 25° C.

Other Oyster Research

Gunter (1951) provided a discussion on the three living genera of the oyster family Ostreidae. Butler (1954) provided a detailed discussion of oyster biology, habitat, ecology, distribution, and growth for those populations found in the Gulf of Mexico. Also included was a discussion of factors that play a part in the eradication of oyster reefs such as temperature, pollution, disease, predators, and commensals. The shell morphology of the prodissococonchs of three species of oysters, (*Crassostrea virginica*, *Ostrea equestris*, and *Ostrea frons*) were described and illustrated by M.L. Forbes (1967). The author found the prodissococonchs of the two *Ostrea* species indistinguishable from each other, but markedly different from the *Crassostrea* species.

Joyce (1972) compiled a partial bibliography of oysters, which included annotations. McGraw and Gunter (1972) conducted experiments on predation by the Gulf oyster borer (*Thais haemastoma*) on oysters. They found that the time taken for an adult *Thais* to kill and completely devour an adult oyster was approximately 24 hours. They also found evidence of a paralytic secretion produced by the oyster borer that inhibits ciliary action in its prey.

Ellender, et al. (1980) evaluated fecal coliform and enterovirus levels in oysters taken from both approved and non-approved growing waters along the Mississippi coast. They identified a total of 10 viral isolates from the approved waters and 51 viral isolates from oysters collected in non-approved waters. The majority of isolates were of poliovirus type 1 or 2, coxsackievirus B3 and B4, and echovirus type 24. Mowdy (1981) studied the physiology of cadmium elimination by oysters taken from Cedar Point, Alabama. The author found a steady decrease in the heavy metal over time.

To determine if geographic races of oysters existed on either side of the Mississippi River in the Gulf of Mexico, Grove and Lester (1982) examined morphological, as well as biochemical, variables between sample populations. The authors found little genetic variation among the four northern populations that were examined; however the population from Laguna Madre, Texas proved genetically different from the other populations. With oysters collected near Dauphin Island, Paparo (1986) investigated the physiology of enzyme activity in the lateral cilia of the ctenidium of bivalves.

Miscellaneous Bivalve Studies

Rosso (1952) compared and contrasted the bivalve fauna of Ocean Springs, Mississippi and Grand Isle, Louisiana. Pulley (1953) conducted a zoogeographic study of the bivalves of the Gulf of Mexico. Jolley (1972) surveyed the commercially significant beds of the sunray venus clam, *Macrocallista nimbosa*, in northwest Florida waters. Information on total production, as well as hydrologic data, was mentioned for each location. Chestnut (1980) provided biological and ecological information on the burrowing clam, *Diplothyra smithii*. This species is commonly found in the valves of the American oyster, *Crassostrea virginica*. Eversole (1982) reported on the biology and ecology of an important commercial fishery species, the hard clam, *Mercenaria mercenaria*.

W. Miller and Kooser (1982) studied the distribution of both living populations and dead shells of *Donax variabilis* along a section of a moderate wave energy beach on Ship Island. M.A. Winter and Hamilton (1985) investigated factors influencing the swimming behavior of the bay scallop, *Argopecten irradians*. They determined that it was possible for the scallop to discriminate among predators. The authors also determined that swimming direction was nonrandom, and served as an escape response enabling the scallop to maintain its position in seagrass beds.

Using starved and unstarved clams (*Rangia cuneata*), Lane (1986) conducted allometric and biochemical experiments. Results showed that starved animals had significantly thinner shells, less periostracum, and less dry flesh than unstarved clams.

Cephalopods

As a part of an early Gulf of Mexico survey, Voss (1954) compiled a species list of squid and octopi, and provided information on their general ecology and natural history. Voss (1956b) provided a review of cephalopods captured in the Gulf of Mexico between 1950-1956. A total of 42 species were described, with four being new to science at the time. In 1973, Levi documented the unusual capture of an oceanic species of squid, *Cranchia scabra*, in Pensacola Bay.

Species Lists and Field Guides

An early catalog of the shell-bearing marine mollusks and brachiopods of the southeastern coast of the United States was compiled by Dall (1889). Vanatta (1903) provided a list of shells collected from the western Florida coast and Horn Island, Mississippi.

Rehder (1954) reported on the distribution of mollusks along the Gulf Coast and southeastern Atlantic Coast, providing a brief survey and bibliography. Voss (1956a) compiled a species list of the cephalopods of Florida, and included notes on their habitats. D.R. Moore (1961) sampled the Mississippi Sound area near Horn and Ship Islands, as well as the vicinity of the Gulf Coast Research Laboratory, for mollusks. A total of 80 species of gastropods were noted, followed by 78 species of pelecypods, 3 species of cephalopods, and 2 species of scaphopods. The greatest number of species were found around the barrier islands, on sandy bottoms in high salinity waters. A guide to the marine shells of Florida was compiled by Vilas and Vilas (1970). Color illustrations, concise descriptions, classifications, and general scientific facts were included.

Annelids

H. Smith and Sturdivant (1948) provided a brief descriptive article on the life history of the annelid, *Nereis pelagica*, found along the Mississippi Gulf Coast. Hartman (1951) compiled a species list of the littoral marine annelids of the Gulf of Mexico, which included a key and illustrations for 158 species. A species list of polychaetes of the Gulf of Mexico, along with notes on ecological associations, was compiled by Hartman (1954). The polychaetes of the continental shelf in the northeastern Gulf of Mexico were surveyed by Bault (1969). Data on distribution and zoogeography were provided. A bibliography and checklist of the polychaetous annelids of the Gulf of Mexico and Caribbean was compiled by T.H. Perkins and Savage (1975).

A new distributional record for the serpulid worm, *Spirobranchus giganteus* var. *giganteus* was provided by Haburay (1976). C.B. White (1978) studied the impact of predators on lugworm aquaculture *in vitro*. The author concluded that commercial aquaculture of *Arenicola cristata* in seawater systems with uncontrolled predation was not economically feasible; a seawater well was considered the best method for the elimination of predators. Uebelacker and Johnson (1984) edited a general taxonomic guide for polychaetes from the northern Gulf of Mexico. A total of 593 species in 288 genera and 59 families were identified, with 41% tentatively recognized as new. Keys to genera and species were provided, as well.

Arthropods

Arachnids

An early report on the ticks of the Mississippi coast was provided by J.S. White (1948). The population was composed of four genera and five species from the family Ixodidae. An extensive survey of solpugids was conducted by Muma (1970). Portions of the land areas surrounding the Gulf of Mexico were included in the survey. Goddard and Norment (1983) reported on the distribution of the Gulf Coast tick, *Amblyomma maculatum*, expanding the range of the species into two northern Mississippi counties. Further information on the response of *A. maculatum* to fire was provided by Scifres, et al. (1988).

Crustaceans

Ostracods

The natural history and ecology of the ostracods of the Gulf of Mexico were the subject of Tressler's (1954) study. A species list was compiled which contained characteristics and locations for each species. Hulings (1958) conducted an ecological study of recent marine ostracods of the Gulf of Mexico. Krutak (1975) studied environmental variation in populations of ostracods along coastal Mississippi. Cohen and Kornicker (1987) presented data on the distribution, ecology, and life history of three genera of ostracods, *Alternochelata*, *Rutiderma*, and *Scleraner*.

Copepods

Schmitt (1954) provided a brief general discussion on the distribution of copepods in the Gulf of Mexico. Descriptions and keys for the genus *Oithona* from the Gulf of Mexico were compiled by Grice (1960). A total of five species were reported for Gulf waters: *O. plumifera*, *O. similis*, *O. brevicornis*, *O. nana*, and *O. simplex*. A general seasonal survey of pelagic copepods off Horn Island was conducted by McIlwain (1966, 1968). A definite seasonal distribution was noted, with peak numbers observed in the summer months. Fifteen species were collected, and only one species, *Acartia tonsa*, occurred year-round. Additional information on salinity, water and air temperature, dissolved oxygen, and water transparency was included, as well. Christmas (1968b) noted large shoals of *Anomalocera ornata* in Mississippi Sound between 5-14 March 1963, with the highest concentrations along the north shore of the barrier islands.

Acosta (1970) surveyed the copepods south of Dog Keys Pass, with a site located between Ship and Horn Islands. Information on abundance, distribution, seasonality, and temperature and salinity tolerance was also provided. The harpacticoid copepods of Horn Island's sandy beaches were studied by L.C. Nicholson (1971). All six species discovered were new to science. Descriptions of each species, together with information on variability and occurrence were provided.

Show (1973) investigated the relationship between selected planktonic organisms and particular water masses off the coast of Mississippi. Eight copepod species, along with four other zooplankters, were selected for an in-depth analysis. It was only possible to separate the water into two regions: inshore and offshore.

A taxonomic description of the copepods of the genus *Aetideus* from the Gulf of Mexico was provided by T. Park (1974). On a more ecological note, J.T. Turner, et al. (1979) studied the infestation of the copepod *Acartia tonsa* with parasitic ciliates. The authors postulated that the infestation may be a factor in the seasonal succession of copepods. Dagg, et al. (1988) studied the distribution of copepod nauplii in three regions of the northern Gulf of Mexico: off Cape San Blas, Florida, the Mississippi River delta, and off Galveston, Texas.

Barnacles

Henry (1954) compiled a species list of barnacles found in the Gulf of Mexico, with information on their distribution by habitats: littoral, pelagic, and deepwater. Barnacles of

the genus *Octolasmis* found in the Gulf of Mexico were described by Causey (1961). Wells (1966) studied the distribution of nearshore barnacles in the northeastern Gulf of Mexico. Notes on range extensions and zoogeography were also included. The burrowing barnacles of the order Acrothoracica were surveyed by Tomlinson (1969). The only species noted in the Florida area was *Kocholorine floridana*. Spivey (1981) reviewed the historical development and zoogeographic affinities of Gulf of Mexico cirriped fauna. A diverse assemblage was revealed, consisting of 78 species, which included 58 thoracians, 2 acrothoracians, and 18 rhizocephalans. Evidence indicated that the Gulf of Mexico is a transition zone between tropical and temperate shelf faunas. Most recently, Gittings (1985), examined collections of barnacles found in the northern and western Gulf of Mexico over the last 30 years, and presented data on the distribution of nine barnacle species from the area.

Shrimp (Penaeids)

General Studies

N.L. Roberts (1966) reported on the feeding biology of the white shrimp, providing an in-depth profile on the anatomy and morphology of the species. J.C. Edwards (1967) investigated the relationship between rainfall and freshwater drainage on the production of brown and white shrimp in Texas and Louisiana waters. White shrimp showed a positive correlation with Texas rainfall; however neither species showed a correlation in Louisiana waters. Subrahmanyam (1969, 1971b) studied the relative abundance and distribution of penaeid larvae in Mississippi waters. All species showed protracted spawning seasons in relation to depth. Protozoae and mysids stages occurred at all depths, and did not exhibit any ontogenetic stratification that would normally have been expected. Subrahmanyam (1971a) provided descriptions of the larval penaeids found in offshore Mississippi waters. The six genera described were: *Penaeus*, *Parapenaeus*, *Trachypeneus*, *Xiphopeneus*, *Sicyonia*, and *Solenocera*.

Couch, et al. (1975) studied the significance of *Baculovirus* infections in penaeid shrimp. This particular virus normally infects insects. Welker, et al. (1975) compared two methods of marking shrimp for mark-recapture studies: Peterson tags versus biological stains. Using brown shrimp (*Penaeus aztecus*) to test the two methods, the researchers found after 18 weeks that 28% of the biologically stained shrimp and 31% of the shrimp with Peterson tags were recovered. They concluded that Peterson tags were more effective because they were more readily recognized over longer periods of time. De la Cruz (1979b) noted a high density of post-larval brown shrimp in Mississippi Sound. Wang (1981) studied the effects of dissolved oxygen concentration, temperature, and body size on the oxygen consumption of brown shrimp. The author found that oxygen consumption varied with temperature, and that there was a correlation between body weight and oxygen consumption. Brown shrimp were the subject of a species profile by S.C. Larson, et al. (1989). The authors included information on the history, growth, habitat, and ecological factors concerning this species.

Commercial Shrimp Fisheries

Lindner and Anderson (1954) reported on the population dynamics, biology, ecology, spawning, seasonality, and distribution of commercial shrimp in the Gulf of Mexico. A general overall survey of the United States shrimp industry was provided by the U.S. Department of Interior, Fish and Wildlife Service (1958), and by the Gulf States Marine Fisheries Commission (1961, 1966). Trends and characteristics of the commercial shrimp fishery of the Gulf of Mexico were examined by Kutkuhn (1963). The catching, landing, and initial processing were described. The statistics available for each species were used to derive population density indices, and trace population spawning classes. Between 1956 and 1959 the Gulf of Mexico yielded 167-193 million pounds of shrimp annually. Of the three major species (white, brown, pink), brown shrimp were most important to the industry. Christmas (1965), and Christmas, et al. (1966) sampled post-larval penaeid shrimp in Mississippi Sound for a two-year period (1962-1964) in an attempt to relate annual abundances of this particular life history stage to subsequent commercial catches. Indices of abundance that resulted from the postlarval catches at selected stations approximated the 1964 catch of both white and brown shrimp within 10%.

Christmas (1971) provided a management document on the fisheries of Mississippi, with specific projects developed for priority problems with shrimp and crabs. Langely and Van Devender (1972) sampled commercially important penaeid species from Mississippi estuaries. The first segment of this report reviewed the history and importance of the fishery, while sampling results were provided in the second segment. Caillouet and Koi (1981, 1983) reported on a procedure for monitoring brown and white shrimp populations along the coasts of Texas, Louisiana, Mississippi, and Alabama. Gulland and Rothschild (1984) edited papers presented at a workshop devoted to the biology and management of penaeid shrimp. Provenzano (1985) edited a volume on the economic aspects of the Gulf Coast shrimp fisheries; other areas of the United States were mentioned as well. Topics discussed included fishery locations, methodologies, biological factors, management approaches, and population dynamics.

Shrimp (Carideans)

Spence and Walker (1951) described two species of *Crangon* found in Mississippi Sound. Ballard (1961) studied the effects of salinity changes on oxygen uptake in the grass shrimp, *Palaemonetes pugio*. The shrimp showed a point of lowest oxygen uptake approximately coincidental with the isotonic point. A range extension for the alpheid shrimp, *Leptalpheus forceps* was mentioned by Dawson (1967). Doughtie and Rao (1979) presented a morphological study on the gill structure of *Palaemonetes pugio*.

Anomurans

The behavior of the mudshrimp *Callinassa* was studied by P.J. Phillips (1967, 1971a). The author attempted to determine whether substrate type was a factor influencing the distribution of this species in Mississippi Sound. He found that habitat isolation was a function of species-related differences in ability to burrow and survive in different habitats (sandy versus muddy).

Caine (1975) described and compared the feeding structures of selected anomurans from the Gulf of Mexico. Efford (1976) reviewed the worldwide distribution of sand crabs of the genus *Emerita*. Those species of sand crab found in the Gulf of Mexico include: *E. benedicti*, which is found along the Texas coast and Horn Island; *E. talpoida*, which is found on Horn Island; and *E. portoricensis*, found in the Pensacola area. Keys, descriptions, and illustrations were presented by Garcia-Gomez (1988) for three new species of hermit crabs in the new genus *Enneobranchus*. One species, *E. flaviculus*, was collected off the west coast of Florida as far north as Pensacola.

Brachyurans

Biology/Ecology Studies

Oesterling (1976) provided a general report on blue crab reproduction, growth, and migration along the Gulf Coast of Florida. Farr (1978a) noted blue crabs preying on jelly fish, an unusual prey item for them. The author speculated that the crabs may have been desperate for food as the result of a hard winter. Thurman (1979) studied fiddler crab (*Uca*) ecology in the Gulf of Mexico. The author found that the different species of *Uca*, within each distinct climatic-edaphic zone, appeared to partition the intertidal habitat on the basis of distance from the water (vertical zonation), salinity, substrate composition, and particle size.

West and Williams (1986) investigated prey preferences displayed by blue crabs when foraging within a *Spartina* marsh. The crabs showed a distinct species preference for the snail, *Littorina irrorata*, with a lesser preference for the killifish, *Fundulus similis*, and the mussel, *Geukensia demissa*. Wilber and Herrnkind (1986) studied migration patterns of the stone crab, *Menippe mercenaria*. Seasonal density fluctuations indicated a subtidal movement during the fall and early winter, and movement within the intertidal region during the spring. The authors found that temperature fluctuations may play a major part in the onset of fall emigration.

J.A. Freeman, et al. (1987) developed a method for determining the stages and substages of the postmolt and intermolt periods of the blue crab, *Callinectes sapidus*. Intermolt stages were determined by growth of endoskeleton and appearance of membranous layers. The postmolt phase was based on rigidity of the lateral spine. Average duration of the molt cycle was 38 days. Stuck and Truesdale (1988) reported on the larval development of the speckled swimming crab, *Arenaeus cribrarius*, and provided a comparison with the larval stages of three other crab species.

Distributional Studies

Behre (1954) described the physiographic regions and general distribution of decapod crustaceans in the Gulf of Mexico. Abele (1970) presented distributional data on 154 species of decapod crustaceans from the shallow waters of the northeastern Gulf of Mexico. Soto (1972) discussed the distribution and zoogeography of the decapods along the continental shelf in the northeastern Gulf of Mexico. Whiting (1972) looked at the effects of substrate on the distribution of the fiddler crab, *Uca minax*. The author found that this species preferred substrate of high organic content. Perry (1972) reported on seasonal and areal distribution and relative abundances of larval, post-larval, juvenile, and adult blue crabs (*Callinectes sapidus*) in Mississippi Sound. Also included were notes on associated hydrological factors. In 1974, Perry and Herring provided distributional information on the portunid crabs of Mississippi Sound. Haburay (1975) reported a range extension for *Plagusia depressa*, which was found in the Pensacola area.

Maris (1980) studied the seasonal distribution of porcellanid crab zoeae in the north central Gulf of Mexico. Maximum numbers were recorded in the spring, with highest abundances in waters with warm temperatures and high salinities. In addition, a key was developed for both zoeal and adult stages. Information on the seasonality and distribution of portunid megalopae in Mississippi coastal waters was presented by Stuck and Perry (1981). *Callinectes sapidus* megalopae were abundant from May to November, *C. similis* megalopae peaked from February through April, and *Portunus* spp. megalopae occurred in all months except January. The megalopae of *C. Sapidus* were common to all stations; however the megalopae of *C. similis* and *Portunus* spp. appeared to be limited by salinity.

Commercial Fisheries

A general article by Walburg (1958) discussed abundances, habitat, and life history of the blue crab and stone crab of the Atlantic and Gulf Coasts. Christmas (1971) provided a report on Mississippi fisheries, with specific projects developed for priority problems with shrimp and crabs. Perry (1975a) reported on the blue crab fishery in Mississippi, and in 1980, reported on the life cycle and reproductive habits of blue crabs. Tatum (1979) described the blue crab fishery in Alabama. Perry and Van Engel (1981) edited the proceedings of a blue crab colloquium. Topics included biology, economics, processing technology, and harvesting. Provensano (1985) edited a book on the economic aspects of commercial fisheries in various areas of the United States, including the Gulf of Mexico. Aspects of crab biology, and the commercial culture of decapod crustaceans were presented. Stuck (1987) reported on the potential of the stone crab, *Menippe adina*, for commercial fisheries in the northeastern Gulf of Mexico. The author conducted sampling at Dog Keys Pass, and found numbers abundant enough to support a limited fishery, although loss of traps to shrimp trawlers was thought to be a limiting factor in the development of this fishery.

Keys/Species Lists

Felder (1973) provided an annotated key to the crabs and lobsters of the northwestern Gulf of Mexico. An extensive catalog of brachyuran crabs from the Gulf of Mexico was compiled by Powers (1977). A large portion of the catalog consisted of species lists compiled from previously published literature. Each species' entry consisted of the current valid name, the published original reference of the species description, common names, taxonomic and descriptive references, geographical and bathymetric distributions, habitats, and an annotated bibliography. Maris (1983) assembled a key to the porcellanid zoeae of the north central Gulf of Mexico.

Peracaridians

Mills (1965) discussed the zoogeography of ampheliscid amphipod crustaceans, mentioning *Ampelisca vadorum*, which occurs in the Gulf of Mexico. The two major species of *Ampelisca* were compared, and their origins reviewed. Farrell (1970) reported on the ecology and distribution of gammarid amphipods in Mississippi waters. Farr (1978) investigated clustering behavior in the isopod, *Ligia exotica*. Experiments on object orientation demonstrated a strong tendency to move toward contrasting landmarks, which resulted in occupation of rocky areas; it was also determined that *Ligia* was attracted to conspecifics.

The pelagic amphipods of the Mississippi coast were surveyed by Stuck (1978), with sampling stations near Horn and Ship Islands. A total of 74 species were identified and broken down into the following groups: 52 species of hyperids, 20 species of gammarids, and 2 species of caprellids. In addition, illustrations and keys were provided. Stuck, et al. (1980) provided an update a few years later. Stuck, et al. (1979a) provided an annotated key to 17 species of Mysidacea from the north central Gulf of Mexico. In another study, Stuck, et al. (1979b) reported on the known distribution of several shallow water species of Mysidacea in the eastern Gulf of Mexico. A key to the genera of the tanaidacean, *Nototanoides*, was provided by Sieg and Heard (1985). Information on the seasonal and spatial distribution of cumaceans in the Mobile Bay estuarine system was discussed by Modlin and Dardeau (1987).

Insects

Several volumes are available on the arthropods of Florida; each volume centers on a single group. Species lists, collection sites, species descriptions, taxonomic notes, and other pertinent bits of information are included in each volume. Information on the following groups are available: lepidopterans (Kimball, 1965), scarab beetles (Woodruff, 1973), armored scale insects (Dekle, 1976), ichneumonids (Heinrich, 1977), and sand flies (Blanton and Wirth, 1979).

King, et al. (1939) provided detailed information on the mosquitoes of the southeastern United States. Included in the report was a species list, as well as breeding, migration, and distributional data. Descriptive keys were also included. C.A. Wilson (1958) discussed the ecology and life history of aquatic and semiaquatic hemipterans of Mississippi. Spilman (1959) provided distributional notes on several tenebrionid beetle species found throughout the Gulf Coast area, including the barrier islands. Howden (1963) described the speciation and distributional patterns of the scarab beetle, *Gronocarus autumnalis*, which is found in the Mobile Bay area in Alabama. The larval habitats of tabanids in Alabama and northwest Florida were investigated by Hays and Tidwell (1967). Mather (1971) provided a review of the coleopterans, neuropterans, and lepidopterans found along the Mississippi coast. A preliminary list of the damselflies (zygopterans) of Mississippi was compiled by Lago, et al. (1979). A total of 35 species, with 11 species new to Mississippi, were reported by county. Stark (1979) conducted a comparative study between the stoneflies (plecopterans) of Mississippi and those of neighboring states. Included was information on the systematics and taxonomy of 42 species. The predaceous water beetles of the genus *Desmopachria* along the Gulf Coast were described by F.N. Young (1981). McCoy and Rey (1981) surveyed the coleopterans of northwest Florida salt marshes, noting a total of 51 species.

Frank (1981) reported on a revision of the coleopteran genus *Neobisnius*. Included were species' descriptions, together with distributional and ecological information on the species found in the north central Gulf of Mexico region. Readio and Sweet (1982) reviewed the taxa of Geocorinae (Hemiptera: Lygaeidae) of the United States, with several of the species discussed being found in the Gulf Coast area. The authors provided keys and illustrations, as well. Oliver and Chapin (1983) provided information on the biology of the yellow-margined leaf beetle, *Microtheca ocoloma*, whose range has extended into Mississippi, Alabama, and Florida. Goddard and Lago (1983) compiled an annotated species list of the blowflies (Calliphoridae) of Mississippi. J.M. Burns (1985) reported on the distribution of two species of butterflies, *Wallengrenia otho* and *W. egermet*, in North America. Both species are found in all of the Gulf Coast states. M.C. Thomas (1985) provided a review of the history of nomenclature for the coleopteran genus *Hemipeplus*. Three species were recorded from Florida. Another

coleopteran species, *Lobopoda socia*, was studied by J.M. Campbell (1986). This species is widely distributed from the Gulf coastal plain of eastern Texas south to Nicaragua. The author reported an extension of the species over most of coastal Florida. Freidberg and Mathis (1986) provided a revision of the dipteran genus, *Neospilota*, and discussed its relationship with the subfamily Terelliinae. Distributional information was presented, as well, listing Mobile County in Alabama, and Escambia and Okaloosa Counties in Florida as sites. La Salle (1986) reported on the life cycle of the neuropteran montispid, *Climaciella brunnea*. McCoy and Rey (1987) identified over 100 species of hymenopterans collected from northwest Florida salt marshes, and compared the species found to those commonly found in East Coast marshes. Shawler and Reagan (1987) discussed the biology and ecological interactions of the fire ant throughout the southeastern United States.

Bryozoans

Osburn (1954) described the natural history of the bryozoans of the Gulf of Mexico. In the first paper to describe all the shallow water bryozoan fauna of the northern Gulf of Mexico, Shier (1964) reported 62 species, with 9 previously unknown to the area.

Chaetognaths

E.L. Pierce (1954) described 14 species of chaetognaths from the Gulf of Mexico. T.M. Smith (1955) reported on the distribution, annual abundance, and reproduction of five inshore chaetognath species in west Florida. The seasonality of chaetognaths in Mississippi Sound was studied by Mulkana and McIlwain (1973). The population fluctuated according to seasonal changes, and to the influx of water masses from various sources. A total of 8 species were identified.

Echinoderms

A.H. Clark (1954) compiled a species list of the echinoderms (exclusive of holothurians) found in the Gulf of Mexico, while Deichmann (1954) compiled a species list of the holothurians of the Gulf, and provided a key as well. D.R. Moore (1962a) observed brittle stars, *Ophiophragnus wurdemanni*, partially buried in a shoal off the Mississippi coast, with one to three arms extended out into the water to feed. Alexander and Haburay (1977) discovered an extensive population of the brittle star *Ophiophragnus moorei* about 7 meters offshore in Florida waters, extending their previously recorded range 75 km eastward. A general guide to the starfish of the Gulf Coast was compiled by J.M. Foster (1983).

Cephalochordates

Hefley and Shoemaker (1952) reported on the distribution of *Branchiostoma* [=Amphioxus] in Mississippi and Louisiana waters; they were found to occur in 2-4 feet of water on sandy bottoms, and were found near Petit Bois, Horn, and Ship Islands. Hedgpeth (1954e) studied the distribution of lancelets along the Gulf Coast. Boschung and Gunter (1962) studied the distribution of *Branchiostoma caribaeum* in Mississippi Sound. Harima (1973) provided extensive information on the life history of the lancelet, *Branchiostoma floridae*. Also included was information on the organism's habitat, feeding, reproduction, and morphology.

Miscellaneous Species Studies

Coe (1951, 1954) surveyed the ribbon worms (nemerteans) of the Gulf of Mexico and southern Florida. A total of 16 species were noted for the northern Gulf Coast and 3 species for southern Florida, with only two species common to both regions. De Laubenfels (1953) surveyed the sponges of the Gulf of Mexico. A total of 52 species, all within the class Demospongiae were noted. Several miscellaneous groups were surveyed as part of the Gulf of Mexico inventory in the early 1950's: mysids and euphasids (Banner, 1954); stomatopods (Chace, 1954); acanthocephalans (Chandler, 1954a); nematodes (Chandler, 1954c); parasitic helminths (Chandler and Manter, 1954); echiurids (Hedgpeth, 1954c); horseshoe crabs (Hedgpeth, 1954f); zooplankton (H.B. Moore, 1954); and tunicates (Van Name, 1954).

Lukens (1977) collected two species of the shrimp *Stenopus* off an artificial reef near Horn Island, Mississippi, extending their range in the Gulf by 400 km to the northwest. Cobb and Phillips (1980) edited a book on the extensive research done on the biology of lobsters, in order to integrate the available information with management strategies and problems. Mention of the spiny lobster, *Paruliris*, which is the most common commercial species of the northeast Gulf of Mexico, was included. Abele (1982) summarized information on the biogeography of crustaceans. Topics included paleozoogeography, patterns of species richness, biogeographic migration, morphology, and distribution of taxonomic groups. Busack (1988) conducted an electrophoretic survey of several populations of crayfish (*Procambarus clarkii* and *P. actus*). *P. larkii* showed very little intra or interpopulation variability, whereas *P. actus* formed three geographical groups. A.B. Williams (1988) compiled an illustrated guide to lobsters, including those species found in the Gulf of Mexico.

Invertebrate Communities

Meiofauna

The interstitial gastrotrichs of Mississippi Sound were surveyed by Friauf (1968) to determine their distribution. Physical parameters of the sampling areas were also discussed. L.W. Bennett (1972) studied the factors affecting the vertical and horizontal distribution of a unique community of micrometazoans, the thalassopsammon. In 1974, L.W. Bennett provided a preliminary report on the distribution of the meiofauna of Ship Island. The author found that the organisms were limited by low salinity, xeric conditions, and temperature landward; wave turbulence seaward; and oxygen diffusion with depth. Shaw (1977) compared the distribution and abundance of meiofauna found in two low energy beaches, one in the Pensacola area and one in south Florida. The author attributed differences in the composition, density, and distribution of several major taxa to variations in the following physical and chemical factors: beach profile, interstitial water content, and organic matter content. Harp (1980) studied the meiofaunal communities associated with two salt marshes on Dauphin Island, Alabama, with particular emphasis on the harpacticoid copepod community.

Macrofauna

Coghlan, et al. (1952) provided observations on the invasion and establishment of beach communities on a denuded mud beach near Davis Bayou. After approximately 15 days, mud shrimp and polychaetes invaded, then, after 6-8 weeks, fiddler crabs were observed. Using various survey reports, Hedgpeth (1954b) discussed the oyster bottoms and shrimping grounds of the northern Gulf of Mexico. Site locations included Biloxi, Mississippi, Mobile Bay, Alabama, and the mouth of the Pascagoula River, Mississippi. R.H. Parker (1960) reported on the ecology and distribution of marine macroinvertebrates in the northern Gulf of Mexico. De Vries and Dobbs (1971) presented a study on the invertebrate zonation in the rocky intertidal area of Fort Pickens, Florida. The authors noted a high density of fauna, as well as several tropical fish species not previously found in the area. Defenbaugh (1973) studied benthic macroinvertebrates taken in neritic trawl collections from Corpus Christi, Texas to Pensacola, Florida. The author found that species assemblages varied with depth, longitude (i.e. sediment type), and season. L.N. Eleuterius (1974b) investigated the association between various invertebrates and seagrass beds located in Mississippi Sound near Horn Island. Lyons and Collard (1974) provided a discussion of the benthic invertebrate communities of the eastern Gulf of Mexico. V. Mitchell and Winstead (1974), and Winstead and Mitchell (1975) sampled the benthic, epibenthic, and shoreline areas of the proposed Navarre Pass on Santa Rosa Island. Polychaete worms were the dominant organisms, followed by mollusks and crustaceans. Nicol (1977) studied geographic relationships of Florida's benthic marine mollusks. The author stated that Florida has the most diverse, marine, shallow-water molluscan fauna in the continental United States. W.D. Humphrey (1979) studied the benthic fauna of a Mississippi tidal marsh, providing information on diversity, distribution, and relative abundances. McBee and Brehm (1979) compared the benthic macroinvertebrates of a residential canal (man-made) to a nearby bayou (natural). Polychaetes and oligochaetes were most abundant in the winter and spring, amphipods in the summer, and chironomids in the spring. Shaw, et al. (1982) provided a characterization of a benthic macro-infauna community

in Mississippi Sound and adjacent waters. Sherrard (1983) studied the macrobenthic invertebrate assemblages of Ranger Lagoon on Horn Island in Mississippi. Geomorphological, biological, and hydrological parameters for the area were presented, as well. Five microhabitats were delineated from the total area of the lagoon: sand (70%), silt (24%), intertidal (5%), grassbed (0.5%), and oyster reefs (0.5%). A total of 109 species were collected and identified. Polychaetes and crustaceans dominated the fauna (38%), followed by mollusks (19%), and miscellaneous species (13%). The silt microhabitat exhibited the lowest diversity, while the grassbed exhibited the highest diversity. Using samples of macrofauna from Pensacola Bay, Stoner, et al. (1983) compared two types of sampling gear (cores versus suction sampler) in two different habitats (vegetated versus unvegetated). The authors found that the core method provided the best estimate of macrofauna density and composition in soft sediment, with or without vegetation.

Interspecies Relationships

Parasitism

Molluscan Parasites

Ray (1963) surveyed oysters along the Gulf Coast for the parasite, *Dermocystidium marinum*. In Santa Rosa Sound, eight of nine oysters tested positive for the parasite. Quick and Mackin (1971) discussed the parasitism of oysters by the fungus *Labyrinthomyxa marina*. This parasite was found associated with its host throughout the year. High temperatures were considered a contributing factor to the high rate of parasitism. Quick (1972) elaborated further on the effects of this fungal parasite on oysters. One particular oyster kill, over a three-day period, was attributed directly to *Labyrinthomyxa*. There was 100% loss reported in most commercial areas. The author attributed the favorable growth environment for the fungus to the polluted waters of Escambia Bay. Cake (1975) conducted extensive sampling of the parasitic cestodes of gastropods and pelecypods, from the Florida Keys to Mississippi Sound. In 1976, Cake compiled a key to the larval cestodes surveyed in the previous study. Eleven species from the northern Gulf of Mexico were included in an illustrated key; host species were also listed. Cake (1977) compiled a species list of the cestode parasites of the edible mollusks of the northeastern Gulf of Mexico. A total of ten species of parasites were obtained from both edible, and potentially edible, mollusks. Many of the cestodes are known to infect humans.

Cake and Winston (1980) traced the infection of *Tylocephalum* metacestodes through commercial oysters, and their gastropod predators, in the eastern Gulf of Mexico. Ogle and Flurry (1980) studied the seasonality of the protozoan parasite, *Perkinsus marinus*, in Mississippi oysters. Winstead and Couch (1981) conducted a histological examination of the American oyster, *Crassostrea virginica*, for the trematode parasite, *Proctoeces* spp., in three northern Gulf Coast estuaries. Unencysted metacercariae of the trematodes were found in the gonadal ducts of some of the oysters, with the highest incidence of the parasite in oysters from the Mississippi Sound area near Pasagoula.

Crustacean Parasites

Christmas (1968a) studied the occurrence of a parasitic barnacle on blue crabs from Mississippi estuaries. He found the parasite only on juvenile crabs. Sprague and Couch (1971) compiled an annotated list of the protozoan parasites of decapods.

Couch (1973) presented information on the morphology of the ciliate protozoan, *Lagenophrys callinectes*, found on blue crabs along the East and Gulf Coasts. Markham (1975) provided information on new host and locality records for two species of parasitic isopods found infesting the decapod crustacean, *Hexapanopeus augustiformis*, in Mississippi Sound. Buckner, et al. (1978) reported on an intermediate host for the acanthocephalans, *Tegorhynchus furcatus* and *Dollfusentis chandleri*. The amphipods, *Lepidactylus* spp. and *Haustorius* spp., were found infested with cystacanths of *T. furcatus*, while *D. chandleri* was described from the amphipods, *Lepidactylus* spp., *Grandidierella bonnieroides*, and *Corophium lacustre*. These infected amphipods found in brackish and marine Mississippi

waters represented the first intermediate hosts known for the aforementioned acanthocephalans. Fusco (1978) discussed the life cycle and development of *Spirocamallonus cricotus*, one of the most frequently occurring species of nematodes in the northern Gulf of Mexico. Heard and Overstreet (1987) reported on the presence of an epicaridian isopod parasite on mysid shrimp (*Mysidopsis bahia*) from Horn and Ship Islands. Although the isopod was absent in June, it infested over 80% of the female mysids by mid-August. The authors postulated that the presence of a suitable copepod intermediate host, in addition to higher salinity near the islands, might have influenced the infestation.

Fish Parasites

E.H. Williams and Williams (1978) surveyed the cymothoid isopods found in selected marine fishes of the northern Gulf of Mexico. Seven new hosts were recorded. E.H. Williams (1979) compiled a species list of the leeches found on some Mobile Bay fishes. Incidence was low, with only four leech species found on thirteen host species. Fournie and Solangi (1980) reported on the prevalence of the protozoan coccidian, *Eimeria funduli*, in longnose killifish (*Fundulus similis*) from Horn Island, Mississippi. The prevalence of the parasite was apparently related to low salinity in Mississippi Sound, which promoted the migration of infective intermediate hosts from inshore waters to the island.

Commensalism

Bock and Moore (1968) provided a note on a commensal relationship between a foraminiferan and a benthic clam found off of Horn Island. A new species of pinnotherid crab, *Fabia tellinae*, was found in the clam *Tellina magna* by Cobb (1973). Courtney and Couch (1981) reported on the discovery of a commensal relationship between the palaemonid shrimp, *Pontonia domestica*, and the pen shell, *Atrina rigida*. A total of sixty pen shells were found washed ashore on Santa Rosa Island following Hurricane Frederic in 1979. Eighty six shrimp were found in the bivalves; 48 females and 38 males. Data on the distribution of shrimp within the shells, in addition to the shrimps' sex and reproductive status, were presented. Caine (1983) studied community interactions of caprellid amphipods on sea whips.

Mutualism

Mariscal (1972) studied the adhesive properties of the symbiotic sea anemone, *Calliactis tricolor*, to shells. Cake (1983) reported on the symbiotic relationship between the southern oyster drill (*Thais haemastoma*) and two species of crabs: blue crabs, and striped hermit crabs. The crabs were found to provide passive transport and food for the attached drills. J.M. Morris (1983) examined a symbiotic association between sea nettle (*Chrysaora quinquecirrha*) medusae and various brachyurans in Mississippi Sound. A total of 73% of the medusae examined from this study had some form of brachyuran symbiont, which included *Libinia dubia*, *Callinectes sapidus*, *C. similis*, *Portunus gibbesii*, and *Pinnixa* spp. Also included was ecological information on the nature of the relationship during various life history stages of the crabs.

Effects of Pollutants and Pesticides on Invertebrates

Introduction

This section includes studies on the effects of various pollutants on a wide range of invertebrate organisms. Since many of the test organisms are found in the areas where pollution can upset a delicate balance, their individual roles in the estuarine ecosystem are of vital importance. Although a certain type of pollutant may have a direct detrimental effect on only one species, it will undoubtedly have an indirect effect on the entire system. Consequently, studies that focus on the effects of a certain pollutant on individual species, should also provide insight into the delicate nature of the estuarine environment.

The following sections are arranged phylogenetically from protozoans to crustaceans. The last section deals with the effects of pollutants on mixed species communities.

Ciliates

Cooley, et al. (1972) studied the effects of the pesticide Mirex, and the polychlorinated biphenol (PCB) Aroclor 1254, on the ciliate *Tetrahymena pyriformis*. The authors found reductions in growth rates and population density. The test organisms were also found to bioaccumulate the pollutants, thereby passing the effect along the food chain. Similar results were found in a later study conducted by Cooley, et al. (1973) on the effects of PCBs, Aroclors 1248 and 1260.

Lugworms

Schoor and Newman (1976) conducted a laboratory experiment to estimate the effect of Mirex (fire ant toxicant) on the burrowing activity of the benthic lugworm (*Arenicola cristata*). The authors concluded that the feeding and burrowing activity of the lugworm was affected by the addition of Mirex to the system. They also found that the organism acted as a distributing agent, channeling the pollutant through the benthic habitat. No statistical analysis was provided for this study. Rubenstein, et al. (1980) tested the effects of used drilling fluids on three estuarine species: mysid shrimp (*Mysidopsis bahia*), oysters (*Crassostrea virginica*), and lugworms (*Arenicola cristata*). Levels of 30-100 ppm were found to be highly toxic to the lugworm.

Mollusks

Since oysters are an important commercial fishery, all of the following studies deal with the effects of various pollutants on one particular species, *Crassostrea virginica*. Several of the articles are contributions from the U.S. Environmental Protection Agency's Gulf Breeze Laboratory in Gulf Breeze, Florida.

Butler (1962) studied the effects of various environmental factors on estuarine mollusks. The author looked at the effects of salinity, low temperature, and pollution, and found that low levels of both man-made and natural pollutants changed productivity without causing mortality. J.I. Lowe, Wilson, et al (1971) conducted experiments on oysters by exposing them to DDT, toxaphene, and parathion. One group of oysters was raised in 1 part per billion (ppb) of each of the toxicants mixed together; the other group was raised in 1 ppb of each separate toxicant. The group exposed to the mixture had significantly lower weights than the corresponding control group. On the other hand, there was no effect on the oysters raised in each separate toxicant. J.I. Lowe, Parrish, et al. (1972) investigated the effects of the polychlorinated biphenol (PCB), Aroclor 1254, on oysters. Results showed a decreased growth rate, together with atrophy of digestive and connective tissues, for as long as exposure continued. However, little mortality was observed. Butler (1973) reported on the Florida and Mississippi state monitoring sites for organochlorine residues in estuarine mollusks. At the time of the study, DDT and organochlorines were on the decline. The results of the National Pesticide Monitoring Program for persistent synthetic pesticides, conducted from 1965 - 1972, showed that the levels of DDT residues found were too low to be a threat to human health, and that DDT residues have been on the decline since 1968. Sample areas included sites in Florida, Alabama, and Texas (Butler, 1974).

Harvey and Knight (1978) measured concentrations of mercury (Hg), lead (Pb), and cadmium (Cd) in oysters collected from the waters off of Biloxi, Ocean Springs, and Pascagoula, Mississippi. Mercury levels were low, and appeared to be natural background levels; lead levels compared favorably with levels in Atlantic Coast oysters; however cadmium levels in the Atlantic Coast oysters were approximately 6.7 times greater than in local specimens. Rubenstein, et al. (1980) tested the effects of used drilling fluids on oysters, and found that the growth rate was inhibited. A more general analysis on the toxicity of several chemicals to oysters was conducted by Borthwick and Allen (1981).

Using oysters as indicators, Isphording, et al. (1983), and Settine, et al. (1983) studied the effects of environmental pollution. Isphording, et al. (1983) studied metal contamination levels, and found that fine particulate matter, in colloidal phase located just above the

sediment/water interface, impacted the oysters most severely. Settine, et al. (1983) provided a baseline look at the effects of organic pollutants on the oysters of Mobile Bay.

Couch (1984) examined the relationship between pollution and disease frequency in oysters. The author found that epithelial atrophy of the digestive gland demonstrated a positive association with contamination by organic pollutants, thereby serving as an indicator of polluted environments. An investigation of the water quality of the shellfish grounds of the Gulf of Mexico was conducted by Broutman and Leonard (1988). Data were collected at sites from the waters of all the Gulf Coast states. Most shellfish in Gulf of Mexico waters failed fecal coliform standards, due to sewage treatment and pastureland run-off.

Crustaceans

Grass Shrimp

A.L. Jensen and Nimmo (1972) developed a linear model for the uptake of PCBs by the grass shrimp, *Palaemonetes pugio*. Redmann (1973) found this species to be fairly sensitive to the pesticide Mirex by both direct and indirect exposure. Results showed an inverse correlation between shrimp size and mortality.

Avoidance of pesticides by grass shrimp was demonstrated to some extent by D.J. Hansen, et al. (1973). Although the shrimp were very vulnerable to all toxins, they did not discriminate as well between pesticides on this laboratory study as fish did in an earlier study.

Nimmo, et al. (1974), and Tyler-Schroeder (1976) studied the effects of different types of Aroclor, a polychlorinated biphenol, on grass shrimp. In 1979, Tyler-Schroeder developed a method for using the grass shrimp in life cycle toxicity tests, using the chlorinated hydrocarbon pesticide, endrin. Rao, et al. (1979), and Rao and Doughtie (1984) conducted investigations into the toxicity of pentachlorophenol (PCP), and its effect on the various life history stages of the grass shrimp. They found shrimp, at the time of post-ecdysis, were the most prone to mortality.

The by-products of oil drilling also pose a threat to marine life. Conklin, et al (1980) studied the effects of used drilling muds on crustaceans, most particularly grass shrimp. They found a 30-60% mortality rate at 1000 ppm. Another group of toxins found in the marine environment are chlorophenols, which are used as wood preservatives. Rao, et al. (1981) conducted a comparative study on this type of pollutant, using grass shrimp.

Conklin and Rao (1982) studied the effects of dithiocarbamates (fungicides) on molting and inhibition of limb regeneration in grass shrimp. The authors found no effect on molting schedule, but they did find an inhibition of limb regeneration when the shrimp were exposed to the chemical. In addition, Rao and Doughtie (1984) looked into the associated histopathological changes in the shrimp when exposed to this particular fungicide. Chromium was found to cause cuticular lesions and limb loss on grass shrimp (Doughtie, et al. 1983). Further studies into the toxicity of this pollutant were conducted by Rao, et al. (1985). Chromium is introduced into the estuarine environment by the dumping of sewage sludge, industrial effluents, and by offshore oil drilling.

The effects of fenvalerate (a pyrethroid insecticide) on larval development and metabolism in grass shrimp was studied by McKenney and Hamaker (1984). Results showed a significant effect on larval metamorphosis at both lethal and sublethal concentrations of the toxin.

Penaeid Shrimp

Nimmo, Blackman, et al. (1971) conducted experiments on the effects of Aroclor 1254 (PCB) on pink shrimp (*Penaeus duorarum*). Results showed that a concentration of 1 ppb killed juveniles within 15 days, whereas concentrations of 2.4 - 4.3 ppb killed adults within 53 days. Nimmo, Wilson, et al. (1971) also found, through laboratory experiments, that the amount of PCBs in the shrimp was related to the amount of PCBs in the sediments.

A study on the effects of DDT on cations in the hepatopancreas of various penaeid shrimp was undertaken by Nimmo and Blackman (1972). They found significantly lower concentrations of sodium and potassium in the ashed hepatopancreatic tissue of shrimp exposed to .01 ppb DDT than those of the control group.

Couch (1978) compiled a review of infectious and noninfectious diseases of the commercial penaeid shrimp of the Gulf and south Atlantic. Chemical pollutants, heavy metals, and environmental stress were listed as examples of noninfectious disease agents.

Schoor and Brausch (1980) conducted experiments in an attempt to determine a link between acetylcholinesterase (AChE) inhibition in the ventral nerve cord of penaeid shrimp and organismic death. The authors hoped to use the results as an assessment of pollutant stress. They found, however, that the degree of AChE inhibition in the ventral nerve cord of captured shrimp was not a reliable predictor of water pollution levels.

Borthwick, et al. (1985), using the mosquitocide fenthion, confirmed that laboratory toxicity tests could be used to predict ranges of lethal and nonlethal acute field exposures of this toxin for pink shrimp.

Crabs

Nimmo, Wilson, et al. (1971) studied levels of Aroclor 1254 (PCB) in fiddler crabs caught in the Escambia Bay area. Through lab experiments, the researchers found that the amount of PCBs in the crabs was related to the amount of PCBs in the sediments. Apparently the crabs either ate contaminated sediment particles, or absorbed the PCBs through their cuticle. Similar results were found in relation to pink shrimp, as mentioned in the preceding section on penaeids. Bookhout, et al. (1972) tested the effects of Mirex on the larval development of two species of brachyuran crabs, *Rhithropanopeus harrisi* and *Menippe mercenaria*. They found a slowing of growth stages for *Rhithropanopeus*, and structural aberrations in *Menippe*. In two long-term studies by Schimmel, et al. (1979), the bioaccumulation and toxicity of Kepone in the blue crab, *Callinectes sapidus*, were investigated. The first study was to determine the uptake and depuration rates of Kepone in blue crabs exposed to the insecticide via seawater and food. The second study was to determine the effects of Kepone on molting and survival of blue crabs. The researchers found that very little of the toxin was taken up directly from the water, but that most was absorbed through the food of the crabs. They also found that blue crabs fed on oysters contaminated with 0.25 µg/g Kepone accumulated the insecticide into their muscles and other tissues within 28 days; however, after an equal amount of time in a Kepone-free environment, the same crabs showed no depuration of the compound. The authors concluded that Kepone residues would persist in blue crab tissue as long as it was available in the food source.

Mysids

Nimmo, Bahner, et al. (1977) successfully experimented with the mysid, *Mysidopsis bahia*, in life cycle toxicity tests using cadmium and Kepone. Indicator effects in low concentrations of cadmium noted in this experiment included delay in formation of brood pouches, untimely release of young, fewer young produced by females, and decreased growth rates. Nimmo, Hamaker, et al. (1981) conducted further investigations into the use of mysids as environmental indicator species for routine testing of pesticides. Sensitivity levels were determined for effects on growth, reduced reproduction, and chronic toxicity.

Mixed Species Communities

The effect of synthetic organic pesticides on commercial fisheries was emphasized in a report from the U.S. Department of Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries' Biological Laboratory at Gulf Breeze, Florida (1966).

Cantelmo and Rao (1978) experimented with the effects of various concentrations of pentachlorophenol (PCP) on laboratory-established meiobenthic communities. The effects of barite (a major component of drilling mud) on meiofauna were studied by Cantelmo, et al.

(1979) in a flow-through experimental system. When barite was mixed throughout the sediment, an increase in meiofaunal densities resulted; however when barite was deposited on top of the sediment (actual drilling situation) a significant decrease in density occurred.

Tagatz, Plaia, et al. (1983) assessed the effects of marine grade creosote on macrobenthic community structure. The number of species of annelids, echinoderms, and arthropods were significantly less in aquaria contaminated with 177 $\mu\text{g/g}$ creosote than in control aquaria. Mollusks, as a group, proved most resistant. Tagatz, Deans, et al. (1983) investigated the effects of di-n-butyl phthalate (DBP) on field and laboratory-developed benthic communities. Both numbers of individuals and species were significantly reduced in aquaria exposed to 3.7 mg DBP/l (lab-colonized) and 3.3 mg DBP/l (field-colonized), as compared to controls, or those exposed to lower concentrations. Chordates, mollusks, arthropods, and annelids were those groups affected in both laboratory and field assemblages.

Checklists, Surveys and Keys

A general species list of Gulf Coast crustaceans was compiled by Lindsey and Walker (1949). Reports on marine invertebrates found in the area of the Gulf Coast Research Laboratory were compiled by Tolbert and Walker (1950), and J.F. Walker (1950). Rings and Richmond (1953) conducted a survey of the mosquitos of Horn, Ship, and Cat Islands, Mississippi. The most abundant species of the 26 listed was *Aedes sollicitans*. Steidinger, et al. (1967) compiled a key to 37 genera of naked and armored (thecate), free-living marine dinoflagellates of Florida's west coast.

Estuarine invertebrates and zooplankton were surveyed in Mississippi for the Cooperative Gulf of Mexico Inventory. Perry and Christmas (1973) found copepods to be the dominant group. Data were presented in both temporal and areal distribution, together with relative abundances of species. Physical parameters were also discussed. Christmas and Langley (1973) surveyed the young of commercially important invertebrates. Data on occurrence, relative abundance, and seasonal and areal distribution in relation to a salinity-temperature matrix were reported. A total of 180 species from 124 families were recorded. Sediment samples included 62 species from 43 families that were not collected in trawls and seines. White and brown shrimp were the two most abundant species caught.

An extensive biological and historical inventory of the waters surrounding Horn and Petit Bois Islands in Mississippi was conducted by J.A. Jackson, et al. (1979). Much of the work was done to determine the impacts of dredging Petit Bois Pass. Included in the appendices were lists of the zooplankton and benthic invertebrates of Mississippi Sound. Shaak (1980) cataloged the type invertebrate fossils for the Florida Bureau of Geology. The specimens were arranged by family. Information on the geologic time period they were from was also provided. Franz (1982) edited a volume on the rare and endangered invertebrates of Florida. A species account and status, as well as selected references, were provided for 15 corals, 18 mollusks, 18 crustaceans, 154 insects, 12 spiders, and one tailless whip scorpion. Heard (1982) compiled an illustrated field guide to the common marine invertebrates of the northern Gulf of Mexico.

Cake (1983) compiled a listing of the shellfish associated with the barrier islands off the coasts of Mississippi, Alabama, and Florida. An annotated guide to the barnacles of the northern Gulf of Mexico was provided by Gittings, et al. (1986), which included a taxonomic key to 49 species of thoracican barnacles. Heard and Stuck (1988) conducted a survey of the brackish and marine macroinvertebrates of Horn and Ship Islands in Mississippi, and Perdido Key in Florida.

There are several taxonomic keys to the invertebrates of the northern Gulf of Mexico on file at Gulf Islands National Seashore Headquarters in Ocean Springs, Mississippi. Included are keys for amphipods, crustaceans, decapods, echinoderms, holothurians, isopods, ophiurans, and polychaetes (N.A., N.A.m).

FISH

Individual Species Studies

Sharks

Branstetter, et al. (1987) compared age and growth rates of tiger sharks in the Atlantic Ocean off the coast of Virginia and in the northwestern Gulf of Mexico. Growth rates were faster for juvenile sharks in the Gulf of Mexico, and both male and females matured sooner (7-8 years) in the Gulf than those in the Atlantic (10 years). Tiger sharks were found in the coastal waters from spring to fall, and in deeper continental shelf and offshore regions year-round.

Menhaden

Combs (1969) studied ovary development in menhaden (*Brevoortia patronus*) captured in the waters off Dauphin Island, Alabama over a five-year period. Cytological and histological studies of gonadal tissue included inception in larve, sexual differentiation, and cyclic changes associated with oogenesis and spawning in mature fish. Dahlberg (1970) discussed the hybridization, geographical variation, population structure, and zoogeography of the genus *Brevoortia* in the Gulf of Mexico. Also included was a key to menhaden species and their hybrids. Tagatz and Wilkens (1973) studied the seasonality of young *Brevoortia patronus*, as well as other species in the estuaries of Pensacola Bay. Larvae and juveniles were caught in the bay from December through May; by August, young began migrating towards the Gulf. Christmas and Waller (1975) studied the seasonality of menhaden spawning in the Gulf of Mexico.

The results of a tagging study of Gulf menhaden by Pristas, et al. (1976) showed little east - west movement of adults during the fishing season (April - November). Also, little mixing of populations occurred offshore between December and March. Mortality appeared high, but could not be estimated by tag returns. Few individuals survived longer than three years. W.R. Nicholson and Schaaf (1978) conducted an aging study on *B. patronus*. About 50% of the fish examined were aged using scale annuli. Those individuals with no scale annuli were either assigned to age "one or younger" or age "two or older" based on body length. Results of length-frequency distribution, tag returns, and analysis of scale annuli indicated that over 97% of Gulf menhaden caught in the purse seine fishery were between the ages of one and two. R.M. Lewis and Roithmayr (1980) studied spawning and sexual maturity of Gulf menhaden. The authors reported that this species spawns for the first time at age one, after completing two seasons of growth, and spawns yearly thereafter. Frye (1980) provided a general report on the life history of Atlantic and Gulf menhaden, covering their reproduction, migration, and distribution.

Ahrenholz (1981) estimated rates of exploitation, population movements, and recruitment into the fishery through tag returns of juveniles and adults. Christmas, et al. (1982) developed two models for habitat suitability for Gulf menhaden; however, the models were not field tested. In addition to describing the species, the report provided information on growth, food habits, migration, life history, and reproduction. Habitat requirements for larvae, juveniles, and adults were discussed as well. Hettler (1984) described the eggs, larvae, and juveniles of the Gulf menhaden, and compared this species with Atlantic and yellowfin menhaden. The eggs and larvae of Gulf menhaden were difficult to distinguish from yellowfin menhaden; they could only be separated by pigmentation and morphometrics. Sogard, et al. (1987) studied the depth distribution of larval menhaden in the northern Gulf of Mexico. A consistent distributional pattern was observed.

Silversides

Garwood (1967) provided notes on the life histories of silversides, *Menidia beryllina* and *Membras martinica*, from Mississippi Sound. Salinity had little effect on spawning or the entry of post-larvae and juveniles into Mississippi Sound, while temperature was thought to have somewhat of an effect on spawning. Middaugh and Hemmer (1984) examined the effects of interruptions in current velocity and diel light cycles on the frequency and timing of spawning

by the tidewater silverside (*Menidia peninsulae*). Results indicated that reproductive timing was mediated by at least two external signals, current velocity and diel light cycle. In addition, results showed that *M. peninsulae* is a nocturnal spawner. McMullen and Middaugh (1985) determined the optimal culture conditions of temperature and food density for larval *M. peninsulae*. Results showed that the influence of food density on larval growth was temperature dependent. A model was developed incorporating the influences of temperature and food density on the growth and survival of this species.

Preliminary information on the use of *M. beryllina* for mosquito control was presented by Middaugh, et al. (1985). Feeding trials were conducted in the laboratory and under semi-natural conditions in varying salinities. No results were reported. Middaugh and Hemmer (1987a) studied the reproductive ecology of the tidewater silverside, *Menidia peninsulae*, collected in Santa Rosa Sound. The reproductive cycle extended from February through July, with highest spawning activity during March and June in water temperatures between 16.7 - 30.8° C. Further studies on *M. peninsulae* were conducted by Middaugh and Hemmer (1987b) concerning the sex ratio of this species. Significant deviations from the expected 1:1 ratio were revealed.

Miscellaneous Clupeiformes

E.J. Edwards (1967) studied the life history and seasonality of bay anchovy (*Anchoa mitchilli*) populations in Mississippi Sound. They were most abundant May through October. Juveniles were found in low salinity estuarine waters, and preferred shallows and protected bays. Tagatz (1973) provided the most northern record of a larval tarpon, *Megalops atlantica*, in upper East Bay, Florida. Goodman (1977) reported on the occurrence of chain pickerel, *Esox niger*, in Santa Rosa Sound. This species, normally found in low salinity waters, was able to enter the sound due to a heavy, three-day rainfall just prior to sampling.

Miscellaneous Cypriniformes

Harvey (1971) described the development of the embryos and larvae of the marine catfish, *Galeichthys felis*. Overstreet and Edwards (1976) provided a description of benign, subcutaneous, mesenchymal fibromas found in sea cats (*Arius felis*) collected in the offshore waters of Ship Island, Mississippi. Beecher (1980) discussed segregation of habitat by carpsuckers (*Carpoides cyprinus* and *C. velifer*) in Florida's Escambia River. Relyea (1983) studied two species' complexes of *Fundulus*, providing descriptions of morphometric variations and ranges, as well as some general ecological information on the two species (*F. grandis grandis* and *F. majalis*). Wooten, et al. (1988) discussed systematics of the mosquitofish (*Gambusia*) found in the southeastern United States, specifically mentioning populations in Mobile Bay, Alabama. The authors considered populations found in drainages west of Mobile Bay to be *G. affinis*, and those found east of the divide to be *G. holbrooki*.

Eels

Leiby (1981) described the morphological development of the eels, *Bascanichthys bascanium*, *B. scuticaris*, *Ophichthus melanoporus*, and *O. ophis*. In addition to a detailed description of the larvae of these species, the author compared and contrasted developmental osteology between the four species.

Pipefish

Whatley (1969) reported on an unusual species of pipefish, *Syngnathus scovelli*, that breeds in freshwater, brackish water, and saltwater. The author conducted the study in Lake St. John, Louisiana, Davis Bayou, Mississippi, and the waters off of Horn Island, Mississippi. Dawson (1972) sampled nektonic pipefish off the Mississippi Coast between 1967 and 1969. A total of 108 juvenile specimens, representing two genera and five species, were collected. Species composition, distribution, and selected meristic and length-frequency data were reported.

Striped Bass

Yeager (1985) discussed the hybrid striped bass fishery in the Escambia River in Florida. The author presented harvest and success rates between 1981 and 1982. Woods (1987) edited a series of articles on the research and management of striped bass, several of which discussed the Gulf Coast fisheries. Hawke, et al. (1987) provided information on the isolation and identification of a bacterial infection of striped bass, *Morone saxatilis*, collected in the coastal waters of Alabama. The bacterium, *Pasteurella piscicida*, was identified as the cause of the fish pasteurellosis. Salient histopathological features of the disease were described as well.

Porgies and Pinfish

Henwood, et al. (1978) studied the feeding habits of the longspined porgy (*Stenotomus caprinus*). This species was found to be an opportunistic bottom feeder; the diet consisted of small invertebrates, predominantly crustaceans and polychaetes. Henwood (1978) described the life history and distribution of *S. caprinus* collected from the offshore waters of Mississippi, Alabama, and Florida over a one-year period. Distributional data showed a gradation in size of individuals, with depth. Life expectancy was two years, and spawning occurred between November and April.

D.J. Hansen (1970) reported on the food, growth, migration, reproduction, and abundance of pinfish and Atlantic croakers collected in Pensacola estuaries. Schimmel (1977b) studied the embryonic development of pinfish (*Lagodon rhomboides*). Darcy (1985a) compiled and reviewed available research on pinfish biology. Luczkovich (1988) studied the importance of chemoreception, vision, and prey activity in the process of prey detection by *L. rhomboides*. Vision and chemoreception were used jointly in locating prey.

Drums

Croakers

Christmas and Howse (1970) observed the presence of lymphocystic tumors in Atlantic croakers taken from Mississippi estuaries. The pollution load was much greater in the estuarine system where lymphocystis was encountered. D.J. Hansen (1970) studied the diet, growth, migration, reproduction, and abundance of Atlantic croaker (*Micropogonias undulatus*) in Pensacola estuaries. The croakers were described as carnivores, feeding on annelids, fish, and arthropods. Further information on the diet of *M. undulatus* collected from Mississippi Sound was compiled by Overstreet and Heard (1978a). The primary components of the diet were crustaceans, polychaetes, mollusks, and fish.

Black Drum

Cave (1978) studied the predator/prey relationship between black drum (*Pogonias cromis*) and American oysters (*Crassostrea virginica*) in Mississippi Sound. The drum were able to detect oysters with their chin barbels, and crush the shells with their teeth. Although the drum could break apart oyster clusters, they preferred single oysters for ease of feeding; for this reason, transplanted oysters and planted seed were most susceptible to predation.

Kingfish

McMichael and Ross (1980), and McMichael (1981) reported on habitat utilization by *Menticirrhus* spp in the surf zone off Horn Island, Mississippi. A total of three species were collected over a 16-month period. The most abundant species was *M. littoralis*, making up 62% of the total, followed by *M. americanus* (21.9%) and *M. saxatilis* (15.5%). Fritzsche and Crowe (1981) contributed to the knowledge of the life history of the southern kingfish (*M. americanus*) in Mississippi. They reported that the species migrated offshore in the winter months, and stayed in the estuaries during the summer. A prolonged spawning period occurred between March and November, peaking in April. A habitat suitability index model was constructed by Sikora and Sikora (1982) for the southern kingfish. Information on distribution, growth, feeding and reproduction was provided. Crowe (1984) studied the

distribution of juvenile and adult southern kingfish off the Mississippi Coast with regard to depth, salinity, temperature, and seasonal movements. Juveniles were mainly found in the estuaries and inshore waters, while the adults were found in deeper, offshore waters. The southern kingfish was found over wide ranges of salinity (2.0-36.6 ‰); however larvae and juveniles were found in waters ≤ 15 ‰. This species was also eurythermal, found in waters between 8° C - 37.3° C.

Red Drum

Overstreet and Heard (1978b) reported on the diet of red drum (*Sciaenops ocellata*) taken from Mississippi Sound. Decapod crustaceans accounted for the majority of food items encountered through gut analysis. Polychaetes were another important food item. The authors suggested that the migration of the red drum may be regulated by the optimal abundance of certain dietary organisms. Overstreet (1983b) provided extensive data on the life history, population dynamics, fecundity, spawning, parasites, and the physical parameters of the habitat of red drum in Mississippi waters. Steen and La Roche (1983) provided information on the diet of juvenile and larval red drum taken from Mississippi Sound and the northern Gulf of Mexico. Diets among different size classes of larvae, and capture sites were compared. Copepods and other crustacean nauplii were the most abundant food items encountered. Lyczkowski-Schultz, et al. (1988) described the early life history and recruitment of red drum in the north central Gulf of Mexico. The authors characterized diel, vertical, and horizontal distributional patterns, as well as planktonic prey, during the early stages of development.

Seatrout

Weinstein and Yerger (1976) conducted an electrophoretic analysis of several *Cynoscion* species collected in the Gulf of Mexico and Atlantic Ocean. *C. nebulosus* was found to be the most divergent of the forms studied. The taxonomic status of *C. arenarius* was questioned, but electrophoretic patterns indicated that it should be regarded as a subspecies of *C. regalis*. Overstreet (1983a) provided extensive information on the meristics, life history, population dynamics, fecundity, spawning, and parasites of the spotted seatrout, *Cynoscion nebulosus*, from Mississippi waters. Sutter and McIlwain (1987b) provided information on the life history and habitat requirements of the sand seatrout and silver seatrout of the Gulf of Mexico. The sand seatrout were common in shallow, offshore waters with temperatures greater than 15° C and salinities less than 15 ‰; while the silver seatrout was found in deeper waters with temperatures ranging between 5° to 30° C and salinities greater than 25 ‰.

Flounder

Overstreet and Edwards (1976) described benign, subcutaneous, mesenchymal fibromas in southern flounder, *Paralichthys lethostigma*, collected in the waters off Ship Island, Mississippi. Leslie and Stewart (1986) described the systematics and distributional ecology of flounder belonging to the genus *Etopus*. A new species, *E. cyclosquamus*, and *E. crossotus* were noted as occurring in the Gulf Coast area.

Mackerel and Tuna

D.W. Lee, et al. (1983) discussed interpretation of vertebral and otolith growth bands of bluefin tuna (*Thunnus thunnus*). Data indicated that growth bands on the vertebrae should be interpreted as equal to at least one year each. Manooch and Mason (1983) studied and compared the stomach contents of yellowfin (*Thunnus albacares*) and blackfin (*Thunnus atlanticus*) tuna from the Gulf Coast. Both species consumed crustaceans, cephalopods, and surface-feeding fish.

Finucane, et al. (1986) studied the reproductive biology of king mackerel, *Scomberomorus cavalla*, collected in the offshore waters of Texas and Florida, as well as Louisiana, Mississippi, and North and South Carolina. Fable, et al. (1987) studied the growth of Spanish mackerel, *Scomberomorus maculatus*, collected in the Gulf of Mexico. Palko, et al. (1987) presented catch per unit effort (CPUE) data for the southeastern United States on Spanish mackerel; Trent, et al. (1987) presented similar data on king mackerel.

Mullet

De Sylva, et al. (1956) conducted biometric analysis of meristic characteristics of black [= striped] mullet, *Mugil cephalus*, from several locations in Florida, including Pensacola. Edwards and Overstreet (1976) reported on the occurrence of fibrous, subcutaneous tumors in the tissues of five striped mullet taken from Mississippi Sound. The authors suggested a possible relationship between the tumors and increasing pollution in the Sound.

Snook

Cooley (1974) reported on a range extension of snook, *Centropomus undecimalis*, to Santa Rosa Sound in Florida. Rivas (1986) provided a review the systematics of the genus *Centropomus*. Twelve species were accepted as valid, based on a review of 802 specimens collected from 159 localities. *C. pectinatus* was found distributed along Florida and Mississippi coastal areas, while *C. undecimalis* was found only in the Pensacola area of Florida.

Blennies and Gobies

Dawson (1966) conducted ecological studies on the gobies of Mississippi Sound, which included information on their habitat, abundance, distribution, seasonality, morphology, and interspecific relationships. In 1969, Dawson provided an illustrated key to the gobies of Mississippi Sound and its adjacent waters.

J.T. Williams (1983) discussed the taxonomy and ecology of blennies of the genus *Chasmodes*. The author described characteristics of the species that would allow for identification regardless of where they were found. In addition, a mechanism was proposed to explain the maintenance of genetic integrity between species.

Miscellaneous Perciformes

Collins and Smith (1959) reported a range extension for butterfly fish (*Chaetodon sedentarius*) to the north central Gulf of Mexico. The authors observed the species in the offshore waters of Ship Island, Mississippi while skin diving. T.C. Lewis and Yerger (1976) analyzed the species of the family Triglidae (sea robins) in the northeastern Gulf of Mexico, providing comments on their distribution, abundance, and biology. Mettee (1977) conducted a distributional study of the Okaloosa darter, *Etheostoma okaloosae*, and the brown darter, *E. edwini*, in northwest Florida. Irby, et al. (1978) provided general information on sailfish, including notes on their economic and recreational importance, their biology, and recent research.

Randall, et al. (1978) revised the triggerfish genus, *Xanthichthys*, recognizing five species. Characteristics of the genus were described, and photographs and a key were provided. Darcy (1985b) provided information on the biology and fishery resources of the sand perch (*Diplectrum formosum*). Peterson, et al. (1987) conducted experiments on the orientation behavior of bluegill sunfish (*Lepomis macrochirus*) to salinity change. The sunfish were observed to reduce all overt activities when rate changes were unnatural or potentially lethal. Behavioral and physiological responses were synergistic when salinity exceeded a critical rate of change. The author speculated that an orthokinetic response to salinity changes allowed bluegills to move in and out of oligohaline marshes.

Sutter and McIlwain (1987a) provided a species profile on pigfish in the Gulf of Mexico. They included information on distribution, spawning, and habitat. G.C. Miller and Woods (1988) described a new species of sciaenid, *Pareques iwamotoi*, collected off Pensacola, Florida. Starnes (1988) discussed the phylogeny of the family Priacanthidae (bigeyes). A complete familial, generic, and species diagnosis was provided, including osteology and scale morphology. Hales and Van Den Angle (1989) compiled a species profile for spot (*Leiostomus xanthurus*). Biological characteristics and environmental requirements were described.

Pollution Effects

Mosquitofish

D.J. Hansen, et al. (1972) studied the avoidance of various pesticides by mosquitofish (*Gambusia affinis*). The test species showed some degree of avoidance for DDT, Dursban, malathion, Sevin and 2,4-D, and no avoidance for endrin; however, the avoidance response was not usually pronounced. D.J. Hansen (1972) specifically looked at the effects of DDT and malathion on osmoregulation by mosquitofish. Selection of significantly higher salinities was noted in the presence of DDT only.

Sheepshead Minnow

Schimmel, et al. (1974) studied the effects of the polychlorinated biphenol, Aroclor® 1254, on the embryo and fry of sheepshead minnows (*Cyprinodon variegatus*) in the laboratory. Aroclor® 1254 had an effect on the survival of both embryo and fry, but had no effect on hatching time. The toxin was more toxic to the fry than juveniles, adults, or to the fertilization of eggs. D.J. Hansen, et al. (1975) examined the effects of Aroclor® 1016 on the fry, juvenile, and adult stages of *C. variegatus* via 28-day, intermittent flow bioassays. Concentrations of 32 and 100 µg/liter were lethal for newly hatched fry, juveniles, and adult fish. Survival at lower concentrations was not affected. Additional flow-through toxicity tests were conducted on *C. variegatus* by Goodman, et al. (1976) using the organochlorine pesticides heptachlor and toxaphene. At concentrations of 4.3, 3.5, 2.2, 2.0, and 1.2 µg/l (ppb) of heptachlor, test animal survival was 1, 5, 61, 79, and 88% respectively. At concentrations of 2.5, 1.1, 0.6, 0.3, and 0.2 µg/l of toxaphene, test animal survival was 10, 85, 79, 88, and 80% respectively.

D.J. Hansen, et al. (1977) studied the effects of Kepone® on the various life history stages of *C. variegatus*. The insecticide proved toxic to, and was bioaccumulated by, the minnows. Symptoms of poisoning in adults included scoliosis, darkening of the lower third of the body, hemorrhaging, edema, fin rot, uncoordinated swimming, and cessation of feeding. D.J. Hansen and Parrish (1977) endorsed the use of *C. variegatus* as a test species for life cycle toxicity tests, and discussed its use in toxicity tests with endrin, heptachlor, carbofuran, methoxychlor, and malathion. Goodman, et al. (1979), using Diazinon®, tested its chronic effects on sheepshead minnows, especially its effects on brain acetylcholinesterase (AChE). G.S. Ward, et al. (1982) tested the effects of ammonium jarosite on the early life history stages of *C. variegatus*. Slight delays in hatching were observed at concentrations of 140 ppm, and juvenile mortality was significantly increased at concentrations ≥ 230 ppm.

Silversides

Solangi (1980) studied the histopathological effects of crude oil on various organs of the silverside, *Menidia beryllina*. Goodman, et al. (1983) tested the effects of chlorine-produced oxidants (CPO) on the early life history stage of the tidewater silverside, *Menidia peninsulae*. Embryos approximately 36 hours old were exposed to various concentrations of the toxin (0.01, 0.04, and 0.21 mg/l). No fish survived exposure to concentrations of 0.21 mg/l.

Spot

Holland and Lowe (1966) studied the effects of malathion on spot (*Leiostomus xanthurus*). Sub-lethal concentrations were tolerated, and elevated brain AChE levels apparently had no adverse effects. Exposure effects wore off quickly when the toxin was removed. Schimmel, et al. (1976b) exposed spot to heptachlor for 24 days, followed by 24 heptachlor-free days. Concentrations in edible tissues were monitored; the maximum amount of heptachlor was absorbed within three days. Only 28% of the chemical remained in the tissue after 28 heptachlor-free days.

Mullet

Minchew and Yarbrough (1977) studied the relationship between crude oil contamination and fin rot in mullet (*Mugil cephalus*) in an experimental estuarine pond

system. Fin rot occurred in all mullet examined 6-8 days following exposure. Tan, et al. (1981), and Tan and Melius (1982) conducted research on the ability of mullet to metabolize Aroclor® 1254.

Miscellaneous Species

J.I. Lowe (1965) studied the effects of endrin on various estuarine fishes. Near-lethal concentrations produced mortality in all species. An anonymous author (Anonymous, 1970) reported on 42 fish kills that occurred in Escambia Bay, Florida from June 21 to September 4. The kills were caused by overnutrification of the bay waters. Cripe (1979) described an automated device to monitor avoidance behavior of pollutants by fish.

Schimmel (1975) studied the effects of toxaphene on an important predator link in the estuarine food chain, the longnose killifish, *Fundulus similis*. Embryonic sensitivity and tolerance were determined. Melius, et al. (1980) looked at the ability of mullet, sea catfish, and Gulf killifish to metabolize aromatic hydrocarbons. James, et al. (1988) tested the ability of small estuarine and freshwater fish to metabolize selected xenobiotic substrates. The freshwater species were more sensitive to the pollutants than the estuarine species. The reaction most commonly observed was carcinogenesis activation.

Fisheries Research

Management

Christmas (1971) provided a discussion on the various environmental, engineering, socioeconomic, and legal aspects of fisheries management in Mississippi. Etzold and Christmas (1979) summarized the biological, social, and economical aspects of Mississippi's finfish fishery.

Industry

An early report on Gulf fisheries was presented by Collins and Smith (1891), which provided a statistical review of the commercial fishing industry of the Gulf Coast states. Rounsefell (1954) provided information on the ecology, biology, and life history of the commercial fish species of the Gulf of Mexico. Kemmer, et al. (1974) summarized the results of experiments on the use of satellite-acquired information (ERTS-1) in predicting the distribution and abundance of menhaden. The Gulf South Research Institute (1976) provided a report on the management practices of the fishing industry of the Gulf Coast states. McNeil (1977) discussed the history of Pensacola's red snapper industry from its beginnings in the 1840's through 1965. Competition, insufficient labor force, inactive markets, depleted stocks, and rising costs made it unprofitable to continue operations out of Pensacola. W.R. Nicholson (1978) reported on the Gulf menhaden purse seine fishery in the northeastern Gulf of Mexico between 1964-1973. One and two-year old fish comprised 95-99% of the catch by weight.

A general account of Florida's fishery resources was presented by Seaman (1985). Statewide resource management and information transfer was reviewed. Using landing data from 1964-1978, W.R. Nelson and Ahrenholz (1986) described the characteristics of the menhaden, *Brevoortia patronus*, fishery in the Gulf of Mexico. The authors presented a deterministic simulation model, and discussed the future status of the fishery.

Sport Fisheries

Irby (1974) conducted a fishing survey of Choctawhatchee Bay and adjacent waters. Data were compiled through personal interviews, aerial surveys, and questionnaires. The author recommended the initiation of a statewide system of collecting sport fishing data. A species list and maps were included as well. Daniel and Seward (1975) estimated fishing pressure on reefs in Mississippi Sound through aerial surveys (boat counts). Feasibility of new reef construction was under consideration.

A guide to fish frequently caught by fishermen in the southeastern United States including the Gulf of Mexico was compiled by Manooch (1984). The text is divided into sections on habit (life history, descriptions, distribution), fishing (how, when, and where a particular species is caught), and preparation (edibility and food preparation). Watts (1984) reported on Gulf fishing in the fall, discussing the seasonality of sport species, and where to locate them along the barrier islands. Murray, et al. (1987) discussed an educational program aimed at increasing the demand for underutilized fish species in the southeastern United States. Included were descriptions of short and long-term objectives, strategies, and development of educational materials.

Multispecies Ecological Studies

Gulf of Mexico

Rivas (1954) provided information on the natural history and population dynamics of fish in the Gulf of Mexico. By determining the distribution of fish eggs and larvae through plankton tows, Arnold (1958) listed the spawning areas of various Gulf of Mexico fish.

Using the Mobile Bay/Mississippi River/Mississippi Sound system as an example, Gunter (1967) discussed the importance of estuaries as nursery grounds for fish. The author also discussed important nursery areas, as well as the important species common to the nursery areas. Christmas, et al. (1972) sampled coastal pelagic fish from Mobile Bay to the Chandeleur Islands. Nakamura, et al. (1980) surveyed the estuarine areas of the Gulf of Mexico for recreational species.

Lukens (1981) studied the colonization by fish of an artificial reef in the northern Gulf of Mexico. A total of 60 species from 33 families were recorded. Data indicated that reef communities were influenced by seasonal temperature changes. S.T. Ross (1983) surveyed surf zone ichthyofauna from various areas of the Gulf of Mexico. Faunas were temporally dynamic both seasonally and daily. Young fish occurred off high energy beaches in the spring and summer, and remained into the fall. Anchovies, scaled sardines, menhaden, kingfish, mullet, croakers, and pompano were the numerically dominant species. S.T. Ross (1986) reviewed literature on resource partitioning in fish assemblages worldwide, and included data on assemblages near Horn Island, Mississippi and Apalachicola Bay, Florida.

Mississippi

Franks (1970) surveyed the fish populations of the inland waters of Horn Island to determine species composition and relative abundances. A total of 69 species were noted, representing 35 families. Both marine and brackish water species were represented, however no true freshwater species were observed. *Cyprinodon variegatus*, *Fundulus similis*, *Gambusia affinis*, *Menidia beryllina*, and *Poecilia latipinna* were the most frequently observed species. Physical data of the sampling area were also collected. Modde (1980) evaluated the temporal association of the juvenile fish to the surf zone habitat of the Gulf shore of Horn Island. Resident fish species comprised 42% of all fish sampled. Modde and Ross (1980) looked at the seasonal and annual variation in species composition of fish in the previously mentioned surf zone habitat (Modde, 1980). The surf zone was dominated by immature clupeid fishes. Greatest numbers were collected in late spring and early summer, followed by a secondary peak in late winter.

Overstreet and Heard (1982) analyzed the stomach contents of six commercial species (spotted seatrout, sand seatrout, silver seatrout, black drum, sheepshead, and southern flounder) collected from Mississippi Sound. Principal food items encountered were anchovies, brown and white shrimp, and blue crabs. Benson (1982) synthesized information on the spawning, nursery, and migratory requirements of 41 species of fin and shellfish from Mississippi Sound to aid in considerations for U.S. Army Corps of Engineers navigation dredging. Modde and Ross (1983) studied trophic relationships between several species of fish (Florida pompano, Gulf kingfish, scaled sardine, striped anchovies, and dusky anchovies) occurring in the surf zone of Horn Island. Statistical analysis indicated considerable interspecific resource separation. Ruple (1984) provided further information on the larval fish

found in the surf zone of western Horn Island. Included were data on species composition, abundances, seasonality, spawning, and diel comparisons.

Florida

D.K. Caldwell (1959) provided notes on tropical marine fish observed during the summer months from Panama City to Destin. Haburay, et al. (1968, 1974) also provided records of tropical fish sightings in Pensacola. Jetties and submerged wrecks in the area supplied a suitable habitat. R.W. Hastings (1972) described the establishment of fish fauna on a jetty at East Pass. Successional and seasonal changes were compared to older, established reef habitats. Plumb, et al. (1974) described marine fish kills in northwest Florida waters caused by a *Streptococcus* infection. Menhaden were the primary species affected. Bortone (1976) described the effects of hurricanes on the ichthyofauna in the waters of Destin. Oxygen depletion resulted from vertical mixing, and the storm surge and sediment load generated by the wind caused injury. Beecher and Hixson (1982) studied the seasonal abundance of fish in three northwest Florida rivers: Escambia, Choctawhatchee, and Apalachicola.

Surveys/Species Lists

General Gulf of Mexico

Incidental fish catches taken in the menhaden fisheries of Alabama, Mississippi, and Louisiana were listed by Christmas, et al. (1960). Topp and Ingle (1972) compiled an annotated list of post-1950 literature on fish distribution in the Gulf of Mexico.

Mississippi

A progress report compiled by R.M. Bailey, et al. (1949) listed fish species found in Mississippi Sound between Pascagoula and Biloxi. The authors added 22 species to the previously recorded number of 31, bringing the total of Mississippi Gulf Coast species to 53. Franks (1964, 1967) listed the fishes of the inland waters of Horn Island. A total of 69 species were recorded, representing 35 families. S.T. Ross (1977) listed fish species from the surf zone of Horn Island. In an evaluation of the wilderness status of Horn Island, J.A. Jackson, et al. (1979) provided an extensive species list of fishes collected in the offshore waters of Horn and Petit Bois Islands.

Alabama

Boschung (1957) surveyed the fish of Mobile Bay and the offshore waters of Alabama. Swingle and Bland (1974) also provided a species list of fish caught in coastal Alabama waters.

Florida

An early series of articles in the U.S. National Museum Proceedings (Goode, 1879; Jordan, 1882, 1884, 1885, 1886; and Dressel, 1885) provided notes on fish collected by a wholesale fish dealer, Silas Stearns, from Pensacola.

A checklist of Florida fishes was compiled by Evermann and Kendall (1900). Locations of fresh, brackish, and saltwater species were provided. R.M. Bailey, et al. (1954) reported on the occurrence and distribution of fishes in the Escambia River. A total of 109 species were listed. Briggs (1958) compiled a general list of the fishes of Florida, including information on their ranges and habitats.

Powell, et al. (1972) provided a revision of the holdings of the fish reference collection of the Marine Research Laboratory of the Florida Department of Natural Resources at St. Petersburg, Florida. Information on the 720 species recorded from Florida waters includes the number of specimens, length, location, and date of catch. Gilbert and Pritchard (1979) edited a volume on rare and endangered biota of Florida, including a list and species account of 43 species of fish.

Keys

Wahlquist (1966) provided a field key to the sawfish, guitarfish, skates, and rays of Florida. The author also provided information on the ecology of the 51 species listed. Houde and Fore (1973) compiled a guide to the eggs and larvae of some clupeid fish of the Gulf of Mexico. Boschung (1978) presented a key to the sharks of the Gulf of Mexico.

REPTILES AND AMPHIBIANS

Amphibians

Frogs

Goin and Netting (1940) described a new gopher frog from the Gulf Coast and provided comments on the *Rana areolata* group.

Salamanders

Grobman (1950) provided distributional information on the races of the dusky salamander (*Desmognathus fuscus*) in the southern United States. F.A. Cook (1957) wrote on the salamanders of Mississippi. Means (1975) studied competition between two salamanders, *Desmognathus auriculatus* and *D. fuscus*, along a habitat gradient in western Florida. Geographic distributions were mapped for both species under both allopatric and sympatric conditions.

Reptiles

Snakes

F.A. Cook (1943c) provided a report on the snakes of Mississippi. List and Smith (1954) reported a rare snake anomaly collected at Biloxi; a snake (*Natrix*) bore an offspring with two bodies and a single head; it died shortly after birth. Keiser (1982) compiled a laypersons guide to the venomous snakes of Mississippi, along with information on first aid for snake bites.

Alligators

F.A. Cook (1943a) reported on the alligators and lizards of Mississippi. Gunter (1977) studied territoriality and competition in the American alligator (*Alligator mississippiensis*) of the brackish waters of Mississippi. C.A. Ross and Roberts (1979) studied and compared scalation variations in American alligators throughout their range. The authors found considerable variation between populations throughout the range.

Gopher Tortoises

Logan (1979) conducted a preliminary survey of the gopher tortoise (*Gopherus polyphemus*) to determine its status at Gulf Islands National Seashore in Florida. A follow-up survey was conducted by Valentine in 1980, with no definite sighting of any tortoises, nor any solid evidence of their existence within the park unit.

Turtles

Pope (1939) compiled a book on the turtles of the United States, providing general species accounts and keys. Although none of the areas within Gulf Islands National Seashore are mentioned specifically, a guide such as this might prove useful in providing historic distribution patterns. Ernst and Barbour (1972) also provided a general guide to the turtles of the United States, which included species descriptions, and information on geographic variation, behavior, reproduction, growth, feeding, distribution, and habitat, along with distributional maps. Gunter (1981) reported on the status of coastal turtles in Mississippi; areas in the survey included Davis Bayou, Mobile Bay, Horn Island, and Mississippi Sound. Observations of the following freshwater turtles in low salinity waters were recorded: Florida cooter (*Pseudemys floridana*), snapping turtle (*Chelydra serpentina*), alligator snapper (*Macrolemys temminckii*), and gopher tortoise (*Gopherus polyphemus*). The diamond-back terrapin (*Malaclemys terrapin pileata*) was also found in the brackish waters of Mississippi and Alabama.

Sea Turtles

Individual Species Studies

The U.S. Department of Interior, Fish and Wildlife Service, Office of Endangered Species, and Office of Biological Services provided a series of species accounts on endangered and threatened sea turtles of the United States (1980b, c, d, e). Information on the life history, distribution, ecological requirements, nesting, and conservation of the green, hawksbill, Kemp's ridley, and leatherback sea turtles were presented.

Dodd (1988) compiled and reviewed available literature on the life history, distribution, populations, exploitation, and conservation of the loggerhead sea turtle, *Caretta caretta*, from all areas of the United States, including the Gulf Coast area. D.A. Nelson (1988) reported on the life history of loggerheads as well as providing data on nesting locations, migration patterns, and diet.

General Ecology

F.G.W. Smith (1954b) provided information on the ecology, morphology, and distribution of sea turtles from the Gulf of Mexico. Carr and Caldwell (1956) reported specifically on the sea turtles of Florida. D.K. Caldwell (1960) also provided general ecological information on sea turtles of the United States, including data on nesting, growth, and the feeding habits of green, ridley, loggerhead, hawksbill, and leatherback sea turtles.

Rebel (1974) wrote a book on the sea turtle industry of the West Indies and the Gulf of Mexico. Along with general information on sea turtle distribution, biology, and ecology, the author also discussed fishing methods, turtle products, turtle cultivation, and the value of the fishery. Using data collected by a satellite receiving system over an eight month period, Timko and Kolz (1982) tracked the movements of a female loggerhead from the Mississippi barrier islands to Texas.

Carr (1987) discussed the requirements of the pelagic stage of sea turtle development in the open ocean. Possardt (1988) provided a brief report on sea turtle conservation in the southeastern United States, including general information on the life history of all sea turtles listed as threatened or endangered.

Nesting

Shabica (1979c) reported on a program to monitor sea turtle nesting within the National Parks of the southeastern United States. The program was designed to determine where the turtles nest, when nesting activities take place, and to estimate the relative size of nesting turtle populations over time. Shoop, et al. (1985) conducted aerial surveys of sea turtle nesting crawls in the southeastern United States. Florida had 85 % of all observed nests, most of which were loggerhead nests. Possible reasons for the observed distribution were predation, habitat destruction, human impacts, and temperature.

Incidental Captures

Bullis and Drummond (1978) recorded incidental sea turtle captures by exploratory fishing vessels between 1950-1976. All captures occurred over water depths greater than 50 fathoms. A total of 53 turtles were taken over the 26 year period: 41 loggerheads, 7 green, 4 hawksbill, and 1 leatherback. Witzell (1984) reported 204 incidental sea turtle captures between 1978-1981 by the Japanese tuna longline fleet. Henwood and Stuntz (1987) collected data on incidental captures by commercial shrimpers in the Atlantic and Gulf of Mexico. A total of 52 were captured in the Gulf. The authors estimated that 9,874 loggerheads, 767 Kemp's ridleys, and 229 green sea turtles are killed annually in Atlantic and Gulf waters.

General Surveys and Species Lists

Mississippi

Carrington (1927) provided an early species list of the amphibians and reptiles of Biloxi. M.J. Allen (1932) surveyed the amphibians and reptiles of Harrison County. P.W. Smith and List (1955) also compiled a species list of amphibians and reptiles, concentrating on Harrison County. A total of 76 species were listed: 11 salamanders, 17 salientians, 28 snakes, 12 turtles, and 8 lizards. In 1975, Cliburn and Jackson compiled a preliminary list of the rare and endangered amphibians and reptiles of Mississippi.

Alabama

C.G. Jackson and M.M. Jackson (1970) provided an annotated species list of the herpetofauna of Dauphin Island. Mount (1975) listed and discussed the natural history of the reptiles and amphibians of Alabama. The history of herpetology in Alabama was also related.

Florida

McDiarmid and Pritchard (1979) edited a book on the rare and endangered amphibians and reptiles of Florida. Included was a description of the terrestrial and wetland herpetofauna habitats. A species account was provided for each of 45 species, as well as distributional maps.

Gulf Islands National Seashore

An early preliminary survey of the herpetofauna of the area near the Gulf Coast Research Laboratory at Ocean Springs, Mississippi was conducted by Scanlon and Nichols (1953). A total of 18 species were listed, with descriptions of their morphology, habitat, and ecology. In their status review of endangered and threatened species, J.A. Jackson, Schardien, et al. (1979), and J.A. Jackson (1984a, b) identified four reptile species whose populations were considered in trouble. J.A. Jackson (1984b) reported breeding populations of American alligators on Petit Bois, Horn, and East Ship Islands. The author offered management suggestions relating to the interaction of humans and alligators at the National Seashore. Several management recommendations were also presented for sea turtles nesting at the Seashore.

An unpublished list of the amphibians and reptiles of Gulf Islands National Seashore is available at the Gulf Breeze Unit in Florida (Garnett, 1980).

BIRDS**Individual Species Studies****Pelicans**

G. Simmons (1974) discussed the near extinction of the Brown Pelican, along with its distribution and nesting habits. The author stressed the protection of nesting sites and limited pesticide use. The U.S. Department of Interior, Fish and Wildlife Service (USDOIFWSOBS, 1980a) provided a more in-depth look at the status of the Brown Pelican along the Gulf Coast. Included was information on their life history, distribution, requirements, and conservation. Grimes, et al. (1989) studied the effects of anthelmintic drugs on the helminth parasites of 29 Brown Pelicans from the Gulf Coast. Two anthelmintics were highly effective against all of the parasites encountered: albendazole and fenbendazole.

Hérons

In a monograph on herons of the world, Hancock and Elliot (1978) provided information on the distribution, migration, habitat, identification, behavior, and feeding habits of Gulf Coast species. Dusi and Dusi (1987) summarized the status of heron colony sites over a 34-year period along Alabama's coastal plain. Little Blue Herons were the first to nest year after year, with active colony sites changing over time.

Ducks and Geese

Hackney and Hackney (1976) reported on the nesting habitat of the Mottled Duck in Mississippi marshes. A habitat suitability index model for Mottled Ducks was presented by Rorabaugh and Zwank (1983). Parkin and Rockwell (1988) discussed evidence of former allopatry between the two color phases of the Lesser Snow Goose.

Sandhill Cranes

J.M. Valentine and Noble (1970) reported on a Mississippi Sandhill Crane colony. The 1970 population was estimated at 30-40 birds. The author cited several reasons for colony endangerment: pine plantations, drainage, and human encroachment. Aldrich (1972) described a new subspecies of Sandhill Crane from Mississippi and compared it to the Florida Sandhill Crane. J.M. Valentine, et al. (1976) discussed the approved recovery plan for Mississippi Sandhill Cranes. Also included was general information on the life history, habitat, and conservation of the species. The U.S. Department of Interior, Fish and Wildlife Service (1980f) prepared a report on the status of the Mississippi Sandhill Crane. Information on their range, habitat, ritual dances, reproduction, and conservation was presented.

Zwank and Wilson (1987) reported on survival data and causes of mortality for captive, parent-reared Mississippi Sandhill Cranes over a six year period of annual releases at the Mississippi Sandhill Crane National Wildlife Refuges in Gautier and Ocean Springs, Mississippi. Over the six year period (1979-1985), 40 juvenile cranes and a one year old crane were released. Through December of 1986, 46% of those released had survived from 359 to 2141 days. Predation by wild dogs, bobcats, and raptors was the major cause of mortality. Zwank, et al. (1988) studied foraging differences between native and released Mississippi Sandhill Cranes. Pecan orchards and private farms were used most intensely by native cranes from September through December. Released cranes did not adopt the foraging patterns of native cranes.

Clapper Rails

R.E. Stewart (1952) surveyed salt marshes of the Gulf Coast for the distribution of Clapper Rails. Numbers ranged from common to abundant from east Texas to northwest Florida. Also included was information on nesting success, life history, and habitat. Holliman (1981) surveyed impacts to Alabama Clapper Rail habitat caused by damage from Hurricane Frederic in September 1979. Heard (1982b) reviewed and compared the feeding habits of five

Clapper Rail subspecies endemic to the marshes of the Atlantic and Gulf Coasts. There were no distinct differences in feeding behavior between subspecies; differences in diet reflected the type of marsh habitat. The author also discussed taxonomic uncertainties concerning the Clapper Rail subspecies.

Least Terns

J.A. Jackson (1976) reported on the nesting ecology of Least Terns along the Gulf Coast of Mississippi. Toups (1976) provided a brief history of Least Tern conservation along the Mississippi Coast. J.A. Jackson and Schardien (1976*) provided a status report on Least Tern populations in Mississippi. Gunter (1982) reported on the death of Least Tern chicks at Gulfport, Mississippi in 1980 due to air temperatures that reached 107°F.

Black Skimmers

Portnoy (1978) surveyed Black Skimmer populations on Horn and Petit Bois Islands. Modlin (1986) provided a general information article on the feeding, nesting, and distribution of Black Skimmers along the Atlantic and Gulf Coasts, specifically mentioning Mobile Bay, Alabama.

Red-cockaded Woodpeckers

J.A. Jackson (1971) reported on the distribution and taxonomy of the Red-cockaded Woodpecker, and also discussed the status of the species. J.A. Jackson (1977) prepared a report on the identification of cavities in pine trees which are used by Red-cockaded Woodpeckers for nesting. The purpose of the report was to aid wildlife managers in verifying the presence of the species in a particular area.

Miscellaneous Species

J.C. Jones (1940) studied the diet of the American Coot. Laboratory analysis of stomach contents showed a diet that consisted of various plants, mainly pondweeds, sedges, algae, and grasses. Insects and mollusks were a part of the summer diet. Huntington (1952) compared northern and southern populations of the Purple [= Common] Grackle (*Quiscalus quiscula*). The author analyzed bill and wing lengths, migration and invasion routes, various adaptations to climate, and width of integration zones. Gunter (1973, 1975) provided information on the mass movement of Blue Jays in coastal Alabama, Mississippi, and Louisiana in 1972.

Gunter and Burke (1977) reported on the status of the Northern Gannet in the Gulf of Mexico and described the migration route. The Eastern Peregrine Falcon Recovery Team (1979) proposed a restoration project for new self-sustaining populations of Peregrine Falcons in the eastern United States; cost projections and management considerations were included. Stroud and Lange (1983) reported on a die-off of 2,500 Common Loons along the Gulf Coast of Florida, Alabama, and Mississippi between January and April, 1983. High levels of parasites were found in the tissues of the dead loons, and the mercury and cesium levels were higher in the dead loons than in the control group. The authors speculated that high levels of metals may have weakened the birds, allowing parasite invasion, which resulted in their death.

An anonymous author (Anonymous, 1983a) reported the first sighting of a Manx Shearwater on Santa Rosa Island. Another anonymous author (Anonymous, 1983c) reported on the possible nocturnal migration of Eastern Kingbirds from Gulf Breeze, Florida. C.M. Johnson and Baldassarre (1988) studied the ecology of overwintering Piping Plovers in coastal Alabama. A total of 90% of their time was spent foraging. Tidal height was negatively correlated with foraging. A total of 63% returned the following year (1984-1986).

Multispecies Ecological Studies

Waterfowl

Bent (1923, 1925) reported on the life histories of waterfowl of the order Anseres [= Anseriformes]. Included was information on the habits, distribution, and migration of ducks, geese, and swans, along with descriptions of eggs, young, and adults. Particular mention was made of those species found along the Gulf Coasts of Mississippi, Alabama, and Florida. A.C. Martin and Uhler (1951) studied the diet of game ducks in the United States and Canada. The Gulf Coast region was one area of study. Outlines, descriptions, and illustrations of food items were provided, along with suggestions on the propagation of waterfowl foods and the development of feeding grounds. Rond (1956) compiled information on the ecology and biology of water and game birds, which included the Gulf Coast area. A description of each species and their habitat and nesting colonies was presented, as well as data on predators, wintering areas, and abundances. Clapp, et al. (1982) reported on the biology and ecology of waterbirds of the order Anseriformes from the Gulf of Mexico: ducks, swans, geese, brant, wooducks, widgeons, gadwalls, shovelers, scaup, eiders, and scoters.

Shorebirds and Seabirds

Sperry (1940) studied and compared the diet of several shorebirds: woodcock, snipe, knot, and dowitchers. A systematic breakdown of each species' diet was provided. Nelson (1962) censused the gulls and terns of the Mississippi Coast, and provided notes on flocking behavior as well. J.A. Jackson, et al. (1978*) compiled data on the nesting distribution of Black Skimmers, Royal Terns, Least Terns, Common Terns, Gull-billed Terns, and Laughing Gulls. Clapp, et al. (1982) reported on the distribution, abundance, food habits, breeding, and ecology of the following orders of marine birds of the southeast United States and the Gulf of Mexico: Gaviiformes (loons), Podicipediformes (grebes), Procellariiformes (albatross, fulmars, petrels, shearwaters, storm-petrels), and Pelecaniformes (tropic-birds, frigatebirds, cormorants, gannets, boobys, and pelicans). Recommendations for future research, as well as individual bibliography on each species, was also provided. Clapp, et al. (1983) provided similar information on the Charadriiformes: phalaropes, gulls, terns, noddys, and skimmers. Clapp and Buckley (1984) censused the seabirds of the southeastern United States to provide the status of each species. Loss of habitat due to coastal development and human disturbance were cited as the principal hazards to the breeding populations.

Wading Birds

Ohlendorf, et al. (1977, 1979) studied the relationship between the presence of organochlorine and the thinning of eggshells in Anhingas and other wading birds. Eggs were collected from 50 locations in the eastern United States in 1972 and 1973. Occurrence of pesticide residues was highest in eggs collected from the Great Lakes and lowest in the Gulf Coast region. Among species, the highest residue level was found in the eggs of Great Blue Herons, Wood Storks, Black-crowned Night Herons, and Great Egrets; lowest levels were found in the eggs of White Ibises, Least Bitterns, Green Herons, and Yellow-crowned Night Herons.

Marsh Birds

Bent (1926) reported on the life histories of three orders of marsh birds: Odontoglossae [= Phoenicopteriformes], Herodiones [= Ardeiformes], and Paludicolae [= Gruiformes]. Although somewhat outdated, this report may be useful for general information on descriptions, distributions, life histories, and habitats of those species found in the Gulf Coast states. Low and Mansell (1983) compiled a general book on North American marsh birds. A total of 52 species were examined, many of which inhabit Gulf Coast marshes. General ecological information and descriptions were provided for each species.

Endangered Species

A list of the rare and endangered birds of Mississippi was compiled by J.A. Jackson (1975b). P.A. Buckley and Buckley (1976b) discussed the conservation of colonially nesting

waterbirds designated as threatened. The author listed the types of disturbances that are potentially dangerous to nesting areas, and provided guidelines for the management of nesting sites.

Kale (1978) edited a volume on the rare and endangered birds of Florida; references were provided for each of the 72 taxa of birds appearing on the FCREPA's list. J.A. Jackson, et al. (1979), and J.A. Jackson (1984b) reviewed the status of the endangered or threatened bird species at Gulf Islands National Seashore, and provided management recommendations for each of the following species: Brown Pelican, Double-crested Cormorant, Reddish Egret, Black-crowned Night Heron, Mottled Duck, Bald Eagle, Northern Harrier, Osprey, American Kestrel, Merlin, Peregrine Falcon, Snowy Plover, Gull-billed Tern, Least Tern, Burrowing Owl, and Red-cockaded Woodpecker.

General Studies

Lowery (1945) provided an in-depth discussion on the effects of various weather conditions on the trans-Gulf, spring migration of birds from the Yucatan Peninsula in Mexico, to various "hiatus" sites along the Gulf Coasts of Louisiana, Alabama, Mississippi, and Florida, before proceeding further inland. Weber (1975) proposed a study to compare avian community ecology between mainland and insular groups in Mississippi.

F.G. Buckley and Buckley (1980) contrasted two types of seabird feeding habitats: neritic and pelagic. In addition, the authors discussed the ecological and evolutionary significance of breeding habitat selection by seabirds. Some of the topics covered included the concept of habitat selection, variability in habitat selection, competition, predation, behavioral interactions, and morphological determinants.

Surveys, Species Lists, Inventories

Colonial Nesters

J.M. Valentine (1969) conducted an inventory of colonially nesting birds, and provided a description on their nesting environment as a part of a design management program to improve nesting environments. A protection program was also described. Portnoy (1977a, b; 1981) surveyed colonial waterbird populations along Gulf Coast wetlands and islands from Sabine Pass, Texas to Mobile Bay, Alabama. A total of 168 seabird and wader colonies were located. Important nesting areas were mapped according to wetland habitat type. The most abundant species in decreasing order were: Louisiana Heron, Snowy Egret, Cattle Egret, White Ibis, Little Blue Heron, Great Egret, Laughing Gull, and Sandwich Tern. Information on the breeding activity of all species was included as well. An update on wading and seabird colonies of coastal Louisiana and Mississippi was provided by C.E. Keller, et al. (1984). Sites located by Portnoy (1977a, b; 1981) were checked, and additional areas were searched for new colonies. A total of 188 active colonies were observed. The location, species composition, habitat, and overall estimate of colony size were recorded for each colony.

Florida

Several bird checklists are available for areas in northern Florida: Pensacola (N.A., 1969), Escambia County (Florida Audubon Society, 1970), Fort Pickens (Florida Audubon Society, 1974a), and Escambia and Santa Rosa Counties (Florida Audubon Society, 1974b).

Weston (1965) provided a compilation of previously published material on the birdlife of northwestern Florida. Brief accounts of 336 species, along with a discussion of the topography and climate, were included. Fichter (1971) wrote on the birds of Florida, including general information on the biology and life history of 23 groups.

A beginners' guide to the bird species common to Gulf Islands National Seashore was compiled by Shea (1971*). Further information on the avifauna of Gulf Islands National Seashore is available on file at the Gulf Breeze Unit in Florida. One file is a compilation of total number of sightings on a given day during the 1970's and 1980's. The other file contains

birds in alphabetical order, listing the species' name, location, date, time, weather, description, behavior, and illustrations.

Mississippi

Burleigh (1944) described the avifauna of Mississippi's Gulf Coast, providing information on the seasonality and nesting locations of Southern Bald Eagles, Marsh Hawks [= Northern Harriers], American Osprey, Duck Hawks [= Peregrine Falcons], and Eastern Pigeon Hawks [= Merlins]. Weber (1977) compiled a checklist of birds observed at the Mississippi Unit of Gulf Islands National Seashore. Toups and Jackson (1987) provided an annotated species list of the birds found along the Mississippi coast. A total of 357 species were noted.

Gulf of Mexico

Bullis (1952, 1954) provided a species list of birds migrating across the Gulf of Mexico from Yucatan, Mexico to the Florida panhandle. Lowery and Newman (1954) listed bird species of the Gulf of Mexico divided into three groups: offshore birds, birds of the coast, and land birds over the open Gulf. C.D. Duncan and Harvard (1980) listed the abundances, frequencies, and seasonality of pelagic birds of the Gulf of Mexico.

MAMMALS

Aquatic Mammals

Dolphins

M.C. Caldwell, et al. (1965) provided notes on observations of captive Atlantic bottlenosed dolphins (*Tursiops truncatus*) taken from the northern Gulf of Mexico. Leatherwood (1975) reported on the feeding behavior of *Tursiops* in Mississippi Sound. They utilized seasonally abundant species such as menhaden, mullet, cigar minnows, silver eels, and miscellaneous shrimp. Due to their limited range and short-term movements, plasticity in food habits is necessary for survival.

Leatherwood, et al. (1978) evaluated an aerial census technique for bottlenosed dolphins. Strip sampling and line-transect estimates were more consistent among different observers than were quadrat sample estimates. Results for Mississippi Sound in 1974 were 1342 ± 847 ; and in 1975 were 879 ± 368 . J.E. Reynolds and Odell (1979) conducted research on the population biology of bottlenosed dolphins in Florida waters. A total of 3269 dolphins in 649 separate herds were spotted in aerial surveys along the west coast of Florida from Fort Myers to Pensacola.

Whales

D.K. Caldwell, et al. (1956) provided ecological notes on the killer whale, *Orcinus orca*, in the northeastern Gulf of Mexico. Gunter and Christmas (1973) reported on the first record of a finback whale (*Balaenoptera physalus*) stranding in Mississippi. It ran ashore on Ship Island, and subsequently died. Gunter and Overstreet (1974) later corrected the identification of the whale identified in Gunter and Christmas (1973) as a sei whale, *Balaenoptera borealis*. Also included in the report was the landing of a four month old female dwarf sperm whale (*Kogia sinus*) along the Mississippi coast in Biloxi. This was only the third reported sighting of this species in the Gulf of Mexico, and the first reported sighting from the Mississippi coast.

Manatees

Moore (1975) provided distributional information for Florida manatees between 1941-1952, including maps. Collard, et al. (1976) reported on the sighting of the endangered Florida manatee, *Trichechus manatus* in Pensacola Bay. Gunter and Corcoran (1981) reviewed the taxonomy and distribution of *T. manatus*. A live manatee was captured in the harbor at Gulfport, Mississippi in 1979.

Seals

Gunter (1978) reported on the status of seals in the Gulf of Mexico via records of live or dead reported specimens. The only seal native to the Gulf of Mexico was the West Indian seal (*Monachus tropicalis*), which has been extinct since the 1950's. The author provided accounts of the species found along the Gulf Coast.

Terrestrial Mammals

Beach Mice

Genetics/Evolution

H.G. Anderson (1960) reported on the morphological variations encountered in several subspecies of *Peromyscus polionotus*. Borthwick and Grow (1968) studied genetic changes in *Peromyscus polionotus leucocephalus* through electrophoretic analysis of serum proteins. The analysis only defined sexual dimorphism, not the evolution of separate subpopulations. However, Bowen (1968) reported the existence of partial reproductive barriers between several subspecies of *P. polionotus*, indicating that morphological differences were more than superficial variations in pelage. The author concluded that evolution was progressing toward speciation.

Griswald (1970) studied serum protein patterns in the Santa Rosa Island beach mouse population. This population is thought to have been established in relatively recent geological times by the founder principle from a small population. Stullken (1972*) reported on a distinct race of beach mouse, *P. polionotus albifrons*, found on Ono Island, Alabama. The author compared the new race to the parent race inhabiting Alabama Point. Further genetic studies on the Santa Rosa Island beach mouse were conducted by an anonymous researcher (Anonymous, N.A.d). Successive changes in the mouse populations were found to coincide with several Pleistocene shorelines.

Behavioral Studies

Under laboratory conditions, M.H. Smith (1967) studied mating behavior of *P. polionotus* collected from Santa Rosa Island. Westergrad (1977) compared behavior between two subspecies of beach mouse, *P. polionotus polionotus* and *P. polionotus leucocephalus*. She found no significant difference in aggressive behavior; however, there was a significant difference in grooming behavior between the two subspecies. The author speculated that grooming for longer periods of time kept the fur of *P. p. leucocephalus* whiter, in order to blend with the sand and avoid predation.

Population Dynamics

Blair (1946) provided an estimate of the total number of beach mice (subspecies *leucocephalus*) on Santa Rosa Island through field observation, live trapping, and mark-recapture. The author reported that conditions for differentiation of subspecies was favorable on Santa Rosa Island due to the small population size, geographic isolation, and selection pressure against predators due to the concealing coloration of the mice. Approximately 12,000 individuals were estimated between Winter 1941 and Spring 1942. Further research by Blair (1951) provided information on the population ecology of *P. polionotus leucocephalus* on Santa Rosa Island. Sex ratios varied seasonally due to immigration. Population density also varied seasonally. Predation was noted as the most important factor affecting survival. M.H. Smith (1971) studied the role of food in the population ecology of *P. polionotus*.

Status/Management Studies

Humphrey and Barbour (1979, 1981) discussed the status and habitat of the subspecies of *Peromyscus polionotus* in Florida. The Perdido Key beach mouse, *P. p. trissyllepsis* and the Choctawhatchee beach mouse, *P.p. alloparys* were described as being threatened by beachfront development. There was no mention of the status of the Santa Rosa Island beach mouse (*P.p. leucocephalus*) in either report. Wolfe (1981) however, focused exclusively on the status of the Santa Rosa Island subspecies. The author reported a population density of 5.2 ± 1.7 mice per hectare of suitable habitat. Because mice were present in all areas sampled, and fifty percent of all females caught were pregnant, the author concluded that the status of this subspecies was stable.

Holliman (1982, 1983) documented the distribution of the Gulf Coast beach mice, *P.p. ammobates* and *P.p. trissyllepsis* in Alabama. Populations of *P.p. ammobates* were found from Fort Morgan Peninsula to Romar Beach, while *P.p. trissyllepsis* was found at only one site at Florida Point on Perdido Key. Population densities for *P.p. ammobates* were estimated at 6.5 mice/hectare, and only one *P.p. trissyllepsis* was caught from an area of 25.2 hectares. In addition, the author provided a description of the vegetation, and a discussion of the factors responsible for the waning numbers of beach mice in Alabama.

Meyers (1983) reported on the status and microhabitats of the various subspecies of the Gulf Coast beach mice, providing management recommendations as well. He found microhabitat conditions at Gulf Islands National Seashore unsuitable due to erosion by the Hurricane Frederic in 1979, and disturbance by off-road vehicular traffic in the foredunes. He recommended that *P.p. ammobates* and *P.p. alloparys* be classified as threatened, and suggested the purchase of dune ecosystems as preserves. The author also highly recommended a program to educate beach users on the needs of this species.

Feral Hogs

Brent and Corcoran (1977) headed a group study conducted by an environmental impact analysis class at the University of Southern Mississippi which examined the effect of feral hogs on the stability of Horn Island, Mississippi. Baron (1979a, b) studied the effects of feral hogs on the vegetation of Horn Island. She found that hog activity was not harmful to dune vegetation, and that there was no disruption of the ecological dynamics of the island. Singer (1981) surveyed the effects of wild pig population in all National Parks. Less than 60 pigs were recorded for Gulf Islands National Seashore, with minimal effects on vegetation.

Nutria

Griffo (1957) reported on the status of nutria (*Myocastor coypus*) in Florida. In Escambia County 15 individuals were recorded. Wolfe (1983) studied the ecology of nutria in Mississippi. They were found on Cat, Ship, Horn, and Petit Bois Islands. The author discussed basic management techniques, and recommended monitoring the populations of the Mississippi barrier islands.

Bats

L.N. Brown (1985) documented the first observance of the little brown bat, *Myotis lucifugus*, in Okaloosa County. In 1986, L.N. Brown reported on the observance of a silver-haired bat, *Lasiorycteris noctivagans*, in Escambia County.

Miscellaneous

Couvillion, et al. (1986) reported on the distribution of white-tailed deer (*Elaphaphora schneideri*) in the southeastern United States between 1962 and 1983; Escambia County was included in the survey. Maehr and Brady (1986) studied the food habits of bobcats (*Lynx rufus*) in Florida. There were no regional, sexual, or age differences found in food habits. Ritke and Kennedy (1988) studied cranial variations in raccoons (*Procyon lotor*) in relation to environmental variables. Larger raccoons were found in the northwest United States, while smaller ones were found in the southeast. In general, larger raccoons inhabited areas characterized by high seasonality and low primary productivity. Portions of the Gulf Coast were included in the study.

General Surveys and Species Lists

Several general surveys, checklists, and/or species lists of mammalian fauna have been compiled for the individual Gulf Coast states: Louisiana (Lowery, 1943, 1974); Mississippi (Wolfe, 1976; Wolfe and Simons, 1985); Alabama (Holliman, 1963; Linzey, 1970); and Florida (Sherman, 1952; J.C. Moore, 1953; Layne, 1970).

Gunter (1954) surveyed the marine mammals of the Gulf of Mexico. Notes on the biology and distribution of species from the orders Pinnipedia, Sirenia, and Cetacea were included. B. Russell and Cupp (1977) compiled an extensive checklist of the mammals found within the boundaries of Gulf Islands National Seashore in Florida. Schmidly (1981) provided a synthesis of available data and literature on cetaceans and pinnipeds of the southeastern United States and the Gulf of Mexico. A total of 33 species (29 cetaceans and 4 pinnipeds) were documented in the study area. Information on distribution, abundance, status, seasonal movements, and life history was included, as well as reported sightings and strandings.

ESTUARINE ECOLOGY

Ecological Processes

Water/Soil Chemistry

A.T. Simmons (1972) conducted a chemical analysis for nitrogen and phosphorus in the waters and sediments of Bayou Texar. The author reported Carpenter Creek as a primary source of nitrogen (except nitrates), and noted a significant exchange of phosphates in the water column and adsorbed to sediments. Andren (1973) compared the presence of mercury in three Gulf of Mexico estuaries. The author found 4.5×10^3 kg of mercury had settled in Mobile Bay estuary. May (1973b) studied the seasonality of oxygen depletion in Mobile Bay, Alabama. During the summer, the lack of dissolved oxygen drives fish and crustaceans, found near the bottom, shoreward. Although the problem has occurred historically, industrial and domestic pollutants have increased the oxygen depletion in the recent past. The muds of a mesotrophic bayou in Pensacola were analyzed by Moshiri and Crumpton (1978) for redox potential, pH, organic content, and bacterial numbers over a four-month period. Based on their findings, the authors concluded that the redox status of the deeper sediments could possibly reveal long-term trends. Moshiri, Crumpton, and Blaylock (1978) speculated that the cause of fish kills in Bayou Texar was due to dinoflagellates, rather than stress from low dissolved oxygen. A nationwide review of oxygen depletion and eutrophication of coastal waters was provided by Rabalais, et al. (1985). The dissolved oxygen for Mississippi Sound, recorded at <2 mg/l in the summer, was very low, while Biloxi Bay was recorded at 4 mg/l, which was acceptable.

Nutrient Cycling

Bayou Texar was sampled by Hannah, et al. (1973) for major nutrients. The researchers found evidence to support the hypothesis that the water from Carpenter Creek has an effect on the phytoplankton productivity in Bayou Texar. Green (1973) conducted a fourteen-month survey of nitrogen fixation in two salt marshes along the northern Gulf Coast of Florida. She found that the old stems in the *Spartina* zone had the highest levels of fixation in the marsh. Moshiri, et al. (1974, 1976) studied various aspects of nutrient cycling in Bayou Texar. Moshiri, et al. (1974) cited several sources of nutrient input: Carpenter Creek, stormwater runoff, lawn fertilizer, and sewer overflow. The bayou was described as approaching eutrophication, as indicated by highly fluctuating oxygen and primary productivity patterns. Several recommendations were offered to improve circulation and flushing. Moshiri, et al. (1976) related sediment/water nutrient exchange to bacterial activity. Moshiri (1978) studied water column-to-sediment phosphate exchange in Bayou Texar and Mulatto Bayou. The author found the dissolved oxygen (DO) level in Mulatto Bayou to be constantly low, and, in addition, found a negative correlation between DO and dissolved phosphates (PO_4^{3-}). On the other hand, the DO levels in Bayou Texar were seldom low, and there was no significant correlation between DO and dissolved PO_4^{3-} . Moshiri, Crumpton, and Aumen (1979) conducted further hydrological studies in Bayou Texar. They found a seasonal pattern of high, dissolved glucose levels. At the upper end of the bayou, there was a strong correlation between DO and carbon fixation rates. Frederickson and Reformat (1985) compared microbial biomass, community structures, and community metabolism of sediments collected from the rhizosphere of *Spartina alterniflora*, and cores collected from a nearby, non-vegetated tidal flat. Results showed that microbial biomass, community structure, and community metabolism were heterogeneous within sediments less than 15 meters apart. The authors also found that the benthic microbial communities showed substrate preferences for lipid biosynthesis.

Productivity

A preliminary look at the seasonality of the standing plankton crop in Mississippi Sound was provided by Mulkana (1966). The author found an increase in standing biomass and reproductive activities in the warmer months. In 1967, Mulkana looked at the protein content of the standing nanoplankton biomass of Mississippi Sound. He found no marked seasonal variation in productivity, except for small blooms in June and late July. Mulkana (1968), and Mulkana and Abbott (1973) measured the nutrient content of the standing plankton

biomass of Mississippi Sound for a full year to document seasonal changes in proteins, carbohydrates, lipids, and caloric content. Samples were broken down into net plankton and nanoplankton. The authors found a seasonal trend in biomass, with an increase in warmer weather. Although protein and lipid levels were higher for net plankton samples on a unit-weight basis, total nutrients available from nanoplankton were substantially higher than net plankton on a unit-area basis.

J.K. Adams (1972) compared and contrasted phytoplankton primary productivity in two geologically and morphometrically similar Florida bayous, Mulatto Bayou and Catfish Basin. The main differences between the two were that Mulatto Bayou received waste discharges and had been dredged, while Catfish Basin was free of human impacts. Hannah (1972) examined the relationships between organic production and dynamics of ammonia, nitrate, and phosphate in Bayou Texar. Other factors considered included light penetration, temperature, and dissolved oxygen. Moshiri, et al. (1978) sampled Bayou Texar for a one-year period for nitrates, ammonia, phosphates, and total organic carbon in the water column, phytoplankton, and zooplankton. The authors found a negative correlation between salinity and nitrates, and between ammonia and dissolved oxygen. A positive correlation was found between organic carbon and ammonia.

Benson (1981) discussed freshwater inflow into estuaries in the Gulf of Mexico. Decreases in the quality of freshwater inflow has reduced estuarine production on both the Florida and Texas coasts. Cross and Williams (1981) edited the proceedings of a symposium on the variability of freshwater inflow into estuaries. Several problems associated with freshwater inflow were addressed: reduction in volume due to inland water diversions, modifications of seasonal flow regimes, the reduction in water quality, and alteration of sediment and nutrient content. Potential solutions and recommendations were also offered.

General Ecology

Data on the geology, soils, water, plant zonation, and succession of the tidal marshes of the Gulf of Mexico were presented by Kurz and Wagner (1957). Sampling stations were located between Pensacola and St. Marks, Florida. Hopkins (1975) studied the ecology of Escambia Bay and its adjacent waters. Biological, chemical, and geological parameters were examined. There was a correlation found between chemical parameters and phytoplankton density and biomass. High turbidity in Escambia Bay greatly influenced the ecology of the area. Using available literature, Daiber (1982) provided a detailed look at the biology and natural history of tidal marsh animals. The Gulf of Mexico area was mentioned in general, as well as specific sites in the area.

Distributional Studies

Woodmansee (1962) compiled distributional information on the planktonic diatoms of the genus *Rhizosolenia* in Biloxi Bay and Mississippi Sound. Diatoms were transported seaward on surface currents and landward on bottom currents. Maximum numbers were found at intermediate salinities in Biloxi Bay. Swingle (1973*) reported on the distribution and abundance of commercial invertebrates and fishes from Mississippi Sound to the head of Mobile Bay. The marsh clams increased in number in the less saline waters at the head of Mobile Bay. Keel and Cook (1975) isolated the bacterial organism, *Vibrio parahaemolyticus*, from Biloxi Bay. This particular organism causes food poisoning, and can be concentrated by shellfish. Roszak-MacDonell (1982), and Roszak-MacDonell and Hood (1982) studied the salinity and temperature ranges of bioluminescent bacteria along the northern Gulf Coast. Bacteria were isolated over a one-year period from sites between Pensacola Bay and Perdido Bay. Salinities ranged from 14 - 35 ‰, and temperatures ranged between 12° - 31° C.

Estuarine Pollution

Pesticides (Man-made)

Organochlorines

DDT

Crocker and Wilson (1965) applied DDT to a tidal marsh ditch, and noted the effects on the flora and fauna. They observed a swift uptake in vegetation. Within the first three days there was 83% animal mortality (mainly fish); there was no significant mortality observed in fiddler crabs and snails. Using water collected from Santa Rosa Sound, A.J. Wilson (1976) studied the effect of suspended material on the measurement of DDT in estuarine water. Results demonstrated the problems that could be encountered when monitoring estuarine water for DDT residues.

Mirex

Two studies were conducted concerning the effects of mirex on selected estuarine organisms. J.I. Lowe, et al. (1971) found high mortality rates for juvenile brown shrimp, grass shrimp, juvenile blue crabs, and fiddler crabs. However, mirex was not toxic to juvenile pinfish. Tagatz, Borthwick, and Forester (1975) attempted to determine the seasonal effects of mirex that had been leached into saltwater via fire ant bait traps. In this study, the authors found mirex to be toxic to pink shrimp, grass shrimp, and blue crabs, but not to sheepshead minnows. The greatest amount of leaching occurred in the summer months.

Tagatz (1976) conducted laboratory experiments to determine the effects of mirex on predator-prey interactions in the estuarine environment. The toxin significantly effected the survival of grass shrimp after one, two, or three days of predation by pinfish.

Kepone®

Through the use of laboratory bioassays, Bahner, et al. (1977) studied the accumulation, transfer, and loss of Kepone® in several estuarine organisms. Kepone® was bioaccumulated by oysters, mysids, grass shrimp, sheepshead minnows, and spot from concentrations as low as 0.023 µg/l of seawater. Similar results were found by Schimmel and Wilson (1977) using grass shrimp, blue crabs, sheepshead minnows, and spot. These authors, however, looked at acute toxicity levels over a 96-hour period, and calculated average bioaccumulation factors (the concentration of Kepone® found in tissues divided by the concentration of Kepone® measured in seawater) for each species. The two fish species had the highest numbers (sheepshead minnows, 1548 and spot, 1221), while the grass shrimp averaged 698, and the blue crab only 8.1.

Estuarine bacteria were the subject of Kepone® toxicity tests conducted by Mahaffey, et al. (1982). Gram-positive organisms showed higher sensitivity than those that were gram-negative. Kepone® was shown to reduce the number of colony-forming units at all concentrations; under aerobic conditions however, the toxin had no effect on anaerobic microorganisms. O'Neill, et al. (1985) studied the effects of lugworms and seagrass on the distribution of Kepone® through sediment and water. Through laboratory experiments using continuous flow, sediment/water systems, the authors found that lugworm activity increased Kepone® concentration in sediments, while it decreased concentration in the water. The presence of seagrass did not have a significant effect on the concentration of Kepone® in water.

Miscellaneous

Parrish, Patrick, et al. (1973) conducted acute toxicity tests using dieldrin, a chlorinated hydrocarbon insecticide, on oysters, pink shrimp, grass shrimp, and sheepshead minnows. The rate of uptake for the toxin was also examined. The authors found dieldrin acutely toxic to all of the test organisms. A series of reports on the effects of various other pesticides on species similar to those mentioned in Parrish, Patrick, et al. (1973) are available, as well: hexachlorobenzene (Parrish, Cook, and Patrick, 1974); endrin (Schimmel, Parrish, et

al., 1974); chlordane (Parrish, Schimmel, et al., 1976); heptachlor (Schimmel, Patrick, and Forester, 1976a); toxaphene (Schimmel, Patrick, and Forester, 1977a). All of the chemicals previously mentioned, except hexachlorobenzene, proved highly toxic to all test organisms.

Schimmel, Patrick, and Forester (1977b) conducted flow-through, 96-hour bioassays of BHC and lindane on several estuarine organisms; in addition, two bioconcentration studies using BHC on oysters and pinfish were conducted. The authors found lindane and BHC to be acutely toxic to all test organisms at low concentrations. However, neither pesticide was readily bioconcentrated or retained in tissues for as long as other pesticides that had been previously tested. Another pesticide, endosulfan, was tested in a similar manner by Schimmel, Patrick, and Wilson (1977), with similar results.

Tagatz and Ivey (1981) conducted acute toxicity tests on both field- and laboratory-reared estuarine benthic communities using the insecticide fenvalerate. Based on their results, the authors concluded that even very low concentrations of fenvalerate could have an adverse effect on benthic communities, as well as those organisms found in the water column. Tagatz, Gregory, and Plaia (1982) conducted an experiment similar to the one previously mentioned, using the insecticide chlorpyrifos. They concluded that concentrations of less than 0.1 part per billion of chlorpyrifos in water could have a serious impact on saltwater ecosystems.

Organophosphates

Malathion

Tagatz, Borthwick, Cook, and Coppage (1974) studied the effects of the mosquitocide malathion on a salt marsh area at Pensacola Beach, Florida. Mortalities were observed in blue crabs, pink shrimp, and grass shrimp. Only trace amounts existed in the water after 24 hours. Bourquin (1975, 1977a) conducted studies on the degradation of malathion by salt marsh bacteria. The author found seven isolates that exhibited the ability to degrade malathion as a sole carbon source. Using an artificial salt marsh environment in the lab, Bourquin (1977b) conducted further studies on malathion degradation by bacteria, with results similar to prior experiments.

Parathion

Bourquin, et al. (1977), using methyl parathion, proposed an artificial laboratory system to test microbial interactions with pollutants in the salt marsh environment. Farr (1977, 1978c) found sublethal doses of methyl and ethyl parathion altered behavior in grass shrimp enough to make them more susceptible to predation by Gulf killifish. He postulated that this impairment in antipredator behavior could cause serious changes in a multi-prey community, thereby altering community structure and trophic relationships.

Miscellaneous

Schimmel, Hamaker, and Foester (1979) conducted toxicity and bioaccumulation studies using the insecticides EPN and leptophos on selected estuarine organisms. Results indicated that acute toxicity of either insecticide at concentrations $\geq 1.0 \mu\text{g/l}$ could have a more adverse effect on crustaceans and fish than could either chronic toxicity or bioaccumulation of the pollutant.

Creosote

Borthwick and Patrick (1982) conducted creosote toxicity studies using oysters, mysids, pink shrimp, and sheepshead minnows. In addition, the authors set out to determine the biological and chemical half-life of creosote in seawater. Mysids were found to be most sensitive to the toxin, and the half-life of creosote under experimental conditions was less than one week. The effects of creosote on macrobenthic community structure were assessed by Tagatz, Plaia, et al. (1983). The abundance of annelids, echinoderms, and arthropods was significantly less in aquaria contaminated with $177 \mu\text{g/g}$ creosote, than controls. Mollusks were found to be more resistant to creosote than those species of the other representative phyla.

Various

Ahearn, et al. (1977) sampled surface films in Escambia Bay to study microbial interactions with pesticides. Tagatz, Ivey, et al. (1979) studied the effects of the insecticide Sevin on experimental estuarine communities. The toxin was added in various concentrations (1.1 $\mu\text{g/l}$, 11.1 $\mu\text{g/l}$, and 103 $\mu\text{g/l}$) to aquaria. The average number of species was less in aquaria with 11.1 $\mu\text{g/l}$ and 103 $\mu\text{g/l}$ concentrations. Rubinstein, et al. (1980) developed a flow-through toxicity screening test to detect polluted dredge spoil sediments before disposal in the estuarine environment.

Schimmel, Garnas, et al. (1983) conducted acute toxicity tests, as well as bioconcentration and persistence studies, using AC 222 and 705, benthocarb, chlorpyrifos, fenraterate, methyl parathion, and permethrin. The authors ranked each toxin according to toxicity, solubility, and persistence. Results of the acute toxicity tests showed that mysids were consistently most sensitive, while sheepshead minnows were least sensitive. The results of depuration tests showed that oysters could reduce concentrations of each insecticide to nondetectable levels within one week.

Van Veld and Spain (1983) studied the degradation rates of three synthetic organic compounds: p-nitrophenol, methyl parathion, and p-cresol. Three types of laboratory test systems were employed: shake flasks with water, shake flasks with water and sediment, and intact sediment/water cores (eco-cores). The resulting degradation rates were compared and contrasted. Also included was a discussion on a first order kinetic model used to describe the degradation of the three compounds. Spain and Van Veld (1983) examined how microbial communities adapted to a faster degradation of xenobiotic compounds when pre-exposed to the compound in eco-cores.

Tagatz and Deans (1983) compared community structure between field- and laboratory-developed macrobenthic assemblages. Species density, diversity, and dominance were similar in both colonized boxes in the Fall, but not in the Spring. The authors concluded that, due to the similarity, laboratory assemblages could be used for laboratory toxicity studies.

Further investigations into the degradation rates of chemical pollutants were conducted by W.W. Walker, et al. (1985) using *in vitro* estuarine water and sediment/water systems.

Joslyn (1987) provided a thorough literature review of mosquito pesticides used in Atlantic and Gulf Coast National Parks.

Non-Pesticides (Man-made)

PCPs

Tagatz, Ivey, Moore, and Tobia (1977) reported on the effects of three concentration levels of pentachlorophenol (PCP) on the species composition of an estuarine community. The total number of individuals and species were significantly altered after exposure to 76 $\mu\text{g/l}$, compared to those at 7 $\mu\text{g/l}$, or to the control group. Borthwick and Schimmel (1978) conducted static toxicity tests using pentachlorophenol and related compounds on sheepshead minnow fry, prolarval pinfish, grass shrimp larvae, and developing eastern oyster embryos. Results indicated an extreme sensitivity of prolarval pinfish to sodium pentachlorophenol (Na-PCP). The authors concluded that PCP and the related compounds were toxic to the developmental stages of those organisms tested. Schimmel, Patrick, and Faas (1978) conducted flow-through toxicity tests using Na-PCP on grass shrimp, brown shrimp, longnose killifish, pinfish, and striped mullet. The uptake rates of Na-PCP for organisms that survived the toxicity tests, as well as uptake and depuration rates for eastern oysters, were also provided.

Tagatz, Ivey, and Tobia (1978) tested the effects of Dowicide® G-ST (79% sodium pentachlorophenate) on experimental benthic macrofaunal communities. The numerically dominant groups were mollusks, arthropods, and annelids, with the mollusks being most sensitive to the toxin. As a result of this, and previous studies, the authors concluded that

discharge of PCPs into natural waters could have a significant impact on colonization of substrate by benthic organisms, thereby impacting various ecological relationships among localized populations. A comparable study by Tagatz, Ivey, Gregory, and Oglesby (1981) provided similar results. In 1983, Tagatz, Deans, Plaia, and Pool reported on the recovery of experimental benthic communities after exposure to PCP, by comparing the numbers of individuals and species of organisms grown from planktonic larvae in contaminated versus non-contaminated aquaria. They found significantly fewer individuals and species immediately after exposure to PCP in the contaminated aquaria as compared to the control aquaria. Arthropods, chordates, echinoderms, and mollusks decreased in number, while annelids and coelenterates were unaffected. Seven weeks after exposure to PCP was discontinued, there was no difference found in total numbers of individuals and species between aquaria. PCP did not appear to have had a lasting effect on the aquaria with regard to recolonization.

PCBs

Several reports are available concerning the effects of various Aroclors® (polychlorinated biphenol formulations) on estuarine fauna. D.J. Hansen, Parrish, and Forester (1973) studied the effects of Aroclor® 1016 on American oysters, brown shrimp, grass shrimp, and pinfish. Nimmo, Hansen, et al. (1975) looked at the physiological effects of Aroclor® 1254 on similar estuarine organisms. Three estuarine species showed pathological changes at cellular and tissue levels after chronic exposure to the chemical. D.J. Hansen (1975) provided an overview of the effects of Aroclors® 1016, 1242, and 1254 on various estuarine organisms.

Bourquin, Kiefer, et al. (1975) tested bacteria and fungi taken from Pensacola Bay for sensitivity to PCBs. Fungi were not sensitive, while bacteria varied in their sensitivity to the pollutant. Bourquin and Cassidy (1975) elaborated further on the effects of PCBs on estuarine bacteria. Sensitive strains contained both gram-positive and gram-negative bacteria. They concluded that the inhibition of specific heterotrophic bacteria attached to organic detritus could inhibit the normal turnover of carbon in estuarine sediments. A.J. Wilson and Forester (1978) demonstrated the persistence of Aroclor® 1254 in the sediments and oysters of Escambia Bay following an accidental industrial leak. PCBs in oyster tissue decreased after the leak, and sediments had low amounts (<0.31 ppm) in 1970 and 1971.

NTA

Bourquin and Przybyszewski (1976, 1977) provided information on the distribution of estuarine bacteria capable of metabolizing nitrilotriacetate (NTA), a phosphate substitute used in detergents.

Fuels

Ahearn, Cook, and Crow (1981) studied inshore surface films from Escambia Bay for microbial activity. Oil production activities produced a shift toward carbon-utilizing forms. A selective effect on microfungi was noted, as well.

Spain and Somerville (1984) described the degradation of jet fuel by microorganisms, using laboratory experiments to simulate a field situation. In 1985, Spain and Somerville conducted further experiments on the degradation of the high density missile fuels, RJ-5 and JP-9 in a laboratory system. They found that the fuels resisted biodegradation, and that they were not toxic to microbial communities at concentrations of 400 mg/l. RJ-5, however, was toxic to the mysid, *Mysidopsis bahia*.

Tagatz, Plaia, and Deans (1985b) reported on the impacts of lime mud (a by-product of the oil drilling process), and its diesel oil component, on a field-colonized, macrobenthic community. Dominant phyla in decreasing order of abundance included: Mollusca, Annelida, Chordata, and Arthropoda. Mollusks and annelids were significantly affected.

Miscellaneous

Harriss, et al. (1971) studied the distribution of mercury in the estuaries of the northern Gulf of Mexico. The USEPA Surveillance and Analysis Division (1973) reported on the effects of thermal pollution on some of the flora and fauna of the lower Escambia River. Temperatures of 93° F were recorded for surface sediments 100 yards downstream from the point of discharge. Andren and Harriss (1973) studied the movement of mercury in the sediments of Mobile Bay, as well as the effects of mercury on fish. Olinger (1975) reported on the Escambia Bay Recovery Study, which was initiated due to the degraded condition of the Bay. Success of pollution abatement programs was due to the cooperation of academic institutions, industries, government agencies, and concerned citizens.

Livingston, Cripe, et al. (1976) attempted to determine a relationship between laboratory avoidance reactions of blue crabs and pinfish to stormwater runoff and pulp mill effluents. However, it appeared that factors other than pollution avoidance contributed to the field distribution of the test species. The authors stated that intraspecific and interspecific competition and predation, habitat alteration, and trophic response should be considered, as well. Tagatz and Tobia (1978) looked at the effects of barite on the development of a laboratory estuarine community. Fewer numbers of individuals and species developed in sand covered with barite, than in sand with no barite, or sand with a small proportion of barite. Annelids were significantly effected in all treatments, as compared to the control.

Tagatz, Ivey, Lehman, and Oglesby (1978) investigated the effects of drilling mud on laboratory communities developed from planktonic larvae, using sand as a control. Fewer individuals and fewer species resulted in the aquaria with drilling mud. Therefore, the authors concluded that the discharge of these polluted muds into the estuarine environment could affect the colonization of substrates by benthic animals. Tagatz, Ivey, and Oglesby (1979) reported the effects of biocides in drilling muds on macrobenthic communities in the laboratory. After seven weeks exposure, the abundances of chordates, mollusks, and annelids were significantly reduced.

Tagatz, Plaia, and Deans (1985a) reported on the effects of 1,2,4-trichlorobenzene (TCB) exposure via sediment and water on benthic communities in a laboratory setting. Concentrations of sediment-bound exposure of TCB were two orders of magnitude higher than waterborne exposure. However, the same types of organisms were affected, regardless of the mode of exposure. More recently, Elder and Dresler (1988) studied the bioconcentration of several polycyclic aromatic hydrocarbons (PAHs) in a nearshore estuarine environment. Although very little PAH was found in the water or sediments of the test sites, high bioaccumulation (10x) was found in mollusks at the test sites. Fluoranthene, pyrene, and phenanthrene were most accumulated.

Natural Pollutants

A brief note on red tide in Florida was written by an anonymous author (Anonymous, 1975) describing the September, 1974 outbreak between Panama City and Penscola. The dinoflagellate, *Gymnodinium breve*, was identified as the etiologic agent. Couch, Martin, et al. (1984) presented a system for determining the risks of infectivity and pathogenesis of an insect virus, *Baculovirus*, on a non-target species, the grass shrimp, *Palaemonetes vulgaris*, via dietary exposure. Results showed no evidence that experimental exposure of the virus to the grass shrimp caused infection or related pathogenicity. Couch (1985) described disease prevalences, and chronic diseases and disorders of oysters and fish in the Pensacola Bay system, the Mobile Bay system, and the Pascagoula Harbor portion of Mississippi Sound.

General Pollution Surveys/Research

Murdock (1955) evaluated the pollution conditions of the lower Escambia River. Butler (1966) reported on the toxic effects of 150 chemicals on fish, mollusks, crustaceans, and phytoplankton. Results indicated that mollusks and fish could concentrate and store organochlorines.

The Annual Report of the USDOIFWS Bureau of Commercial Fisheries Biological Laboratory (1966) emphasized the effects of synthetic organic pesticides on commercial fisheries. The USFWPCA (1968) provided the proceedings of the Alabama Public Meeting - National Estuarine Pollution Study. Odum (1968), and Coppage and Duke (1971) provided general information on the effects of various pesticides on estuarine organisms. The USEPA Southeast Water Laboratory (1971a) studied the effects of circulation on water pollution in Escambia Bay.

Walsh (1972) conducted a general survey of various types of pesticides, insecticides, and polychlorinated biphenols in estuaries. Schomer (1974) developed a systems model for the recovery of Escambia Bay after abatement of pollution sources. A general overview of the research activities of the USEPA Gulf Breeze Environmental Research Laboratory with regard to pesticides was provided by Duke (1974).

Ecological Surveys and Inventories

T.S. Hopkins (1969) compiled a technical report on Escambia River and Escambia Bay, which included physical, chemical, and biological information. The National Estuary Study conducted by the USDOIFWS (1970c) provided biophysical profiles, fishery data, and recreational information for Apalachicola Bay in Florida. The U.S. Fish and Wildlife Service provided a checklist of 712 benthic and pelagic species collected between 1961-1963 in Escambia Bay, Pensacola Bay, and Santa Rosa Sound (Cooley, 1970, 1978).

Results of an extensive estuarine inventory are available for the following Gulf Coast states: Louisiana (Barret, 1971; Perret, et al., 1971); Alabama (Crance, 1971; Swingle, 1971); and Mississippi (Christmas, 1973a; Christmas, et al., 1973). Information on the wildlife ecology, geology, hydrology, and history of each coastal area was provided.

Livingstone, et al. (1972) conducted a one-year study on the effects of dredging and advanced eutrophication on Mulat-Mulatto Bayou. An ecological characterization of the estuarine environment of Biloxi Bay and Mississippi Sound via remote sensing and surface monitoring techniques was edited by Christmas (1974). An environmental study of the estuarine and offshore waters of Alabama was conducted by Chermock, et al. (1974). Various physical and biological parameters were discussed. Information on the seafood industry, recreation, and the environmental impact of oil spills in the area was also mentioned.

A technical report on the restoration of Bayou Texar was compiled by Henningson, Durham, and Richardson, Inc. (1975). An evaluation of data collected by various agencies was discussed; also included was information on water quality, sources and nature of pollution, and corrective measures to be taken. An extensive assessment of estuarine and nearshore marine environments, in general, was edited by M.P. Lynch, et al. (1975). Included was information on the status of estuarine management and estuarine resources, harvests, and projections. Sapp, et al. (1976) conducted a coastal marsh inventory of Alabama.

Loyacano and Smith (1979) prepared a document on the natural resources of Mobile Estuary, Alabama. Included was information on various physical parameters such as mineralogy, sedimentation, and hydrography. Biological parameters such as submerged aquatic vegetation, plankton, benthos, fish, shellfish, birds, and mammals were also provided.

An extensive historical and biological inventory of the offshore lands and waters of Horn and Petit Bois Islands, Mississippi was conducted by J.A. Jackson, et al. (1979). The document was mainly concerned with the impacts of dredging Petit Bois Pass. Included were extensive species lists for algae, phytoplankton, zooplankton, fish, reptiles, birds, and mammals. The USACEMD provided a reconnaissance report on a dredged material disposal area in Mississippi Sound and adjacent waters (1979e).

Miscellaneous Ecological Studies

Allan (1950) provided a general overview of land-use planning for Gulf Coast

marshlands. Included were the characteristics and uses of the three successional stages of a salt marsh.

Gunter (1967) described the important relationship between estuaries and commercial fisheries. Using the Mississippi River - Mobile Bay system, the author discussed the importance of river waters entering bays, and why that sort of environment makes a good nursery area.

As part of the biological phase of the Gulf of Mexico Environmental Inventory, Perry and Christmas (1973) studied the zooplankton of Mississippi. Copepods were the dominant group, with *Arcatia tonsa* as the most abundant plankton species. Data were presented on the temporal and areal distribution and abundance of various zooplankters, as well as the biotic and physical factors that effect the variations observed. Provost (1973) discussed the ecology of wetlands in Florida, and the need to protect them, due to their importance to commercial fisheries. L.R. Brown, et al. (1978) provided an evaluation of the ecological role of tidal marshes along the Mississippi/Alabama Gulf Coast, together with recommendations on management techniques. Charles (1978) studied salt marsh meiofaunal communities on Dauphin Island, Alabama, with particular emphasis on harpacticoid copepods. Sage (1978) sampled Graveline Bay Marsh, near Ocean Springs, Mississippi, for edaphic blue-green algae. *Schizothrix calcicola* was the dominant form in all zones throughout the year, while subdominant forms varied with season.

The seasonality of benthic community structure in Mobile Bay, Alabama was the topic of a masters thesis by P.G. Johnson (1980).

Stout (1984) studied the ecology of irregularly flooded black needlerush salt marshes along the northeastern Gulf of Mexico. She examined community structure and function for different zones, and provided detailed descriptions of marsh zonation, marsh fauna, ecological dynamics, and human impacts. Deegan, et al. (1986) discussed the relationship between physical factors, vegetation distribution, and fishery harvest in 64 Gulf of Mexico estuaries. The researchers found a strong relationship between fishery harvest, freshwater input, and physiography. Emergent vegetation was related to intertidal area and rainfall. Chabreck (1988) provided an ecological look at coastal marshes in general, with a close look at several Gulf Coast regions. The author discussed the distribution of coastal marshes, environmental influences, ecological processes, plant and animal communities, and marsh management.

Sampling Methodology

Butler and Wilson (1957) described the acquisition of a continuous water sampler to test daily fluctuations of plankton in estuarine waters. Other uses of the equipment, such as a food source for filter-feeding organisms, a monitor for salts and trace elements, and a pollution monitor, were mentioned, as well.

Crow, et al. (1975) evaluated a membrane adsorption technique for counting microbial populations in coastal water surface films. All samples were taken from the estuaries along the Gulf Coast between Florida and Mississippi.

CULTURAL/HISTORICAL

General Area History

Gulf Coast

The British engineer, Pittman (1770) surveyed the Gulf Coast between 1765-1768. He described Gulf Coast settlements, forts, inhabitants, and natural resources. It was the first English book to fully describe the lands acquired in 1763 by the Treaty of Paris. B.D. Jones (1882) described the history of Pensacola shipping, the decline of the lumber industry, and the desolation of cut-over lands, including notes on Santa Rosa Island. Mereness (1916) edited a collection of journals on travels in West Florida, relating experiences with native Americans.

A brief historical sketch of discoveries and exploration in the Gulf of Mexico was written by Galtsoff (1954b), starting with the discovery of the Gulf of Mexico by Vespucci in 1497, and ending with present day activities. Crane (1956) provided a history of the first English settlements along the southern coast, including the Pensacola area, and other areas in the vicinity of Gulf Islands National Seashore. Dibble and Newton (1970) organized the first Gulf Coast History and Humanities Conference into a series of articles on the culture and heritage of the colonial history of the Gulf Coast, especially Florida's panhandle.

Ellsworth (1972) explored the economic, religious, political, and historical aspects leading to Florida's statehood. Abernathy (1972) reviewed the history of Florida with regard to the Spanish frontier; included was a background of General Mathews, who was a special agent of the President concerning Florida affairs, and a history of the forts of Florida. McWilliams and McWilliams (1981) completed the first English translation of explorer Pierre Le Moyne d'Iberville's Gulf Coast journals. Weddle (1985) provided an historical overview of the early history of the Gulf of Mexico. Shipwrecks were the topic of an article by Giesecke (1987). The author discussed public interest in shipwrecks, current case law, state law, and state programs.

A collection of articles, letters, and pamphlets are available at Gulf Islands National Seashore, Ocean Springs, Mississippi concerning the general history of the Gulf Coast (N.A., N.A.f.).

Florida

Under Spain

J. Campbell (1742) provided a concise history of Florida and its neighboring islands while under Spanish rule. McCall (1868) described the lives of the Spanish residents of Pensacola during the years prior to the Civil War. Haarmann (1960) discussed the Spanish conquest of British West Florida (1779-1781). TePaske (1964) examined the governorship of Spanish Florida (1700-1763) by looking at the administrative, judicial, economic, military, social, and religious problems with which the Governor had to deal. Coker (1979a) recounted John Forbes' description of Spanish Florida during the early 1800's.

Under Britain

Alvord (1916) described the first several years under British rule in West Florida. Howard (1947) discussed the law and policies of the Royal Colonies up to the time of the Revolutionary War. Born (1963) discussed the British trade empire along the Gulf Coast.

The transfer of West Florida from Spanish to British control was recounted by Gold (1964); it occurred between 1763-1764 over a period of 21 months, and involved a cooperative exchange between the two countries. A general history of British West Florida at the time of the American Revolution was provided by Starr (1976).

Territorial Years

S.W. Martin (1974) wrote an historical account of Florida's territorial period (1819-1845). During this time Florida went from a Spanish colony to an American state.

Statehood

H.B. Fuller (1906) provided an account of the purchase of Florida by the United States. A later account of the steps that led to the acquisition of Florida was written by F.N. Anderson (1915).

Santa Rosa County

Cameron (1928 a,b) described the establishment of the first forest experiment station in America in 1828 on Santa Rosa Island. J.H. Scott (1971) reported on the growth of Santa Rosa County from 1900-1920, with an emphasis on local industry, agriculture, and social life. W.R. Adams (1972) provided a discussion on the live oak farms of West Florida. He related the importance of live oak wood to the ship-building industry, and the efforts required to grow and obtain live oak lumber for a better Navy. M.L. King (1973) also provided a more lengthy history of the county, beginning in 1497 up until 1954.

Miscellaneous Florida History

Chapin (1914) provided an historical overview of 400 years of Florida history (1513-1913), discussing a wide range of topics from war to industrial development. Carter (1938) edited a collection of legislative proceedings, correspondence, and other papers relating to the American occupation of West Florida. W.C. Lazarus (1951) discussed the history of aviation in Florida. Included were notes and photographs on the early Pensacola naval aviators.

An historical and topographical description of Florida was presented by J.G. Forbes (1964). Kerrigan (1970) translated a Spanish version of early Florida history (1512-1722) written in journal form by Barcia. The journal contained the principal events that occurred in Florida during its early years. Information on Indian customs, government, and warfare was also included. Tebeau (1971) provided another history of Florida, focusing on political, economic, and social forces. Through first hand accounts and government documentations, R.L. Campbell (1975) provided a history of colonial Florida.

Mott (1983) reported on the history of seismic activity in Florida between 1727 and 1981; date, time, and geographic locale were provided. Snell (1983) discussed the preservation, development, and interpretation of the Deer Point Naval Line Oak Plantation. The author surveyed all the naval timber preservation efforts made from 1794 until the 1860's.

Mississippi

General History

Claiborne (1880) provided a history of the frontier period of Mississippi. A more extensive history of Mississippi was compiled by Rowland (1925).

Ship Island

Several general histories of Ship Island are available, providing information on its discovery and use through history (Caraway, 1942; Maples, 1947; and Steckel, 1975).

Bearss (1984) conducted an historic resource study of Ship Island for the National Park Service, by identifying the significant historical features associated with the island.

Handwritten notes, penned by an anonymous author (N.A., N. A. 1.) are available at the Gulf Islands National Seashore, Ocean Springs Unit, outlining the history of Ship Island.

Horn and Petit Bois Islands

As part of a management document for the National Park Service, J.A. Jackson, et al. (1979) conducted an historical, as well as biological, inventory of Horn and Petit Bois Islands. Included was a brief historical background of the two islands. Madson (1981) wrote a common interest article about Horn Island, mixing history, geology, and local folklore.

A variety of articles were collected on the history of Horn and Petit Bois Islands, available at the Ocean Springs Unit of Gulf Islands National Seashore (N.A., N.A.e).

Cat Island

R.M. Thompson (1961b) and Stettler (1986) provided historical accounts of the colorful past of Cat Island, including information on Indians, smugglers, and local industry.

Alabama

An historical account describing the capture of Mobile by the Spanish from the British was recounted by J.D.L. Holmes (1966). The author also provided information on each of the Spanish military commanders.

Archeology

Gulf Islands National Seashore

General Area Reports

Tesar (1973b) provided an in-depth background of the archeology of the shoreline area that is included in the Florida portion of Gulf Islands National Seashore. Lenihan (1973) conducted an archeological survey of the waters immediately surrounding the western end of Santa Rosa Island and the eastern tip of Perdido Key. Shipwrecks were the primary find, but bricks were also discovered that were thought to be part of the mid-19th century Fort McRae.

Naval Live Oaks

W.C. Lazarus (1961) discussed the results of his findings from 10 midden sites on the Naval Live Oaks Reservation. Maps were included, giving the geographic locations of sites. Several other researchers have provided various types of archeological information on the Naval Live Oak Reservation: general area surveys (Parks, 1975; Prokopetz, 1976; Faust, 1977; Huston and Stoutamire, 1982; and Doran, 1982); underwater survey for submerged, early man sites (R.E. Johnson, 1979); specific site investigations, such as the Rattlesnake Midden site, 8-SR-73 (Doran, 1983c); and studies on spatial patterning and chronology (Doran, 1985a).

Forts

Two reports are available concerning forts in the area. Braley (1979) conducted an archeological investigation of Fort Barrancas, Bateria San Carlos and Advanced Redoubt. In 1980, an unidentified author (N.A., 1980) provided a more in-depth discussion of the findings of the three previously mentioned areas.

Perdido Key

Prokopetz (1974, 1979) conducted an archeological survey at Perdido Key on an aboriginal Fort Walton Period (1400-1750) site; however no historical sites were located from that period. A literature review revealed no significant historical occupation of the key, other than Fort McRae, which had existed on the eastern end during the mid-1800's.

Mississippi Unit

Tesar (1973c) conducted an archeological survey and testing of the Mississippi Unit of

Gulf Islands National Seashore. Areas surveyed on Ship Island included a French warehouse dating from 1699-1750's, the lighthouse complex dating from 1853-1885 and 1885-1972, and Fort Massachusetts. From the Davis Bayou Unit, a site in Magnolia State Park and the CCC training camp were surveyed. Along with the archeological testing results, a chapter on the ethnohistory of the areas was also included. J.W. Walker and Taylor (1982) investigated two sites located within the proposed right-of-way for the park entrance road at Davis Bayou. A few artifacts could be assigned to cultural periods, but due to the shallowness of the deposits, the paucity of artifacts, and the lack of midden features, no further work was recommended other than a surface survey after the vegetation had been cleared from the sites. No further archeological materials were recovered after the surface survey, and the sites were deemed archeologically insignificant.

General Southeast Region

W.H. Holmes (1903) provided some general information on aboriginal pottery of the eastern United States. L.H. Larson (1980) reported on aboriginal subsistence technology during the late prehistoric period along the southeastern coastal plain.

General Gulf Coast

A study on the distribution of shipwrecks and related artifacts along the continental shelf area of the northern Gulf of Mexico was conducted by the National Park Service. A basic data sheet was compiled by USDOINPS Cultural Resource Management Studies (1977b) for 1,904 reported wrecks. Gagliano (1977), and USDOINPS Cultural Resource Management Studies (1977a) evaluated the cultural resource potential of the Northern Gulf of Mexico. A geographical history was developed for the study area, and an inventory was made of known sites in the northern Gulf area that were occupied from 55,000 B.P. to 3,500 B.P. Data on age, ecofacts, artifacts, and associated landforms were provided for each site. In 1978, using side-scan sonar, Gagliano surveyed the ocean bottom along the northern Gulf of Mexico continental shelf for shipwrecks of cultural/historical interest.

Dilworth (1979) described 12 aboriginal pipes found along the northern Gulf Coast. Stowe (1985) provided a brief description of the Pensacola Variant and the Bottle Creek Phase. Site locations included Gulf Coast strip, Mobile Bay, and the Mobile-Tensaw Delta.

Florida

American Indians

Sternberg (1876) provided the first description of archeological excavations on an Indian burial mound and shellheap near Pensacola, Florida. C.B. Moore (1901) described several aboriginal remains found along the north Florida coast. G.L. Adams and Lazarus (1960) reported on the discovery of two pottery vessels that contained male and female skulls found in the Choctawhatchee Bay area.

Head (1966) conducted an archeological study of the American Indians of Gulf Coast Florida. Wing (1967) reported on animal remains from the Deptford Period found in a midden at Fort Walton Beach. McDonald (1968) studied various pottery types from certain cultural periods along Choctawhatchee Bay.

Y.W. Lazarus (1968) discussed the origins of Gulf Coast Indians, early subsistence patterns, village life, the development of complex culture and traditions, and historic contact between Indians and European explorers. Information on Fort Walton culture, as well as illustrations of artifacts, were also included. W.C. Lazarus (1971), and Brose and Percy (1978) elaborated further on the Fort Walton Culture.

Reitz (1982a) studied the prehistoric use of fish by American Indians along coastal Florida and Georgia. Claassen (1985) studied early human use of shellfish in Escambia Bay. The dominant shellfish species used was *Rangia cuneata*, followed by *Polymesoda caroliniana*.

General Area Studies

In 1942, Willey and Woodbury compiled a chronology of pottery types found along the northwest Florida coast. Also included were descriptive and distributional data on pottery styles. Willey (1949, 1973) provided a complete and integrated synthesis of Florida Gulf Coast archeology. The first publication (1949) was comprised of field reports of unpublished excavations, and a compilation and reinterpretation of previous archeological work in the area, which resulted in a view of a succession of cultures and cultural growth throughout several centuries. The later publication (1973), integrated more recent information into the former publication, and contained information on geology, soils, vegetation, and climate, as well as excavations in and around Gulf Islands National Seashore.

Milanich and Fairbanks (1980) reported on Florida archeology in general; the authors discussed geographical and temporal boundaries, the environment, types of people present, settlement trails, and social organization. Jenkins and Mann (1985) conducted an archeological reconnaissance of the Conecuh River drainage area to locate sites eligible for nomination to the National Register of Historic Places. The authors then provided a review of the cultural history of the area.

Scarry (1985) proposed a breakdown of ceramics by certain styles: a type-variety system. N.M. White (1985) reviewed current archeological work done in the northwest Florida area. Brose (1985) provided a critical re-evaluation of Gordon R. Willey's (1949) symposium on the archeology of northwest Florida. He pointed out that archeologists of today continue to interpret evidence of prehistoric societies in northwest Florida within the archeological framework of the 1940's. Willey (1985) provided a personal account of his research on the archeology of the Florida Gulf Coast. The author also discussed the present status of archeological research in northwest Florida.

Santa Rosa

H.G. Smith (1965) reported on excavations and findings around Santa Rosa, Pensacola. French-made artifacts were found, in addition to artifacts with some connection to England, northern Europe, Mexico, and China. Photographs, maps, and surveys were also included in the article. As part of an archeological excavation of Santa Rosa, Pensacola, Stacy (1965) described the aboriginal pottery of the area. Bense (1985) surveyed Santa Rosa Island for prehistoric archeological sites.

Dating Techniques

Doran (1984, 1985b) reported on proton-induced x-ray emission (PIXE) analysis of pottery shards found in Florida. The author found clear elemental differences between north and south Florida pottery shards using this new technique.

Alabama

C.B. Moore (1905) studied Indian burial mounds along the Mississippi Coast. R.S. Fuller (1985) discussed the Bear Point Phase of the Pensacola Variant. The Bear Point Phase appears to extend along the Gulf Coast strip from Biloxi Bay on the west, to Choctawhatchee Bay on the east. The author stated that further refinement of this Phase and the Pensacola Variant will forge a needed link between prehistory and history.

Mississippi

R.B. Lewis (N.A.) surveyed the Mississippi Gulf Coast for the distribution of archeological sites. As part of the Mississippi geological survey, C.S. Brown (1926), reported on the archeology, by presenting a systematic idea of the different types of Indian remains found in the state. Great detail was provided on all artifacts that were recovered. Reitz (1982b) compared vertebrate fauna from four excavations along the Mississippi Coast.

Historic Structures/Sites

Forts

Fort George

Cublerley (1928) described the British fort built in 1778 on the north side of the old city of Pensacola, and provided an account of its destruction by Andrew Jackson in 1814, as well.

Fort Massachusetts

The National Park Service (C.L. Johnson, 1934) provided a detailed historical account of Fort Massachusetts for consideration as an historic site. Bearss (1974) prepared an in-depth historic structure report on the fort, which included administrative data, defense schemes, construction history, and war usage. Dugan and Kay (1980) compiled extensive notes on preservation techniques for rodman gun, top carriage, and chassis at Fort Massachusetts.

Fort Pickens

Simons and Lazarus (1961) filed a site report on Fort Pickens. Dibble (1971) provided a history of Fort Pickens, and the people who were a part of it. A similar history published by the Pensacola Historical Society (N.A.) recounted the circumstances involved in choosing Fort Sumter over Fort Pickens as the location of the first stand of the Civil War. In 1973, Berndt nominated the historic fort to the National Registry. Bearss (1977, 1983b) prepared a monograph on the structural history of Fort Pickens from 1829-1897. Several pamphlets with photographs were prepared by D. Dodd (N.A.), and are available through the National Park Service.

Fort Barrancas

Appleman (1938) provided an inspection report and recommendations for both Fort San Carlos and Fort Barrancas. Reeves (1968) conducted a survey of the fort as an historic American building. As part of a report for the National Park Service, Holland and Jones (1973) reported on the physical condition of Fort Barrancas, and provided recommendations for improvement. An anonymous author (Anonymous, 1974) described the fort for the Pensacola Historical Society. Gjessing and Garner (1975) provided an historic site report on Advanced Redoubt at Fort Barrancas. Greene (1977) reported on the restoration of Fort Barrancas undertaken by the National Park Service between 1975-1976. Bearss (1983a) undertook an historic resource study of the fort, and provided an in-depth history.

Miscellaneous Forts

Lattimore (1936) reported on the condition of the forts found along the Gulf of Mexico. Also included was a history of each fort, and recommendations for the preservation of each structure. An historical review of the forts of Pensacola was provided by R.L. Anderson (1969) and Faye (1972). A more general report on the forts of Florida was written by Gray (1972). It contained general information on the architecture, history, and location of all known Florida forts and military camps. With a broader scope, E.R. Lewis (1979) surveyed seacoast fortifications of the United States. Further information on the fortifications of the Pensacola area was compiled by J.C. Coleman and Coleman (1982). Included were descriptions of all early Spanish, British, and American forts, as well as a chronology of events.

Naval Live Oaks

Castellina-Dudley (1977) prepared a report concerning the nomination of Naval Live Oaks to the Historic District National Register of Historic Places.

Lighthouses

Coker (1968) conducted a survey of the Pensacola lighthouses. In his history of

America's lighthouses, Holland (1972) discussed several of those found along the Gulf Coast; lighthouses in Pensacola, on Cat Island and Ship Island, and in Biloxi were among those mentioned. Fryman (1973) prepared the nomination form for the Pensacola Lighthouse to the National Register of Historic Places.

A history of the lighthouses and lightships of the Gulf of Mexico was compiled by Cipra (1976). A brief mention of the life of the lighthouse keeper, engineering, and architecture, together with recent histories of the lighthouses were also included.

Miscellaneous

Early engineers' reports on Gulf Coast forts (1827-1918) are available at Gulf Islands National Seashore, Gulf Breeze, Florida (N.A., 1918).

Jefferys (1970) described the harbor and settlement of Pensacola. R.J. Bailey and Lowrey (1975) edited a comprehensive plan that detailed the status of historical preservation activity and philosophy in Mississippi. Murtagh (1976) compiled extensive listings of historical sites in the United States for the National Register of Historic Places; included were sites in Florida and Mississippi.

The history of the Panton House of Pensacola was discussed by T.D. Watson and Wilson (1981). Bearss (1982) provided a detailed history of the structures constituting the Pensacola Harbor Defense Project from 1893-1947. Included was information on administrative data, costs, construction history, and submarine defenses development.

Stevens (N.A.a) compiled a file of miscellaneous newspaper articles and correspondence concerning fortifications and civil war prisons, available at Gulf Islands National Seashore, Ocean Springs, Mississippi.

Gulf Coast Military History

Revolutionary War

Siebert (1916) reviewed the settlement of loyalists in West Florida.

War of 1812

Latour (1816) provided an historical account of the events leading to the Battle of New Orleans, and the war in West Florida and Louisiana in 1814-1815. Waldo (1818) recounted the memoirs of Andrew Jackson on the occupation of Pensacola in 1814, and the invasion of Florida in 1818. Owlsley (1981) covered the history of Spanish and British hostilities over Gulf frontierslands, including information on battles, Indian relations, and the significance of the War of 1812.

Civil War

Mississippi

A copy of the diary of Eugenia Phillips, a prisoner of war held on Ship Island from July 4 - August 6, 1862, is available at the Ocean Springs Unit of Gulf Islands National Seashore (E. Phillips, 1862). Additional information relating to Mrs. Phillips confinement, compiled by Stevens (N.A.b), is available, as well, at the Ocean Springs Unit. Another diary, written by Lt. Col. A. Rust Jr., and transcribed by M.J. Stevens, is also available at the Ocean Springs Unit (Rust, 1862). A. Walker (1862), in a letter to Jefferson Davis, described the brutal conditions and behavior of the "barbaric tyrant" Ben Butler of the Union Army, and the living conditions of the prisoners of war at Ship Island. Z.H. Burns (1971) described the relationship between Ship Island and the Confederacy, providing a chronology of major events that occurred on the island during the Civil War. A memorial file containing correspondence and articles on the purchase of a monument to be placed on Ship Island to commemorate Confederate soldiers who died and were buried there, was compiled by Stevens (1975). Two files are available at Gulf

Islands National Seashore (Ocean Springs Unit), concerning prisoners held on Ship Island during the Civil War (Stevens, N.A.c, d).

Alabama

Bergeron (1980) detailed the Confederate defense of Mobile, Alabama during the Civil War. Fort Morgan and Fort Gaines guarded the main entrance channel to Mobile Bay. Additional defenses were also built during the war, that were both elaborate and expensive. The Union campaign against Mobile was deterred until March, 1865; the city surrendered April 12, 1865.

Florida

Scassellati (1861) provided an historical account of the first shots of the Civil War fired January 8, 1861 against the Confederates who were trying to take Fort Barrancas, by Lt. Adam Slemmer's troops who were occupying it. Two days later, when Florida seceded from the Union, Slemmer abandoned Barrancas and took over Fort Pickens. Hoag (1866), a member of the Union Army, wrote a personal account of his life while fighting in Pensacola, with descriptions of forts and battles in the area. J.S.C. Abbott (1866) recounted Civil War events in Florida, especially in Pensacola. A complete history of the Confederate Navy was compiled by Scharf (1887). Notes on vessels constructed at the Pensacola Navy Yard before 1861, and activities in the Gulf of Mexico, with emphasis on Fort Morgan and Fort Pickens, were included.

G. Morris (1891) wrote an historical account on events that occurred in and around Fort Pickens between June, 1861 and November, 1862, including the Battle of Santa Rosa Island. The events surrounding the surrender of the Navy Yard at Pensacola on January 12, 1861 were recounted by Erben (1897).

A partisan history of the Civil War and Reconstruction in Florida was presented by W.W. Davis (1913). The author summarized key events that occurred in Pensacola during this period, such as the Battle of Santa Rosa Island, the evacuation of Pensacola, and Reconstruction in Pensacola. Larkin (1959) provided descriptions and illustrations of the Battle of Santa Rosa Island, in which the Confederate forces attacked the Union encampment near Fort Pickens on October 9, 1861. An historical perspective of Fort Pickens was provided by Reese (1964).

General Information

The U.S. War Department (1901) compiled a series of volumes containing official records of the Union and Confederate Armies. The first series consisted of formal reports of all military operations in the field for both Union and Confederate forces, and information on property seizures. The second series consisted of correspondence orders and prisoner of war reports. The third and fourth series consisted of Union and Confederate correspondence respectively.

Strickland (1979) provided an historical account of Confederate blockade runners, and the risks taken by sneaking out of blockaded ports to pick up cargo from Havanna, Bermuda, and Nassau.

A file is available at the Ocean Springs, Mississippi Unit of Gulf Islands National Seashore on the regimental histories of the Civil War (N.A., N.A.k).

World War II

A file of miscellaneous newspaper articles and correspondence concerning the use of Horn Island during World War II as a disposal site for toxic gas bombs is available at the Ocean Springs, Mississippi Unit of Gulf Islands National Seashore (U.S. Department of Army, 1941*; N.A., N.A.h.). Huey (1985) discussed the opening of the U.S. Army installation on Horn Island for the testing of biological warfare agents.

Pensacola

Colonial Era (1559-1821)

General History

Hill (1916) compiled a catalog of documents relating to Pensacola between 1783-1817. Dunn (1917, 1926) wrote on the occupation of Pensacola Bay from 1689-1698. H.C. Armstrong (1930) provided a general sketch of Escambia County after 1821. The author also described the Live Oak Reservation and Navy Yard, the 1834 outbreak of yellow fever, Pensacola during the Civil War, and provided biographical sketches of the leading citizens of Escambia County. L.C. Ford (1939) discussed the intercolonial struggle for Pensacola between England, France, and Spain during 1689-1739.

Early Spanish histories of Pensacola (1689-1693) were related by Leonard (1939) and Griffin (1959). Cox (1967) provided an in-depth historical account of colonial Pensacola between 1798-1813, focusing on political and military strategies concerning ownership of the South. Several other documents are available relating similar information on colonial Pensacola (Andrews and Higgins, 1970; McGovern, 1972; and C.T. Hoffman, 1980).

The French period of Pensacola's history (1660-1720) was recounted by the John Appleyard Agency staff (1976). Lloyd (1986) compared and contrasted the influences of Britain, France, and Spain on the development of colonial Pensacola.

British Pensacola (1763-1781)

Several authors have provided descriptions of Pensacola life under British rule (C. Johnson, 1971; Rea, 1974; John Appleyard Agency, 1975; Gantzhorn, 1977). Von Eeling (1977) provided an account of the happenings in Pensacola between November 1778 and June 1781, as an 1863 diary including maps and drawings of the area, that was translated by Krupp. The minutes, journals, and acts of the General Assembly of British West Florida were compiled by Rea and Howard (1979). Included was the text of speeches by Governors George Johnstone and Peter Chester, Lieutenant-Governors Montfort Browne and Elias Durnford, as well as petitions, addresses, and other papers originating in the two houses.

The Battle of Pensacola (1781)

Spain regained control of Pensacola from Britain after the siege in 1781. J. Allen (1841) compiled notes on Admiral Sir William Hargood and the capture of Pensacola in 1781. Parks (1981), Servies (1981), Coker and Rea (1982), and Wilkie (1983) have written books on the subject, as well.

Civil War

Through his diary, J. Walker (1845) provided a personal account of his trial and imprisonment for helping slaves out of bondage. Gansevoort's (1867) personal journal also gave an inside glimpse of life in Pensacola during the Civil War. Henry Gansevoort's accounts of Pensacola and West Florida during Reconstruction were compiled by Hoadley (1875). In letters to his sister, Gansevoort described the Pensacola Navy Yard, Fort Barrancas, the Live Oak Reservation, and the political and social life of Pensacola.

A Union soldier from Iowa, J.S. Clark (1916) recounted his experience during the Civil War, describing military experiences, battles, and his arrival at Pensacola. Alison (1967) also provided an account of Pensacola during the Civil War. He described skirmishes with Union soldiers under Lt. Slemmer at Fort Pickens. Parks, et al. (1978) described the battle of Santa Rosa Island that resulted in a Confederate withdrawal from the island.

A chronology of Ante Bellum Pensacola was provided by Dibble (1974), using government documents, personal correspondence, and diaries.

Yellow Fever Epidemics

Hulse (1842) provided a description of the yellow fever epidemic in Pensacola between August and November, 1841. A list of ships arriving at the Pensacola yellow fever quarantine station between September and October, 1876 was compiled by Davison (1876).

Two reports on the yellow fever epidemic of 1882 in Pensacola were written by assistant surgeons of the U.S. Navy, R.C. White (1883) and W. Martin (1884). An overview of yellow fever epidemics in Pensacola was presented by Pearce (1978). The author discussed the social and economic impacts of the epidemics on the community.

Miscellaneous Pensacola History

A descriptive account of late 19th century Pensacola was presented by A.M. Brooks (1883). Some of the things the author described were the old forts in the area, the fishing and lumber industries, the depletion of fish and game, and observations of alligators in Perdido and Escambia Bays. An anonymous author (Anonymous, 1899) reviewed Pensacola history, with information on commerce, climate, and social life.

Barr and Hargis (1938) recounted the events leading to the voluntary exodus in 1857 of Pensacola Creoles. Also included was a summary of Florida legislative acts and resolutions concerning free Negroes (1828-1850). Carageorge (1979) wrote about the Greek emigration to Pensacola to escape economic hardship in Greece.

The history of Pensacola's Naval development was told by Pearce (1980). The author covered a wide time range, from the triangular struggle for the city between England, France, and Spain, up to development in the 1900's.

Parks (1986) provided a good overview of Pensacola's colorful, distant, and not so distant, past.

Historical Figures

Walter Anderson

A biographical sketch of the artist was provided by his daughter, providing an introduction to her book *Sea-Earth-Sky: The Art of Walter Anderson* (Pickard, 1980). Another biographical account was written by Burton (1982). The artist was a hermit who spent long periods of time on Horn Island, producing thousands of drawings, paintings, and journal entries that chronicled Horn Island's seasons and wildlife. Excerpts from Anderson's personal diary, along with photographs of his paintings were compiled by Toops (1982).

Ben Butler

Two historical accounts of the controversial Massachusetts general of the Union Army during the Civil War are available (Bradley, N. A.; F. Russell, 1968). General Butler supervised the POW camp on Ship Island from New Orleans for a short period of time.

Henry Brackenridge

W.F. Keller (1972) provided a biographical sketch of Henry Marie Brackenridge, the president of the first American forest station, which is now the present day Naval Live Oaks Reservation. Further historical accounts of Brackenridge's conservation efforts in the Pensacola area were included in an essay on the culture of live oaks (Brackenridge, 1980).

Miscellaneous

A portrait of Lt. Adam J. Slemmer, as well as comments on, and illustrations of, Union and Confederate confrontations were provided by Gilman (1884). Some brief notes on the leading authority on flora of the southern United States, Alvin W. Chapman, were compiled by

Knowlton (1899). Rea (1963) reported on John Ellis, the first "Kings Agent", who was responsible for distributing parliamentary approved funds for the development of British West Florida. Dibble (1970*) discussed the influence of William H. Chase on the economics of Pensacola and on Gulf Coast military forts. Rea (1985) related the mapping travels of James Cook along the Gulf Coast. Cook developed one of the earliest charts of Pensacola Bay for the British. He also did some exploratory work on Cat and Ship Islands.

American Indians

A lengthy historical account of Catawba, Cherokee, and Chickasaw Indians of Mississippi and Florida was written by Adair (1775), the leading authority of the day on Indians of the southeastern United States. Catlin (1841) provided descriptions and notes on the Indians of the Perdido River area and Santa Rosa Island. Wheatley (1889) recounted the surrender of Geronimo, and the confinement of some Apache Indians to Fort Pickens. Royce (1899) reported on Indian land cessions in the United States; included were maps of Alabama, Florida, and Georgia showing trade routes, Indian territories and reserves, towns, forts, and historic sites.

Brannon (1952) studied the nature and extent of the Pensacola Indian trade. Included in the article were notes on trails, roads, and trade centers. Simpson (1956) provided a summary of the histories of both native and immigrant tribes of Florida, whose languages have enriched the nomenclature of the state. Ridaught (1957) described the band of Choctaw Indians who entered Florida with Andrew Jackson in 1814. The author discussed the relationship between the Indians and the French, their discontent with the British, and Jackson's march on Pensacola.

Hudson (1978) compiled an in-depth history of southeastern Indians. The author discussed social organization, subsistence, ceremonies, art, music, and the final conquering of the South's Indian heritage. Dysart (1982) discussed the assimilation of Creek Indians in Pensacola during the nineteenth century.

Natural History

W. Roberts (1763) wrote an account of the first discovery of Florida, providing descriptions of the plants, animals, Indians, and the shoreline of the Gulf Coast. Gould (1765) provided an early account of Pensacola's coastal features and climate. Romans (1775) provided a varied account of East and West Florida, including information on natural history, American Indians, Negroes, slavery, climate, disease, and the hurricane of 1772. Hutchins' (1784) memoirs included historical accounts and topographic descriptions of West Florida and Louisiana. Detailed descriptions of rivers, settlements, climate, soil, produce, weather, flora, fauna, and minerals were included, as well as directions for sailing into bays, lakes, harbors, and rivers on the north side of the Gulf of Mexico, and navigating between islands.

Bartram (1791) compiled an extensive natural history of East and West Florida, North and South Carolina, and Georgia. J.L. Williams (1827, 1837) wrote two books on the natural history of Florida, which included information on geography, climate, flora, fauna, and historical notes on Pensacola. Wailes (1854) described the agriculture and geology of Mississippi; also included were land titles, maps, and information on the flora and fauna of the area. As a result of a four month voyage down the Mississippi River into the Gulf of Mexico, N.H. Bishop (1879) was able to provide a natural history of the region from New Orleans east to Cape San Blas, Florida, including descriptions of the Perdido River, Santa Rosa Island, and Fort Pickens.

Walter Inglis Anderson's log book and watercolors of Horn Island were the subject of a book edited by Sugg (1973). The natural and cultural history of Mississippi offshore islands was reported by Stevens (1974).

Shangle (1979) provided historical and recent accounts of various regions of Florida, including information on the climate, the people, plants, and wildlife.

Cultural Resources

Dyer (1894) provided a description of the coastal resorts of the 1890's, including photographs of the buildings. Desporte (1973) compiled various oral histories on the Gulf Coast and Ship Island, from the Civil War to the early 1900's. The tapes are available at the Ocean Springs, Mississippi Unit of Gulf Islands National Seashore.

The proceedings of the Gulf Coast History and Humanities Conference were edited by Ellsworth and Ellsworth (1976). The sessions were organized to explore the cultural legacy of the Gulf Coast through an analysis of both literary and non-literary sources. Some of the topics covered included the economic assets of preservation, planning as part of preservation, Pensacola's economic rise, cultural life from 1870-1940, folk culture, and architecture.

Miscellaneous Topics

Carter (1962) edited a collection of documents called the Territorial Papers of the United States, which included mention of Florida's territorial ownership, transfer of ownership, maps, and military history. Coker (1979b) discussed the financial history of the Spanish Presidios of Pensacola between 1698 and 1763. The USDOINPS History Division (1987) outlined the extent to which the cultural resources of the National Park System and National Historic Landmarks reflect our nation's past.

Muir (1983) compiled a bibliography of material in Gulf Islands National Seashore historical research files, available at the Gulf Breeze Unit in Florida.

MANAGEMENT, LEGISLATION, RECREATION, MISCELLANEOUS

Park History/Legislation

Humm (1957) reported on the process of having Horn Island declared a National Wildlife Refuge. By 1958, Horn Island was established as a refuge, and a final report on the procedure was prepared by Yancy, et al. (1959). Colmer (1969) introduced a bill to the U.S. House of Representatives which was referred to the Committee on Interior and Insular Affairs for the "establishment of Gulf Islands National Seashore, in the states of Alabama, Florida, Louisiana, and Mississippi, for the recognition of certain historic values at Fort San Carlos, Fort Redoubt, Fort Barranacas, and Fort Pickens in Florida, and Fort Massachusetts in Mississippi, and for other purposes." Further information on the establishment of the Seashore was provided by the U.S. Congress, House Committee on Interior and Insular Affairs (1970, 1971). Reynolds, Smith, and Hills, Inc. (1971b) discussed the development of an interpretive program for all units of the Seashore. The U.S. House of Representatives and the U.S. Senate (1971) presented House Report 91-1397 and Senate Report 91-1514 (1971) analyzing the legislative history of Gulf Islands National Seashore.

Kurtzeborn (1973) discussed the history, inhabitants, plants, and geography of Gulf Islands National Seashore. Robinson (1979) reviewed the historical development of National Seashores in general, along with basic management and planning policies. The author also mentioned future development and conservation of the seashores.

Park Management Documents

Management Plans/Environmental Impact Statements

A preliminary draft of the master plan for Gulf Islands National Seashore was presented by the USDOINPS (1971). Reynolds, Smith, and Hills, Inc. (1971a) discussed the biophysical characteristics, extant facilities, the aesthetic character, and cost estimates for facilities located on Santa Rosa Island, Davis Bayou, and Ship Island. A master plan for the preservation of portions of Petit Bois and Horn Islands as National Wilderness Areas was proposed by the USDOINPSDSC (1973). Reynolds, Smith, and Hills, Inc. (1973b), and the USDOINPSDSC (1976) conducted environmental impact assessments for Santa Rosa Island, Davis Bayou, Ship Island (West), and Naval Live Oaks. Each site was described, and data on the geology, soils, water resources, tides, water quality, climate, vegetation, wildlife, air quality, and aesthetic quality of each area were presented.

In 1976, a resources management plan was compiled by the staff of USDOINPSGUIS (1976). The USDOINPSDSC (1978b) presented a long-range strategy for resource management, visitor use, and development of Gulf Islands National Seashore. The visitor use plan outlined strategies for interpreting park resources, visitor safety, and information services. The USDOINPSDSC (1978a) compiled a general management plan as a guide for future management and development of Gulf Islands National Seashore. Five proposals were reviewed: 1) establishment of a visitor center and administrative offices at Davis Bayou and the Naval Live Oaks Reservation; 2) day-use beach recreation facilities at Santa Rosa, Fort Pickens, Perdido Key, and West Ship Island; 3) boating access for the Florida and Mississippi Districts; 4) more recreational and interpretive opportunities at most units; and 5) enhanced protection of cultural and natural resources.

P.J. Godfrey (1978) provided some basic management guidelines for barrier island parks in general. The author discussed beach erosion caused by pedestrians and off-road vehicles. An interpretive prospectus was prepared by the staff of USDOINPSGUIS (1979a). In 1980, Hodapp, et al. provided an environmental assessment of the development concept plan for the Fort Pickens Unit in Florida. The purpose of the document was to examine alternative development strategies for the Fort Pickens Unit. A land protection and acquisition plan was outlined by Christensen (1984) for non-NPS owned lands adjacent to Gulf Islands National Seashore.

Miscellaneous Plans

Hurst (1976) discussed methods of vegetation control used at Gulf Islands National Seashore. The USDOI, Heritage Conservation and Recreation Program (1979) examined federal programs that contributed to the development or protection of barrier islands along the East and Gulf Coasts of the United States. In addition, alternative changes and their consequences were discussed. The use of a shoreline management model for predicting erosion and accretion patterns was implemented for Gulf Islands National Seashore (Cubit Engineering, Limited, 1983). Of all the barrier islands within the seashore, Petit Bois was shown to be the most vulnerable to the forces of nature.

Recreation/Visitor Use

ORVs

A series of reports on off-road vehicle use at Perdido Key, Florida were written by Shabica and Shabica (1978), Shabica (1979a, b), and Shabica, et al. (1979). Prior to 1971 Perdido Key had a traditional history of uncontrolled off-road vehicle use. The impacts on the grasslands were studied, and as a result, the authors recommended that management of the area be implemented by the National Park Service. The USDOINPSQUISFL (1980) discussed the current ORV management techniques and alternatives for Perdido Key. Some of the suggested alternatives were permit requirements, restrictions on vehicle types, speed limits, route markings, dune crossovers, and no ORVs. Shabica and Cousens (1983) examined user conflicts on Perdido Key between ORVs and scientists. Suggestions for resolutions included: 1) resource protection, 2) prioritization of users, and access based on potential resource impacts, and 3) knowledge of the resource. An anonymous author (Anonymous, 1984) provided a general discussion of the ORV problem on Perdido Key.

National Parks in General

D.L. Scott and Scott (1979) compiled a guide to the National Parks of the eastern United States, including summaries of each park's importance, history, visitor activities, facilities, and overnight accommodations. A more comprehensive guide to National Parks was provided by Frome (1980). The U.S. Department of Interior (1985) reported on the National Park system in general, and provided addresses and summaries of the wilderness areas, river systems, and trails for each park. "The Official Visitors Guide" to America's National Parks was compiled by Quirk and Fise (1984) to aid in trip planning. An additional state-by-state, trip-planning guide to federal areas of scenic and recreational importance was edited by Crump (1984).

Water Related Activities

D.C. Williams and Daniel (1970) reported on water related activities in Mississippi's State Parks, including Magnolia State Park, which has since become part of Gulf Islands National Seashore. Only 8% of visitor activities were directly water-related. R.D. Baker (1973) assessed the beaches of Santa Rosa Island for swimming hazards. Although the area was considered relatively safe, several hazards were listed: littoral currents, Portuguese men-of-war, sudden lightning, and underwater obstructions visible only at low tide.

Miscellaneous Visitor Use Reports

General Gulf Islands

An anonymous author (Anonymous, 1980b) provided a descriptive report on the history of Gulf Islands National Seashore, and included visitor information as well. R.B. Hoffman (1981) reported on the wayside exhibit plan for the Seashore. A total of 51 exhibits were planned throughout the park.

Florida

Wirth (1971*) conducted a recreational survey of Santa Rosa Island. The author described the physical characteristics of the area relating to recreational activities, such as boating possibilities, forest and wildlife values, land costs, and population data. Management plans for the east day-use area of Santa Rosa Island were presented by Reynolds, Smith, and Hills, Inc. (1971c). Hensley-Schmidt, Inc. (1977) documented visitor use at the Florida Unit of Gulf Islands National Seashore to evaluate the potential for development of a transportation system. The USDAFS (1986) presented a draft plan for the proposed route of the Florida National Scenic Trail. Gulf Islands National Seashore is the proposed end of the trail, but not the preferred route.

Mississippi

The Mississippi Research and Development Center, Recreation and Tourist Branch, Community Development Division (1975) presented a statewide comprehensive outdoor recreation plan, which included 80-90% federal participation in funding, as well as planning coordination between state and federal agencies. All lands within Gulf Islands National Seashore were mentioned and mapped, along with salt marshes and seagrass beds. Matthews (1979) listed the recreational facilities of Jackson County, including those within Gulf Islands National Seashore. Higgins, et al. (1980) proposed a bikeway through the Davis Bayou campgrounds. A survey of the local population indicated that the lack of safe bike travel routes kept biking down. A file of photographs on facilities, wildlife, natural resources, and landscapes is available at the Ocean Springs Unit of Gulf Islands National Seashore (N.A., N.A.j).

Cultural Resources

Piatek (1980) reported on a construction monitoring project for archeological resources at Gulf Islands National Seashore. Monitoring at the Naval Live Oaks Reservation revealed no construction impacts on previously known sites. There was an extensive loss of significant data at many sites due to erosion. Monitoring at Fort Barrancas led to the discovery of three significant archeological features. At Fort Pickens a 19th century shipwreck was discovered. USDOINPSGUIS (1984) provided an analysis of cultural resources as part of the resources management plan.

Pollution

General Pollution Studies/Surveys

Beck (1954) reported on a pollution survey of western Choctawhatchee Bay, eastern Santa Rosa Sound, and area bayous. The U.S. Department of Health, Education, and Welfare (1954) provided data on water pollution in several areas along the northeast coast of the Gulf of Mexico: the Perdido-Escambia area, the Mobile Bay area, the Pascagoula River area, and the Pearl River area. Tisdale (1969) evaluated water pollution in the Escambia River and Bay, Pensacola Bay, Bayou Chico, and Perdido Bay. As part of the National Estuarine Pollution Study, the USFWPCA (1969) prepared a report for the Secretary of the Interior on various aspects of estuarine pollution, and provided recommendations for a comprehensive national program for the preservation, study, use, and development of estuarine zones. The USFWPCA (1970a) compiled information from a conference on the pollution of the interstate waters of the Escambia River Basin. The purpose of the conference was to review the existing situation, and to make provisions for future actions. The USFWPCA Southwest Laboratory (1970b) conducted a study on the waste sources of Perdido Bay and its tributaries. The USFWPCA Southwest Laboratory (1970c) presented the results of a conference on the effect of polluted shellfish beds in Mobile Bay on interstate commerce. The report summarized data on shellfishery statistics, water quality, and waste sources collected by federal and state agencies from 1949 to 1969.

Giam, et al. (1972) determined residue levels of DDT, DDE, and polychlorinated biphenols (PCBs) in various faunal types from the Gulf of Mexico and Caribbean Sea. All three toxins were found widely distributed in all sample fauna, with higher levels found in samples

taken from coastal waters. Terrebonne (1973b) studied the decline of water quality in the Pensacola area, and its effect on local fishing, tourism, recreation, and property values. The USDCNOAA (1975) discussed the effects of pollution, overfishing, and other human impacts on ocean ecosystems. The Mississippi, Alabama, and Florida shelf regions were included.

T.F. Lytle and Lytle (1982) discussed pollutant transport via sediments in Mississippi Sound. Hanson, et al. (1986) provided preliminary results on the sampling of bottom-dwelling fish and surficial bottom sediments in Pensacola Bay, Mobile Bay, and Mississippi Sound for organic contaminants.

Pesticide Pollution

General Area Studies

Duke (1974) discussed pesticide research conducted by the USEPA's Environmental Research Laboratory in Gulf Breeze, Florida. Duke and Dumas (1974) reported on state-of-the-art research done on effects of pesticides on the coastal aquatic organisms. W.W. Walker (1976) examined sediments collected from 37 locations in Mississippi Sound and Biloxi Bay for pesticide residues. Results indicated that the Mississippi coastal zone appeared to be relatively free of contaminants. Mearns and Van Ness (1987) reported on an historical survey of chlorinated pesticide contamination of U.S. coastal fauna. Results indicated a decline of DDT in coastal and estuarine fish and shellfish since 1965.

Effects on Fauna

Butler (1960) filed a report on a two-year study on the effects of pesticides on commercial fisheries. Acute toxic concentrations, and the chronic effects of low concentrations on various aquatic organisms were determined. Croker (1962) studied the effects of mosquito control spraying on non-target estuarine species. Brown shrimp and blue crabs showed high mortality rates, while mullet showed low mortality, and oysters showed no mortality. The USDOIFWS (1962, 1963), and Butler (1964, 1965) reported on the effects of pesticides on wildlife, and sport and commercial fisheries. They also provided recommendations for minimizing dangers. Butler (1966) monitored the Gulf Breeze area randomly for presence of organochlorine pesticides in the estuarine environment. Results showed a fluctuating, but continuous, presence of pesticides. Residues were found in plankton, fish, and mollusks. Duke (1970) provided a brief article on pesticide monitoring research at Gulf Breeze, Florida. D.J. Hansen and Wilson (1970) tested fish caught in an estuary near Pensacola, Florida for DDT residues. Certain species concentrated DDT more readily than others. The authors suggested the use of benthic fish as monitors of DDT point-source contamination. Bahner, et al. (1977) studied the bioaccumulation and transfer of Kepone® through estuarine food chains. Significant amounts of Kepone® were transferred from water to plankton, and from prey to predator fish. Bourquin (1977) reported on the degradation of malathion by salt marsh bacteria. Farr (1977) examined the effects of sublethal levels of parathion on the ability of grass shrimp to avoid predation. Exposure to sublethal levels of ethyl or methyl parathion increased spontaneous activity and decreased physical stamina in the grass shrimp.

Oil-related Pollution

Hildebrand and Gunter (1955) reported on tar deposits found along the beaches of the northern Gulf of Mexico. Aukland and Trexler (1970) described a remote sensing technique used to discriminate oil types on the surface waters of the Gulf of Mexico. Jeffery (1973), and Jeffery, et al. (1973) reported on pelagic, beach, and bottom tars found in the Gulf of Mexico.

H. Harper (1978) described the cleanup of an accidental spill of 12,500 gallons of oil in Pensacola Bay. The cleanup took three weeks, and cost taxpayers \$90,000. Cantelmo, et al. (1979) experimented under laboratory conditions with the effects of barite, a major component of drilling muds, on meiofauna. When barite was mixed throughout the sediment, there was a significant increase in meiofaunal densities; however, when barite was distributed on top of the sediments (actual drilling conditions), there was a significant decrease in meiofaunal

densities.

L.R. Brown and Hegre (1980) compiled a report for the USEPA on the effects of oil on the aquatic environment of the Gulf Coast region. Emphasis was placed on the long-term, low-level, chronic effects of oil pollution on the aquatic ecosystem. Five types of crude oil were studied in both laboratory and field experiments. Romero, et al. (1981) monitored Florida beaches between September, 1979 and October, 1980 for stranded tar. The beaches of Santa Rosa Island were included in the study. De la Cruz (1982) studied the effects of oil on phytoplankton. Primary productivity in phytoplankton communities was reduced by 44-65% two weeks after exposure to oil. R.A. Smith, et al. (1982) described an oil spill risk analysis model, using simulated oil spills, and relating oil spill trajectory movements to the locations of wildlife populations, fishing areas, and other potential target areas. Grose, et al. (1983) also provided a model to predict the surface transport of oil in the Gulf of Mexico.

O'Neil, et al. (1983) provided summary descriptions of the coastal shorelines of Mississippi Sound, Mobile Bay, and Perdido Bay to assist in oil spill contingency planning and decision making. Conklin and Rao (1984) studied the toxic effects of drilling muds on the larvae of grass shrimp (*Palaemonetes intermedius*). Toxicity to the larvae was directly proportional to increased amounts of oils in the mud. Middleditch (1984) reviewed the fates and effects of produced water effluents from offshore oil and gas production platforms on the marine environment in the Gulf of Mexico. Van Vleet, et al. (1984) monitored the distribution of floating oil residues in the eastern Gulf of Mexico. Groundings of tar occurred along the southeast coast of Florida. Approximately half of the tar samples collected originated from tanker operations.

Industrial Pollution Surveys

The Florida State Board of Health, Bureau of Sanitary Engineering (1957, 1958) conducted bioassays of Escambia Bay for wastes released by Escambia Chemical Corporation and Columbia National Corporation, to determine the causes of fish kills and discolored waters near Fisherman's Point and Sandy Point. B.H. Adams, et al. (1972) provided an evaluation of the waste treatment and waste controls of the American Cyanamid Company near Pensacola. The author characterized, quantified, and evaluated all plant discharges between March 6-12, 1972. Barada (1972) discussed the pollutants produced by Escambia Chemical, Monsanto, American Cyanamid, Container Corporation of America, and Gulf Power Company.

The USEPA, Surveillance and Analysis Division (1972) conducted a study of the water generated by Air Products and Chemicals, Inc. of Pensacola, and discussed alternative technology for waste treatment. W.W. Walker, et al. (1984) studied the microbial degradation of a phthalic acid ester, dibutylphthalate (an industrial chemical used by the plastics industry) in estuarine and freshwater locations along the northern coast of the Gulf of Mexico from Louisiana to West Florida.

A series of bioassays on industrial effluent outfalls were conducted by the Florida Department of Environmental Regulation, Bureau of Water Analysis on the following industries: Air Products and Chemicals (1980a); American Cyanamid Company (1980b, 1984b); Saufley Field Sewage Treatment Plant (1980d); City of Pensacola, Main Street Sewage Treatment Plant (1980e, 1981c); Monsanto Textiles Company (1981a); and St. Regis Paper Company, Kraft Division, Pensacola Mill (1981b)

Water Quality Surveys

The Florida State Board of Health, Bureau of Sanitary Engineering (1963) conducted a pollution survey of the Escambia River south of the Florida-Alabama line. The USEPA and USFWPCA presented a series of documents on the proceedings of conferences on water pollution in various locations of Florida and Alabama: Escambia River Basin (USEPA, Water Quality Office 1970, 1972a; and USFWPCA, Southeast Laboratory, Pollution Control Board, 1970a); Perdido Bay and its tributaries (USFWPCA, Southeast Laboratory, 1970b; and USEPA, Water Quality Office, 1971, 1972b); and Mobile Bay and its tributaries (USFWPCA, Southeast

Laboratory, 1970c).

The USFWPCA, Southeast Water Laboratory (1970c, 1971b) reported on the water quality of Perdido Bay. They concluded that inadequately treated waste effluent from St. Regis Paper Company was the major cause of the degraded water. The USFWPCA, Southeast Water Laboratory (1970d) evaluated Escambia Bay near Pensacola for waste sources.

The U.S. Geological Survey (1977) provided information on water quality data stations located in the coastal areas of the Gulf. Brinson and Keltner (1981) reported on the water quality, and provided biological assessment of Bayou Chico, Florida. They studied the effects of the removal of contaminated sediments on water quality and benthos, and characterized the storm water entering the bayou.

Water Quality Plans

Flood and Associates, Inc. (1973) presented a plan for water quality management in Pensacola area. The USACEMD (1973f) discussed the water quality, water resource problems, and planning efforts of 16 counties in northwest Florida. Le Febvre (1974) reported on a water quality surveillance program at Eglin Air Force Base. A water quality management plan was presented by the WFRPC (1975g) for Escambia and Santa Rosa Counties. Included was information on the physical environment, climate, surface and groundwater, drainage basins, aquifers, water availability, pollution contributors, water quality, and wastewater facilities. Similar plans were presented by the Florida Department of Environmental Regulation (1976) for the Perdido-Escambia River basin; Flood and Associates, Inc. (1978) for South Escambia and Santa Rosa Counties; and the WFRPC (1978a) for Escambia, Santa Rosa, and Okaloosa Counties. The WFPRC (1978a; 1979a) presented a summary of a three-year water quality study of Escambia, Santa Rosa, and Okaloosa Counties in Florida. Recommendations were made to improve water quality over a 20-year planning period (1976-1996).

Waste Management

Subsurface Injection

M.J. Kaufman (1973) reported on a project by the U.S. Geological Survey to assess the environmental impacts of subsurface injection of liquid wastes in Florida. Two sites were located in Santa Rosa County at the time of this report. The author reported that over 7 billion gallons of industrial wastes and treated sewage had been injected at the various sites throughout Florida through mid-1971. Also provided in the report were the observed hydraulic and geochemical effects at the sites. G.L. Faulkner and Pascale (1975) described a local waste injection monitoring problem in the limestone aquifer, near Pensacola, Florida. An increase in static pressure had caused an introduction of diluted wastes into a nearby monitoring well in 1973; by 1974, pressure effects extended in about a 40-mile radius from the injection site. Merritt (1984) provided a digital simulation of the localized effects of subsurface waste injection near Pensacola, resulting in a generalized simulation of the flow system of the region, and simulation of observed changes in water level.

Other Waste Disposal Treatment Studies

The Escambia County Health Department, Environmental Health Division (1968) provided a listing of the public water and sewage systems in Escambia County, Florida, including maps for 26 systems. Converse and Company, Inc. (1970, 1972) conducted a study on the water supply and wastewater disposal methods of Okaloosa County and Fort Walton Beach in Florida. A five-year sewer plan for metropolitan Pensacola was presented by Flood and Associates (1971), based on rational planning and pollution control criteria. Baseline, Inc. (1973) provided an environmental assessment of Pensacola Bay for its capacity to handle treated sewage effluent.

The WFPRC (1977b, c, d) provided a series of reports on the 208 Areawide Waste Treatment Management Plan. Nissan, et al. (1980) conducted a waste disposal inventory for the coastal counties of Mississippi and Alabama. TRW, Environmental Engineering Division

of Redondo Beach, California (1981) summarized alternative disposal methods for offshore platform hazardous wastes. Sloan (1984) studied various land treatment sites in the Pensacola area for use as industrial and domestic waste effluent disposal areas. The USEPA (1984) provided an environmental impact statement for the construction of wastewater facilities in south Escambia and Santa Rosa Counties. Capuzzo and Kester (1987) edited a book on marine pollution; included were papers on the biological aspects of waste disposal as related to the bioaccumulation and toxicological effects of contaminants on marine organisms.

Miscellaneous Pollution Studies

Duke (1970) examined the distribution of Aroclor 1254® (PCB) in Pensacola estuaries. Samples of the biota (fish, crabs, oysters, and shrimp), water, and sediments were tested. Juvenile shrimp were most sensitive to the PCB; mortality occurred at 5.0 ppb. Concentrations of the toxin at the mouth of the Escambia River were less than 1 ppb. D.B. Ward and Chapman (1973) studied the effects of herbicide driftage at Eglin Air Force Base in Florida. Spraying of defoliants (Agents Purple, Orange, White, and Blue) had already begun at the time of the study, so that the original vegetation was not sampled. Few changes were noted in species composition or abundance. Weedy species increased near the test area following the temporary defoliation of the test species. D.W. Cook (1976) studied the distribution of fecal bacteria in Mississippi Sound and Biloxi Bay over a nine-year period. Highest fecal counts in Biloxi Bay were consistently found in areas of lowest salinity; whereas Mississippi Sound remained relatively free of fecal pollution throughout the study. Bourquin, et al. (197) studied the interaction of microbes with various toxicants under laboratory conditions. J.S. Lytle and Lytle (1977) analyzed sediment samples taken from coastal areas between Fort Myers, Florida and Pascagoula, Mississippi for the presence of hydrocarbons. Bourquin and Pritchard (1979) reported on the proceedings of a workshop on the degradation of pollutants by microbes in the marine environment. Topics included biochemistry of microbial degradation, biodegradation in microcosms, and methodology of microbial degradation.

Rubinstein, et al (1979) studied the effects of contaminated sediments on benthic organisms. These organisms served as quantitative estimators of xenobiotic activity in dredged material. Borthwick and Patrick (1982) estimated a half-life of less than one week for marine-grade creosote to be acutely toxic. McLelland (1987) assessed the effects of municipal sewage pollution abatement in Ocean Springs Harbor by measuring phytoplankton and chlorophyll levels over a two-year period. Before abatement, there were high chlorophyll levels, with increased productivity of phytoplankton in the warm, nutrient-rich waters of the harbor. Phytoplankton species succession showed trends more closely associated with seasonal factors than with pollution factors. Shigenaka and Price (1988) provided information on regional sources of organic contaminants in benthic environments of the coastal and estuarine sediments of the United States, including sites along the Gulf Coast.

Wildlife, Ecology, and Natural History

General Ecological Studies

Florida

T.S. Hopkins (1973) provided a report on the marine ecology of the Escarosa region to establish a baseline for making management decisions concerning marine resources. As part of the National Science Foundation, Student-originated Studies Project (1974) several researchers reported on various physical, chemical, biological, and socioeconomic aspects of Navarre Beach. Topics included botany, phytoplankton, bacteriology, macroinvertebrates, water chemistry, sedimentology, hydrography, vertebrates, sociology, and economics. W.H. Valentine (1980*) provided a brief general description of the beach, dune, forest, and marsh ecosystems of Santa Rosa Island. S.H. Wolfe, et al. (1988) presented an ecological characterization of the Florida panhandle. The authors described the geology, climate, hydrology, terrestrial habitats, aquatic habitats, and estuarine, saltwater, wetland, and marine habitats of the area. Also included was information on population densities by county, as well as projected population increases by county.

Alabama

As part of the Alabama coastal region ecological characterization, O'Neil and Mettee (1982) characterized the coastal waters and uplands, described the flora, fauna, and endangered species, and developed an energy-flow model for the bay/sound area, together with the lowlands.

Mississippi

Irby and McCaughan (1975) compiled a collection of works by area scientists on a variety of topics: oceanography, geology, flora, fauna, mariculture, fisheries, and pollution. They also listed all research laboratories, facilities, and agencies in the area, and discussed coastal law and education. Bradburn (1977) provided a general article on the barrier islands of Mississippi, describing each island's flora, fauna, and accessibility. L.R. Brown, et al. (1978) conducted a comprehensive study on the ecological role of tidal marshes on the Mississippi/Alabama Gulf Coast. The authors suggested that, through proper management techniques, the primary productivity of marshes might be increased. Kelly (1981) edited a document on the results of a symposium on Mississippi Sound. A variety of topics were discussed: marine fisheries, marshes, marine flora, pollution monitoring, habitat mitigation and restoration, oyster reef rehabilitation, benthic communities, geology, and resource management.

General Gulf of Mexico

J.J. Lynch (1941) discussed both the beneficial and detrimental effects on wildlife and habitat when control burning is used as a management tool. The author concluded that control burning was an efficient and practical management tool for Gulf Coast marsh refuges. Galtsoff (1954a) coordinated an extensive document summarizing knowledge about the Gulf of Mexico through 1954. Numerous articles on a wide range of topics were included: exploration, geology, meteorology, water chemistry, pollution, flora, and fauna. Stephens (1968) provided a general account of the plants and animals found along southern seashores, including the Gulf of Mexico. J.I. Jones, et al. (1973) edited a general report on the scientific knowledge of the eastern Gulf of Mexico, which included information on the physical and biological environment, marine resources, recreation, industry, and environmental quality. Lazell (1979) studied and compared the terrestrial vertebrates, commenting on their origin and status, of Atlantic and Gulf Coast barrier islands, including those islands between Louisiana and Florida. Fore and Peterson (1980) edited a volume on the proceedings of the Gulf of Mexico Coastal Ecosystems Workshop. The purpose of the workshop was to provide information to coastal decision makers on developments in coastal ecology with regard to assessing human impacts on fish and wildlife resources. As part of the Mississippi Deltaic Plain Region Ecological Characterization, Wicker (1980) conducted a habitat-mapping study to identify and measure different habitats in the study area. Two habitat maps were constructed, one for the mid 1950's and one for the late 1970's. In 1981, Carey, et al. edited the proceedings of the U.S. Fish and Wildlife Service Workshop on Coastal Ecosystems of the Southeastern United States. The major emphasis was on three types of systems: marshes, mangroves, and seagrasses.

Van Beek, et al. (1981) provided an assessment of the natural resources of the Mississippi deltaic region. The high productivity of the region is directly related to the inflow of Mississippi River water and sediments, resulting in a rich array of wetlands and estuaries. The authors presented data on the geology, hydrology, meteorology, biology, fisheries, and ecology of the region. A series of maps on various subjects relating to the Mississippi deltaic region were compiled by Garofalo (1982). Topics included socioeconomic features, oil, gas, and mineral resources, soils, geology, climatology, coastal processes, and biological resources. Bahr, et al. (1985) presented management recommendations for environmental problems of the Mississippi deltaic region. The report summarized the following: 1) major classes of environmental problems; 2) history, structure, and function of the region's natural systems; 3) recommendations for environmental problems; and 4) use of technical data bases to approach problems. Rabalais, et al. (1985) reported on oxygen depletion in the estuarine and coastal waters of Texas, Louisiana, Mississippi, Alabama, and Florida. Oxygen levels in Mississippi Sound were very low during the summer. Baugh (1986) discussed the physical parameters,

wildlife, and history of Cat, West Ship, East Ship, Petit Bois, and Dauphin Islands. Laist, et al. (1986) traced the evolution of the U.S. coral management programs. The economic value of corals found along the Gulf Coast was discussed.

Ecological Inventories/Assessments

Florida

The Florida State Board of Health, Bureau of Sanitary Engineering (1966b) conducted a chemical, biological, and bacteriological survey of the Escambia River. As part of the Gulf of Mexico Estuarine Inventory and Study, McNulty, et al. (1972) described the mangroves, tidal marshes, submerged vegetation, stream discharge, and artificial reefs of Florida. Moshiri, et al. (1981) conducted an environmental inventory and performed a biological assessment of a section of Santa Rosa Island, including Sabine Island. Data on climatology, geology, flood and storm tides, vegetational zones, and fauna of the area were included.

Alabama

An early, extensive biological survey of Alabama was conducted by A.H. Howell (1921). More recently, the Alabama Coastal Area Board (1980) provided an extensive inventory of Alabama's coastal resources.

Mississippi

J.W. Ward, et al. (1948) compiled a species list of animals collected in the vicinity of the Gulf Coast Research Laboratory in Ocean Springs, Mississippi. Richmond (1962) compiled an extensive species list of the flora and fauna of Horn Island. An extensive bibliography was also provided. As part of the Cooperative Gulf of Mexico Estuarine Inventory and Study, Christmas (1973b) provided an area description of Mississippi's coastal region. J.A. Jackson, et al. (1979) conducted a biological and historical inventory of the offshore lands and waters of Horn and Petit Bois Islands. In addition, the authors reported on the socioeconomic status of the area with regard to the impacts of dredging. They recommended that the wilderness status of the islands be extended to include "all submerged lands within one mile of the high tide mark of the islands", including the Horn Island Pass shipping channel.

General Gulf of Mexico

J.M. Valentine (1967) provided a brief habitat description of the proposed barrier islands for Gulf Islands National Seashore. As part of a study to inventory and assess developed and undeveloped barrier islands proposed by President Carter in 1977, Lins (1980) presented an interpretation of data collected between 1945-1955 and 1972-1975 on patterns and trends of land-use on Atlantic and Gulf Coast barrier islands. Beccasio, et al. (1982) compiled an information base and bibliography as a user's guide for the Gulf Coast. Ecological resources were summarized by geographic zones; descriptions and locations of special status species were listed; and aquatic and terrestrial species of high commercial, recreational, and aesthetic value were discussed, as well. Ehler and Basta (1983) discussed the USDCNOAA's program for the Gulf of Mexico to develop information useful in setting or modifying national objectives for marine resource development and conservation. In 1983, the USDCNOAA presented the results of an environmental assessment of the Gulf of Mexico. The assessment presented a review of several economic factors, and their direct and indirect relationships to the physical and biological marine and atmospheric environments. Pensacola, Florida and Mobile, Alabama were two of the selected study sites.

Endangered Species

Florida

Hendry, et al. (1982), and the Florida Game and Freshwater Fish Commission (1982) compiled a complete list of Florida's threatened and endangered species. In 1985, Wood presented an update on the endangered fauna of Florida, listing scientific names, common

names, and status as designated by various state and federal agencies.

Alabama

Keeler (1972) edited a report on the rare and endangered vertebrates of Alabama. Boschung (1976) edited a list of plant and animal species categorized as endangered, threatened, or of special concern within Alabama. Aside from the species list, data on habitat, location, status, and morphological features were provided as well. The USDOIFWS(1981) provided an inventory of endangered and threatened species of the Tennessee-Tombigbee Corridor, which includes the Mobile Bay area.

Mississippi

J.A. Jackson (1975a) compiled a preliminary list of the rare and endangered vertebrates of Mississippi. Shabica (1977) reported on the status of Ship, Horn, and Petit Bois Islands' endangered and threatened species. At the time of the report, the American alligator, the Eastern Brown Pelican, the Southern Bald Eagle, and the Peregrine Falcon were listed as endangered. Other proposed endangered species were loggerhead sea turtle, green sea turtle, and Osprey. J.A. Jackson, et al. (1979) provided a status report on the endangered and threatened species of Gulf Islands National Seashore. Four reptile and seventeen bird species were identified as endangered; five of those species (American alligator, Osprey, Snowy Plover, Gull-billed Tern, and Least Tern) were reported to nest on the barrier islands.

The Mississippi Department of Wildlife Conservation (1982) compiled a species list and locations of the threatened and endangered plants and animals of Mississippi. As part of the Northern Gulf of Mexico Estuaries and Barrier Islands Research Conference, J.A. Jackson (1983a) presented the results of his study on the endangered or threatened species of Gulf Islands National Seashore, Mississippi between 1978 and 1982. Included was a listing of four species of reptiles and seventeen species of birds, along with an account of each: status, seasonality, abundance, and habitat. Further information on the previously mentioned endangered species was presented by J.A. Jackson (1983b), along with recommendations for management (J.A. Jackson, 1984b).

General

An anonymous author (Anonymous, 1977b) discussed the decline of three species of sea turtles: loggerhead, green, and ridley. The author recommended a move toward habitat protection, a modification of commercial fishing gear, and further research on the biology and ecology of each species. Christman and Lippincott (1978) provided a listing of the rare and endangered vertebrates of the southeastern United States' coastal plain.

Floral and Faunal Studies

Carr and Goin (1955) presented a guide to the identification of Florida's reptiles, amphibians, and freshwater fish. A list of 333 species was compiled, along with information on the distribution, range, and habitat of each species. A supplement to the flora and fauna of Horn Island, Mississippi was compiled by Richmond (1968). A total of 1568 species were collected and identified from 1944 through 1966. Insects were the predominant group represented, followed by fish. Franks and Christmas (1971), and Franks, et al. (1972) presented two volumes on the seasonality of nektonic and benthic faunas off the coast of Mississippi. Volume One consisted of the results of their seasonal study, which included data on various physical parameters. Volume Two contained the appendix and index, together with a species list. Benson (1982) edited a document on the spawning, nurseries, and migratory requirements of selected finfish and shellfish of Mississippi Sound to assist the U.S. Army Corps of Engineers in planning their dredging activities. Using sampling sites along the south shore of Horn Island, S.T. Ross, et al. (1987) studied seasonal and diel variations in the standing crop of fish and macroinvertebrates. Both fish and macrofauna were most abundant in the summer, while lowest abundance for both groups was recorded in the winter. Seasonal factors were more important than physiochemical factors in influencing abundance.

Conservation

The USDOIFWS (1970a, b) reported on the results of the National Estuary Study, which was conducted to develop the means to protect, conserve, and restore estuaries. Chapter three of the first volume dealt directly with the estuarine zone of the Gulf of Mexico, providing zone boundaries, dominant estuarine features, and indigenous fauna. B. Hansen (1973) reported on the Air Products Wildlife Sanctuary in Escambia Bay, describing the terrain, various habitats, and the wildfowl colonies that utilize the sanctuary. Stry (1984) discussed the importance of marshes as loci for settlement and growth during the Colonial Period. The author also discussed how federal laws were established, and described the formation of societies to protect and preserve wetlands. The USDOIFWS(1985) presented a draft report to Congress concerning the conservation of coastal barrier resources. Two chapters dealt directly with areas in the Gulf of Mexico; a physical characterization and ecological assessment were performed for each site. Field, et al. (1988) proposed the development of a national data base for coastal wetlands of the United States.

Coastal Zone Management

Regional Studies

Florida

General Plans/Policies

The FCCC (1971a) proposed the use of a suggested state zoning system for land and water areas. It was recommended that detailed zoning in areas of development should be carried out by local and county authorities; however, "key facilities" would be subject to criteria established by the FCCC. Escambia and Santa Rosa Counties were the subject of a pilot study concerning coastal zone management (FCCC, 1971b). Air pollution, groundwater, waste disposal, estuarine pollution, and shore erosion were some of the aspects of coastal management discussed. In 1972, the FCCC provided an overview on various aspects of the coastal environment for planners and decision makers. Milo Smith and Associates, Inc. (1972a) conducted an inventory of Florida's coastal areas. The three volumes were divided into counties, cities, and statewide areas. Milo Smith and Associates, Inc. (1972c) presented a shoreline management plan for the Escambia - Santa Rosa region of Florida. The West Florida Regional Planning Council (1975a-f) provided a series of reports on Florida's coastal zone. Included were an economic analysis, an environmental quality assessment, a land ownership analysis, a land-use analysis, a population analysis, and a support services analysis.

Ditton, et al. (1976) presented a general conceptual framework for coastal recreation, planning, and management. In addition, they furnished a broad spectrum of potential management strategies. The Florida Department of Natural Resources (1976) provided a preliminary draft for coastal management in Florida. The objectives were to develop a program of preservation, protection, development, restoration, and enhancement of Florida's coastal zone. Fischer, et al. (1986) provided an overview of an approach to consolidating information for coastal zone management in Florida. G.W. Stone and Salmon (1988) developed nine planning criteria for shoreline restoration following hurricanes: erosion rate, foredune preservation, hazard zones, estuarine setbacks, planned-unit development, evacuation planning, vertical evacuation, hazard district location, and public participation. These criteria were related to data from hurricanes that occurred in 1979 and 1985.

Miscellaneous Plans/Policies

The USACEMD (1965) provided an appraisal report on beach conditions along Florida's coastline. They defined problem areas, existing Corps projects, and future project needs. The USACEMD (1967b) reported on the construction of jetties at the seaward end of the East Pass Channel in Florida. The USACEMD (1971b) compiled a special flood hazard report for the Okaloosa County beaches on Santa Rosa Island.

Milo Smith and Associates, Inc. (1972b) presented a land management plan for Pensacola Beach. The USACE (1972c) provided an overview on the flood potential and flood hazards of Pensacola. Included in the report was historical information, together with data on past floods, and the types of situations that facilitate flooding in the area. The USACEMD (1972a) evaluated the weir-jetty systems of Perdido Pass in Alabama and East Pass in Florida. Provost (1973) studied mean high water levels and tideland delineation throughout Florida, including Pensacola. The author stressed the use of vegetation as a key to delineation.

The University of Florida's Coastal and Oceanographic Engineering Laboratory (1974) studied shoreline erosion in Escambia County, and developed a "safe" setback line for future development. A development plan for Pensacola Beach was presented by the Escambia County Department of Community Development (1974b). They recommended allowing developers one half mile of the one-mile section of Pensacola Beach requested for low density development. The University of West Florida (1974) conducted a baseline study on the physical, chemical, biological, and socioeconomic environments of Navarre Beach, for the purpose of reopening Navarre Pass. J.H. Davis (1975) reported on the use of vegetation to stabilize coastal property. The Escambia County Department of Community Development (1975) presented a natural resources management plan for Pensacola Beach in order to maintain orderly development.

The USACEMD (1976c) reported on beach erosion control and hurricane protection for the Florida beaches from Panama City to the Alabama state line. G.W. Stone (1984b) applied wave refraction theory to the proposed channel and jetty system at Navarre Pass. Application of this theory for the purposes of coastal management and future planning were discussed. Using Perdido Key as an example, Rhode (1985) discussed growth and development on coastal barriers. The author recommended letting nature dictate the placement, type, and density of development, and, in long-term planning, give consideration to physical constraints, biological productivity, and natural beauty. He also mentioned an elevation of public attitude to dependence on nature, rather than a mastery over it. Fischer (1986) outlined the decision-making processes surrounding beach erosion control in Florida. The author stressed that all affected groups should be involved in decision-making processes.

Alabama

The USACE (1955) conducted an erosion control study at Perdido Pass. They concluded that the most suitable plan for stabilization of the Pass would be the construction of a single jetty approximately 3,100 feet long, extending southwestward from Florida Point; however the plan could not be justified by the evaluated benefits, so no Federal project was authorized at the time. In 1978, the USACEMD presented a feasibility report for beach erosion control in Mobile County. Recommendation was made for a dredging/nourishment plan. The Alabama Coastal Area Board (1979) presented a coastal area management program for public review and comment. The USDCNOAA, Office of Coastal Zone Management and Alabama Coastal Area Board (1979) provided a coastal zone management program and a draft environmental impact statement for Alabama. Stout (1980) provided information on restoration techniques for damaged dunes. Weggel (1981) discussed the methodology for design of weir sand-bypassing systems. Methods of data analysis and interpretation of weir system design were presented.

Mississippi

Watts (1958) studied beach fill behavior along a 25-mile stretch of shoreline in Harrison County. Material losses were slight, less than 0.1 yd³/yr/linear foot. The Mississippi-Alabama Sea Grant Consortium (1974) published the proceedings of a conference on coastal zone management. The conference focused on high-use alternatives rather than the protection/preservation aspects of coastal management. The Mississippi Marine Resources Council (1974) discussed the issues, problems, goals, and objectives of coastal management in Mississippi. V.J. Henry (1976) reported on the results of a beach nourishment project by the USACE on the western end of Ship Island. A 28-month monitoring period followed, in which the eastern one third of the beach retreated over 80 meters. During the initial 22-month period following nourishment, the shore retreated an average 1.3 meters/month. Walton and Purpura (1977) presented a case study of beach fill success carried out in Harrison County, Mississippi.

over a 20-year period; they found that 29.4% of the initial fill, added in 1951, had eroded. The USACE (1979c) recommended either the construction of a seawall or beach nourishment to preserve the shoreline of Fort Massachusetts on Ship Island. In 1980, the USDCNOAA, Office of Coastal Zone Management and the University of Southern Mississippi discussed various aspects of coastal and wetland management. T.P. Collins (1982) provided a guide for laypersons to coastal management in Mississippi. Included was a history of Mississippi coastal development and land-use. Leard (1983), and the Mississippi Department of Wildlife Conservation, Bureau of Marine Resources (1983) also discussed Mississippi's coastal management program. Weinstein (1988) edited a document on the results of a workshop held to address questions regarding the effects of coastal engineering projects on the recruitment of the egg and larval stages of fish and shellfish.

General Gulf Coast Studies

Federal Studies

The USACE (1971) discussed guidelines for a national shoreline protection study. Regional protective measures were presented for the Gulf Coast. Typical erosion control measures, examples of shore protection facilities, and criteria for planning were discussed. Giannio and Wang (1974) presented guidelines for the design of a small boat marina with minimal adverse environmental impact to the marsh estuarine ecosystem. The USDOI, Heritage Conservation and Recreation Service (1978) discussed the preservation and wise use of barrier islands. Topics included the characteristics and development of barriers, storm-dependent features, the impacts of development, reasons for protection, protection efforts by federal, state, and private organizations, and the influence of federal programs.

Rocawich (1982) profiled the brackish water areas of nine southern states, including those along the Gulf Coast. The author discussed natural features, indigenous cultures, and special problems reflecting policy towards coastal resources and residents. J.K. Mitchell (1982) compared national coastal zone management policies, including mention of various policies in the Gulf Coast region. The author discussed the evolution of the federal government's responsibilities for coastal zone management. The USDCNOAA, Office of Coastal Zone Management (1982) listed coastal policies on various issues on a state-by-state basis. The USDOIMMS (1983; 1984) reported on the proceedings of the Gulf of Mexico Information Transfer Meetings. Pollution, artificial reefs, offshore oil impacts, and wetlands impacts were some of the topics included.

Other Studies

Zile (1973) discussed the substance and direction of the Coastal Zone Management Act of 1972. Carroll (1974) described, from a preservation standpoint, the processes by which Gulf Islands became a National Seashore. H.C. Miller (1982) discussed the dangers of oceanfront development. P.A. Buckley (1982) reported on the structural vs. non-structural solutions to coastal erosion problems. The author listed "hard structure" solutions from least (mainland, bayside bulkheading) to most (bulkheading on barrier islands bayside) damaging. He also stated that "no action" should be considered as the primary alternative. The USDOIFWS (1970g) presented a listing of state development plans and policies as a part of the National Estuary Study. Gregg, et al. (1983) evaluated a variety of alternatives to federal involvement in the development of barrier islands. Titus (1986) described the possible consequences of the greenhouse effect and sea level rise on the beaches and coastal wetlands of the Gulf Coast.

Dredging

Dredge Disposal

Harmon Engineering and Testing (1984), and the USEPA (1986) filed reports on the designated Pascagoula offshore disposal site for dredged materials from the Pascagoula Outer Bar Channel. The disposal site was located approximately two miles southeast of the eastern end of Horn Island, in nine to ten meters of water. Alternatives to this location were also discussed. An anonymous author (Anonymous, 1987) discussed designated, dredged material

dumpsites in the Gulf of Mexico, including a site off Pensacola, Florida. For this particular site, only sand-sized particles will be permitted. Although this site had been previously used, only temporary detrimental effects were noted. Thackeray (1987) reported on three examples of beneficial uses of dredged materials at Gulf Islands National Seashore: 1) the protection of Fort Massachusetts on Ship Island; 2) bird nesting sites on Petit Bois and Horn Islands; and 3) beach nourishment for Perdido Key Beach.

Channel Maintenance Dredging

Stimson (1942) reported on a dredging project in Mississippi Sound at Pass Christian Harbor. Royall (1949) reported on maintenance dredging in Gulfport Harbor, Mississippi. Local interests requested a modification of the existing project to provide a 32-foot deep and 300-foot wide channel crossing Ship Island bar. The USACEMD (1959) studied possibilities for improvement of the maintenance dredging procedures for Biloxi Harbor, Mississippi. An economic and hydrographic survey was conducted for other Gulf Coast harbors and waterways: Pascagoula Harbor, Mississippi (USACEMD, 1961; 1962a); Pensacola Harbor, Florida (USACE, 1962b); Perdido Pass Channel, Alabama (McNamara, 1964); Bayou La Batre, Alabama (USACEMD, 1964a); Biloxi Harbor, Mississippi (Brucker, 1969); Mobile Harbor, Alabama (USACEMD, 1970b); and Gulfport Harbor, Mississippi (USACEMD, 1979d).

The USACEMD (1973 b) discussed the adverse effects of the maintenance dredging of Escambia River-Escambia Bay in Florida. They reported on a temporary disruption of vegetation and wildlife productivity, a disruption of the benthic communities on the channel bottom, and a temporary increase in turbidity with a possibility of siltation. Similar environmental impact statements were provided by the USACEMD for: Gulfport Harbor, Mississippi (1973c); Pascagoula Harbor, Mississippi (1973d), Perdido Pass Channel, Florida (1973e).

The USACEMD (1976b) reported on their plans for the maintenance dredging of the Gulf Intracoastal Waterway. Little dredging of Santa Rosa Sound was planned; no dredging of the Mississippi barrier islands was indicated; and only the dredging near Perdido Key would possibly impinge on Gulf Islands National Seashore. A species checklist and maps were included in the appendices. The USDOINPSSERO (1977) provided an environmental assessment of maintenance dredging for the Davis Bayou boat channel. The USACE (1980c) reported on the planning, economics, and environmental impacts of a channel-deepening project for Mobile Harbor, Alabama.

Dredging Impacts on the Environment

Ingle (1952) conducted a detailed analysis of the muds of Mobile Bay, Alabama, and Apalachicola, East, and Pensacola Bays in Florida to determine the effects of dredging on fish and shellfish. The USEPA (1972) conducted a baseline environmental study of the effects of dredge spoil disposal in Mobile Bay. Over 75% of the core sample sediments exceeded EPA standards of heavy metal pollution for open water dredge disposal. Lackey, et al. (1973) studied the effects of maintenance dredging in Ship Channel (Mobile Bay, Alabama) on the distribution of coliform bacteria, benthic invertebrates, and plankton. There was no evidence of coliform dispersion caused by dredge discharge. Benthic invertebrates showed low diversity and total numbers, indicating stress, possibly due to low salinity. The plankton community was only effected in the immediate vicinity of the dredge discharge. The USACEMD (1973a) determined the extent of existing and proposed dredging operations in Mobile Bay, and conducted a baseline environmental study of their own.

The U.S. Coast Guard (1973) prepared an environmental impact statement for the proposed maintenance dredging of the channel from the Santa Rosa Coast Guard Station to the navigable waters of Pensacola Bay. Water and Air Research Inc. (1975) conducted a study on the effects of maintenance dredging on ecological parameters in the Gulfport Ship Channel, Mississippi. Similar environmental impact statements were prepared by the USACEMD for East Pass Channel in Florida (1975a) and Escambia River-Escambia Bay, Florida (1976a).

Bouma (1976) edited a book on the economic and environmental effects of shell dredging on Gulf Coast environments, including notes on Choctawhatchee and Pensacola Bays in Florida. Vittor (1978) provided a literature review of studies on the effects of dredging in Mississippi Sound. Berger and Boland (1979) conducted a model study on the effects of dredging in Mobile Bay to determine the effects of widening and deepening the navigational channels, and to determine the impact of dredge spoil islands on tides, currents, salinities and dye dispersal patterns in the bay. Shabica and Shabica (1979) studied the effects of maintenance dredging on the immediate physical environment along the western edge of Petit Bois Island, Mississippi. T.F. Lytle and Lytle (1982) developed a sampling and chemical analyses procedure for the evaluation of the transport and impact of organic pollutants in Mississippi Sound.

Oil Drilling

Ecosystems Management (1974) published an evaluation of Alabama's offshore oil drilling regulations. The University of Southern Mississippi, Department of Geography and Area Development (1976) reported on the environmental impacts of outer continental shelf oil drilling, transport, and refining on oyster beds, seagrass beds, and beaches in the Gulf of Mexico. The Jackson County Planning Commission (1976b) discussed geographic areas of concern with regard to the impacts of oil drilling on the outer continental shelf off Mississippi. Negligible environmental impacts were found for Gulf Islands National Seashore. Fore (1977) edited the proceedings of the 1977 Oil Spill Response Workshop. The responsibilities, capabilities, and procedures for the USDOIFWS in response to oil spills were discussed. The USDOIBLM (1978) provided an environmental impact statement for outer continental shelf (OCS) oil and gas lease sale 51. Similar studies were conducted by the New Orleans Outer Continental Shelf Office (1981) on proposed OCS oil and gas lease sales 67 and 69; Christopher, et al. (1985) for proposed OCS oil and gas lease sales 104 and 105; and Reinhardt, et al. (1986) for proposed OCS oil and gas lease sales 110 and 112.

Mumphrey and Carlucci (1978) presented an overview on the past and potential impacts of offshore oil and gas exploitation on living resources and their habitats in the Gulf of Mexico. Chasis (1979) discussed the federal government's leasing program for oil and gas development on the outer continental shelf. She also discussed potential impacts on coastal and marine environments as the result of oil spills. Vittor and Associates (1980) conducted a monitoring program for the Mobil Oil test-well in Mobile Bay. Topics included climatology, water chemistry, hydrography, meiofauna, macrofauna, and sediment analysis. The Getty Oil Company (1981) described their proposed oil drilling activities in East Bay, Florida. The Mississippi Department of Wildlife Conservation, Bureau of Marine Resources (1982) provided an environmental profile of the sensitive natural resources of Mississippi's coastal waters that require a buffer area from oil and gas drilling rigs. O'Neil and Mettee (1982) edited a document summarizing available information on the natural resources of coastal Alabama to aid in planning for the development of Alabama's outer continental shelf oil and gas resources. The USACEMD (1982) reported on Mobil Oil's drilling of production wells for natural gas at the entrance to Mobile Bay between Dauphin Island and Perdido Key. A physical, ecological, and socioeconomic description of the affected environment was provided. Nikituk and Farris (1986) reviewed the leasing of federal offshore lands for oil and gas drilling from 1954 through 1984. The geology and physiography of the outer continental shelf of the Gulf of Mexico was described, along with a discussion of socioeconomic factors, regional issues, and planning areas.

Fisheries

Commercial

General Gulf of Mexico

The USDOIFWS (1958) conducted a survey of all aspects of the U.S. shrimping industry. Anderson (1966) provided a general article on the life history, growth, and descriptions of white, brown, and pink shrimp taken by the Gulf of Mexico shrimping industry. The Gulf South Research Institute (1976) discussed the management priorities of the Gulf Coast states

with regard to commercial fisheries. Other topics included aquaculture and environmental impacts. The Gulf States Marine Fisheries Commission (1977) proposed several solutions to problems of the Gulf area fishing industry. They discussed new taxes, dredging, licenses, regulations, funding sources, and research needs. Lindall and Saloman (1977) studied the impacts of estuarine destruction, and the consequent alteration of the fishery resources of the Gulf of Mexico. Fishing industries of the Gulf are extremely dependent on estuaries; approximately 90% of commercial catches consist of estuarine-dependent species. Flandorfer and Skupien (1980) presented the results of a workshop on the utilization of potential fishery resources in the northern Gulf of Mexico. The Pensacola area fishery was specifically mentioned.

Couch (1985) studied the frequency of infectious and non-infectious diseases in oysters and fish from Pensacola and Escambia Bays in Florida, Mobile Bay in Alabama, and Pascagoula Harbor and Mississippi Sound in Mississippi. Stations near heavily-industrialized Pascagoula Harbor yielded a higher frequency of diseased organisms; however, the study revealed "no grossly evident epizootics of pollutant-related disease". Jarman and Conner (1987) edited the results of a conference on Gulf and South Atlantic fisheries. Presentations reflected the experiences of those actively involved in fishery resource issues. J.M. Ward (1988) reviewed the published cost and revenue data of Gulf of Mexico shrimp vessels. The author also compared profit margins between large and small vessels. Cost and revenue estimates suggested that the fishing industry has been generally profitable from 1971-1980. Medium-sized vessels (25-50 feet) showed the best financial performance. A portion of the data covered the Florida west coast fishing ports.

Mississippi

Maghan (1967) reported on the history of Mississippi's oyster industry. Christmas (1971) identified and discussed several fishery research and development problems in Mississippi, including environmental, engineering, socioeconomic, legal, and fisheries management. Projects were developed for priority problems with shrimp, crab, and coastal pelagic fish species, and proposals were approved for funding under the Commercial Fisheries Research and Development Act. Christmas and Waller (1973) studied the occurrence, relative abundance, seasonal and areal distribution, distribution in the salinity-temperature matrix, spawning, and growth rates of fish from Mississippi estuaries. The objective was to establish a baseline of information to aid in the management of fisheries resources which are dependent on estuaries. Over 93% of the total numbers caught were in three families: Engraulidae, Clupeidae, and Sciaenidae. Keel and Cook (1975) isolated a bacterial organism found in oysters, shrimp, and finfish from Biloxi Bay that is responsible for food poisoning.

Etzold and Christmas (1979) discussed the goals and objectives of a proposed state management plan for Mississippi's fisheries. The authors summarized the laws and regulations of the present program, and presented a conceptual model for the proposed plan. Benson (1982) discussed the spawning, migration, distribution, habitat, and life history requirements of selected finfish and shellfish in Mississippi Sound. B. Jones and Benson (1982) compiled a users guide to a finfish and shellfish database for Mississippi Sound and Mobile Bay. The database includes information on spawning, nursery areas, migration, distribution, and environmental requirements.

Florida

The annual report of the Commercial Fisheries Biological Laboratory at Gulf Breeze, Florida was prepared by Butler and Johnson (1967). A portion of the report discussed the effects of various pesticides on spot, blue crabs, and oysters. Also included was a systematic inventory of the marine fauna in the Pensacola estuary.

Recreational

Artificial reefs

Daniel and Seward (1975) conducted an aerial survey of sportfishing locations via boat

counts. The report provided estimates of fishing pressure on artificial and natural fishing reefs in Mississippi Sound, and provided economic guidelines for determining the feasibility of reef construction. Meek (1977), and Michot-Foss (1980) discussed the sinking of World War II vintage ships along the Gulf Coast for the creation of artificial reefs. R.B. Stone (1978) discussed the history of artificial reefs, and their use as a fishery management tool to maintain stocks of certain types of fish.

An anonymous author (Anonymous, 1983b) reported on the donation of an offshore oil and gas production platform to the State of Florida by Tenneco Oil for use as an artificial reef. The platform was moved, and submerged in 175 feet of water, 22 miles southeast of Pensacola in 1982. Pybas (1987) compiled a guide to the locations and characteristics of more than 200 artificial reefs where fishing and diving are permitted in Florida waters. Reggio (1987) reported on the conversion of obsolete, nonproductive, offshore oil and gas structures to artificial reefs. The author reported that 125 artificial reef projects have been permitted in the waters of the Gulf Coast states. Also included was a discussion of construction options for conversion of rigs to reefs.

Miscellaneous

Becker (1970) related his own fishing experiences in the Gulf, and provided information on locations for good fishing. G.A. Jackson (1972) monitored various sportfishing parameters in Biloxi Bay through interviews and postcard surveys. Results indicated that the average catch rate compared favorably with other areas, and that people fishing were mainly comprised of local men, with October being the heaviest fishing month. Darovec, et al. (1975) presented guidelines to aid in the restoration of various coastal features (sand dunes, salt marshes, mangroves, seagrass beds, and reefs) for fishery enhancement in Florida. Etzold, et al. (1977) reported on charter boat fishing along the Mississippi Gulf Coast. J.C. Johnson, et al. (1987) discussed the use of non-traditional fish among marine recreational fishermen of the southeast United States, including the west Florida area. The authors discussed the development of educational materials for enhancing the use of certain underutilized species. Schmied and Burgess (1987) provided an overview of marine recreational fisheries in the United States, including the Gulf Coast area. Landing data, estimated expenditures, and a characterization of marine recreational fishermen were provided.

Miscellaneous Topics

Regional Land-use and Development

McGee, Dewitt and Associates (1965) prepared a general management plan for the Santa Rosa Island Authority, Pensacola Beach, Florida. Volume One consisted of a resource survey and analysis; Volume Two was a general development plan. The Escambia-Santa Rosa Regional Planning Council (1968) conducted a study of the legislation and administration needed by Escambia and Santa Rosa Counties for future growth and development. Reynolds, Smith, and Hills, Inc. (1973a) provided the National Park Service with an evaluation of the development potential of three tracts of land on Perdido Key in Florida. An investigation of the real estate market and the availability of utilities revealed no apparent reason why the tracts could not be developed.

The Escambia County Department of Community Development (1974a) proposed a land-use and environmental management ordinance. In addition, they provided a summary of other laws, regulations, and ordinances for land-use. The Florida Department of Administration, Division of Planning (1976) provided a list of recommendations to be taken into consideration with future development and the increase in population. The WFRPC (1977a) discussed the physical characteristics, population, and economy of west Florida, and provided recommendations for land development in Escambia, Santa Rosa, and Okaloosa Counties.

Education

W.Y. Bennett and Haburay (1976) compiled a teachers guide to the beach ecology of

Santa Rosa Island. Disinger (1976) provided a directory of the recipients of federal funds, along with recommendations of state education agency specialists. For Gulf Islands National Seashore, funds recipients included the Environmental Education Center, Environmental Studies Center, Santa Rosa Island beaches, Fort Pickens, and Black Bird Marsh Nature Trail. The Environmental Studies Center of Pensacola, Florida (1976) provided an interpreters guide for teachers and other group leaders. The guide contained information on biotic communities and their ecology, in addition to a species list of flora and fauna, with references for further information. The Environmental Studies Center and USDOINPSGUIS (1976) compiled a reference guide for local beaches, and presented suggestions for pre-trip, on-site, and follow-up classroom activities. Topics included barrier islands, beaches, dunes, intertidal and subtidal areas, flora, fauna, soils, climate, and human impacts.

Research Activities

Caylor (1951) reported on the objectives and purpose of the Gulf Coast Research Laboratory in Ocean Springs, Mississippi. An historical perspective of the lab was presented by Gunter (1957). He provided a general description of the area, and mentioned some of the successful research projects that have been carried out at the lab.

The FCCC (1971c) presented plans for research coordination, and discussed the need to develop a management plan. In 1973, the FCCC provided a summary and bibliography for marine environmental studies conducted along Florida's Gulf Coast.

Atwood (1981) convened a symposium on environmental research needs in the Gulf of Mexico. Some of the research topics included circulation, meteorology, geochemistry, wetlands, coral reefs, fisheries, and petroleum-hydrocarbon distribution. Gordon, et al. (1981) reported on the locations of existing and projected coastal energy development projects nationwide. Tables showed existing facilities, planned expansion, proposed projects, and possible facilities. Shabica, et al. (1983) edited the proceedings of a research conference on northern Gulf of Mexico estuaries and barrier islands. Topics included estuaries, offshore petroleum exploration and development, barrier islands, and resources management.

An overview of the Gulf Coast Research Laboratory in Ocean Springs, Mississippi was provided by Howse (1983; 1984). The author described the various facilities and programs the lab has to offer. The USDCNOAA (1984) conducted an inventory of non-federally funded marine pollution research, development, and monitoring along the Gulf Coast. The inventory included estuarine, coastal, and freshwater areas.

Non-Park Legislation

Bartley (1968) discussed the legislation and administrative organization needed for the planning of future growth and development in Escambia and Santa Rosa Counties in Florida. The USDOIFWS (1970f) reviewed existing laws, actions, and pacts for the Gulf Coast states with regard to estuarine resources, as part of the National Estuary Study. Also included were federal, state, and local laws on the zoning, commercial use, preservation, and land acquisition of estuarine areas.

W.T. Watson and Harrison (1974) compiled a document on the water laws of Alabama. The authors discussed the preservation and development of coastal areas, the Alabama Water Management Act, and riparian and littoral rights. Kusler (1978) prepared a report to aid states in the development of wetlands protection programs. The report defined coastal and inland wetlands, data gathering requirements, and states' standards and regulations of activities. Graber (1986) discussed coastal legislation in Mississippi. Uplands, tidelands, and submerged lands were covered separately. In 1988, Graber discussed Alabama's coastal laws. The article described Alabama's Coastal Area Act of 1979, and covered such topics as land titles, determination of tidal boundaries, leasing and regulation, and public access.

Storm Surveys

W.K. Wilson (1966) conducted an historical survey of hurricanes along the northwest

coast of Florida. As a result, the District Engineer of the USACEMD recommended no new hurricane protection measures be undertaken. Included in the document were many photographs of historical value. A similar document was prepared by the USACEMD (1967c) for the Mississippi Coast. The USACEMD (1967a) reported on storm damage and coastal protection along Alabama's shoreline. The report identified potential damage areas, compared historical hurricane data, established a tide stage/frequency curve, determined potential annual damages in exposed areas, evaluated emergency preparedness planning, and developed an economic analysis of protective measures. Criswell and Cummins (1970) surveyed the Gulf Coast for structural damage following Hurricane Camille in 1969. The storm center came ashore near Pass Christian, Mississippi with winds in excess of 190 mph and tides 16 feet above normal. The report presented a qualitative assessment of structural damage; photographs were included. The low-lying areas of the Mississippi Gulf Coast were most heavily damaged. Also included in the report was information on the performance of various structural types (masonry versus wood) during the storm.

The USACEMD provided a series of reports on the flooding history of several areas of Florida's Gulf Coast. The reports also served as a guide to land-use control and flood plain development, and contained maps and photographs. The following areas were studied: Destin coastal area, Okaloosa County (1979a); Choctawhatchee Bay, Fort Walton Beach vicinity, Okaloosa County (1971a); Big Lagoon-Santa Rosa Sound-Pensacola Bay-East Bay, Escambia and Santa Rosa Counties (1972); Blackwater Bay and Escambia Bay, vicinity of Pensacola, Santa Rosa and Escambia Counties (1975b); and Perdido and tributary bays, Alabama and Florida (1975c).

The University of Florida's Coastal and Oceanographic Engineering Laboratory (1972) conducted an analysis of projected storm tides for Choctawhatchee Bay, Florida. Sensabaugh, et al. (1977) discussed a comprehensive engineering study and topographic survey of Florida's coastal areas to establish a coastal construction setback line as a protection measure for coastal area properties, and to monitor erosion. Rockefeller (1980) discussed the risks involved in developing barrier islands. The author stressed the need for a protection plan in the event of natural disasters.

Freshwater Management

Flood and Associates (1972) presented a five-year water plan for the Escambia and Santa Rosa County Planning Council. The Escambia County Department of Community Development, and Durham, Henningson, Richardson, and Hart, Inc. (1974) presented a report on the hydrology of Escambia and Santa Rosa Counties, as related to the stormwater runoff of seven major stream basins, including runoff from roads, agriculture, septic tanks, and erosion. The U.S. Geological Survey, Water Resources Division (1978) presented a compilation and analysis of water resources data for the South Atlantic-Gulf Coast region. The area covered included North Carolina southward to Florida, and westward to Louisiana.

J.M. Wright (1983) discussed the future of Mississippi's groundwater resources. The author reported that the wells in the area were designed for economic reasons, with little regard for conservation; as a result, most wells extract their water from the same narrow band, causing a severe reduction in static water levels. Due to apathy and economics, the author projected poor prospects in the future for Mississippi's freshwater supplies. The USACENOD(1983) conducted a feasibility study of freshwater diversion from Mississippi and Louisiana estuarine areas to Lake Pontchartrain and Mississippi Sound. Included in the report was a cultural resource reconnaissance, an economic and social analysis, proposed planning goals and objectives, a comparison and evaluation of existing water quality in the area, an evaluation of the environmental impacts of discharged dredged material into the project area, coastal use guidelines, and information on the criteria and monitoring system required for the operation of the freshwater diversion system.

Socioeconomics

Fernald (1981) compiled an atlas of Florida, designed as a comprehensive graphic representation of the physical and cultural resources of the state, to be used by students,

researchers, and planners. Presented in graphic form, the atlas is divided into eight sections: an introduction, the natural environment, population history and culture, economy, recreation and tourism, transportation and communication planning, energy, and Florida's future. O'Neil, et al. (1982), and Friend, et al. (1982) provided quantitative and qualitative descriptions of several socioeconomic aspects of coastal Alabama: industrial and residential development, agricultural production, mineral production, commercial fisheries, transportation, recreation and tourism, multiple use conflicts, and environmental issues. French and Parsons (1983) presented a similar characterization of northwest Florida's natural and aesthetic values. Also included was a discussion of the economic and recreational activities of the area.

Maps

U.S. Department of Interior, National Park Service, Gulf Islands National Seashore, Mississippi Unit, Ocean Springs, MS.

Miscellaneous Maps

- Vegetation, Davis Bayou Unit, 1977, 1:500' and 4:10'.
- General Development Plan, Preferred Alternative, GUIS MS and FL, 1976.
- Boundary Survey, Magnolia Area, GUIS-MS, 1976, 1:660', Perry S. Ransom, Jr., Consulting Engineers, Biloxi, MS. 7 pp.
- Photo Atlas Sheet, Jackson County, MS, 1976, 1:500', Consolidated Consultants, Inc., Gulfport, MS.
- Description of State of Mississippi lands known as Magnolia State Park and 4-H Camp, located in Jackson County, MS, 1971, 1:200', Perry S. Ransom, Jr., Ocean Springs, MS.
- Operational Headquarters, Davis Bayou, MS, 1:500', Reynolds, Smith, and Hills, Jacksonville, FL.
- Environmental Assessment, Davis Bayou, MS, 1976, 1:500', Reynolds, Smith, and Hills.
- Davis Bayou, existing conditions surveyed as of 12/77, 1:50', Reynolds, Smith, and Hills, 86 pp.
- Topographic sheet of Magnolia Area, 1:50', no date, USDOINPSDSC.
- Ship Island Pass to Petit Bois Pass, Gulf of Mexico, MS, shoreline mapping, 1:20,000'.
- Wetland changes on Petit Bois Island, MS (1956-1978), USDOINPSGUISMS using 1956 and 1978 data, 1:24,000', habitat type, USDOIFWS National Coastal Ecosystems Team, Slidell, LA.
- St. Stephens Meridian, 1:1000', Federal and non-Federal land, USDOINPS, Office of Land Aquisition and Water Rsources, Horn and Petit Bois Islands.
- Horn Island Reference Line Survey, 1/80, 1:24,000'.
- Gulfport Channel and anchorage basin dredging, 1979, USACEMD, 13 sheets.
- Davis Bayou, channel restoration, prepared from information from Hurricane Camille damage, USACEMD.
- Vegetation map of Horn Island, Eleuterius, L.N. and Caldwell, S.D., Botany Section, Gulf Coast Research Laboratory, Ocean Springs, MS.

Airphotos

- Perdido Key, Florida Department of Transportation, Tallahassee, FL, 8/19/85, 1:600', BEW.
- All USDOINPSGUIS, Ship Island Pass to Petit Bois Island, 1:600', 6/11/86, USDCNOAA, Rockville, MD.
- Perdido Key, 1:6000', 8/8/84.

U.S. Coast and Geodetic Survey Charts

- Mississippi Sound, Western Part, Round Island to Grand Island, Chart No. 190, Ed. No. 5, 10/16 and 1/08.
- Mississippi Sound and approaches, Dauphin Island to Cat Island, Chart No. 1267, Ed. No. 10, 3/65; Ed. No. 7, 12/60, revised 7/61; Ed. No. 6, 3/47, revised 1/56 and 8/55; Ed. No. 5, 4/45; Ed. No. 3, 9/33; Ed. No. 2, 2/76; Ed. No. 1, 2/20; Chart No. 11373, Ed. No. 21, 2/76.
- Mississippi Sound, Western Part, Round Island to St. Joseph's Island, Chart No. 190, Ed. No. 3, 1/1887; Ed. No. 5, 1/08; Ed. No. 2, 9/1877; Ed. No. 1, 1/1860.

U.S. Department of Interior, National Park Service, Gulf Islands National Seashore, Florida Unit, Gulf Breeze, FL.

Map File Drawer 1 (Fort Pickens)

- 1797, *Bateria Povicional, Santa Rosa en la Punta Siguenza*, (Spanish battery located on Santa Rosa Island).
- 1874, June 6, Plan of Fort Pickens showing modifications, Sheet 14.
- 1874, Sections and elevations of modifications, Fort Pickens, Sheet 15.
- 1822, Point of Santa Rosa Island at the entrance of Pensacola Bay, West Florida, Sheet 3.
- 1829, Plan of a fort projected at Santa Rosa Point (architectural and topography plans for Fort Pickens), 2 sheets.
- 1831, Plan of the Fort at Santa Rosa Point, Florida.
- ?, Island of Santa Rosa, aerial of Siguenza Point showing location of Fort Pickens, wharf, assistant engineer quarters.
- 1860, Fort Pickens, sketch exhibiting the covering line, and the positions of the traverse circles for barbette carriages.
- 1860, Fort Pickens, plans.
- 1841, Profiles of Santa Rosa Point (levels of ground at various positions around fort).
- 1841, Casemates of Fort Pickens (plans), 2 sheets.
- 1857, Fort Pickens, aerial sketch.
- 1854, Fort Pickens, sketch of the central channel bastion, showing the position of its barbette guns, and the required modification of the parapet.
- 1857, Fort Pickens, sketch showing the slopes of the lower terreplaine [sic] of the central bastion.
- 1851, Fort Pickens southwest bastion (sketch of Bastion D)
- 1858, Fort Pickens, sketch of southwest bastion.
- 1858, Fort Pickens, sketch of northwest bastion.
- 1864, Fort Pickens, sketch of southwest bastion showing the position of its barbette guns, and the modification of the parapet.
- 1861, Fort Pickens, showing the position of Fort Pickens, and all the mainland batteries and forts (aerial).
- 1863, Armament of Fort Pickens throughout fort (4 sheets).
- 1864, Fort Pickens, 15" gun platform in central channel bastion (plan and section).
- 1865, Fort Pickens -plan showing all platforms, barbette, and casemates.
- 1868, Fort Pickens, southwest bastion (details showing 15" gun platform and parapet).
- 1868, Fort Pickens, sketch of northwest bastion.
- 1868, Fort Pickens, Santa Rosa Island (aerial plan), 8 sheets.
- 1868, Fort Pickens, horizontal section through embrasures (plans).
- 1868, Fort Pickens, sections and elevations (3 sheets).
- ?, Wharf at Fort Pickens, architectural plans.
- 1875, Kitchen, mess room, and stables at Fort Pickens (sketch showing proposed locations).
- 1890, Plan of Fort Pickens showing locations of platforms that can be most readily adapted for mounting 8" converted rifles.
- 1829, Projected fort at Santa Rosa Point (profiles of fort including plans and details relating to mine chambers), Sheet 72-A.
- 1829, Plan of a fort projected at Santa Rosa Point, Sheets 72-B,C,D.
- 1829, Projected fort at Santa Rosa Point (sections and elevations of the tower bastion, plans and details), Sheet 72-F.
- 1894, Proposed Ken Wharf at Fort Pickens (plans for wharf).
- 1908, Proposed seas wall construction, Fort Pickens, Florida, Sheet 89-5.
- 1898, Cable tank, Fort Pickens (plans and sketches).
- 1904, Mining casemate at Fort Pickens (plan showing location).
- 1909, Mining station, Fort Pickens (plans).
- 1899, Fort Pickens, map with legend depicting destruction and impact of explosion of Bastion D.
- 1901, Contour map of Fort Pickens, Sheet 99-1.
- 1908, Portion of old Fort Pickens and Battery, Pensacola (elevations of ground from fort to beach line).
- ?, Pensacola Harbor, tide gage [sic] on wharf (plans for a tide gage on U.S. Engineer

Wharf, Fort Pickens).

1873, December 1, Fort Pickens depicting cannon emplacements, type of platform, cannon, carriage (2 sheets).

1892, Fort Pickens, Pensacola Harbor (armaments, pintles, carriages throughout fort), Sheet 25-8.

1898, Fort Pickens, Pensacola Harbor (armament throughout fort), Sheets 25-12 and 25-15.

1900, Fort Pickens, Pensacola Harbor (cannon locations in fort), Sheet 25-28.

1909, Fort Pickens, aerial map showing placement of barracks, mess hall, lieutenants quarters, etc.

1899, Frame barrack building, Fort Pickens (barracks plans, one-story buildings located west of Fort Pickens).

1974, 4'x4' contour map of Fort Pickens, prepared by USGS R-8.

1977, Stabilization of Fort Pickens (drawings and blueprint of plans for stabilization).

Map File Drawer 2 (Fort Barrancas and Water Battery)

---?, Fort San Carlos de Austria.

1838, Plan of Fort San Carlos de Barrancas (5 sheets).

1840, Sketch of old site of Fort San Carlos de Barrancas (4 sheets).

1841, Plans, sections, and elevations, Fort Barrancas.

---?, Sections and elevations, Fort Barrancas (2 sheets).

---?, Details of drawbridge, Fort Barrancas.

1861, Sketch of foundations dug into Fort Barrancas.

1861, House, storeroom, mess room, servants quarters (architectural plans), 2 sheets.

1844, Fort San Carlos de Barrancas (sketch of main work).

1842, Fort Barrancas (work up to 1942).

1842, Fort Barrancas, plan and section of relieving arches.

1844, Fort Barrancas, plan and section of iron pintle and wedges (letter included).

1844, Plan and section of Fort Barrancas.

1846, Plan of quarters of commanding officer, Fort Barrancas.

1846, Plan of the Gonzalez House and lot at Fort Barrancas (3 sheets).

1846, Plan and section of Gonzalez House at Fort Barrancas (2 sheets).

1866, Sketch of Fort Barrancas showing barracks and certain lots.

1852, Sketches of old and new barracks at Fort Barrancas.

1869, Fort San Carlos de Barrancas, aerial drawing and layout of fort.

1869, Fort San Carlos de Barrancas, architectural layout of parts of fort.

1892, Fort Barrancas and Spanish Battery (gun emplacements).

1869, Fort Barrancas (portion of gallery).

---?, Fort Barrancas, Florida searchlight (map of past, present, and proposed location of portable searchlight shed).

1970, Schematic developed area plan of Pensacola forts (aerial map drawn of Pensacola Naval Air Station).

1968, Fort Barrancas, site plans for fort and water battery.

1978, Preservation of Fort Barrancas and water battery (architectural plans for restoration).

---?, Fort Barrancas, contact/comfort station, comprehensive design.

Map File Drawer No. 3 (Fort McRee)

1840, Fire control cables, Fort McRee (aerial layout).

---?, 8" gun battery, Fort McRee (design for gallery connecting gun platforms).

1835-1842, Plan of the castle at Foster's Island, exhibiting the progress of work up to 30 September 1835.

---?, Plans and elevations of hospital, kitchen, quarters for Fort McRee.

1856, Plans and details of Fort McRee (architectural sketches).

1849, Aerial sketch, Foster's Bank, Fort McRee, and new outlet of the lagoon (2 sheets).

1852, Sketches of Foster's Bank and the site of Fort McRee and Advanced Battery.

1868, Shoreline of Fort McRee (sketch showing shoreline jetties in existence at Fort McRee).

1922, Defense of Pensacola searchlights No. 1, 2, and 3 (drawings and plans for light).

1899, Emplacement for four 15 pounder R.F. guns, Fort McRee (design and layout).

- 1909, Proposed sea wall, Fort McRee.
- 1846, Aerial drawing of Fort McRee.
- 1842, Fort McRee (plan of part of 2nd floor showing the construction of interior and exterior galleries).
- 1837, Plan of the fort on Foster's Island (architectural plans).
- 1940, January 3, Fire control cables, Fort McRee.
- 1973, Resource components, Perdido Island.
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Map File Drawer 4 (Advanced Redoubt)

- ?, Sketch of Advanced Redoubt.
- 1844, Sketch at Advanced Redoubt, Sheets 23 and 24.
- 1844, Profile sections of Advanced Redoubt (2 sheets).
- 1846, Plans of masonry and roofing of arches, Advanced Redoubt (2 sheets).
- 1846, Sections and elevations of the Advanced Redoubt (2 sheets).
- 1847, Plan showing the condition of Advanced Redoubt and Fort Barrancas (3 sheets).
- 1859, Traverse section for covered way, Advanced Redoubt (architectural plans).
- 1857, Advanced Redoubt, drawings of bastions and relieving arches, Sheets 58, 61, and 62.
- 1857, Advanced Redoubt, southeastern half of bastion (design).
- 1869, General section through middle of Redoubt, Fort Barrancas (architectural layout), Sheet 68.
- ?, Various sketches of Advanced Redoubt, including 1) cross section, 2) aerials, 3) Harper's Weekly aerial of Pensacola, Florida showing the forts.
- 1974, Reference plan, Advanced Redoubt (aerial drawing plan of fort, along with a cross section cut).
- 1974, Stabilization of fortifications of Pensacola, Advanced Redoubt (drawing of plans).

Map File Drawer 5 (Battery Cullum)

- 1983, Preservation of Battery Pensacola (14 sheets).
- 1982, Floor plan of Battery Langdon.
- 1903, Battery Cooper, emplacement for two 6" rapid fire guns on disappearing carriages, Sheet 105-1.
- 1903, Battery Cooper, proposed location for two 6" rapid fire guns, Sheets 105-2 and 105-3.
- 1906, Battery Cooper, two 6" rapid fire guns showing electrical wiring, supply, and drainage, Sheet 105-4.
- 1934, Battery Cooper, 155 mm gun emplacement 360° (materials list), Sheets 105-6, 105-6A, and 105-6B.
- 1896, Battery Cullum, plan for proposed battery for 10" guns, disappearing carriage of Santa Rosa Island, Sheet 81-1.
- 1896, Battery Cullum, details for platform for 10" gun battery of Santa Rosa Island, Sheet 81-4.
- 1896, Battery Cullum, 10" gun battery on Santa Rosa Island, outline of concrete showing proposed changes, Sheet 81-5.
- 1904, Battery Cullum, proposed enlargement of loading platforms, and addition of shell and relocater rooms, Sheet 81-15.
- ?, Battery Cullum, emplacement for four 10" B.L. rifles, Sheet 81-16.
- 1907, Battery Cullum, plans and details for modernizing, Sheet 81-17.
- 1908, Battery Cullum, proposed location of powder hoist, Sheet 81-18.
- 1909, Battery Cullum, showing proposed alteration of powder magazine, Sheet 81-22.
- 1914, Battery Cullum, proposed station and plotting room, Sheet 81-29.
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MAPS, CHARTS, AND AERIAL PHOTOGRAPHS OF GATEWAY NATIONAL SEASHORE

Order of contents

Abbreviation list

Aerial photographs

Books and articles concerning maps

Maps, various topics:

- Coastal Geomorphology
- Ecology/Vegetation
- Floods/Storms
- Geology/Hydrology
- Miscellaneous Maps
- Zoning/Land Use Cover

National Ocean Survey (U.S. Coastal and Geodetic Survey) - Hydrographic Survey

National Ocean Survey (U.S. Coastal and Geodetic Survey) - Nautical Charts Topographic maps

Government agencies from which maps and photos may be obtained

Source Address List

ABBREVIATIONS

AIRPHO	Air-Photographics, Inc.
ANON	Anonymous
ASCS	Aerial Photography Field Office
CACO	Cape Cod National Seashore
CCES	Center for Coastal and Environmental Studies
DMA	Defense Mapping Agency
EROS	Earth Resources Observation System
GATE	Gateway National Seashore
MANN	Mann Library, Cornell University
MONCPB	Monmouth County Planning Board
NARO	North Atlantic Regional Office
NASAJIS -	
NOS	National Ocean Survey
ROBASI	Robinson Aerial Surveys, Inc.
SCS	Aerial Photography Field Office
TXAERO	Aero Service Corporation
TXPIC	Petroleum Information Center
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USDOIFWS	United States Department of Interior, Fish and Wildlife Service
USDOINPS	United States Department of Interior, National Park Service
USDOINPSDCS	United States Department of Interior, National Park Service, Denver Service Center
USDOINPSNARO	United States Department of Interior, National park Service, North Atlantic Regional Office

Aerial Photographs

Introduction

Aerial photographs are listed in chronological order in the following format: Producer, Date, Location, Scale, Type, Source.

Producer: listed as found in citations, indexes, and on photographs. If producer is not given it is listed as an Anon.. Addresses of producers are included in the Source address list.

Date: xxxx(xx/xx), year of overflight, month, and day if known.

Location: given by present-day towns and feature names.

Scale: given as the representative fraction (i.e. 1:24,000) or as unknown.

Type: indicates if photo is black and white (BW), black and white infrared (BWIR), color (COL), or color infrared (CIR). If photos of the same date are available in two different types this is indicated.

Sources: indicates the agency from which aerial photographs may be purchases, copied, or viewed. Unless otherwise noted the sources are the same as the producers. Addresses of sources are included in the Source address list.

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Format: author, date, title, scale, contours, field survey, revision dates, etc., publisher, source.

Author: person or group that did cartography

Date: taken from citations and maps

Title: taken from citations and maps

Scale: given as the representative fraction (i.e. 1:24,000) or as unknown

Contour: information given where appropriate

Field survey: field survey date, given where appropriate

Revision date, etc.: date revisions were made of previous copy

Publisher: first name given after scale (or after contour, field survey, and revision date, where appropriate) if two are presented. Many times this will be missing and only source will be given. Addresses will be given in source address list.

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- Faden, W., 1776, A Plan of New York Island, With Part of Long Island, Staten Island and East New Jersey, no scale given
- Faden, W., 1779, Plan of the Redoubts at Richmond on Staten Island, 30th October 1779, no scale given
- Holland, S., 1776, The Seat of Action Between the British and American forces; or, An authentic Plan of the Western Part of Long Island, no scale given
- Walling, H.F., 1859, Map of Staten Island, Richmond County, New York 1:1,320, D.A. Fox, New York, NY, MANN

Topography Maps

Gateway National Seashore is divided up into 4 units: Breezy Point; Jamaica Bay; Sandy Hook; and Staten Island.

- Breezy Point - Coney Island quadrangle
- Jamaica Bay - Brooklyn Quadrangle
Coney Island Quadrangle
Far Rockaway Quadrangle
Jamaica Quadrangle
- Sandy Hook - Sandy Hook Quadrangle

- Staten Island - Arthur Kill Quadrangle
The Narrows Quadrangle

General topography

Dripps, Mp., 1872, Map of Staten Island (Richmond Co.) NY, 1:21,120, publisher not given, MANN
 Lockwood, Kessler, Bartlett, Inc., 1979, Gateway National Recreation Area Topography Survey Barren Island Marine, 1:480, Lockwood, Kessler, Bartlett, Inc., GATE
 Slatkin, D., 1954, Plumb Beach - Borough of Brooklyn - Topographical Map, Dept. of Public Works, Area Emmons Avenue - Sheepshead Bay, 1:240, City of New York, Dept. of Parks, NARO

National Ocean Survey (U.S. Coastal and Geodetic Survey)

The National Ocean Survey (NOS) was formerly known as the United States Coastal and Geodetic Survey. Copies of original plane table surveys of the National Ocean Survey can be obtained from the National Archives by specifying place name, county, and state location. Surveys and charts are listed in chronological order.

NOS Hydrographic Surveys

Format: year, number of map, title, scale

Year - year of survey

Number of map- number used for identification

Title - area covered by chart

Scale - given as the representative fraction (i.e. 1:24,000)

Source - charts can be obtained from the United States Coastal and Geodetic Survey and older surveys from the National Archives Addresses included in the source address list.

Breezy Point

1927, T-4325, Rockaway Inlet to East Rockaway Inlet, 1:10,000
 1928, T-4407, Rockaway Inlet, Floyd Bennett Field, 1:10,000

Jamaica Bay

1928, T-4407, Rockaway Inlet, Floyd Bennett Field, 1:10,000
 1928, T-4408, Interior of Jamaica Bay, 1:10,000
 1928, H-4869, Interior of Jamaica Bay, 1:10,000

Sandy Hook

1932, T-4714, Sany Hook, 1:10,000

NOS Nautical Charts

A description of the National Ocean Survey (NOS) is given in the previous section. Charts are listed in chronological orders.

Format: date, title, number, scale, number of historical editions.

Date: date of latest edition

Title: area covered by chart

Number: present number, date of number change, previous number

Scale: given as the representative fraction (i.e. 1:24,000)

Number of historical editions - number of historical editions and time span.

Source charts may be obtained from the National Ocean Survey, National Cartographic Information Center, and older charts from the National Archives. Addresses included in the source address list.

DMA, 1947, Boston - Sandy Hook, sheet no. 6, 1:1,000,000, USGS
 NOS, 1981, Jamaica Bay and Rockaway Inlet New York, as of 1/75 #12351 070174, 1:20,000, 15 historical edition 1964-1980, NOS
 NOS, 1981, New York Harbor Gravesend Bay part of Arthur Kill, as of 8/77 #12349 070174, 1:10,000, 7 historical editions 1946-1977, NOS
 NOS, 1981, Raritan Bay and Southern Part of Arthur Kill, as of 9/74 #12331 070174, 1:15,000, 22 historical editions 1924-1979, NOS
 NOS, 1982, approaches to New York, Nantucket Shoals, Loran A-C, 1:400,000, 1 historical edition 1980, NOS
 NOS, 1982, Cape Sable to Cape Hatteras - Loran A-C, as of 8/74 #13003 070174 previously #1000, 1:1,200,000, 32 historical editions 1900-1978, NOS
 NOS, 1982, New York Harbor, as of 2/75 #12328 070174, 1:40,000, 16 historical editions 1963-1980, NOS
 NOS, 1982, New York Harbor, US East Coast, as of 7/74 #12327 070174, 1:40,000, 37 historical editions 1940-1980, NOS
 NOS, 1982, Sandy Hook Bay New York Harbor - Lower Bay, as of 8/74 #12330 070174, 1:10,000, 10 historical editions 1969-1980, NOS
 NOS, 1982, West Quoddy Head to New York, as of 8/74 #13006 previously #60, 1:675,000, 22 historical editions 1935-1980, NOS
 NOS, 1983, Approaches to New York, Fire Island Light - Loran A-C, as of 10/74 #12326 070174, 1:80,000, 33 historical edition 1914-1981, NOS
 NOS, 1983, Jamaica Bay and Rockaway Inlet New York, as of 12/75 #12350 070174, 1:20,000, 36 historical editions 1924-1980, NOS
 NOS, 1983, Sandy Hook of Little Egg Harbor, NJ, as of 12/74 #12324 070174, 1:40,000, 18 historical editions 1962-1980, NOS

Topographic Maps

Topographic maps are divided up by quadrangle and then listed in reverse chronological order.

Format: producer, year, title, scale, contour, field survey, photo survey, revised, source.

Producer: agency that produced the map

Date: year map was published

Title: taken directly from topographic map

Scale: given as the representative fraction (i.e. 1:24,000)

Contour: contour interval given in feet

Field Survey: year that area was field checked

Photo Survey: year that area was phot revised.

Revised: year that information was revised from previous editions.

Sources: indicates the agency where the map may be purchased. Addresses of sources are in the source address list.

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The Narrows Quadrangle

General topography

Dripps, Mp., 1872, Map of Staten Island (Richmond Co.) NY, 1:21,120, publisher not given, MANN

Lockwood, Kessler, Bartlett, Inc., 1979, Gateway National Recreation Area Topography Survey Barren Island Marine, 1:480, Lockwood, Kessler, Bartlett Inc., GATE

Slatkin, D., 1954, Plumb Beach - Borough of Brooklyn - Topographical Map, Dept. of Publish Works, Area Emmons Avenue - Sheepshead Bay, 1"240, City of New York, Dept. of Parks, NARO

Topographic Maps

New York and Vicinity

USGS, 1961, Brooklyn, 1:24,000, contour 5' - 10' - 20', USGS

USGS, 1961, Sandy Hook, 1:24,000, contour 20', USGS

USGS, 1961, Staten Island, 1:24,000, contour 5' - 10', field survey 1955, USGS

USGS, 1955, General area, 1:24,000, contour 20', USGS

USGS, 1954, General area, 1:24,000, contour 10' - 20', USGS

USGS, 1947, General area, 1:24,000, contour 10' - 20', USGS

USACE, 1943, New York Harbor/Lower Bay, 1:125,000, contour 50', field survey 1938, photo survey 1938, USGS

USGS, 1913, Long Island, 1:250,000, contour 20', USGS

USGS, 1892, New York-New Jersey, New York sheet, 1:62,500, contour 20', USGS

New York

DMA, 1979, 1:250,000, contour 25' - 50', field survey 1977, photo survey 1977, revised 1979, USGS

DMA, 1971, 1:250,000, contour 25' - 50', field survey 1960, revised 1969, USGS

USGS, 1975, 1:250,000, contour 25' - 50', field survey 1960, revised 1969, USGS

DMA, 1964, 1:250,000, contour 25' - 50', field survey 1960, USGS

USGS, 1962, 1:250,000, contour 25' - 50', field survey 1946, USGS

DMA, 1960, 1:250,000, contour 25' - 50', field survey 1960, USGS

USGS, 1958, 1:250,000, contour 25' - 50', field survey 1946, USGS

DMA, 1951, 1:250,000, contour 25' - 50', field survey 1946, USGS

New York - Sandy Hook

DMA, 1979, 1:250,000, contour 25' - 50', field survey 1977, photo survey 1977, revised 1979,

USGS

USGS, 1975, 1:250,000, contour 25' - 50', field survey 1960, revised 1969, USGS
 DMA, 1971, 1:250,000, contour 25' - 50', field survey 1960, revised 1969, USGS
 DMA, 1964, 1:250,000, contour 25' - 50', field survey 1960, USGS
 USGS, 1962, 1:250,000, contour 25' - 50', field survey 1946, USGS
 DMA, 1960, 1:250,000, contour 25' - 50', field survey 1960, USGS
 USGS, 1958, 1:250,000, contour 25' - 50', field survey 1946, USGS
 DMA, 1951, 1:250,000, contour 25' - 50', field survey 1946, USGS

Newark to Sandy Hook

USGS, 1975, 1:250,000, contour 100', field survey 1945, photo survey 1944, revised 1969, USGS
 DMA, 1971, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1969, USGS
 DMA, 1968, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1947, USGS
 DMA, 1964, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1947, USGS
 DMA, 1960, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1947, USGS
 DMA, 1950, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1947, USGS

Staten Island

USACE, 1921, 1:62,500, contour 20', field survey 1897, revised 1910, USGS
 USGS, 1959, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1946, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1932, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1926, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1920, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1913, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1909, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1908, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1906, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1904, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1902, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1900, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1899, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1891, 1:62,500, contour 20', field survey 1889, USGS

Arthur Kill Quadrangle

USGS, 1976, 1:24,000, contour 10', field survey 1966, photo survey 1966, revised 1966, USGS
 USGS, 1969, 1:24,000, contour 10', field survey 1966, photo survey 1966, revised 1966, USGS
 USGS, 1962, 1:24,000, contour 10', field survey 1955, photo survey 1954, USGS
 DMA, 1957, 1:24,000, contour 10', field survey 1955, photo survey 1954, USGS
 DMA, 1957, 1:24,000, contour 10', field survey 1943, photo survey 1940, revised 1947, USGS
 DMA, 1949, 1:24,000, contour 10', field survey 1943, photo survey 1940, revised 1947, USGS
 USGS, 1947, 1:24,000, contour 10', field survey 1943, photo survey 1940, revised 1947, USGS

Brooklyn Quadrangle

USGS, 1979, 1:24,000, contour 10', field survey 1967, photo survey 1977, revised 1977, USGS
 USGS, 1975, 1:24,000, contour 10', field survey 1967, photo survey 1966, revised 1967, USGS
 USGS, 1970, 1:24,000, contour 10', field survey 1967, photo survey 1966, revised 1967, USGS
 USGS, 1966, 1:24,000, contour 10', field survey 1956, photo survey 1954, USGS
 USGS, 1966, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
 USGS, 1963, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
 USGS, 1961, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
 USGS, 1960, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
 USGS, 1959, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
 DMA, 1958, 1:24,000, contour 5' - 10', field survey 1956, photo survey 1954, USGS
 USGS, 1955, 1:24,000, contour 10', field survey 1943, photo survey 1940, revised 1947, USGS
 DMA, 1949, 1:24,000, contour 5' - 10', field survey 1943, photo survey 1940, revised 1947, USGS

USGS, 1948, 1:62,500, contour 10', field survey 1897, revised 1924, USGS
 USGS, 1945, 1:62,500, contour 10', field survey 1897, revised 1924, USGS
 USGS, 1938, 1:62,500, contour 10', field survey 1897, revised 1924, USGS
 USGS, 1931, 1:62,500, contour 10', field survey 1897, revised 1924, USGS
 USGS, 1928, 1:62,500, contour 10', field survey 1897, revised 1924, USGS
 USACE, 1921, 1:62,500, contour 10', field survey 1897, revised 1913, USGS
 USGS, 1916, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1910, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1908, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1906, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1905, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1903, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1900, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1899, 1:62,500, contour 20', field survey 1897, USGS
 USGS, 1896, 1:62,500, contour 20', field survey 1889, USGS
 USGS, 1891, 1:62,500, contour 20', field survey 1889, USGS

Coney Island Quadrangle

USGS, 1979, 1:24,000, contour 5', field survey 1966, photo survey 1977, revised 1977, USGS
 USGS, 1976, 1:24,000, contour 5', field survey 1955, photo survey 1954, revised 1966, USGS
 USGS, 1975, 1:24,000, contour 5', field survey 1955, photo survey 1954, revised 1966, USGS
 USGS, 1968, 1:24,000, contour 5', field survey 1955, photo survey 1954, revised 1966, USGS
 DMA, 1957, 1:24,000, contour 5', field survey 1955, photo survey 1954, USGS
 DMA, 1949, 1:24,000, contour 5', field survey 1943, photo survey 1940, revised 1947, USGS

Far Rockaway Quadrangle

USGS, 1977, 1:24,000, contour 5', field survey 1969, photo survey 1966, USGS
 USGS, 1971, 1:24,000, contour 5', field survey 1969, photo survey 1966, USGS
 USGS, 1966, 1:24,000, contour 5', field survey 1943, photo survey 1941, revised 1956, USGS
 DMA, 1956, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1954, USGS
 DMA, 1949, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1947, USGS

Jamaica Quadrangle

USGS, 1979, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1977, revised 1977, USGS
 USGS, 1976, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1966, revised 1966, USGS
 USGS, 1970, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1966, revised 1966, USGS
 USGS, 1966, 1:24,000, contour 5' - 10', field survey 1957, photo survey 1953, USGS
 DMA, 1959, 1:24,000, contour 5' - 10', field survey 1957, photo survey 1953, revised 1947, USGS
 USGS, 1956, 1:24,000, contour 5' - 10', field survey 1943, photo survey 1941, revised 1947, USGS
 DMA, 1949, 1:24,000, contour 5' - 10', field survey 1943, photo survey 1941, revised 1947, USGS

The Narrows Quadrangle

USGS, 1982, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1976, revised 1981, USGS
 USGS, 1976, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1966, revised 1966, USGS
 USGS, 1969, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1966, revised 1966, USGS
 USGS, 1965, 1:24,000, contour 5' - 10', field survey 1955, photo survey 1954, USGS
 DMA, 1957, 1:24,000, contour 5' - 10', field survey 1955, photo survey 1954, USGS
 DMA, 1949, 1:24,000, contour 5' - 10', field survey 1943, photo survey 1941, revised 1947, USGS

Sandy Hook Quadrangle

DMA, 1983, 1:24,000, contour 20', field survey 1954, photo survey 1975, revised 1975, USGS
 USGS, 1977, 1:24,000, contour 20', field survey 1943, photo survey 1970, revised 1970, USGS
 USGS, 1972, 1:24,000, contour 20', field survey 1943, photo survey 1970, revised 1970, USGS
 USGS, 1969, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1954, USGS
 USGS, 1962, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1954, USGS

USGS, 1957, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1954, USGS
 USGS, 1950, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1947, USGS
 USACE, 1921, 1:62,500, contour 10', field survey 1910, USGS
 USGS, 1919, 1:62,500, contour 10', field survey 1884, USGS
 USGS, 1912, 1:62,500, contour 10', field survey 1884, USGS
 USGS, 1909, 1:62,500, contour 10', field survey 1884, USGS
 USGS, 1907, 1:62,500, contour 10', field survey 1884, USGS
 USGS, 1904, 1:62,500, contour 10', field survey 1884, USGS
 USGS, 1901, 1:62,500, contour 10', field survey 1884, USGS
 USGS, 1898, 1:62,500, contour 10', field survey 1884, USGS
 USGS, 1893, 1:62,500, contour 10', field survey 1884, USGS
 USGS, 1888, 1:62,500, contour 10', field survey 1884, USGS

Zoning/Land Use-Cover

General

USGS, 1979, New York Land Use/Land Cover, 1:250,000, field survey 1973, USGS
 USGS, 1977, New York Land Use/Land Cover, 1:250,000, field survey 1973, 3
 sheets: 1 - political units overlay, 2 - hydrologic units overlay, 3 - census-subdivisions overlay

Breezy Point

Caselli, P., 1977, Environmental assessment of development in the Breezy Point Cooperative, 3
 sheets: 1 - Roxbury Unit, 2 - Breezy Point, East, 3 - Breezy
 Point - West, land use, building, zoning, city streets, proposed buffer zone, 1:24,000, CCES -
 Rutgers University, New Brunswick, NJ, CCES

Staten Island

Anon, 1979, Survey of Property in Gateway National Recreation Area From New Dorp High
 School to Poultney Avenue, 1:80 publisher not given, GATE

Government Agencies from which Maps and Aerial Photographs can be obtained

The Agricultural Stabilization and Conservation Service (ASCS) of the Department of
 Agriculture has probably the largest collection of aerial photographs. Both contact prints and
 a variety of enlargements are available on either paper or on a polyester base. Local ASCS
 offices (state and county) hold the most recent coverage for their area. A personal visit is
 recommended to review photography before placing an order -

ASCS - USDA
 2505 Parley's Way
 Salt Lake City, UT 84109

Defense Meteorological Satellites provide data in the visible/near infrared (0.4 to 1.1
 μm) and the infrared (8 to 13 μm). Positive transparencies of both high and low resolution are
 available for both the visible and infrared and can be obtained from -

DMSP Satellite Data Library
 Space Science and Engineering Center
 1225 W. Dayton St.
 Madison, WI 53706

The Earth Resources Observation System (EROS) Program is administered by the Geological Survey and operates a Data Center to provide access to aerial photography resources. This is imagery acquired by the U.S. Department of the Interior, NASA, LANDSAT imagery and photography, Skylab, Apollo, and Gemini spacecraft, and from research aircraft. A free computer search can be requested by giving the geographic coordinates or path/row designated by EROS.

User Services Unit
EROS Data Center
Sioux Falls, SD 57198

Mosaics of LANDSAT imagery of the US have been prepared by the Soil Conservation Service. They are not available from the Date Center, and should be order from -

Cartographic Division
Soil Conservation Service
Federal Center, Building No. 1
Hyattsville, MD 20782

The National Archives and Record Services has available aerial photography dating from the middle 1930's. They also have the old U.S. Coast and Geodetic Survey charts of the Atlantic coast. These are the original plane table surveys, many of which date back to the 1840's. Information on what they have available can be requested by giving county and state name in which the area of interest is located. They have no listing of records by area (i.e. specific name) -

John A. Dwyer
Assistant Chief, Cartographic & architectural Branch
General Services Administration
National Archives and Records Service
Washington, DC 20408

The National Cartographic and Information Center (NCIC) collects and sells information relative to the cartographic holdings (including imagery) of many federal agencies as well as state, county, and private organization. A computer search can be requested by supplying the geographic corrdinates of an area.

National Cargographic and Information Center (NCIC)
U.S. Geological Survey
536 National Center
Reston, VA 22092

COMPUTERIZED DATA BASES

With the advent of computerized systems for data management, a powerful tool became available for integrating many types of diffuse information into a coherent and useful base of knowledge. The National Park Service has undertaken several projects of this nature.

In 1982, Gary S. Waggoner of the NPS Geographic Information Systems (GIS) Field Unit at Denver, CO, became project manager for a new computerized data base called NPFLORA. The base makes use of the latest checklists of vascular plants available from each park to form a dynamic resource base containing information on presence and distribution of both exotic and native species, and rare, threatened, or endangered species. Information may be accessed in taxonomic groups, within or between park units, and in a variety of other ways. The analysis package, SYSTEM 2000, was chosen for its flexibility of design and for its capacity for update and revision.

As of early 1986, 108 park units including Cape Hatteras have been added to NPFLORA. For inquiries or updates, please contact:

Mr. Gary S. Waggoner
Manager, NPFLORA Data Base
U.S. Department of the Interior
National Park Service
Geographic Information Systems Field Unit
P.O. Box 25287
Denver, CO 80225-0287

The Rutgers NPS Bibliographic Research Team will be producing a computer diskette of Volume I, Bibliography of Scientific Research, for each park using Pro-Cite Personal Bibliographic Software available for both IBM and Macintosh computers. This software will allow for rapid search by general keyword, specific keywords, authors, and date, or a combination of these. As with the NPFLORA, this data base will be most useful if it is periodically updated with new citations for each park. The diskettes (as well as the printed versions of Volumes I and II) are available from:

U.S. Department of Interior
National Park Service
North Atlantic Regional Office
Office of the Regional Chief Scientist
15 State Street
Boston, MA 02109
1-617-223-5129

For a computerized data base concerning marine mammal strandings in the U.S.; with most extensive information available from 1975-1988. Contact:

James Mead
Marine Mammal Events Program
NHB-108
Smithsonian Institution
Washington, DC 20560
(202) 357-1920

Computerized data bases for List of Classified Structures (LCS) and Cultural Resources Management Bibliography (CRBIB) are available through the Cultural Resources Division of the regional Park Service offices. Contact:

Alicia Weber

Park Historic Architecture Division 422
National Park Service
U.S. Department of Interior
P.O. Box 37127
Washington, DC 20013-7127
Telephone: (202)343-8149

Species collections and archeological artifacts collected at Cumberland Island National Seashore are in the process of being catalogued (as of the Summer of 1988) by the Park Curator, Marcia Stout. A computerized database should be available sometime in the near future.

ADDITIONAL INFORMATION SOURCES

The following list provides researchers with additional sources of information relevant to Cumberland Island:

Fort Fredrica National Monument, St. Simons Island, GA. Contact: Eugenia Price - historian.

Kings Bay, Office in Charge of Construction (OICC), Trident Missile Base, Kings Bay, GA. Contact: Nancy Bomgarten - environmental planner.

Information regarding archeology and the impacts of dredging on the environment are available only for the duration of the project (see Management section for background information)

Camden County Library, Woodbine, GA

National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA. (703) 487-4650

Cooperative Park Studies Unit, Institute of Ecology, University of Georgia, Athens, GA. Contact: Dr. Susan Bratton, Director.

St. Simons Lighthouse Library, St. Simons, GA.

University of Georgia, Institute of Marine Science, Sapelo Island, GA 31327. Contact: Dr. James J. Alberts, Director

Savannah State Marine Algal Herbarium, Savannah State College, Savannah, GA.

Skidaway Institute of Oceanography, P.O. Box 13687, McWhorter Drive, Skidaway Island, Savannah, GA 31416. Contact: Dr. David W. Menzel, Director

Woodbine Courthouse, Woodbine, GA. Information on deeds and land ownership available.

Florida State Museum, Gainesville, FL. Contact: Dr. J.T. Milanich, Director. Archeological artifacts from the dredging of the Kings Bay area are housed at the museum.

Mrs. Lucy Ferguson - permanent Cumberland Island resident. Personal library contains specimens of island flora and fauna, historical photos, and unpublished research.

Mrs. Mary Miller - part time resident of Cumberland Island for 60 years. Amateur historian.

The Georgia Conservancy, 711 Sandtown Rd., Savannah, GA 31410. Contact: Dr. Hans Neuhauser, Coastal Director.



As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride In America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administrations. NPS D-66