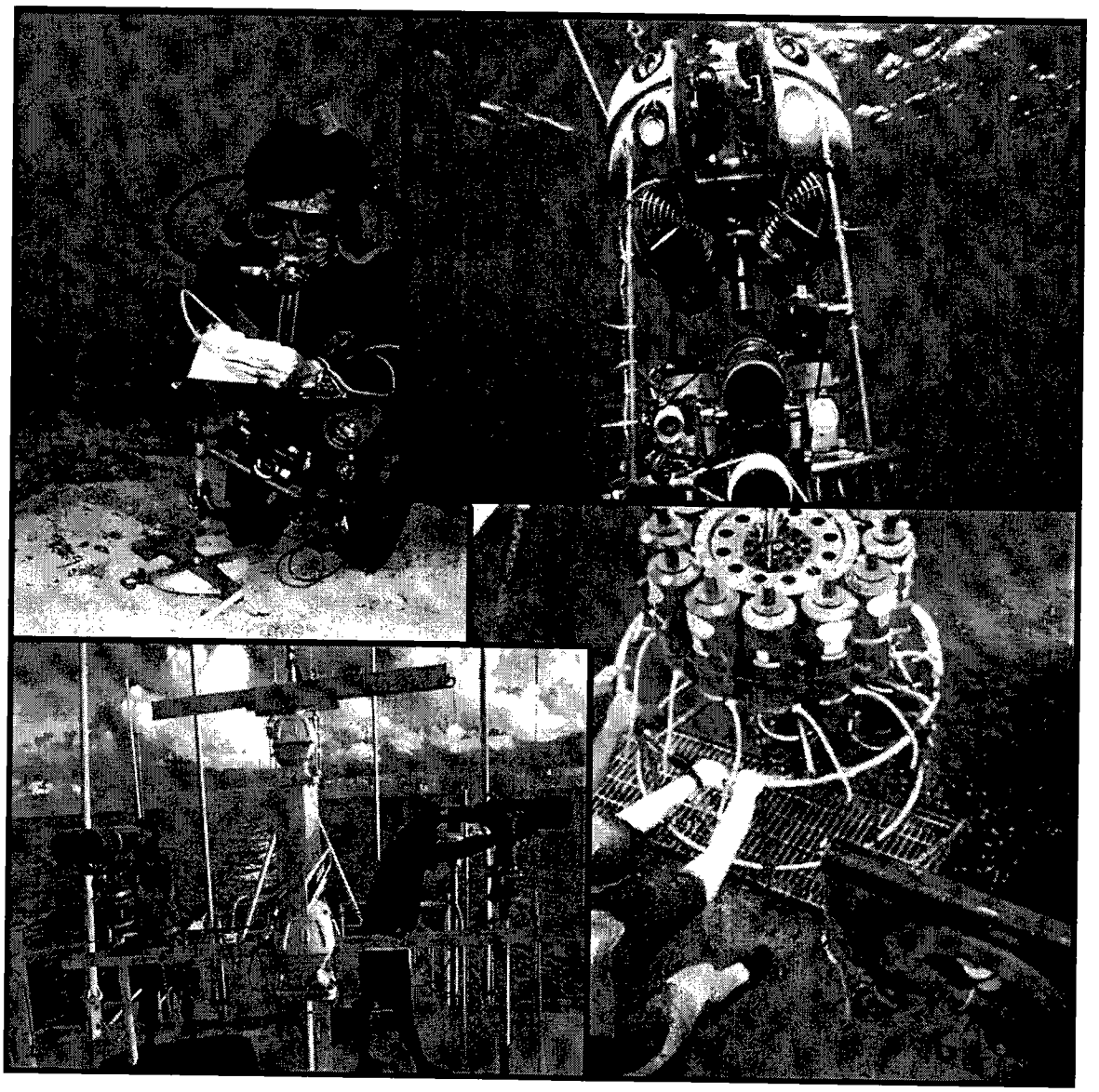
OCS Report
MMS 96-0025

Technical Summaries from Selected Environmental Studies of the Northeastern Gulf of Mexico



MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

OCS Report
MMS 96-0025

Technical Summaries from Selected Environmental Studies of the Northeastern Gulf of Mexico

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Gulf of Mexico OCS Region

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Availability

The technical summaries contained in this OCS report were prepared by various contractors (refer to individual studies) under contract to the Minerals Management Service (MMS). The summaries were compiled and prepared for publication by the MMS, Gulf of Mexico OCS Region, Environmental Studies Section, located in New Orleans, Louisiana.

Copies of the publication can be obtained from the MMS Public Information Office at the address below. Questions about individual studies should be addressed to the Environmental Studies Section (MS 5430), 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394.

Minerals Management Service
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Preface

The Outer Continental Shelf (OCS) Environmental Studies Program, administered by the Minerals Management Service (MMS) of the U.S. Department of the Interior, has sponsored hundreds of environmental and socioeconomic studies in the Atlantic and Pacific Oceans, Alaskan waters, and the Gulf of Mexico OCS Region since the program's inception in 1973. More than $550 million has been spent in gathering the data that support OCS decisions. Most of the reports are available through the MMS Public Information Office, the National Technical Information Service, and regional libraries. The Gulf of Mexico OCS Region of the MMS initiated a project to summarize this vast collection of data and made the condensed information more readily available to potential users. The resulting technical summaries are anticipated to serve the purposes of many users of the information generated by the OCS Environmental Studies Program.

This publication represents a collection of MMS technical summaries of 39 Northeastern Gulf of Mexico final reports. These technical summaries represent selected studies in the northeastern Gulf of Mexico only.

The summaries are prepared following a standard format designed to provide the reader with a synopsis of administrative and technical information. A map is included, when available, to show the area of study. In this publication, the summaries are organized by studies series representing aspects of the OCS Environmental Studies Program. Topics include Environmental Mapping, Physical Oceanography, Marine Ecosystems, Coastal Studies, Living Marine Resources, Ecological Effects, Socioeconomics, Cultural Resources, and Information Management.

Summarizing information contained in hundreds of lengthy "grey literature" reports is a major undertaking. Many individuals contributed to this effort. Under contract to the MMS, Continental Shelf Associates, Inc. (CSA) furnished a team of scientifically qualified technical writers and editors to produce the tightly written summaries contained in this publication. Their attention to detail has resulted in summaries that accurately characterize the scientific findings of the complex, and often lengthy, original reports. Technical summaries of the more recent studies have been prepared by the original contractor.

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SELECTED ENVIRONMENTAL STUDIES OF THE NORTHEASTERN GULF OF MEXICO

Introduction

As the Nation's designated steward of the mineral resources on the Outer Continental Shelf (OCS), the Department of the Interior's Minerals Management Service (MMS) is committed to achieving the proper balance between providing energy for the American people and protecting unique and sensitive coastal and marine environments. MMS's primary responsibilities are prudent leasing and safe management of Federal lands for exploration and development of natural gas and oil on the OCS; and the collection and distribution of bonuses, rentals, and royalties from companies that lease and produce minerals from onshore and offshore Federal and Indian lands.

MMS responds to these challenges through a commitment to quality science, judicious leasing, and safe, clean operations. MMS works diligently to protect the environment and to achieve excellence in every aspect of our Congressionally mandated mission.

Quality Science

Quality science is fundamental to MMS's approach to identifying and assessing areas for potential resource development, determining potential environmental risks, and ensuring safe, clean offshore operations.

MMS conducts, funds, and publishes the results of hundreds of scientific and technical projects and studies that enable us to balance environmental concerns with leasing decisions. These scientific findings may result in revised regulations, stipulations in lease agreements, or special orders to offshore operators.

After analyzing the results of these findings, MMS often determines that good leasing decisions require additional wide-ranging oceanographic, environmental, marine life, socioeconomic, or ecological studies. MMS scientists and engineers

determine ways of protecting environmentally sensitive areas or species, or mitigating potential harm from offshore activities.

MMS conducts rigorous engineering, geological, geophysical, and other scientific assessments on which we base decisions for approval of or modification to lessees' plans for OCS activity. These assessments also enable MMS to measure the long-term environmental and ecological effects of offshore natural gas and oil production.

Upholding Judicious Leasing

MMS provides the Nation with a schedule of lease sales that will produce critically needed domestic energy resources. We base leasing decisions on a 5-year Program of schedules, which shows dates and locations of proposed lease sales. In addition, the 5-year Program gives information relating to geographical, geological, and environmental studies.

MMS balances environmental considerations, the potential for discovery of natural gas and oil, and the potential impact on coastal communities. Interested parties, including State and local governments and the general public, have several opportunities to participate in the decisionmaking process and to review and submit comments to MMS on the program.

The Comprehensive 5-Year Program is adopted only after MMS has reviewed the comments and balanced them with national interest considerations, and has obtained approval from the Secretary of the Interior after a review by the President and the Congress. Developing an approved, final 5-Year Program is a process that takes two to three years.

Ensuring Safe and Clean Operations

From the day a bidder is awarded a lease to operate on the OCS until drilling and production cease--often up to 30 years later--MMS devotes constant attention to safety through a combination of required plans, permits, training, inspections, and, if necessary, penalties for noncompliance with the regulations.

Numerous Federal laws--some under the jurisdiction of MMS, others under the jurisdiction of agencies such as the Environmental Protection Agency or the U.S. Coast Guard--govern offshore activities. These are interpreted and explained in regulations that specify the procedures operators must follow to ensure safe offshore operations. Among the many issues addressed in these regulations are

requirements for inspections, safety training and drills, and accident prevention procedures.

Before and during OCS operations, operators and lessees must prepare and secure approval of detailed plans for exploration and development; they must also secure permits for drilling and for construction or modifications to platform structures and pipelines. These plans and procedures must meet MMS's stringent regulations and operating procedures, which are based on the best available and safest technologies.

A crucial tool in maintaining safe operations is the inspection of offshore facilities. Federal law and regulations require a complete inspection of every offshore platform. Petroleum engineering technicians conduct these inspections and evaluate the overall condition of a facility and its operations.

In the rare event that an accident does occur, MMS strives to minimize harm to individuals and damage to the environment. MMS may revise regulations and operating orders for a particular facility based on results from program investigations and accident reports. Revisions to regulations may be done in an effort to prevent future accidents.

MMS enforces its network of safety regulations and procedures through warnings and penalties. Penalties may include a component or facility shut-in, or civil penalties of up to $20,000 per day for failure to correct an offshore operations violation. Penalties may be as high as $500,000 per day or 10 years in prison or both, for knowing and willful violation of OCS rules, regulations, leases, or permits.

Protecting the Environment

MMS conducts a multifaceted Environmental Studies Program, which generates the scientific research essential to making sound leasing and operating decisions before exploration and development can begin on any particular OCS tract.

In addition, MMS conducts a special program designed to identify and protect valuable underwater prehistoric and historic sites on the OCS. MMS's extensive, constantly evolving Environmental Studies Program supplies the scientific and technical information needed to determine which offshore areas are acceptable for leasing, as well as to predict, assess, and manage the impact of OCS natural gas and oil activities on the human, marine, and coastal environments.

The Studies Program provides information for the environmentally safe operation of natural gas and oil activities and for developing the 5-Year Program. MMS

publishes draft and final environmental impact statements for all proposed leasing areas, describing the existing environment, analyses of possible effects of offshore activities on the environment, oil-spill risk analyses and proposed mitigating measures, as well as thorough environmental assessments, which are conducted after leases are awarded but before OCS operations may begin.

MMS protects underwater archaeological sites by using remote-sensing instruments that detect shipwrecks of whaling, fishing, and military vessels, allowing MMS to determine specific measures that are necessary to protect them.

Managing Royalties

Natural gas, oil, geothermal energy, coal, and other minerals constitute some of our Nation's most important natural resources. These resources belong to all Americans, and Congress has entrusted MMS with ensuring that the Nation receives a fair and appropriate return from interests that lease or develop them.

The Royalty Management Program (RMP) of the MMS collects and distributes the bonuses, rents, and royalties from companies that lease and produce minerals from onshore and offshore Federal and Indian lands. These revenues are one of the largest non-tax sources of income to the U.S. Treasury, ranging from about $3.4 billion to $10 billion annually, depending on the volume of production, prices, and amounts of offshore leasing. Sources of these revenues include 26,000 Federal and Indian producing offshore and onshore leases in rental status.

The RMP collects these funds from the mineral industry and distributes them to State governments, Indian tribes, individual Indian mineral owners, and the public at large through several U.S. Treasury funds.

Federal law requires that these funds be distributed to several types of recipients. The Federal Government, which receives the largest share, disburses the revenues among the General Fund of the U.S. Treasury; special Federal funds for acquisition of National and State Parks, conservation, and recreation areas; the Historic Preservation Fund; and coastal states, Indian tribes, and some 29,000 individual Indian recipients.

These funds are used to acquire and maintain recreational and conservation lands; they are used for State-sponsored education, roads, and other projects; for development of the National Park System; and for acquisition and management of historic properties.

To carry out the complex tasks of collecting, accounting for, and disbursing revenues from thousands of companies to thousands of recipients, the RMP has

developed and implemented automated systems that provide accounting data and tract production information, and account for bonuses and rentals from onshore Federal leases that are not yet producing.

The People of MMS

The MMS workforce consists of about 1,800 individuals in more than 100 occupations. About half of these individuals occupy positions officially classified as professional. About 50 percent of this group have specialized positions as biologists, oceanographers, petroleum engineers, geologists, geophysicists, paleontologists, economists, and automated data processing specialists, among others. Another 30 percent are accountants and auditors, some of who are certified public accountants. More than 20 percent of MMS biologists and physical scientists hold doctoral degrees, while more than one-quarter of all professional personnel have their Master's degrees.

Environmental Studies Program

MMS supports and administers a multidisciplinary Environmental Studies Program (ESP) to develop information needed for assessment and management of impacts to marine and coastal environments that may be affected by OCS oil and gas activities. Since its beginning, the ESP has sponsored over $139 million through more than 220 environmental studies in the Gulf of Mexico, and over $550 million throughout the agency. These funds have supported studies in all aspects needed for a thorough understanding of the complex nature of the Gulf of Mexico and aid in the wise protection of the valuable resources of the Gulf of Mexico.

The gas and oil activities on the Gulf of Mexico OCS are a large contributor to our National energy needs. As the most mature area where OCS gas and oil production occurs, it is the primary focus of MMS's research, regulation, and monitoring effort with regard to the production of offshore gas and oil.

The Environmental Studies Program provides the MMS with the environmental, social, and economic information necessary for the bureau to carry out its mandate as specified in the Outer Continental Shelf Lands Act, as amended in 1978. The studies are specifically designed to provide information for management decisions both before and after lease sales. Study development is a continuing process and recognizes the need for modification, addition, or deletion of identified studies as information is developed by other efforts, as new environmental or management concerns are recognized, and as modifications in the OCS leasing process are implemented.

Each study produces information that is published by MMS and made available to the public through the MMS Gulf of Mexico OCS Region's Public Information Office. The MMS uses information from the ESP to judge the potential environmental problems associated with all levels of gas and oil activities. Final reports, maps, digital data, and photographic or video products resulting from these contracted environmental, social, or economic studies are available to the public from the MMS and from the National Technical Information Service (NTIS), and occasionally from other sources.

Technical Summaries

This document is a compilation of Technical Summaries for studies performed in the Northeastern Gulf of Mexico. Technical Summaries provide a brief synopsis of each study and are grouped by studies series and then listed by contract number. Most of the studies contained in this document were funded during the 1970's and 1980's and on rare occasion into the early 1990's. Listed studies that begin with an alpha character were done during the 1970's when the program was under the Bureau of Land Management.

For More Information

MMS receives a limited number of copies of each report from the study contractor and makes those original copies available to a fixed distribution list including Federal and State agencies, regional libraries, etc. Extra copies are available to the general public. Some publications authored or published by the Gulf of Mexico OCS Region are sold at a minimal price to recover printing costs. Persons wanting copies of reports available from MMS should contact the Public Information Office at the address provided. Persons wanting to inspect a copy of a specific report or borrow a copy for short-term use or photocopying should also contact the Public Information Office.

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Persons desiring additional information regarding the MMS Environmental Studies Program should contact

Minerals Management Service
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For information concerning the activities of the Gulf of Mexico OCS Region or the MMS OCS Oil and Gas Program in general, please contact the Public Affairs Officer (MS 5002) at the same address or by telephone at (504) 736-2595. Other sources for study reports, such as original contractors or cooperating Federal agencies, are listed under each report available from such a source.

The Minerals Management Service has made digital versions of many of the documents cited in this report available through the Internet and the MMS World-Wide Web Home Page. The Technical Summaries and the full text of many (without figures and tables) of the final reports are maintained by MMS in the Environmental Studies Program Information System (ESPIS). This searchable database is located at **http://www.mms.gov/espis/**.

ENVIRONMENTAL MAPPING

This study series seeks to produce and synthesize environmental information into maps, preferably in an atlas format, for use by specialists and managers faced by localized or regional proposals. By using the maps, space or proximity conflicts may be identified, alternatives may be weighed, and the state of knowledge may be assessed. When the database for a given area is large, many topics may be displayed; alternatively, reduced information availability may restrict mapping at the present, but the initial products may stimulate or guide work by other agencies to help fill these gaps.

REPORT TITLE: Baseline Monitoring Studies, Mississippi, Alabama, Florida, Outer Continental Shelf 1975-1976.

MMS PUBLICATION NUMBER: Contract No. 08550-CT5-30.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: In 1974, the U.S. Department of the Interior funded a study to obtain multidisciplinary, short-term, benchmark data on the Mississippi-Alabama-Florida (MAFLA) Outer Continental Shelf (OCS) prior to oil and gas exploration in that region. The project was extended to a long-term, three-year major study in 1975. The results of the 1975-1976 MAFLA investigations are contained in this report.

OBJECTIVES: (1) To conduct seasonal biological, geological, and physical surveys of the water column and seafloor within the MAFLA region; (2) to determine range in concentrations of high molecular weight hydrocarbons and trace metals in sediments, water column, and selected benthic macrofauna; and (3) to conduct histopathological evaluations on selected benthic macrofauna.

DESCRIPTION: The MAFLA/OCS study area was bounded by 81°30' to 89° W long and 25°30' to 30°15' N lat. Depths ranged from 10 to 200 m. Sampling included water column and benthic collections. A box corer (21.3 x 30.5 x 43.2 cm) was used to obtain sediment samples. Forty-five stations were occupied along six transects for box coring. A 9.1-m semi-balloon trawl with 9.5 mm mesh cod-end liner was used to take one sample per station. Two dredge samples were taken at each station using a standard Capetown dredge. Selected biota from trawl and dredge samples were removed for trace metal, hydrocarbon, and histopathological analyses. The Florida Middle Ground area was sampled (photography, observation, and collection) by divers at eight stations during summer and winter.

Temperature and salinity were recorded using salinity-temperature-depth sensors, expendable bathythermographs, water samplers, and reversing thermometers. A transmissometer was used to determine the distribution of light transmission in the water column. Thirty-liter Niskin bottles were used to collect water samples from surface and near bottom. Duplicate zooplankton samples were collected during each of three sampling seasons using 0.5-m Nitex plankton nets with 0.202-mm mesh. Neuston samples were collected using a 1-m floating plankton sampler with 0.202-mm mesh. In the laboratory, sediment samples were analyzed for grain size, percent carbonate, total organic content, benthic clay mineralogy, foraminifera, meiofauna, macrofauna, trace metals, adenosine triphosphate, and hydrocarbons. Macrofauna, macroflora, and demersal fishes were analyzed for hydrocarbons and trace metals. Water samples were analyzed for suspended sediment mineralogy, particulates, primary productivity, chlorphyll a, trace metals, particulate organic carbon, dissolved organic carbon, dissolved hydrocarbons, and salinity following standard methods.

Two ancillary projects were also undertaken. First was the compilation of a lithological map using available geophysical information from the MAFLA area. Second was a pre-, during-,

and post-operational monitoring of selected biological, chemical, and geological aspects of the environment surrounding an exploratory drillsite.

SIGNIFICANT CONCLUSIONS: No petrogenic hydrocarbons were found in sediments, water column, benthic organisms, or zooplankton. Abundance and diversity of organisms suggested that the area was essentially a pristine environment. There was no evidence of stress owing to influx of pollutants. Histopathological tests were also negative. Trace metal concentrations in the samples were normal. The Mississippi-Alabama Shelf did show evidence of hydrocarbon contamination due to input from the Mississippi River. Major oceanographic influences were the Mississippi River, Loop Current, and Hurricane "Eloise."

STUDY RESULTS: Sedimentary zones were identified for the MAFLA area using particle size ratios, percent carbonate, and mineralogy. The major influence on sediments of the Mississippi-Alabama Shelf was input from the Mississippi River. Fine sediments, mostly quartz sand and smectite, predominated in this deltaic region. Eastern and western flanks of De Soto Canyon were comprised of lime muds and carbonate sands, respectively. East of Cape San Blas, a transition to carbonate and kaolinite was evident. The West Florida Shelf was covered by a carbonate sediment sheet; an inshore band of quartz sediment was detected near the coastline.

Infaunal species variability was more closely correlated with depth than grain size. Epifaunal taxa also displayed depth related patterns of abundance and diversity. Four epifaunal assemblages were determined: Middle Shelf, 30 to 60 m; North Middle Shelf, 30 to 60 m and high relief; Deep Middle Shelf, 60 to 140 m; and Deep Shelf, 140 to 200 m. Species abundance, biomass, and diversity for benthic communities were lowest in areas west of Cape San Blas. High microbial biomass and foraminiferans indicated environmental stress. In general, the area east and south of Cape San Blas was considered high in species diversity and relatively stable. The Florida Middle Ground supported diverse communities which exhibited tropical affinities. Epibiota of this area were subjected to natural perturbations (i.e., Hurricane "Eloise") and proved to be resilient. Macroalgae were usually detached by severe storms.

Trace metal concentrations in sediments were variable. Iron used as a mineralogical indicator in predictive plots (iron vs. all other metals) showed no evidence of present-day pollution. Trace metal concentrations were variable within and between epifaunal phyla; corals were the exception, while sponges typified the pattern. Crustaceans and tunicates concentrated copper and vanadium, respectively; both metals are components of respiratory pigments.

Hydrocarbon analysis disclosed that MAFLA area sediments are essentially free of contamination. Exceptions to this were sites south of Mobile, Alabama where stations were characterized by abundant high molecular weight terrigeneous n-alkanes and low molecular weight n-alkanes typical of weathered petroleum. Again riverine input was responsible for these observations. No discernable changes in either the amounts or composition of hydrocarbons in the epifaunal samples were detected between stations or seasons. All hydrocarbons found were biogenic. Some algae did contain hydrocarbons indicative of petrogenic contamination. These findings were seasonal and apparently related to circulation patterns and not petroleum residues in the adjacent sediments.

At the rig-monitoring site, small benthic foraminiferans indicative of rigorous (i.e., stressed) conditions were present before drilling operations began. Foraminiferan populations declined after drilling. Sand, clay, and carbonate levels increased while silt levels decreased during drilling; these trends reversed following drilling operations. Cuttings were found at 100-m and 500-m periphery stations. No significant changes in hydrocarbon content of sediments occurred between the three monitoring phases. Barium was the only trace metal with significantly higher concentrations in sediments during and after drilling.

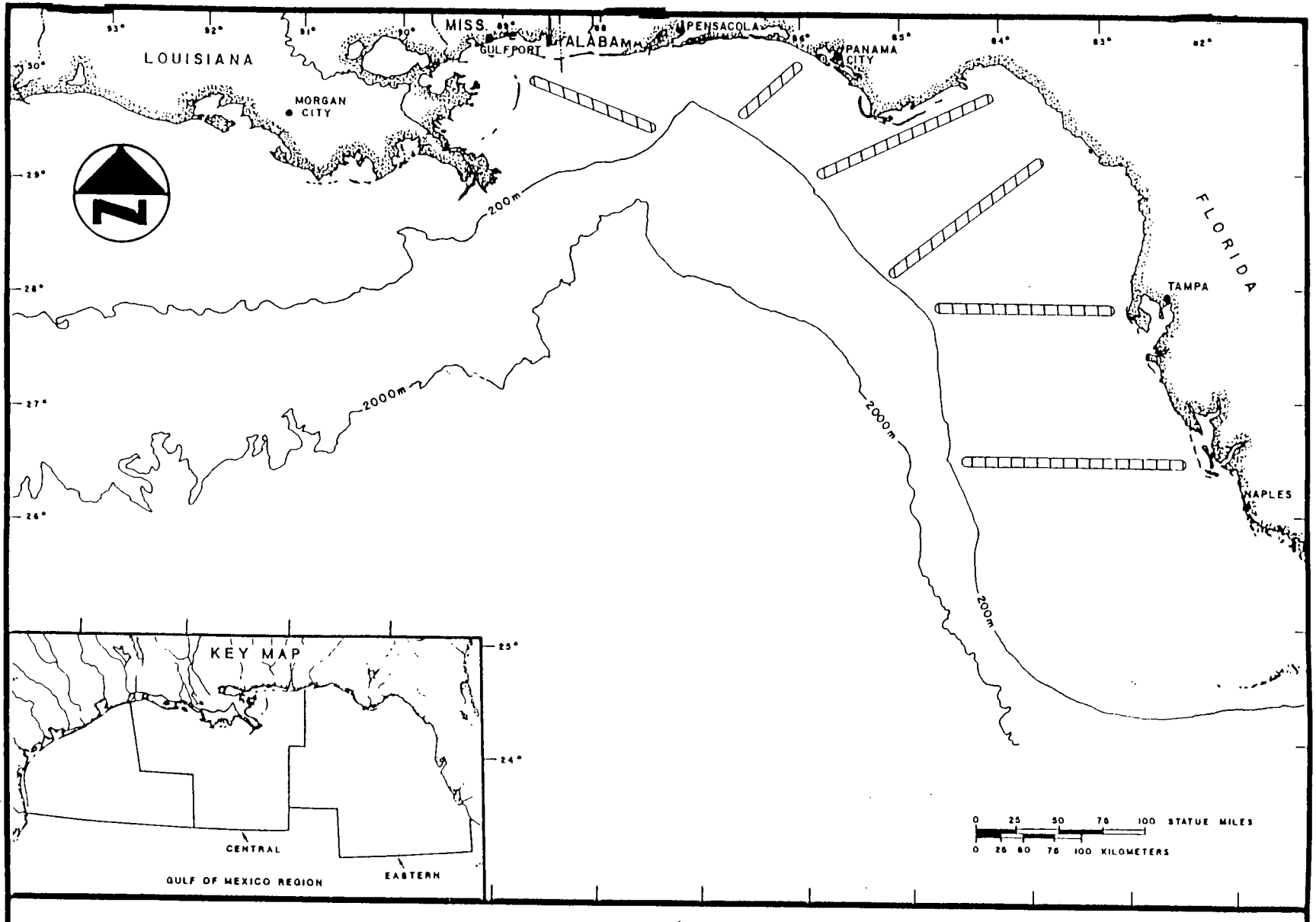
STUDY PRODUCT(S): State University System of Florida, Institute of Oceanography. 1977. Baseline Monitoring Studies, Mississippi, Alabama, Florida, Outer Continental Shelf 1975-1976. A final report for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. Vol. I (Executive Summary) - NTIS No. PB-282-801; Vol. II (Introduction and Methods) - NTIS No. PB-282-802; Vol. III (Results) - NTIS No. PB-282-803; Vol. IV (Discussion) - NTIS No. PB-282-804; Vol. V (Geophysical Investigations for Biolithologic Mapping of the MAFLA-OCS Lease Area) - NTIS No. PB-282-806; Vol. VI (Rig Monitoring) - NTIS No. PB-282-805. Contract No. 08550-CT5-30.

STUDY TITLE: MAFLA Environmental Monitoring Program.

COMPLETION DATE OF REPORT: June 1977.

CUMULATIVE PROJECT COST: $3,872,317.

KEY WORDS: Eastern Gulf; Central Gulf; baseline; hydrocarbons; trace metals; sediment; water column; tissue; Mississippi; Alabama; Florida; macrofauna; meiofauna; maps; zooplankton; histopathology; shelf; DeSoto Canyon; faunal zones; biology; geology; monitoring.



TRANSECTS SAMPLED DURING THE MAFLA ENVIRONMENTAL MONITORING PROGRAM, FY 1975.

ACCESS NUMBER:29000

REPORT TITLE: Eastern Gulf of Mexico Marine Habitat Study.

MMS PUBLICATION NUMBER: Contract No. AA551-CT8-22.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: In preparation for Oil and Gas Lease Sale 65 (October 1978), the U.S. Department of the Interior sponsored several biological and geological studies on the continental shelf offshore west Florida. Results of these studies showed that several areas contain features that favor accumulation of marine biota by providing substratum for attachment of benthic epibiota and shelter and food for demersal fishes. This study was funded to identify and delineate such areas so that they could be considered for further study and/or protection from possible effects of offshore oil and gas activities.

OBJECTIVES: (1) To identify and delineate marine benthic habitats in 49 lease blocks located offshore west Florida that were included in Lease Sale 65.

DESCRIPTION: Two cruises were conducted during July-August 1978 to provide data for mapping of geophysical and biological features of 49 lease blocks in the eastern Gulf of Mexico. The blocks included 3 in the Pensacola Area, 17 in the Destin Dome Area, 5 in the Tarpon Springs Area, 4 in the Elbow Area, 8 in the St. Petersburg Area, and 12 in the Charlotte Harbor Area. The first cruise involved collection of geophysical data within each block using a precision depth sounder, dual side-scan sonar, and high resolution subbottom profilers. East-west survey lines were spaced at 0.2-km intervals, and north-south lines at 2.4-km intervals; the survey grid for each block was designed to complement that of previous geophysical surveys. The second cruise was conducted to provide visual "ground truth" for habitat delineations and to allow a description of associated biota. Twenty-three transects were selected following a review of geophysical data. Transects were surveyed using a towed television/still camera system in conjunction with navigational and bathymetric instrumentation.

For mapping purposes, the 49 blocks were grouped into 10 "areas," or sets of contiguous blocks. These were: Area 1--Pensacola Area Blocks 884, 928, and 972, and Destin Dome Area Block 4; Area 2--Destin Dome Area Blocks 313, 314, 357, and Dome Area Blocks 529, 573, 574, 618, 661, and 662; Area 4--Destin Dome Area Blocks 473, 474, 518, 519, 562, and 563; Area 5--Tarpon Springs Area Blocks 233, 234, 277, 278, and 279; Area 6--Elbow Area Blocks 567, 609, 696, and 697; Area 7--St. Petersburg Area Blocks 661, 662, 705, and 706; Area 8--St. Petersburg Area Blocks 753, 754, 797, and 798; Area 9--Charlotte Harbor Area Blocks 143, 144, 145, 187, 188, and 231; and Area 10--Charlotte Harbor Area Blocks 583, 584, 627, 628, 671, 672, 715, and 716.

Navigational post-plot maps (scale:1:48,000) were produced for each group. A second set of maps (scale:1:48,000) was prepared to show bathymetry and seafloor characteristics for each group. Six categories of seafloor type were assigned: pinnacles, hard bottom, scattered hard bottom, coarse bottom, bedforms, and soft bottom. A third set of maps (scale:1:24,000) presented geologic cross sections for each group.

SIGNIFICANT CONCLUSIONS: The study successfully mapped the distribution of seafloor types within each lease block and provided descriptions of the associated biota at selected locations. Further study to assess and describe potentially sensitive and valuable habitats was recommended for 6 of the 10 groups of blocks surveyed.

STUDY RESULTS: Soft bottom (thick sand or silt) was the most widespread seafloor type, but coarse bottom (soft bottom with a surface rubble layer), hard bottom (low-relief, often scattered and/or partially buried outcrops), and high-relief pinnacles were locally abundant in some blocks. The biota associated with hard bottom and pinnacles typically included (depending on location) sea feathers and fans, hard corals, sponges, encrusting coralline algae, starfishes, sea urchins, and a variety of bottom fishes. The biota was sparse where a silt or sand veneer partially covered the hard substrate, as in several of the Destin Dome Area blocks. The most luxuriant and diverse epibiota was noted in association with large areas of scattered low-relief (<2 m) carbonate outcrops in Charlotte Harbor Area Blocks 143, 144, 145, and 188.

Locations recommended for further study included: areas of extensive pinnacles (up to 12 m relief) in Destin Dome Area Blocks 573, 574, and 661; localized carbonate outcrops (up to 11 m relief) in Destin Dome Area Blocks 473, 518, and 562; extensive hard-bottom areas in Tarpon Springs Area Blocks 233, 234, 277, 278, and 279; small (<2 m relief) outcrops in portions of Elbow Area Block 567; areas of scattered, low-relief, limestone outcrops in St. Petersburg Area Blocks 661, 662, 705, and 706; and extensive areas of scattered, low-relief (<2 m) outcrops in Charlotte Harbor Area Blocks 143, 144, 145, and 188.

STUDY PRODUCT(S): Woodward-Clyde Consultants. 1979. Eastern Gulf of Mexico Marine Habitat Study. A final report for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. Vol. I (Technical Report) - NTIS No. PB294-152; Vol. II (Maps and Cross Sections) - NTIS No. PB294-153; Vol. III (Operations Report) - NTIS No. PB80-164122. Contract No. AA551-CT8-22.

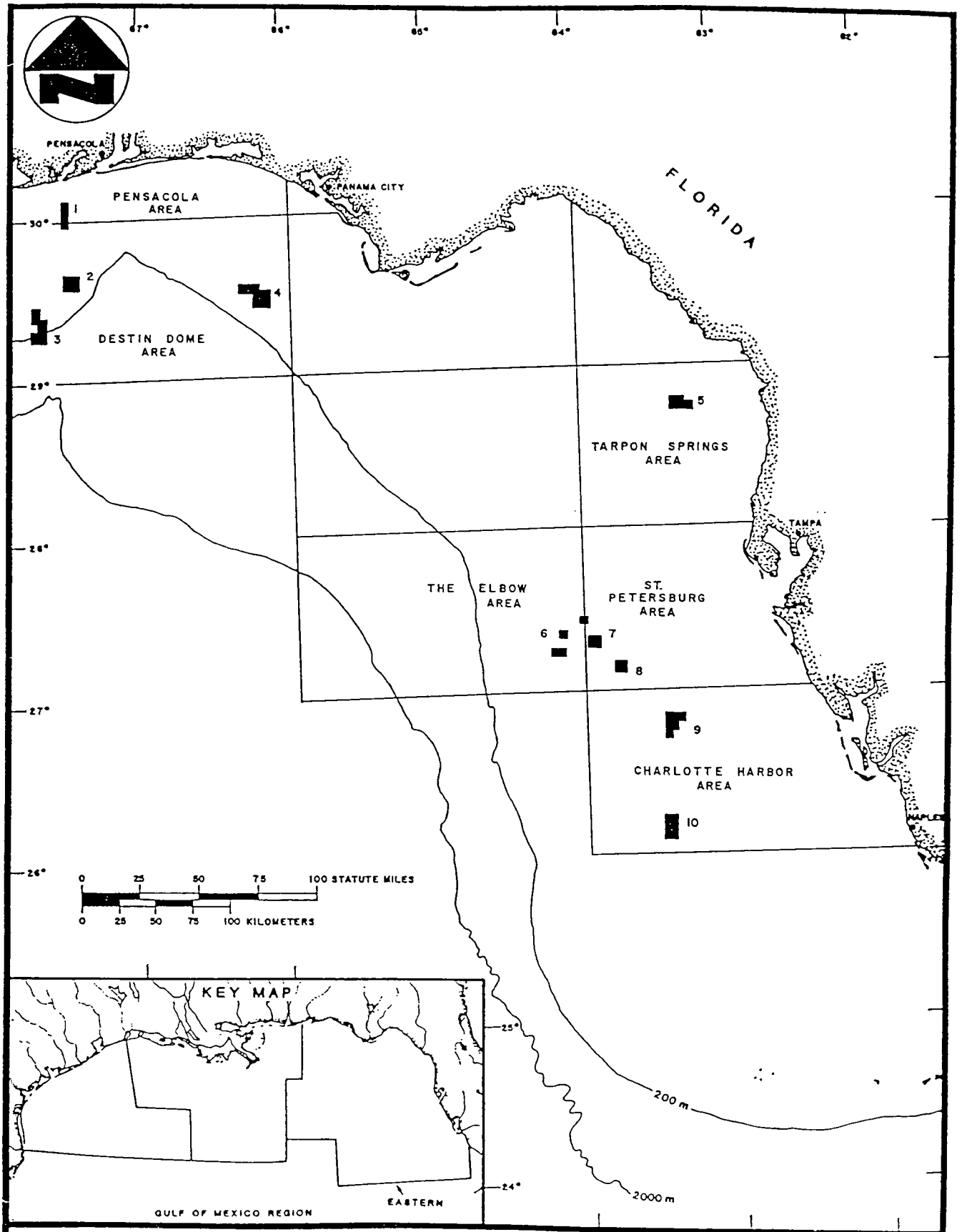
STUDY TITLE: Eastern Gulf of Mexico Habitat Mapping Study.

COMPLETION DATE OF REPORT: January 1979.

CUMULATIVE PROJECT COST: $373,225.

KEY WORDS: Eastern Gulf; biology; geology; geophysical; habitat; maps; videotapes; photographs; hard-bottom.

ACCESS NUMBER: 29006



LEASE BLOCK AREAS SURVEYED DURING THE EASTERN GULF OF MEXICO HABITAT MAPPING STUDY.

REPORT TITLE: Florida Big Bend Seagrass Habitat Study.

MMS PUBLICATION NUMBER: MMS 85-0088.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: The crescent-shaped portion of Florida's west coast from Ochlockonee Bay south to Tarpon Springs is referred to as the Florida Big Bend. The expanse of continental shelf area within the Florida Big Bend is important to fisheries and environmental interests. When this area became the focus of oil and gas developers, the State of Florida indicated that the lack of information on live-bottom and seagrass distribution within the area would not permit responsible management of exploratory activities. Consequently, the U.S. Department of the Interior initiated the Florida Big Bend Seagrass Study to provide supporting data for development of biological stipulations and evaluation of lease block specific plans of exploration or development.

OBJECTIVES: (1) To inventory and map seagrass beds in the Florida Big Bend area by combining aerial remote sensing and extensive ground truthing data; (2) to determine the seaward extent of major seagrass beds within the study area; and (3) to classify and delineate major ecological habitat types in the study area.

DESCRIPTION: The study area encompassed approximately 1.5 million ha of seafloor extending from the coastline to the 20-m isobath. The study was conducted in three parts: (1) a pre-overflight ground truthing cruise; (2) a remote sensing overflight encompassing the study area; and (3) a post-overflight ground truthing cruise to verify interpretation of remote sensing data. During the first cruise (Cruise 1) conducted from 24 October to 1 November 1984, 1,232 km of seafloor between the 10- and 20-m depth contours were surveyed using a towed underwater television system. Navigational fixes consisting of Loran-C time delays and bottom-type descriptions were recorded at 5-min intervals along the transects. Additionally, 50 signature control stations ranging in water depths from 3 to 23 m were established to assist aerial photographic interpretation in locations of known seagrass coverage. At each station, large floating targets were deployed; divers then took quantitative (343.6 cm^2) and qualitative 35-mm photographs of the seafloor under the targets to estimate seagrass density and species composition. Aerial overflights were made between 30 October and 15 November 1984 along 26 north-south flight lines. Photographs were taken using 23 cm x 23 cm color print film. The scale on all photographs was 1:40,000. During Cruise 2 conducted from 19 to 27 February 1985, nine additional transects (174 km) were surveyed using towed divers and underwater television. Eleven of the 50 signature control stations established during Cruise 1 were resampled using the same methods employed during the earlier cruise. Aerial photographs were analyzed stereoscopically, and seagrass beds were classified by density (dense, sparse, and patchy). Due to signature similarities between seagrass beds and low relief coral, sponge, and gorgonid assemblages frequently seen between them, live bottom could not be differentiated from seagrass habitat at the 1:40,000 imagery scale.

SIGNIFICANT CONCLUSIONS: Within the Florida Big Bend study area, 16% of the area was described as dense seagrass beds, 33% as sparse seagrass beds, and 19% as patchy seagrass beds. Seagrass associations occurred in two general zones based on depth. In

waters shallower than 10 m, dense associations of turtle grass, manatee grass, and shoalgrass provided dense images in the aerial photography. Seaward of this zone, sparse associations of seagrasses, macroalgae, and live bottom were identified extending to at least the 23-m depth contour. The extended nature of this sparse, offshore zone was considered a unique feature of the Florida Big Bend area zonation pattern. Seasonal variation in seagrass blade density and species composition was observed at the offshore signature control stations. Little information is available concerning the ecology of the fringing zone seagrass beds of the Florida Big Bend area.

STUDY RESULTS: Approximately 1.5 million ha were mapped during overflights of the Florida Big Bend study area. Two maps were produced: one at 1:40,000 scale and another at 1:250,000 scale. The second map was a composite, produced to be superimposed on existing Minerals Management Service Protraction Diagrams. Results from combined aerial mapping and ground truthing delimited 232,893 ha of dense seagrass beds; 498,034 ha of sparse seagrass beds; and 279,722 ha of patchy seagrass beds within the study area.

On a broad scale, the Florida Big Bend seagrass stands exhibited zonation typical of southern Florida or Caribbean seagrass beds. An inshore association of turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and shoalgrass (*Halodule wrightii*) occurred in water depths less than 10 m. Turtle grass and manatee grass formed dense beds that were easily detected by aerial photographs. At the seaward margin of these dense beds, an overlap area consisting of five species (manatee grass, turtle grass, and shoalgrass, as well as *Halophila decipiens* and *H. engelmanni*) was detected. Offshore, from 10 m out to at least 23 m a sparse fringing zone occurred. This zone was composed of a mixed association of seagrasses, macroalgae, and live bottom. The only true seagrasses present were the *Halophila* species.

Blade density determined from the nearshore association ranged from 41 to 309 blades m^{-2}. In the offshore association, blade densities ranged from 374 to 2,657 blades m^{-2}. Blade density was not indicative of bottom coverage by seagrasses within the two zones. Blade densities at 9 of the 11 signature control stations resampled during Cruise 2 were 50 to 90% lower and *H. decipiens* was completely absent. Temperature, light, and wave action probably contributed to the observed spatial and seasonal patterns in the grass beds.

STUDY PRODUCT(S): Continental Shelf Associates, Inc. and Martel Laboratories, Inc. 1985. Florida Big Bend Seagrass Habitat Study. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. Contract No. 14-12-0001-30188. 89 pp.

Continental Shelf Associates, Inc. and Martel Laboratories, Inc. 1985. Florida Big send Seagrass Habitat Study Photographic Atlas. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. Contract No. 14-12-0001-30188. 6 pp. + 557 plates.

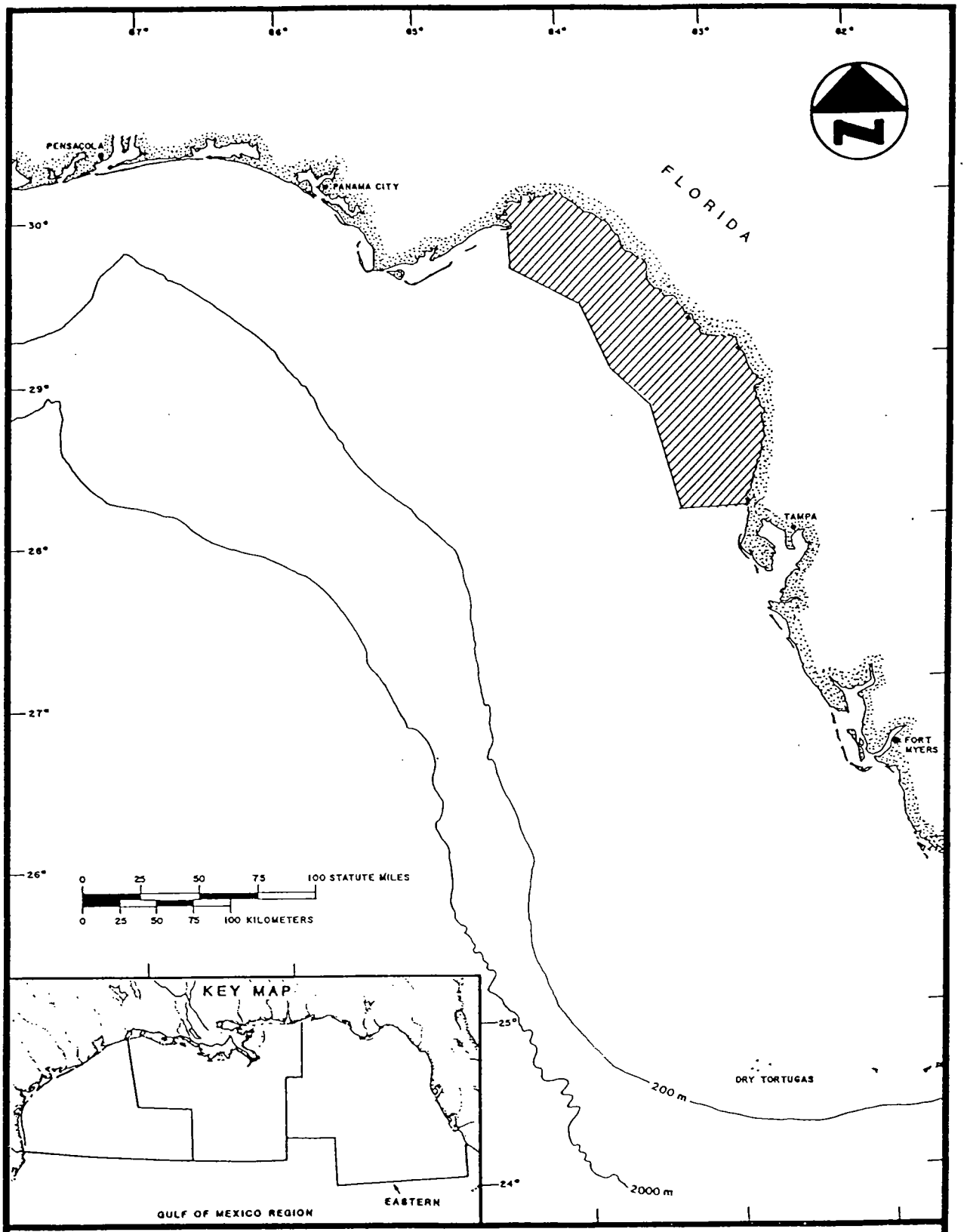
STUDY TITLE: Florida Big Bend Seagrass Habitat Study.

COMPLETION DATE OF REPORT: December 1985.

CUMULATIVE PROJECT COST: $385,946.

KEY WORDS: Eastern Gulf; Florida Big Bend; biology; seagrasses; inventory; maps; aerial photography; survey; photographimetric technique; benthic photographs; habitat; zonation; hard-bottom.

ACCESS NUMBER:30188



FLORIDA BIG BEND SEAGRASS HABITAT STUDY AREA.

REPORT TITLE: Assessment of Hurricane Damage in the Florida Big Bend Seagrass Beds.

MMS PUBLICATION NUMBER: MMS 87-0001.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: During fall and winter of 1984 and 1985, the Minerals Management Service (MMS) funded a seagrass mapping study of the Florida Big Bend area. Following the passage of major hurricanes in summer 1985, the MMS decided to sponsor a follow-up study to assess hurricane impacts and seagrass recovery in the area. New field data were collected during a survey in August 1986, and all previously collected data on seagrasses of the Big Bend area were reviewed and compared with new data sets.

OBJECTIVES: (1) To provide follow-up data to those collected in 1984 and 1985 during the Florida Big Bend Seagrass Study; and (2) to assess hurricane damage and seagrass recovery in the area.

DESCRIPTION: The study area encompassed approximately 1.5 million ha of seafloor extending from the coastline to the 20 m isobath. Two approaches used during the previous study were repeated approximately one year after the passage of major hurricanes. The first involved qualitative observations made along transects surveyed by divers and/or television. The second involved photographic sampling at selected stations in the area. During Cruise 1 of the previous survey, conducted from 24 October to 1 November 1984, 232 km of seafloor between the 10- and 20-m depth contours were surveyed using a towed underwater television system. During Cruise 2, conducted from 19 to 27 February 1985, nine additional transects (174 km) were surveyed using towed divers/television. During the previous study, 50 signature control stations ranging in water depths from 3 to 23 m were established to assist aerial photographic interpretation in locations of known seagrass coverage. Quantitative photographs of the seafloor were taken at these stations using a Nikonos 35-mm underwater camera with a 0.03 m^2 framer. Counts of seagrass blades in each photograph provided estimates of blade density.

From June through October 1985, a seagrass monitoring program was conducted in Gainesville Area Block 707. The aim of this study was to monitor impacts of discharged drilling muds on live-bottom areas and deep seagrass communities. Data collected during this study, particularly dry weight biomass estimates of seagrass leaves (*Halophila decipiens* and *H. englemanni*) and seagrass density estimates from photoquadrats, were used to augment the effort.

The new field surveys were conducted between 14 and 19 August 1986. Days of sampling signature control stations were alternated with days of television/diver transect surveys. Most transects were surveyed with both diver and television in the water at the same time. Navigational fixes consisting of Loran-C time delays and bottom-type descriptions were

recorded at 5-min intervals along the transects. Twenty of the original signature control stations were resampled photographically in August 1986. Four of these stations were live bottom, and a live-bottom reference station from the monitoring program was also resampled. At this station 10 staked quadrats were sampled photographically with a 0.1 m^2 framer.

SIGNIFICANT CONCLUSIONS: It was apparent that seagrass, algal, and live-bottom communities on the west Florida shelf are resilient to storm impacts. Areas of *Halophila* sp. denuded by Hurricane "Elena" in 1985 appeared fully recovered after the 1986 growing season. Live-bottom organisms, particularly octocorals, seem to be adapted to withstand both wave energy and sand scour associated with storms.

STUDY RESULTS: Resurveyed transect data were compared with the original survey data. Little change in percent cover by major habitat types was evident. Along one transect, there was an observed increase in seagrass coverage; however, this was apparently due to an extension of the transect length during the second survey and not to increased seagrass cover.

Comparisons of 1984 and 1986 data from the *H. decipiens* stations showed leaf density and biomass were higher at some stations and lower at others, but the mean values were comparable. There was no demonstrable relationship between standing stock estimates and hurricane tracks that could be shown. Three of the signature control stations dominated by *H. engelmanni* in October 1984 had only sparse *Halophila* shoots and rhizomes present during August 1986. The elimination of *H. engelmanni* at these stations was not considered a hurricane impact. Dense nearshore beds, composed of mixed stands of turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and shoalgrass (*Halodule wrightii*), showed no noticeable changes between the 1984 and 1986 surveys. Biotic coverage and gross taxonomic composition of the epifaunal communities at the live-bottom stations were comparable between 1984 and 1986 surveys.

In 1985, when divers visited the monitoring site in the Big Bend area where Hurricane "Elena" had passed through eight days earlier, tremendous destruction of seagrasses, macroalgae, and sessile invertebrates was found. Considerable sediment movement had also occurred in some places. The August 1986 survey, conducted approximately one year after the passage of the hurricane, showed that seagrasses were again present in areas that had been completely denuded. The seagrass/algal and live-bottom areas of the west Florida shelf were considered resilient to the occasional passage of major hurricanes.

STUDY PRODUCT(S): Continental Shelf Associates, Inc. 1987. Assessment of Hurricane Damage in the Florida Big Bend Seagrass Beds. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, New Orleans, LA. Contract No. 14-12-0001-30188. 95 pp.

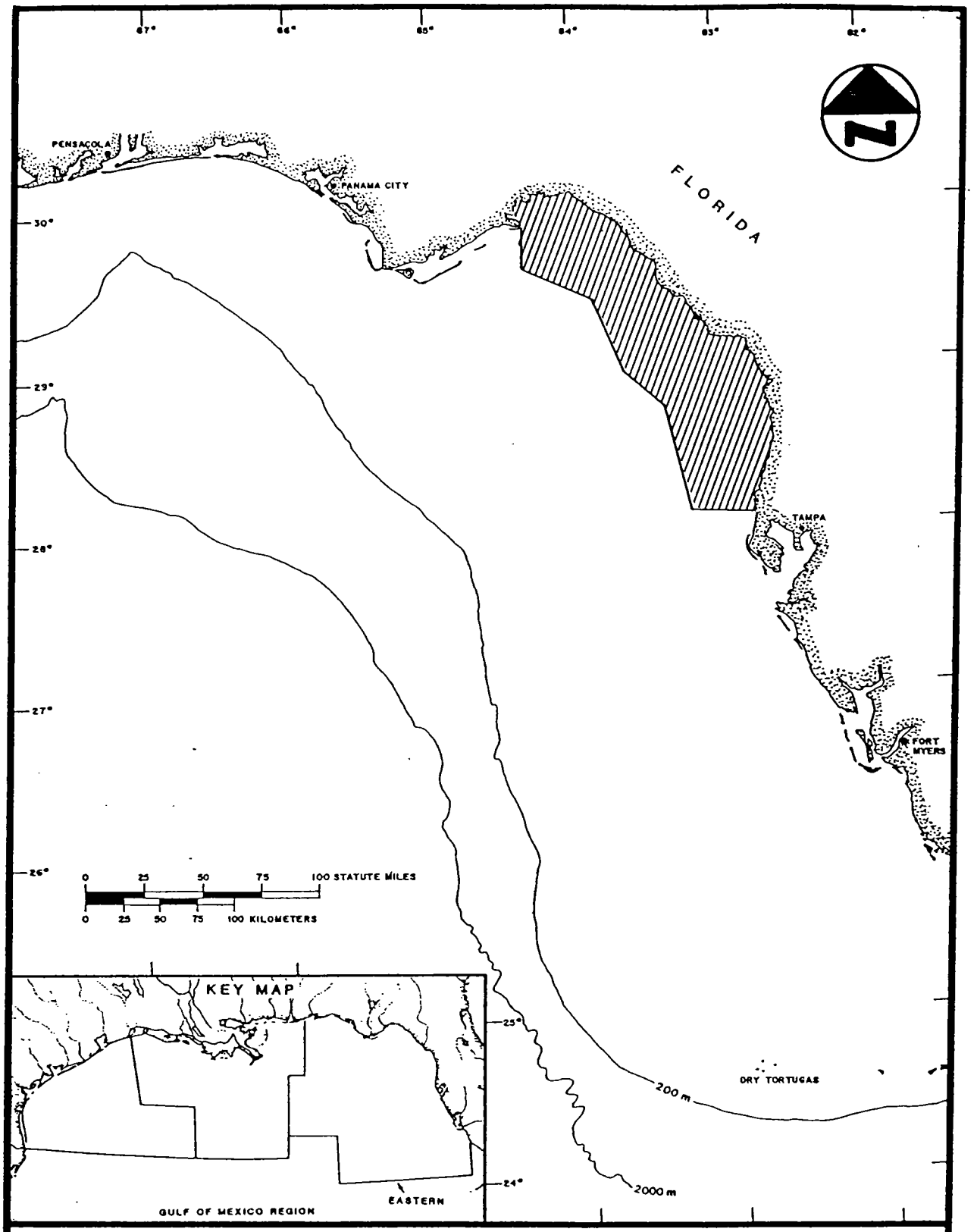
STUDY TITLE: Florida Big Bend Sea Grass Habitat Study.

COMPLETION DATE OF REPORT: February 1987.

CUMULATIVE PROJECT COST: $386,998.

KEY WORDS: Eastern Gulf; Florida; Big Bend; biology; seagrasses; hurricane; recovery; observations; benthic photographs; videotapes; density; hard-bottom; West Florida Shelf.

ACCESS NUMBER:30188.2



FLORIDA BIG BEND SEAGRASS AREA SURVEYED FOR HURRICANE IMPACTS ASSESSMENT.

REPORT TITLE: Mapping of Submerged Vegetation Using Remote Sensing Technology.

MMS PUBLICATION NUMBER: Contract No. AA551-IA8-27.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: Seagrasses have a potential role as indicators of the impact of man's activities on estuarine and coastal ecosystems. Information on changes in seagrass distribution, abundance, and diversity can aid in decisions and guidelines for coastal zone management. However, it is first necessary to develop a technique to provide distribution and abundance data accurately and economically. Aerospace color remote sensing could satisfy this requirement. This project was designed to investigate the potential for utilizing this technology with modifications for mapping seagrass distributions.

OBJECTIVES: (1) To evaluate a 21-channel solid state array spectroradiometer (SAS); (2) to determine if common seagrasses and other bottom types can be detected and differentiated with high resolution spectral data; (3) to develop and document applicable computer algorithms for processing, analyzing, and classifying spectral data into charts of seagrass distribution; and (4) to determine any deleterious effects of water depth and optical properties on spectral signatures of seagrasses.

DESCRIPTION: Two types of data were collected. The first type involved surface truth data collected from 20 stations in St. Joseph Bay, Florida on 17 May 1978. Remote sensing data were collected on 18 and 19 May 1978. Surface truth data were used to identify indigenous seagrasses and to describe respective environments. The remotely sensed data were collected from a Beechcraft E-18S equipped with a 70-mm Hasselblad camera, Zeiss RMK 15/23 camera with a 15.24-cm focal length lens, a RS-18 multispectral scanner, and the SAS. Flights were flown at 1,520 m for the RS-18 and at 3,050 m for the SAS data collection efforts. Remote sensing data were analyzed using spectral information from the training fields and a discriminant function analysis computer program to develop algorithms used in a supervised pattern recognition approach. Secondarily, spectral data were combined with supervised data groupings in a hybrid supervised-unsupervised maximum likelihood pattern recognition approach.

SIGNIFICANT CONCLUSIONS: The project demonstrated the ability to use remotely sensed data and advanced computer techniques to map monospecific benthic vegetation in a fairly stable environment. However, the project was unsuccessful in evaluating the feasibility of mapping multispecies benthic vegetation assemblages in complex open coastal environments.

STUDY RESULTS: The project failed to produce a usable classification product for the user community. It was determined that several modifications were needed before the SAS could be considered an operational sensor, including: (1) a wider field of view so that ground track and aircraft attitude are not so critical; (2) a greater dynamic range for the signal in order to accommodate varying signal levels encountered in a mission; (3) a higher data rate to lower the aspect ratio thereby giving better ground resolution; (4) inclusion of aircraft attitude data in the SAS data stream to allow correction of the data for pointing errors; and (5) overall system noise reduction to achieve true 8-bit resolution.

Qualitative comparison of the classification results with ground truth data led to the conclusion that the classification maps were detailed and accurate. However, some imperfections were noted in the maps. Comparisons were made of seagrass distributions in the bay using historical data and the remotely sensed information from this study. The estimate of 2,300 to 2,400 hectares of vegetation covering the bay measured in this study compared well with an estimate of 2,560 hectares reported in 1972. This supported a finding that the bay macroplant community distribution is relatively stable on an annual basis.

The multispectral scanner sensor used in this investigation offered advantages over surface based mapping or mapping from conventional aerial photography in terms of resolution of different water depths, bottom types, and types and densities of submerged vegetation coverage.

STUDY PRODUCT(S): Savastano, K. J., K. H. Faller, L. W. McFadin, and H. Holley. 1981. Mapping of Submerged Vegetation Using Remote Sensing Technology. A final report by the National Marine Fisheries Service, Southeast Fisheries Center for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. PB82-163072. NOAA Technical Memorandum NMFS-SEFC-73. Contract No. AA551-IA8-27. 68 pp.

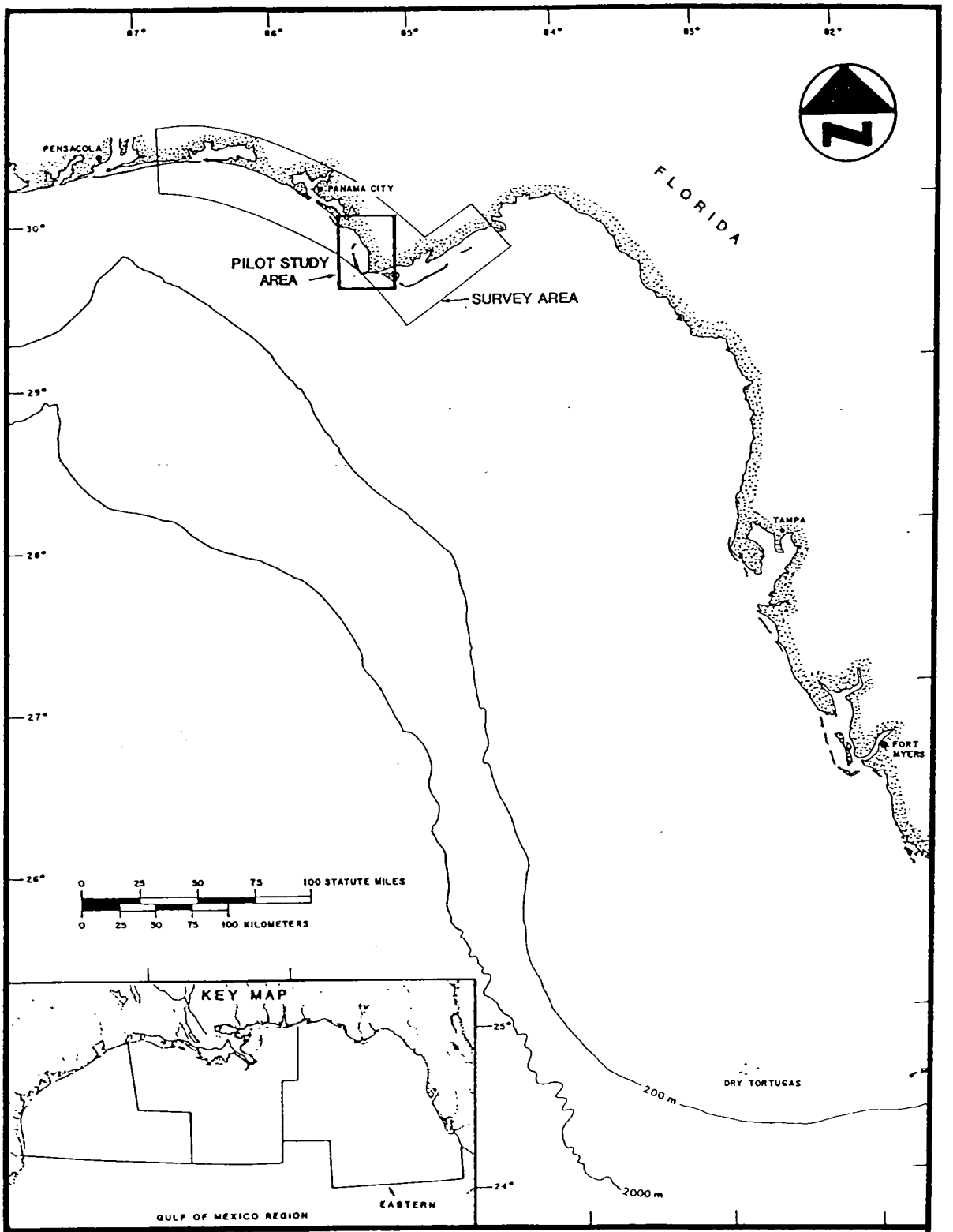
STUDY TITLE: Mapping of Seagrasses by Remote Sensing in the Eastern Gulf of Mexico.

COMPLETION DATE OF REPORT: 1981.

CUMULATIVE PROJECT COST: $5,000.

KEY WORDS: Eastern Gulf; Florida; baseline; seagrasses; aerial photography; photographs; subtidal; St. Joseph Bay; estuarine; coastal zone; maps; historical review; macrophytes.

ACCESS NUMBER:IA8-27



SURVEY AND PILOT STUDY AREAS FOR MAPPING OF SUBMERGED VEGETATION USING REMOTE SENSING TECHNOLOGY.

PHYSICAL OCEANOGRAPHY

Winds, waves, and currents in and around areas of oil and gas activities determine the extent of pollutant transport, the dispersion of waste products, and the expected impacts on nearby biologically sensitive areas. A good understanding of the physical nature of a system is basic to other primary disciplines. Circulation affects recruitment of juvenile organisms, the transport of smothering sediments (including muds and cuttings), and the flushing of waste material from the region. A good understanding of the physical dynamics of a region is necessary to support other disciplines, including biological, chemical, engineering, and geological, and to support diagnostic and predictive modeling efforts. An important use of physical oceanographic data is an input to the Oil Spill Risk Analysis performed by MMS.

REPORT TITLE: Southwest Florida Shelf Circulation Model.

MMS PUBLICATION NUMBER: Contract No. AA851-CT0-72.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: The southwest Florida shelf has been the subject of environmental scrutiny since the U.S. Department of the Interior (USDOI) made lease blocks available for oil and gas exploration. There was an attendant need to have a predictive circulation model that would forecast the possible transport of pollutants associated with petroleum activities. This study incorporates available hydrographic data for use in such a model applicable to the southwest Florida shelf.

OBJECTIVES: (1) To adapt an existing numerical hydrodynamic model to the shelf; (2) to test the model with appropriate existing data from the shelf; (3) to recommend additional data collection efforts needed to improve the model's effectiveness; and (4) to document the model for use by USDOI personnel.

DESCRIPTION: This study was comprised of four separate phases: (1) Literature review and data search; (2) Model modifications and basic sensitivity studies; (3) Model verification and tuning; and (4) Prediction of seasonal circulation patterns. In Phase 1, existing literature pertaining to the Loop Current or the West Florida Shelf circulation was reviewed for raw data needed for input to the model. Phase 2 consisted of the following model modifications: provision for model forcing due to horizontal density gradients, improvement of lateral shear stress parameterization, selection of suitable grid system for the West Florida Shelf, provision for a spatially variable Coriolis parameter, and reorganization of the program coding into modular units. Phase 3 involved comparisons of model simulations with available real time data. Wind data were input into the model, then results were compared to low-frequency, real-time velocity and sea level data. Model parameters were then adjusted to achieve a best fit between model results and data. At the completion of this phase, the model was considered theoretically sound and able to accurately simulate West Florida Shelf dynamics. During Phase 4, long-term reproductions of shelf circulation were accomplished by separately modeling the effects of the Loop Current, differential heating, and wind. These results were superimposed to produce a composite atlas of residual circulation.

To accommodate model requirements, the study area was from 30°N Lat, south to the Florida Keys, and west to the 200-m isobath. This area encompasses the entire West Florida Shelf.

The basic model is a primitive, diagnostic model based on momentum and continuity equations. A weighted residual technique used in model formulation eliminates vertical dependency of the velocity components. All significant forcing mechanisms are included: Coriolis force, horizontal density gradient, surface pressure gradients, wind stress, bottom friction, horizontal and vertical eddy viscosity coefficients, and lateral shearing stresses from the Loop Current.

SIGNIFICANT CONCLUSIONS: Additional data, especially pertaining to circulation patterns, is needed to advance the understanding of West Florida Shelf hydrodynamics. Comparisons of model simulations with available data showed that hindcasts were good for surface elevation and current velocity. A hindcast of winter 1973 data predicted eddies propagating from the Loop Current shoreward. Seasonal (long-term) simulations of surface currents predicted southerly flow during winter and northerly during spring and summer; these simulations agreed with available drift bottle data. Actual model parameterization for the Loop Current was impeded by lack of current meter data.

STUDY RESULTS: Circulation in the eastern Gulf of Mexico is dominated by the Loop Current; annual cycles of this current are subject to considerable variability. The Loop Current abuts the lower portion of the West Florida Shelf during most of the year, and during northward incursions it abuts the entire shelf. Cyclonic eddies, meanders, and tongues from the Loop Current often traverse the shelf. Spin-off eddies may be 200 km in length and have periods of 15 days; short-term hydrographic measurements recorded over similar length scales as the eddies could be serious biased. Lateral shear mechanisms generated by the Loop Current also contribute to shelf circulation. Maximum tidal currents on the shelf were 10 cm s^{-1}, causing advection of about 1 km. Thus, tidal forcing, only important as an advective mechanism near the coastline, was not included in the model. In Phase 2, a grid composed of 12 by 24 elements (30 km on a side) with land, seaward, and lateral open boundary types was developed. Bathymetry was limited to 200-m which did not affect simulations of on-shelf circulation, another modification of slope bathymetry in the southwest corner of the grid was also accomplished with little effect on model output. Sensitivity studies suggested that reasonable values for drag coefficient (bottom friction) and horizontal eddy viscosity range from 0.02 to 0.08 cm s^{-1} and 10^7 to 10^9 cm s^{-1}, respectively. Surface phenomena (wind-induced flow, surface velocity, and coastal surface elevations) were insensitive to changes in drag coefficients, but velocities lower in the water column were sensitive to drag coefficient changes. Addition of a boundary current with an assumed magnitude of 100 cm s^{-1} along the western margin of the grid generated spin-off eddies depending on where the current was imposed. By temporally varying the boundary current, northward migrating barotropic waves were generated. Stratification decreased currents in the lower layer and increased currents in the mixed layer. During Phase 3, comparisons were restricted to synoptic time periods of 2 to 30 days using data sets (current velocity and surface elevation) collected during February-March 1973 and February-March 1978. From the 1978 data, the model predicted real time residual currents usually to within 5 cm s^{-1} over a range of 40 cm s^{-1}, and surface elevations to ± 2 cm over a range of 40 cm. Discrepancies between modeled and observed currents were due to measurement error, inadequately modeled wind field, unmodeled effects of the Loop Current, or horizontal density gradients and not to an inadequate choice of model dissipation coefficients. For winter 1973, surface elevations were modeled within 5 cm in amplitude and 5 h in phase. The model underestimates the surge peaks by about 10 cm. Forcing by the Loop Current over-predicted the surface elevations using a barotropic eddy wave. Using an alternative lateral shear mechanism to model the Loop Current, reasonable comparisons to observed current data were given. Current meter data were affected by the passage of frontal systems. Summer 1974 observed surface elevations were consistent with modeled elevations but the phase was consistently in error. Complications with the wind field was also a problem during simulations.

During Phase 4, seasonally averaged wind fields, density gradients, and Loop Current effects were modeled to achieve a realistic shelf circulation model. Winds were divided into three seasons: fall-winter with northeasterly winds of 4.5 m s^{-1}; spring with south-southeasterly winds of 5.5 m s^{-1}; and summer with southeasterly winds of 4 m s^{-1}. Modeled fall-winter surface currents were about 10 cm s^{-1} and displayed a net movement to the south, implying that drifters will be entrained in the Loop Current and advected to the Florida Keys or the eastern coast of the United States. Spring surface currents were about 3 cm s^{-1} and displayed net movement to the north. Summer surface currents were less than 1 cm s^{-1} and exhibited net movement to the north.

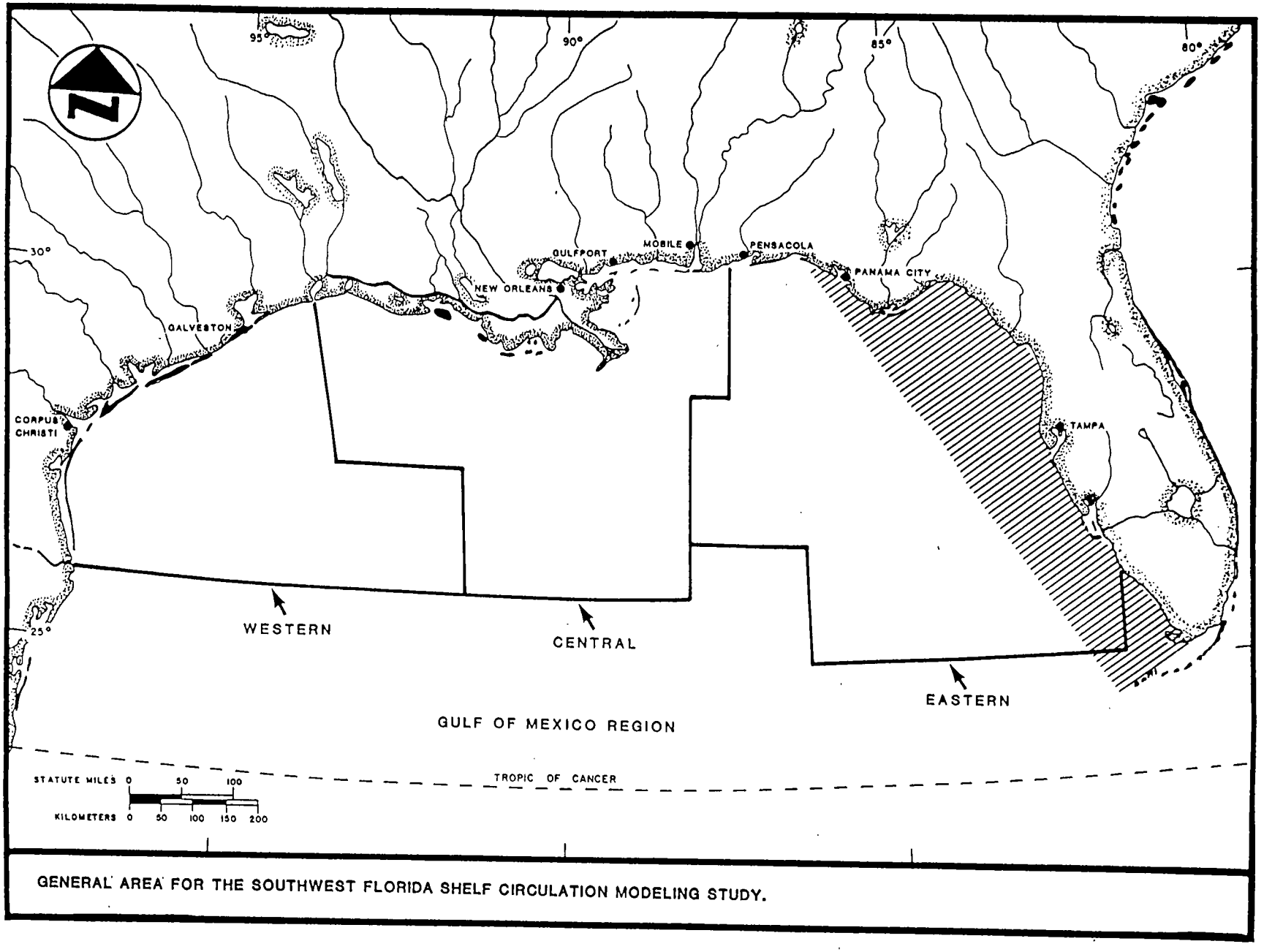
STUDY PRODUCT(S): Cooper, C. 1982. Southwest Florida Shelf Circulation Model. A final report by New England Coastal Engineers, Inc. for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. Vol. I (Technical Report) - NTIS No. PB84-113240; Vol. II (Appendices - Programmer's Guide) - NTIS No. PB84-129857; Vol. III (Data Report) - NTIS No. PB84-113364.
Contract No. AA851-CT0-72.

STUDY TITLE: West Florida Shelf Circulation Modeling Study.

COMPLETION DATE OF REPORT: October 1982.

CUMULATIVE PROJECT COST: $233,455.

KEY WORDS: Eastern Gulf; West Florida Shelf; Loop Current; physical oceanography; hydrodynamics; modeling; currents; meteorology.



GENERAL AREA FOR THE SOUTHWEST FLORIDA SHELF CIRCULATION MODELING STUDY.

ACCESS NUMBER:29021

REPORT TITLE: Gulf of Mexico Satellite Radar Altimetry.

MMS PUBLICATION NUMBER: Contract No. AA851-IA0-11.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: The GEOS-3 satellite, the first dedicated radar altimeter used to obtain oceanographic data, was employed in an altimetry study of the South Atlantic Bight. Principal data products were ocean dynamic heights, significant wave heights, and surface wind speeds. In the present study, GEOS-3 in conjunction with another satellite, SEASAT, gathered similar information for the Gulf of Mexico.

OBJECTIVES: (1) To provide satellite altimetry information for the Gulf of Mexico; and (2) to compare results (sea surface elevation, significant wave heights, surface wave heights) from two satellites over the same area.

DESCRIPTION: Data from passes of each satellite over the Gulf of Mexico from Spring 1975 to Fall 1978 for GEOS-3 and from Spring to Fall 1978 for SEASAT were recorded and analyzed. GEOS-3 operates on a frequency of 13.9-GHz with both global and intensive mode. The intensive mode produces a compressed pulse of 12.5 ns and provides measurements with precision of about 20 cm for a 1^{-6} average. This configuration yields a footprint 3.6 km wide and 11 km along the track from an orbit of 840 km in altitude, an inclination of 115°, and a period of 101.8 min. SEASAT was also designed to operate at a frequency of 13.9 GHz but was compressed to 3 ns providing a precision of about 10 cm for a 1^{-6} average. The SEASAT footprint configuration was 1.6 km wide and 12 km along the track from an orbit of 800 km in altitude, an inclination of 108°, and a period of 100.75 min. Analytic procedures and algorithms used for data reduction were essentially the same for both satellites; sea surface elevation profiles were resolved on a 30-minute geoid of the Gulf of Mexico; this method resulted in considerable resolution variability. To determine overall variability associated with the geoid, a three-year mean topographic map and a three-year standard deviation map were generated using all satellite passes over the Gulf of Mexico by both satellites. These topographic maps are then the average of the pass-by-pass variation calculated over a 15-minute grid over the entire Gulf of Mexico and processed seasonally. Significant wave height was computed aboard SEASAT at 10 s^{-1}, reduced to 4.6 s^{-1}, while GEOS-3 was computed on the ground at major frame rates of 3.2 s^{-1} for high data rates and 2.0 s^{-1} for low data rates. Surface wind speeds were calculated using two formulae; correction factors were applied for different wind speeds. Data rates for SEASAT and GEOS-3 were the same as for the significant wave height data. Anomalous GEOS-3 data passes recorded during July, August, September, and October 1975 were omitted from the final data set.

SIGNIFICANT CONCLUSIONS: The 30-minute grid contributed to appreciable lack of dynamic height geoid resolution and variation maps were biased by the large number of passes recorded during the last few months of the study. Only large dynamic height features could be determined. Significant wave height was generally small for the Gulf of Mexico; only in Winter 1976 did mean wave height exceed 2 m. Surface wind speed data exhibited reduced variability, and distinct seasonal fluctuations were observed.

STUDY RESULTS: The gravimetric geoid method used to extract the residuals from the altimeter heights was inadequate; geoidal undulations of small horizontal scales but ranging in amplitude from 1 to 4 m were poorly modeled and caused inaccurate results in the dynamic height analyses. Surface topography maps were only accurate if a sufficient number of passes had been recorded for that particular map. Of 15 maps analyzed, 2 were totally unusable because of poor coverage, 8 showed sufficient coverage for the Eastern Gulf but not for the Western Gulf, and 5 were excellent with respect to coverage. Only large surface features could be accurately discerned; features in excess of 150 cm were due to dynamic heights. Significant wave height displayed relatively low values from April 1975 to October 1978. A mean value of 2.3 m recorded in January 1976 was the only instance where mean wave height exceeded 2.0 m. Variance was generally constant during the study period. Altimeter readings for waves smaller than 2.0 m tend to be noisy thus precluding quantitative representation of this data. Wind speed measurements were most reliable, and distinct seasonal variations were seen. Highest values were recorded during winter months (8.5 m s^{-1} in November 1977) and lowest values were recorded during summer months (3.3 m s^{-1} in July 1976). There were no appreciable differences in wind speeds between the Eastern or the Western Gulf of Mexico.

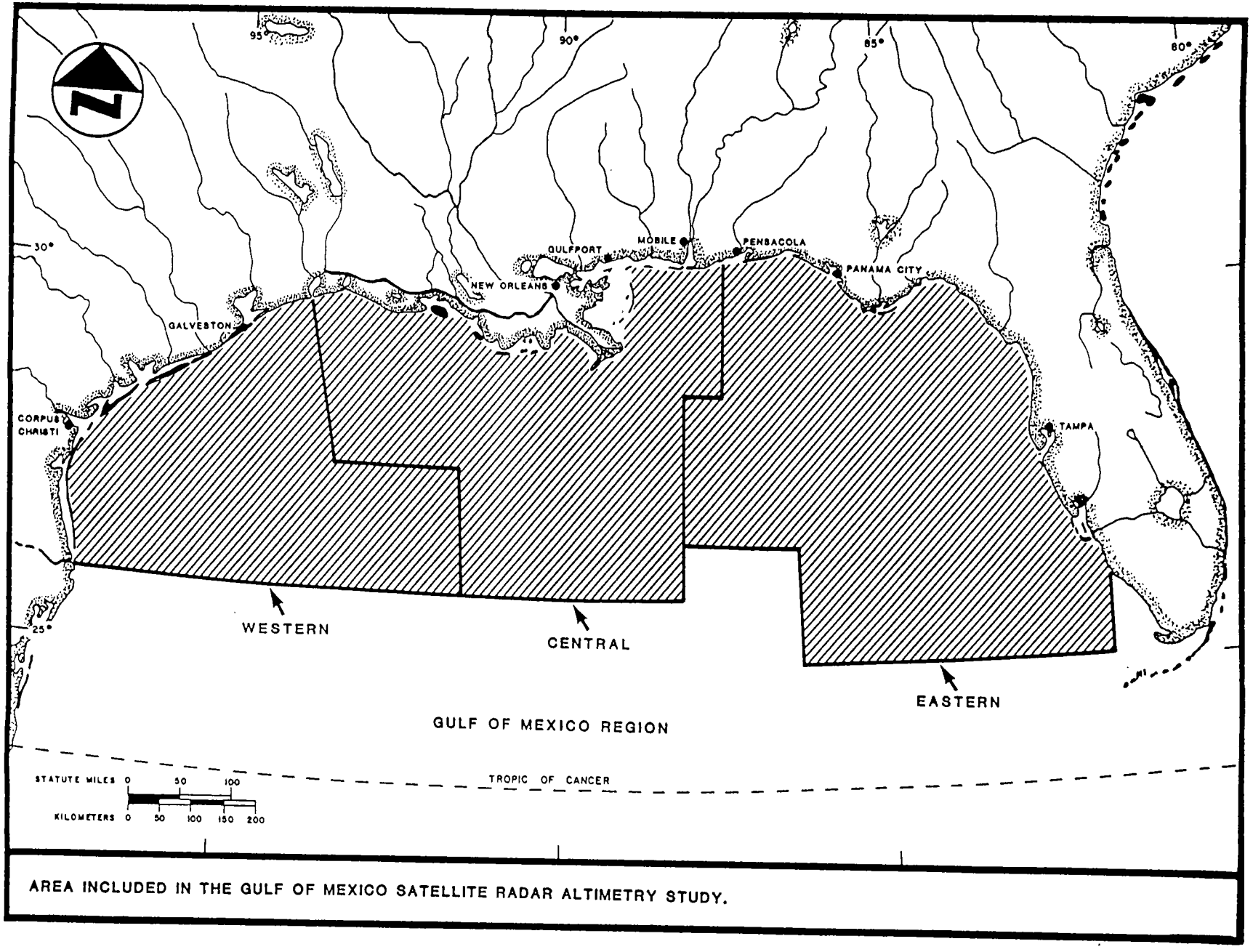
STUDY PRODUCT(S): Parra, C. G., R. G. Forsythe, and C. L. Parsons. 1981. Gulf of Mexico Satellite Radar Altimetry. A joint report by the National Aeronautics and Space Administration and the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. N81-33760/2. Contract No. AA851-IA0-11. NASA Tech. Memo. 73295. 230 pp.

STUDY TITLE: Gulf of Mexico Satellite Oceanography Study.

COMPLETION DATE OF REPORT: August 1981.

CUMULATIVE PROJECT COST: $223,000.

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; physical oceanography; meteorology; satellite imagery; seasonality; wave height.



AREA INCLUDED IN THE GULF OF MEXICO SATELLITE RADAR ALTIMETRY STUDY.

ACCESS NUMBER:28094

REPORT TITLE: Gulf of Mexico Physical Oceanography Program Final Report, Year 4. Vol. I, Executive Summary; Vol. II, Technical Report.

MMS PUBLICATION NUMBER: MMS 87-0007.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: In 1982, the U.S. Department of the Interior initiated a multi-year investigation of physical oceanographic conditions related to or resulting from deep circulation patterns in the Gulf of Mexico. During the first, second, and fourth study years, measurements and interpretation focused on the southeastern Gulf of Mexico with emphasis on the Loop Current and its interaction with the adjacent west Florida shelf and slope. The third study year focused on the western portion of the Gulf of Mexico. The present report includes field measurements from the fourth year and is considered an addendum to the first and second year report.

OBJECTIVES: (1) To develop a better understanding of conditions and processes governing Gulf of Mexico circulation; and (2) to provide a data base to be used as initial and boundary conditions in companion numerical circulation modeling studies.

DESCRIPTION: During the first two study years, data necessary to describe Loop Current behavior and associated circulation patterns were obtained from Lagrangian drifters, satellite thermal imagery, regional shipboard hydrographic surveys, moored current meters, and ships-of-opportunity. The fourth year program continued data collection using current meters, Lagrangian drifters, and ships-of-opportunity only.

Two drifting buoys equipped with position transmitting instrumentation were used to track rings. One buoy was deployed on 18 June 1985 in a newly formed warm core ring at approximately 26°N Lat and 88°W Long; on 18 July 1985, another buoy equipped with a 200-m thermistor string was deployed in another newly formed warm core ring at approximately 26°24'N Lat and 89°24'W Long. Vertical profiles of horizontal currents obtained during the previous years. Work using hull mounted acoustic doppler currents profilers were further analyzed. Current meters were used to measure temperature, subsurface currents, and pressure. In January 1985, six moorings were redeployed on the west Florida shelf and slope. The redeployment of these meters served as a continuation of field measurements that began in this region in January 1983. Five tautline moorings were deployed along a heading perpendicular to the west Florida shelf in water depths ranging from 50 to 3,275 m, while one was placed 167 km north on the 180-m isobath. The ships-of-opportunity program continued to provide information and support the field efforts.

SIGNIFICANT CONCLUSIONS: An anticyclonic feature embedded in the Loop Current was tracked. This revealed that the basic closed pattern of clockwise rotating water may exist regularly in that region interior to high speed flow regimes and can develop at least during or after Loop Current eddy separation. Inertial currents were important to the dynamics of the west Florida shelf oceanography. They were found to be energetic, with amplitudes often exceeding magnitudes of mean currents, low-frequency fluctuations, and tides. Nearshore currents on the west Florida shelf were primarily wind driven.

STUDY RESULTS: A buoy was deployed in June 1985 in what was believed to be a pinched off Loop Current eddy. Actually, separation was not complete and the drifter travelled 525 km southeast, entrained within the Loop Current, by mid-September 1985. There were three complete rotations observed before the drifter moved out of the Gulf through the Straits of Florida. The second buoy was in an actual Loop Current separated eddy. The rotation velocities decreased as the buoy neared the eddy center. Drifter velocities ranged from 30 to 90 cm sec^{-1} and appeared to decrease with time. In both features, the buoys indicated closed circulation. During the hydrographic cruise, 268 hydrographic stations were occupied. These data were obtained on 20 sections, 13 of which were in the vicinity of the Loop Current boundary and three were through a large cold perturbation of the Loop Current front. The general pattern had wave-like boundary features. Higher speed currents were located in a 100 to 150-km near surface band which was adjacent to the Loop Current frontal boundary. Maximum speeds near or at the surface decreased by approximately 50% or more in the upper 250 m. This zone moved laterally from the shelf break to 100 km seaward of the shelf break.

Inertial currents determined from current meter data on the west Florida shelf were energetic with peak amplitudes from 15 to 30 cm sec^{-1}. Peak amplitudes were thought to be associated with the pycnocline. Amplitudes were intermittent in space and time and not well correlated between moorings. Mid-depth maxima of inertial amplitudes were common at moorings which sampled at the base of the mixed layer. Two hurricanes in 1985 (Elena and Kate) had similar tracks and produced sharp peaks of inertial amplitudes at all sites to a maximum of 42 cm sec^{-1}.

Circulation patterns having periods longer than one day were Loop Current- and wind-forced. Wind signals exhibited a seasonal modulation with a summer minimum and a fall-winter-spring maximum. The primary signal was related to frontal passage. Nearshore currents were primarily wind driven. Wind forcing occurred in preferential frequency bands encompassing periods of 3 to 10 days. There was appreciable wind-current coherence which was variable with season. The Loop Current boundary moved onshore and offshore at periods of greater than two weeks.

STUDY PRODUCT(S): Science Applications International Corporation. 1987. Gulf of Mexico Physical Oceanography Program Final Report, Year 4. Vol. I, Executive Summary. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, New Orleans, LA. NTIS No. PB88-170402. MMS Report 87-0006. Contract No. 14-12-0001-29158. 14 pp.

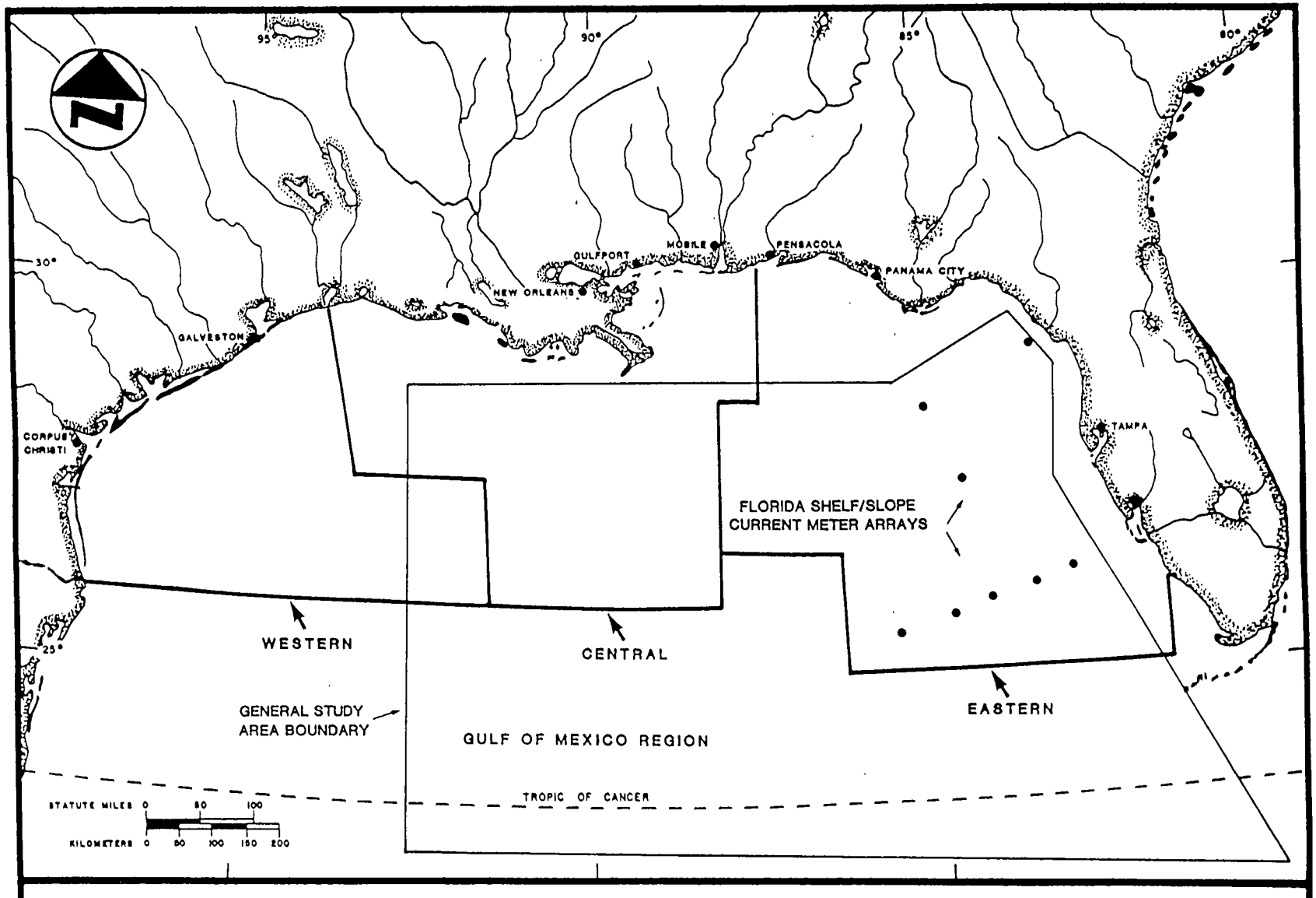
Science Applications International Corporation. 1987. Gulf of Mexico Physical Oceanography Program Final Report, Year 4. Vol. II, Technical Report. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, New Orleans, LA. NTIS No. PB88-170782. MMS Report 87-0007. Contract No. 14-12-0001-29158. 378 pp.

STUDY TITLE: Gulf of Mexico OCS Physical Oceanography Field Study, Year I, II, and III.

COMPLETION DATE OF REPORT: 1987.

CUMULATIVE PROJECT COST: $5,499,579.

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; Florida; Louisiana; Texas; physical oceanography; Loop Current; currents; satellite imagery; hydrography; survey; shipboard observations; nutrients; West Florida Shelf; slope; shelf; eddy; wind forcing; hurricane.



GENERAL STUDY AREA FOR GULF OF MEXICO OCS PHYSICAL OCEANOGRAPHY FIELD STUDY, YEAR 4.

ACCESS NUMBER:29158.2

REPORT TITLE: Gulf of Mexico Circulation Modeling Study Annual Progress Report, Year 1.

MMS PUBLICATION NUMBER: MMS 85-0025.

APPLICABLE PLANNING AREA(S): Straits of Florida; Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: Accurate understanding of circulation patterns in the Gulf of Mexico are essential when predicting dispersal of pollutants or any other transportable contaminants. Conventional methods of obtaining circulation data are time consuming and costly. Computer simulations obviate some of the time and expense involved in characterizing or predicting oceanic circulation patterns. The U.S. Department of the Interior sponsored a four-year effort to upgrade and test an existing computer model of Gulf of Mexico circulation patterns that will provide management personnel with quick and reliable simulations of particular circulation patterns in the absence of field collected data.

OBJECTIVES: (1) To progressively upgrade in modest increments an existing numerical ocean circulation model of the Gulf of Mexico so that the final model has horizontal resolution of about 10 km and vertical resolution approaching 1 to 10 m in the mixed layer, 10 m at the thermocline, and 100 m in deep water.

DESCRIPTION: During this four-year project, the validity of the upgraded model will be continuously tested, and velocity field time series delivered periodically based on the most realistic simulation of Gulf circulation available. Experiments during this first year were with the existing NORDA/JAYCOR two layer hydrodynamic primitive equation ocean circulation model of the Gulf of Mexico on a 0.2 degree grid. Particular attention was given to specifying the coastline and bottom topography for maximum realism. Model parameters included: upper layer inflow transport, lower layer inflow transport, wind stress, horizontal eddy viscosity, grid spacing, upper layer reference thickness, lower layer reference thickness, minimum depth of bottom topography, Coriolis parameter, gravitational acceleration, reduced gravity, interfacial stress, coefficient of quadratic bottom stress, and time step. Experiments were conducted by adjusting these parameters to achieve best simulations when compared with existing data.

SIGNIFICANT CONCLUSIONS: Changes to the original model parameters such as inflow transport of the upper and lower layers improved the simulations. The experiment yielding the best results included the addition of wind forcing after port forcing had fully spun up. The use of seasonal climatological winds introduced considerable variability and was not a successful experiment. This experiment also revealed that ocean circulation climatologies were inappropriate for use in oil spill risk analyses in the Gulf of Mexico.

STUDY RESULTS: Five experiments (Experiments 9, 34, 40, 60, and 68) were included in the Year 1 report. Experiment 9 gave the best simulation of the Gulf of Mexico at the beginning of the project, based on available comparative data. The model was driven from rest to statistical equilibrium solely by a steady inflow through the Yucatan Straits. The model effectively simulated eddy shedding by the Loop Current. As shed eddies propagate westward, the model spontaneously develops a counter-rotating vortex pair, a structure

observed in the western Gulf of Mexico. The simulation sheds an eddy once every 390 days, and observed eddy shedding cycles were very similar. The eddies generated in Experiment 9 were large with high maximum currents. In the two layer model, upper layer transport can be reduced to produce smaller eddies. The use of wind forcing based on seasonal climatology was used in Experiment 34. Basic circulation patterns exhibited much more variability in this case. Experiment 40 employed 20 Sverdrup (Sv) upper layer transport and 10 Sv lower layer transport, as opposed to 26 Sv (upper) and 4 Sv (lower) used in Experiment 9. This experiment produced sea surface variability maps that were consistent with maps produced from hydrographic and satellite altimeter data. Experiment 40 was considered the best mean sea surface variability model for the Gulf of Mexico. Experiment 60 was identical to Experiment 40, except that horizontal eddy viscosity was reduced. Some new circulation features not seen in Experiment 40 were revealed. Experiment 68 was identical to Experiment 40 except for the addition of wind forcing after the port-forced circulation had fully spun up. This experiment produced the furthest northward penetration of the Loop Current ever attained by simulation. Similar intrusions have been seen in the Gulf of Mexico. The model's inadequate representation of shelf topography makes it likely that the currents simulated in shallow water (<100 m) were too high. Simulated surface currents from Experiment 68 were considered the best simulation data available at the end of Year 1. They consist of velocity component (u and v) fields on a 0.2 degree rectangular grid covering the Gulf area, sampled every three days for 3,780 model days (10.3 years).

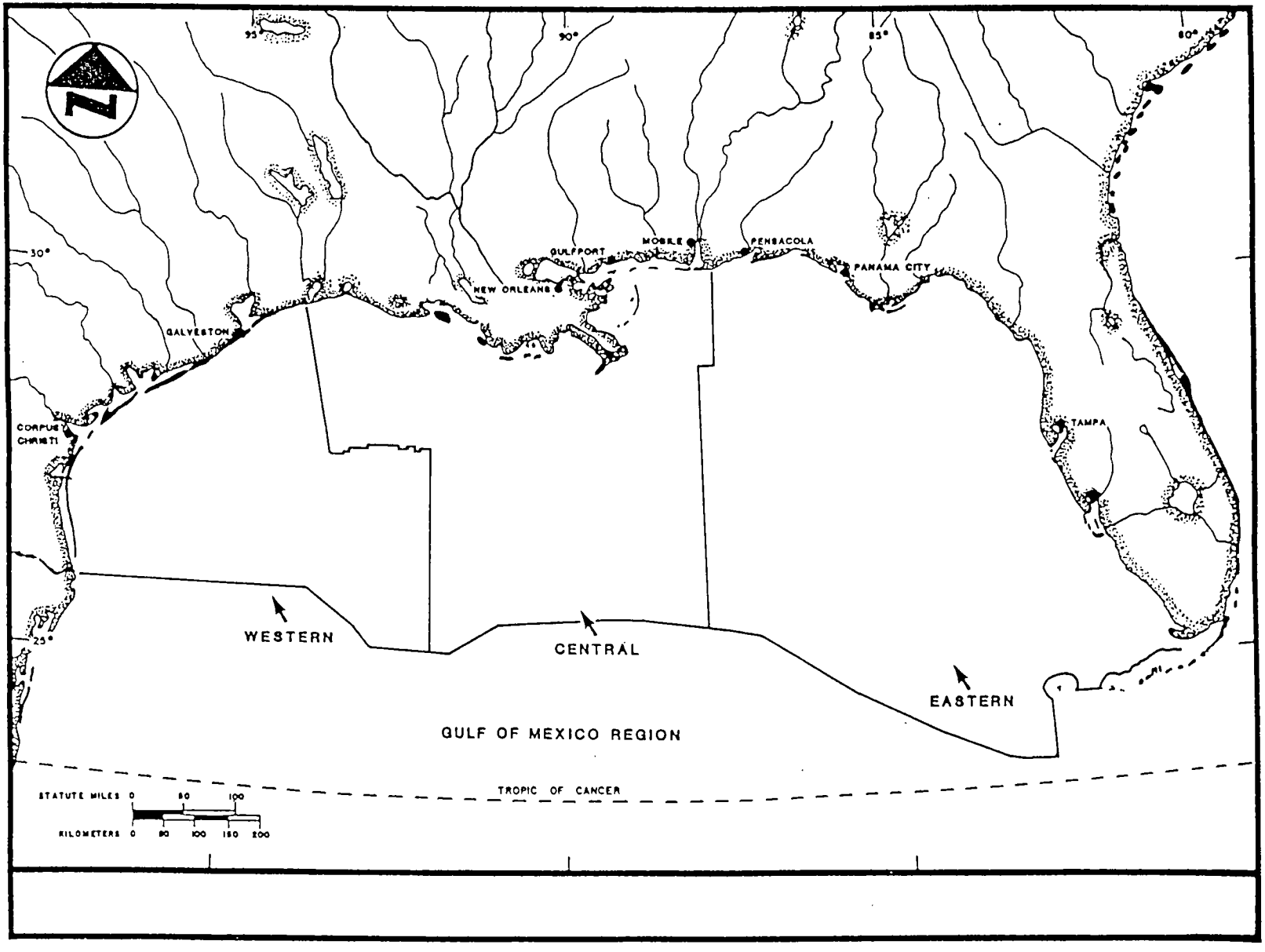
STUDY PRODUCT(S): Wallcraft, A. J. 1984. Gulf of Mexico Circulation Modeling Study Annual Progress Report, Year 1. A final report by JAYCOR for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB87-128641. MMS Report 85-0025. Contract No. 14-12-0001-30073. 106 pp.

STUDY TITLE: Gulf of Mexico Circulation Modeling Study.

COMPLETION DATE OF REPORT: November 1984.

CUMULATIVE PROJECT COST: $78,663.

KEY WORDS: Straits of Florida; Eastern Gulf; Central Gulf; Western Gulf; physical oceanography; currents; modeling; transport; patterns; Loop Current; wind forcing; seasonality; eddy.



Base map of the entire Gulf of Mexico area.

REPORT TITLE: Gulf of Mexico Circulation Modeling Study Annual Progress Report, Year 2.

MMS PUBLICATION NUMBER: MMS 86-0027.

APPLICABLE PLANNING AREA(S): Straits of Florida; Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: In 1983, the U.S. Department of the Interior funded a four-year circulation modeling program for the Gulf of Mexico. The first study year tested the two layer hydrodynamic primitive equation ocean circulation on a 0.2 degree grid. Important aspects of the first year were correctly specifying coastline and bottom topography for maximum circulation simulation, and how best to include wind forcing. During the second study year, investigators utilized the same basic model with various parameter changes to conduct experiments.

OBJECTIVES: (1) To progressively upgrade in modest increments an existing numerical ocean circulation model of the Gulf of Mexico so that the final model has horizontal resolution of about 10 km and vertical resolution approaching 1 to 10 m in the mixed layer, 10 m at the thermocline, and 100 m in deep water.

DESCRIPTION: During this four-year project, the validity of the upgraded model will be continuously tested, and velocity field time series delivered periodically based on the most realistic simulation of Gulf circulation available. Experiments during the second year were with the existing NORDA/JAYCOR two layer hydrodynamic primitive equation ocean circulation model of the Gulf of Mexico on a 0.1 degree grid. Simulations generated included wind-forced only, port-forced only, and wind-forced plus port-forced. Model parameters included: upper layer inflow transport, lower layer inflow transport, wind stress, horizontal eddy viscosity, grid spacing, upper layer reference thickness, lower layer reference thickness, minimum depth of bottom topography, Coriolis parameter, gravitational acceleration, reduced gravity, interfacial stress, coefficient of quadratic bottom stress, and time step. Experiments were conducted by adjusting these parameters to achieve best simulations when compared with existing data.

SIGNIFICANT CONCLUSIONS: Simulations using wind forcing only did not provide realistic Gulf wide circulation patterns. This is because wind-induced flows in the eastern Gulf of Mexico, except on the continental shelf, are very small relative to the dominant port-forced Loop Current system. In the western Gulf of Mexico, wind-forced currents were quite significant. Port-forced experiments provided realistic Gulf wide circulation patterns; however, there was little variability from one Loop Current eddy cycle to the next. The port-forced plus wind-forced experiment provided the best simulation of Gulf surface currents during this study.

STUDY RESULTS: Two wind sets were used in the wind-forcing experiment (seasonal ship winds and monthly modeled geostrophic winds). Both gave similar results everywhere except in the southwestern Gulf in winter and spring. The ship observation-based wind fields generally tended to overestimate wind strengths. Interannual wind variability had significant effects on the simulation. The port-forcing experiment produced the best

simulation and had a horizontal eddy viscosity (A) of 50 m^2 sec^{-1} and a coefficient of quadratic bottom friction of 0.0003. Surface currents were sampled every three days for complete eddy shedding cycles. Little variability was generated in terms of eddy movement as all simulated eddies followed the same south of west path across the Gulf. It was believed that this was the preferred path of actual Loop Current eddies in the Gulf of Mexico. Generally, the port-forced simulations provide good models of a typical Loop Current eddy cycle.

Port-forcing plus wind-forcing experiments were difficult to obtain long-term simulations from because of the effect of wind forcing on the range of horizontal eddy viscosities. Wind forcing produced upwellings between anticyclonic eddies and the coastline; these upwellings stopped the simulation. Monthly averaged winds were added after six years of port-forced spin up. Simulated surface currents were sampled every three days for more than ten years using this experiment.

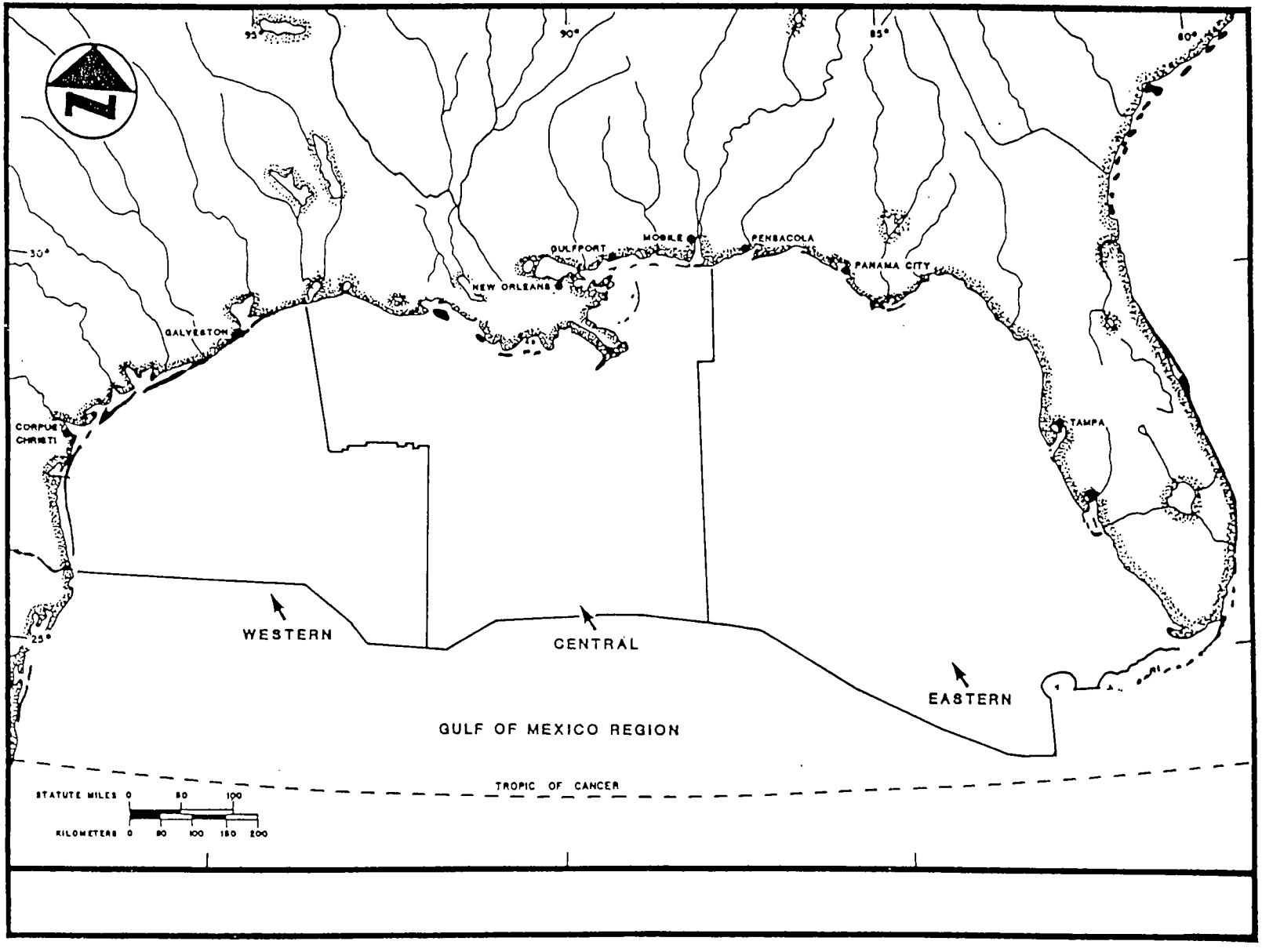
STUDY PRODUCT(S): Wallcraft, A. J. 1986. Gulf of Mexico Circulation Modeling Study Annual Progress Report, Year 2. A final report by JAYCOR for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB87-107421. MMS Report 86-0027. Contract No. 14-12-0001-30073. 94 pp.

STUDY TITLE: Gulf of Mexico Circulation Modeling Study.

COMPLETION DATE OF REPORT: April 1986.

CUMULATIVE PROJECT COST: $158,935.

KEY WORDS: Straits of Florida; Eastern Gulf; Central Gulf; Western Gulf; physical oceanography; currents; modeling; transport; patterns; Loop Current; wind forcing; seasonality; eddy.



Base map of the entire Gulf of Mexico area.

REPORT TITLE: Compilation and Summation of Historical and Existing Physical Oceanographic Data from the Eastern Gulf of Mexico.

MMS PUBLICATION NUMBER: Contract No. 08550-CT4-16.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: A consortium of oceanographers were contracted by the Bureau of Land Management to summarize available information concerning the physical oceanography of the Mississippi-Alabama-Florida (MAFLA) shelf region. The resulting synthesis was to guide future biological, chemical, geological, and physical oceanographic studies targeted for the MAFLA region prior to oil and gas exploration activities.

OBJECTIVES: (1) To assemble the historical and contemporary physical and associated meteorological data of the northeastern Gulf of Mexico for submission to the National Oceanographic Data Center (NODC); (2) to construct a zero-order synthesis of oceanographic conditions in the northeastern Gulf and have them graphically displayed; (3) to describe the general circulation and oceanographic conditions of the northeastern Gulf continental shelf and in the Loop Current of the deeper Gulf areas; (4) to describe qualitatively the interaction between the shelf circulation of the northeastern Gulf and the Loop Current; (5) to describe the seasonal distribution of the fish spawning intensity and zooplankton productivity on the West Florida Shelf and relate these to temperature and salinity data; (6) to develop a first-order understanding of the trajectory of a pollutant in the northeastern Gulf; and (7) to provide recommendations on sampling locations for future biological, chemical, geological, and physical oceanographic investigations.

DESCRIPTION: Data assembled and synthesized for this report relied on archived and recently entered hydrographic data (e.g., salinity, temperature, depth) from NODC files. This information was obtained with expendable bathythermographs, mechanical bathythermographs, salinity-temperature-depth hydrocasts, current meters, and cyclesonde meters. Data sets were generated from the general region bounded by 21 to 30°N Lat and 81 to 90°W Long. NODC established a separate file for MAFLA data. At the request of individual investigators, analyses and graphic displays were produced. Climatic information was provided by the National Climatic Center.

From 1972 to 1974, ichthyoplankton and zooplankton were sampled with paired 60-cm Bongo net plankton samplers. Stations were spaced 24 or 48 km apart on a grid from Dry Tortugas to Cape San Blas and from the 10- to 200-m isobaths at the shelf edge.

SIGNIFICANT CONCLUSIONS: Primary motion inducing forces on the West Florida Shelf were atmospheric disturbances and the Loop Current. Summer or winter tradewinds coupled with tropical cyclones, cold fronts, warm fronts, and hurricanes induce compensatory mass water movements. Primary Loop Current effects include: momentum and water mass transfer from the Loop Current to the shelf; direct incursions of the Loop Current onto the shelf; incursions of Loop Current related eddies, and their associated eddies, onto the shelf; and fluxes of mass from the shelf to the deep basin instigated by Loop Current features.

Three control volumes should be considered for an appropriate sampling grid from which to gather data to be used in forecasting, monitoring, and numerical modeling: the immediate vicinity of a drilling unit, the continental shelf from the Mississippi Delta to the Florida Keys, and the deep basin waters of the eastern Gulf of Mexico. For the first two control volumes, transhelf spacing of current meter moorings should be 25 km, and alongshelf spacing of moorings should be 100 km. A surface current meter should be attached directly to the drilling unit. For the shelf volume, additional meters should be deployed at the shelf break. Monitoring for the deep basin should employ satellite altimeter, satellite imagery, satellite film loops, moored buoys with thermistor chains, tide gauges, and hydrographic sections.

Process-oriented studies for the shelf should include surface and bottom mixed layer dynamics during strong meteorological events, surface gravity wave dynamics during strong meteorological events, dispersal of surface and subsurface materials, and bottom sediment transport dynamics. Suggested deep basin studies were mainly of Loop Current dynamics. Particular areas that might receive attention included De Soto Canyon, Cape San Blas, and the shelf break.

STUDY RESULTS: Meteorologically, there are two distinct seasons in the eastern Gulf of Mexico: winter and summer. Primary atmospheric disturbances during winter months are cold fronts, warm fronts, stationary fronts, and occluded fronts. Cold fronts, most prevalent during winter, move southeast at an average speed of 15 to 20 kn and affect shelf circulation during their passage. Summer atmospheric conditions are primarily affected by the Bermuda-Azores high pressure ridge; however, tropical waves and tropical cyclones also occur that exert pronounced effects on hydrographic conditions. Cumulative river runoff, another hydrographic feature in the MAFLA area, was 18,784 $m^3 s^{-1}$ or 60 x 10^{10} $m^3 yr^{-1}$. The Mississippi River contributes 72% of the total discharge to the MAFLA area. Tidal and inertial motions produce particle orbits with a radius on the order of several kilometers and an orbital period on the order of 12 to 28 h. Such particle motions are likely to play a significant role in horizontal dispersion. Two water masses, the Subtropical Underwater and the Antarctic Intermediate Water, were traversed by the Loop Current in deep basin waters of the eastern Gulf of Mexico. Water mass properties, salinity, temperature, and dissolved oxygen increased in variability with distance from the core of this current. Based on available data, an annual cycle of the Loop Current was proposed. A spring intrusion of the Loop Current was followed by maximum penetration in summer. An anticyclonic eddy then separates from the main flow. During fall, the Loop recedes and with minimum intrusion occurs during winter. Temporal variability of this cycle was unknown, but was believed to be substantial. Detached eddies and the Loop Current often flow directly onto the shelf, usually during summer, and considerably influence shelf circulation. Mean current flow on the shelf usually parallels local depth contours, although near-surface currents on the outer shelf often flow perpendicular to depth contours. This indicates the presence of surface currents and undercurrents operating within the system. Low frequency components, with periods of 5 to 20 days, are important contributors to shelf circulation patterns. Low frequency components were 50 cm s^{-1} as opposed to 10 cm s^{-1} for tidally induced flows. On a time scale of several days to a week, the advective flow field is dominated by low frequency fluctuations. Thermal stratification on the shelf intensified in a shoreward direction during summer. In winter, shelf waters were well mixed vertically, mainly due to atmospheric (wind) forcing. A 25-m thermocline advances shore from January-February to May-June, and moves seaward in August.

Lowest average surface salinities (21 ppt) of shelf waters were recorded during March, and lowest bottom salinities never dropped below 30 ppt at any time. Seasonal cycles in surface salinities were associated with riverine discharges.

Many of these circulation characteristics were responsible for the observed distribution of zooplankton and ichthyoplankton. Mean zooplankton volumes ranged from 69.1 to 287.8 ml 1,000 m^{-3}. Mean fish egg abundances ranged from 163.1 to 927.1 under 10 m^2 of sea surface. Mean larval fish abundances were 55.3 to 825.4 under 10 m^2 of sea surface. Zooplankton, fish eggs, and fish larvae had standing crop values that peaked during summer and dropped during winter. Generally, zooplankton and ichthyoplankton were concentrated in the northern half of the study area, but pooled means did not differ greatly between sectors. Seasonal abundance patterns of fish eggs and larvae were more pronounced within the 50-m isobath. In general, correlations among biological variables (concentrations of organisms) and other environmental variables (temperature and salinity) were not apparent. A biological phenomenon known as red tide is dependent on circulation pattern and is due to massive blooms of the dinoflagellate *Gymnodinium breve*. The actual triggering mechanisms for these blooms is unknown, but ambient currents are important in transporting the red tide and determining subsequent effects.

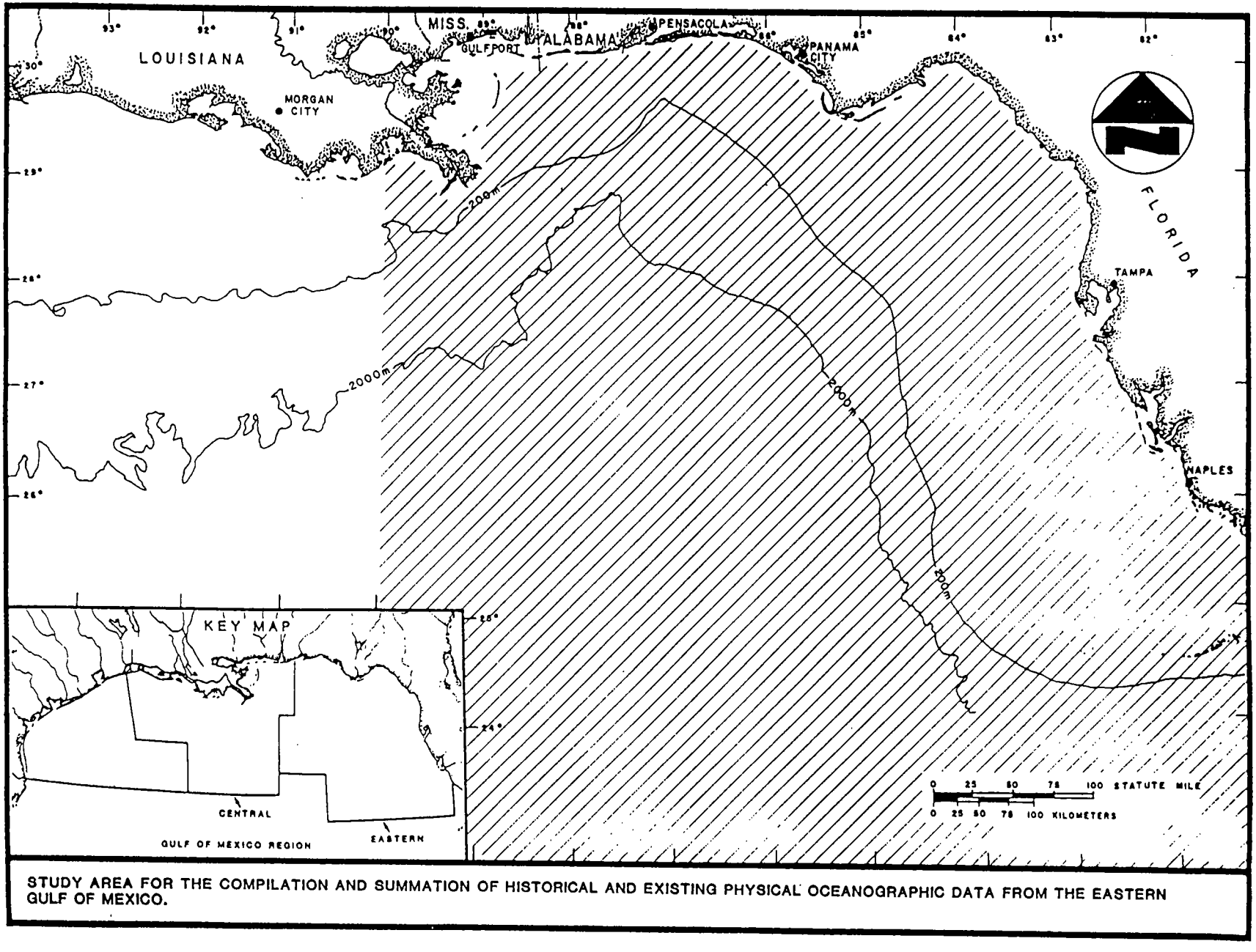
STUDY PRODUCT(S): State University System of Florida, Institute of Oceanography. 1975. Compilation and Summation of Historical and Existing Physical Oceanographic Data from the Eastern Gulf of Mexico. A report for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. PB80-190168. Contract No. 08550-CT4-16. 97 pp. + app.

STUDY TITLE: MAFLA OCS Hydrographic Study.

COMPLETION DATE OF REPORT: July 1975.

CUMULATIVE PROJECT COST: $174,040.

KEY WORDS: Eastern Gulf; Central Gulf; Mississippi; Alabama; Florida; baseline; physical oceanography; hydrography; Loop Current; fish; spawning; meteorology; seasonality.



STUDY AREA FOR THE COMPILATION AND SUMMATION OF HISTORICAL AND EXISTING PHYSICAL OCEANOGRAPHIC DATA FROM THE EASTERN GULF OF MEXICO.

ACCESS NUMBER:CT4-16

MARINE ECOSYSTEMS

The Marine Ecosystem Studies Series includes major field efforts addressing multidisciplinary data gathering, analysis, and interpretation. The objectives of these studies were to gather data characterizing the physical environment and biological communities prior to the onset of oil and gas activities in so-called "frontier" areas, so that changes in these characteristics following oil and gas exploration and development could be ascertained and perhaps mitigated. The baseline studies were brought to an abrupt halt in late 1978 following criticism by various individuals and agencies that the studies did not provide information in a timely manner for lease-management decisions. That is, information describing the physical environment, biological habitats and communities, and naturally occurring regional hazards is needed to make management decisions regarding advisability of leasing in particular areas. Information is also needed for stipulations to mitigate both the hazards to the offshore operations and the hazards to the environment caused by the offshore operations. Similarly, information is needed to define the terms of the lease stipulations or other mitigating measures to assure their effectiveness.

REPORT TITLE: The Ecological Communities of the Continental Slope and Adjacent Regimes of the Northern Gulf of Mexico.

MMS PUBLICATION NUMBER: Contract No. AA851-CT1-12.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: This report dealing with the deepwater ecological communities of the Gulf of Mexico was based upon collection of the macroinfauna and megaepifauna made from 1964 to 1973 aboard Texas A&M University's (TAMU) ship the R/V ALAMINOS. The research was sponsored by various organizations including TAMU, the Office of Naval Research, the National Science Foundation, the Atomic Energy Commission, the Bureau of Land Management, and others.

OBJECTIVES: (1) To describe and discuss the ecological nature and distribution of the macroepibenthic assemblages that occur in the northern Gulf of Mexico; (2) to provide photographic documentation of the nature of the benthic environment within which these assemblages exist, including portrayal of some constituent species that exist within bathymetric zones; (3) to describe, after analyzing available data generated by the present study and found in extant literature, the important gaps in the knowledge of the area, its assemblages, and functioning of the deep ecosystem and then suggest study approaches to reduce these gaps; and (4) to provide an assessment of the significance of the potential impacts on the deep macrobenthic communities by oil and gas exploration and production.

DESCRIPTION: Macro- and megaepifauna were collected using five types of dredges including a Menzies dredge, a plow dredge, a scoop dredge, a 3-m gape skimmer dredge, and a 2-m gape skimmer dredge. A 20-m otter trawl net was also used. A Campbell grab collecting 0.62 m^2 surface area and a Phleger corer were used to collect the macroinfauna and sediment samples, respectively. Two different cameras were used to collect photographic data: a 35-mm underwater multi-exposure model (Alpine Geophysical Associates, Model 314) and a 70-mm Shipek Deep-Sea Camera (Hydro Products Model PC-700). Both cameras were equipped with a 200 watt-second strobe and were focused at approximately 1.5 m. The study area extended from 25°N lat northward to approximately the 150-m isobath and from the east wall of the DeSoto Canyon and the easternmost extension of the Mississippi Fan to the Sigsbee Abyssal Plain and up the slope to the shelf break south of Brownsville, Texas. A total of 193 stations were sampled in water depths of 81 to 3,801 m from 1964 to 1973. Specimens were sorted and preserved in formalin in the field, transferred to laboratories at TAMU, and then sent to taxonomic specialists for identifications. Clustering, applied to faunal similarity indices for each 50-m depth interval, was used to construct a dendrogram to delineate faunal breaks across the slope, rise, and abyssal plain.

SIGNIFICANT CONCLUSIONS: Relative abundances and distributions of various groups of macroepifauna including echinoderms, crustaceans, fishes, gastropods, cephalopods, sponges, coelenterates, bryozoans, brachiopods, and sipunculids, and infauna consisting of polychaetes, bivalves, and scaphopods were discussed. Five faunal zones were recognized to occur from the shelf to the abyss in the northern Gulf of Mexico, conforming reasonably

well with zones described for the northwest Atlantic Ocean. The DeSoto Canyon, Mississippi Trough, and Alaminos Canyon were three canyon systems recommended for future studies.

STUDY RESULTS: The Shelf/Slope Transition Zone assemblage (150 to 450 m) was dominated by demersal fishes, asteroids, and brachyurans with gastropod molluscs and polychaetes also well represented. The Archibenthal Zone assemblage (475 to 950 m) was dominated by demersal fishes, asteroids, and gastropod molluscs with holothuroids increasing in number and brachyurans declining drastically. The Upper Abyssal Zone assemblage (975 to 2,250 m) showed a continuing decrease in demersal fishes and brachyurans, a major increase in the number of species of large holothuroids, and a peak in the number of sponge and gastropod species. The Mesoabyssal Zone (2,275 to 3,200 m) was characterized by large declines in all major species groups. The Lower Abyssal Zone assemblage (3,225 to 3,850 m) had the lowest species richness of all the zones but also possessed a benthic species assemblage not occurring elsewhere in the Gulf. Key species from each of these zones were determined based upon frequency of appearance in samples and numbers collected per trawl.

A deep ecosystem model was proposed consisting of three distinct layers: the euphotic zone extending from the surface to a depth of about 60 m, the aphotic zone extending from the euphotic zone to within a meter of the bottom, and the seafloor with an approximately 1-m thick contiguous water layer. Each of these three functionally distinct layers was further broken down into a five-reservoir food chain. Sources of matter and energy for the ecosystem come not only from the primary productivity of the phytoplankton being passed down the food chain but also from dissolved organic matter, deadfalls of animal carcasses, fallout of terrestrial and shallow marine plants, transport of animals and organically rich sediments in slumps and turbidity flows, and active foraging of demersal fishes and large benthic crustaceans in the midwater region.

Various potential hazards to the deep Gulf ecosystem were discussed and included various types of chemical pollution including oil spills, increased terrestrial sediment deposition, and bottom sediment slumping. Guidelines were proposed for avoiding significant impacts upon the ecosystem by petroleum activities. Major information deficiencies of the deep Gulf of Mexico were also summarized and included measurements of the organic content of the sediments and water column, dissolved oxygen levels within 1 m of the bottom and Eh values in adjacent sediments, the residence time of waters in the Gulf, levels of dissolved metals and various organic pollutants in sediment pore water, information on currents occurring on the continental slope and abyssal plain, the effects of slumping and turbidity flows on the fauna, studies on the deepwater microbiology, comparisons of meiofaunal and macrofaunal abundances from the same areas, and studies of benthopelagic organisms which are capable of transferring major amounts of organic matter between the pelagic and benthic environments.

STUDY PRODUCT(S): Pequegnat, W. E. 1983. The Ecological Communities of the Continental Slope and Adjacent Regimes of the Northern Gulf of Mexico. A final report by TerEco Corporation for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. Vol. I - NTIS No. PB84-113406; Vol. II - NTIS No. PB84-113398. Contract No. AA851-CT1-12. 715 pp.

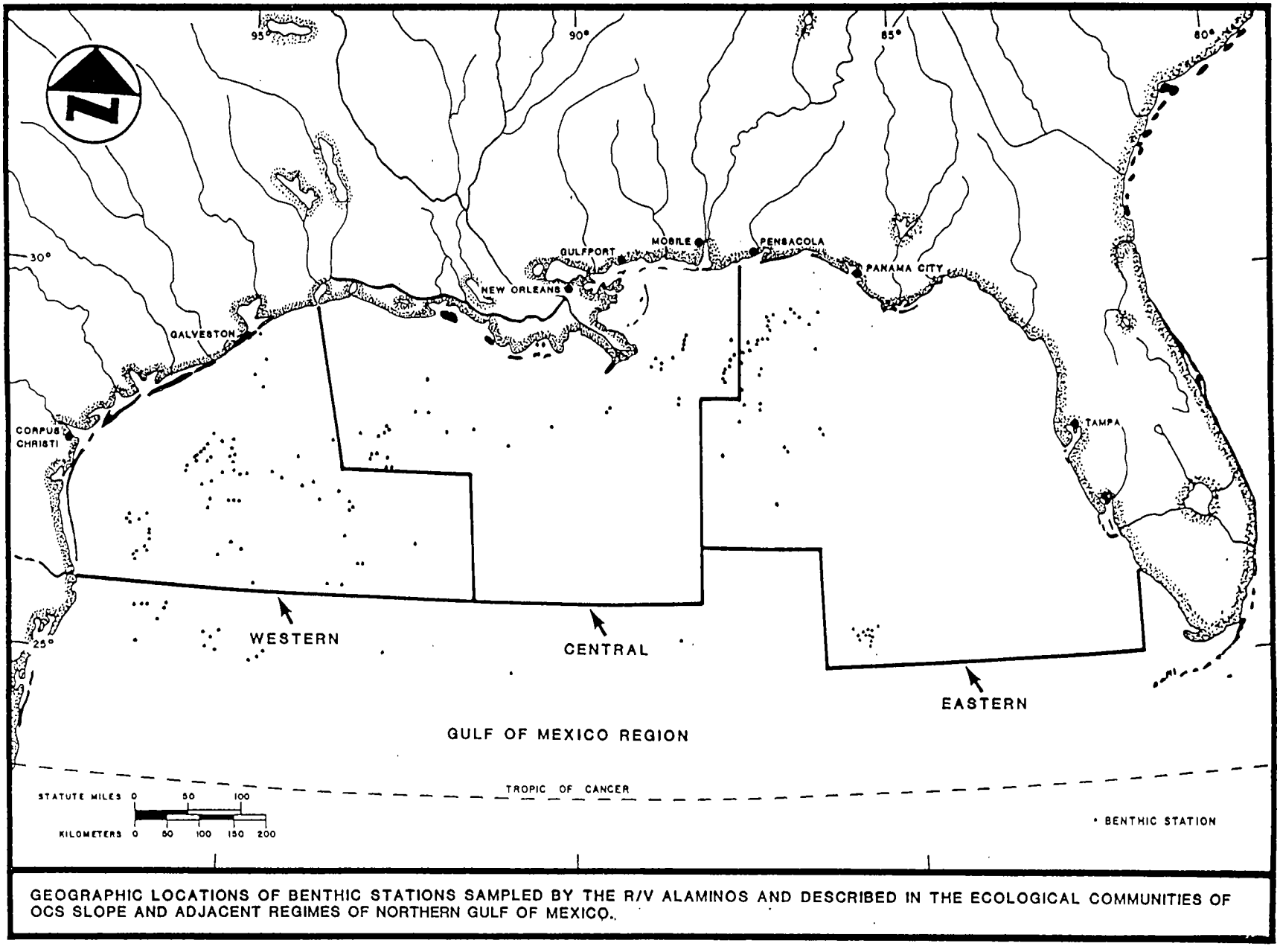
The report also contained three appendices: Appendix A, consisting of an atlas of bottom photographs depicting some of the biological components, physiography, and surficial sediments of the five described faunal zones; Appendix B, containing a listing of collected species; and Appendix C, presenting an annotated bibliography of publications dealing with the oceanography of the Gulf of Mexico.

STUDY TITLE: Ecological Communities of OCS Slope and Adjacent Regimes of Northern Gulf of Mexico.

COMPLETION DATE OF REPORT: August 1983.

CUMULATIVE PROJECT COST: $213,319.

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; DeSoto Canyon; Sigsbee Abyssal Plain; biology; benthos; epifauna; infauna; benthic photographs; sediment; slope; rise; abyssal plain; abundance; distribution; fish; faunal zones; modeling; maps; bibliography; community.



GEOGRAPHIC LOCATIONS OF BENTHIC STATIONS SAMPLED BY THE R/V ALAMINOS AND DESCRIBED IN THE ECOLOGICAL COMMUNITIES OF OCS SLOPE AND ADJACENT REGIMES OF NORTHERN GULF OF MEXICO.

ACCESS NUMBER: 29106

REPORT TITLE: Northern Gulf of Mexico Topographic Features Study. Vols. I through VI.

MMS PUBLICATION NUMBER: Contract No. AA551-CT8-35.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: The geology and biology of 28 banks in the northwestern Gulf of Mexico were characterized by studies that began in 1974. This study concerned eight additional banks (i.e., Alderdice, Coffee Lump, Diaphus, Elvers, Fishnet, Geyer, Jakkula, and Rezak-Sidner) and provided additional information on four banks previously studied [i.e., Applebaum (previously called Little Sister), 32 Fathom, and East and West Flower Garden Banks]. Florida Middle Ground, a unique biotope off Florida's western coast, was also included in this investigation.

OBJECTIVES: (1) To gather biological, chemical, geological, geophysical, and physical oceanographic data to characterize selected topographic features and the Florida Middle Ground; (2) to perform descriptive reconnaissance studies to assess the biology and geology of the features; (3) to conduct chemical analyses for trace metals, high molecular weight hydrocarbons (HMWHC), Delta ^{13}C and total organic carbon in Coffee Lump and East and West Flower Garden Banks sediments; (4) to analyze *Spondylus* and certain fish species collected at the Flower Garden Banks for trace metals and HMWHC, and to analyze water samples for nutrients and dissolved oxygen; (5) to study the size distribution and mineralogy of sediments at select banks; (6) to continue study of reworked fossil coccolith distributions; (7) to continue the East Flower Garden Bank coral, coralline algae, zooplankton, algae, and brine seep monitoring study; and (8) to perform mapping, hydrocarbon analysis, and monitoring studies at West Flower Garden Bank.

DESCRIPTION: Approximately 2,110 statute miles of survey data from eight northern Gulf of Mexico banks and the Florida Middle Ground were obtained during the first mapping cruise. The second mapping cruise was limited to West Flower Garden Bank. Two submersible cruises were conducted for biological and geological reconnaissance and sampling to characterize biotic communities and surficial geology; the submersible was equipped with a manipulator arm, a wire mesh collection basket, and a scoop sediment sampler. For dives at the brine pool, a temperature probe and vacuum collection hose were added to the arm for collection of in situ data and water samples. Data collection associated with sedimentary processes in the bottom boundary layer at East Flower Garden Bank was accomplished through attachment of a transmissometer, salinity/temperature/depth (STD) system, and profiling current meter to the submersible. The coral and coralline algal population phase of the East Flower Garden Bank monitoring study included dive teams that photographed random 10-m line transects; photographic mosaics were used in species identification and transect analyses. The study of recruitment and early growth of corals and coralline algae was conducted using a stereo dissecting microscope and counting grid. Coelenterate larvae and other zooplankton were collected with 0.333-mm mesh nets fitted on a buoy array; nets fished at depths measured in 10-m increments from the surface to 40 m for 1 h of sampling. Water column measurements were taken with a transmissometer, Niskin bottles, STD system, and profiling current meter. For long-term current measurements, current meter arrays were set near East and West Flower Garden

Banks. All *Spondylus* samples for trace metal and HMWHC analyses were collected by the submersible. Sediments for similar analyses, Delta ^{13}C, fossil coccoliths, and total organic carbon were taken with a Smith-McIntyre grab.

SIGNIFICANT CONCLUSIONS: Significant correlation was found between biotic zonation, substrate nature, and top depth of the nepheloid layer. There was no indication of significant change in benthic community condition at East Flower Garden Bank. Biological zonations at West Flower Garden, Alderdice, Elvers, Geyer, Jakkula, and Rezak-Sidner Banks were similar to those at East Flower Garden Bank and therefore warrant a protective classification. The Florida Middle Ground was of particular concern because of its unique fragile biota.

STUDY RESULTS: Crests of Alderdice, Elvers, Geyer, Jakkula, and Rezak-Sidner Banks were above the normal depth of the nepheloid layer and had reef-building populations of coralline algae within well developed Algal-Sponge Zones. These banks also displayed normal carbonate sands associated with biogenic reefs. Diaphus Bank might also have an Algal-Sponge Zone, but its crest was near the lower depth limit of this zone at the Flower Garden Banks. Applebaum, Coffee Lump, Fishnet, and 32 Fathom Banks had less diverse benthic assemblages adapted to chronic turbid water conditions. Strong correlation was found between biotic zonation, substrate nature, and top depth of the nepheloid layer. Currents at the Flower Garden Banks were steered by topography. Water from the base of East Flower Garden Bank cannot flow up to the level of the living reef. Silt and clay were nearly absent from the bank above 80 m, an approximate depth of biotic change; a clear-water fauna existed above that depth but was missing below it.

The crestal graben typical of most banks investigated has not developed at East Flower Garden Bank; significant normal faulting has not yet occurred. A crestal graben has developed at West Flower Garden Bank; continued movement along the faults is expected. Applebaum, Coffee Lump, and 32 Fathom Banks were similar in structure and sediments and considered relatively inactive banks underlain by salt diapirs that have not moved appreciably upward since late Pleistocene times. The remaining banks were described as tectonically active with geologically recent faulting common in their immediate vicinity. No significant changes in benthic community structure or condition at East Flower Garden Bank were noted. There were no changes in rate of accretionary growth of dominant corals over the last decade. Rates of encrusting coral growth and coral mortality were highly variable; there was no indication that encrusting growth had been impaired or that mortality had increased. Larval coral settlement, early growth, and development occurred at normal rates. Leafy algal populations appeared normal and were largest in spring. There was no obvious change in health of benthic communities southeast of the main coral reef at East Flower Garden Bank. The condition of corals and coralline algae within the Algal-Sponge Zone appeared similar to that of previous years. There were no signs of mass mortalities for any conspicuous community component. Natural brine seep effects on benthic biota at East Flower Garden Bank were restricted to an area within a few meters of the seep and recognizable brine-seawater mixture. West Flower Garden Bank had biological zonation similar to that of East Flower Garden Bank (i.e., classified as a sensitive environment). Other banks classified as sensitive included Alderdice, Elvers, Geyer, Jakkula, and Rezak-Sidner Banks. The presence of larger areas of clear-water reefal communities in the upper portion of these banks warrants protection. Remaining banks were classified as being

of low priority. Overall, diversity and abundance of benthic biota were low compared to those of other shelf-edge banks in the northwestern Gulf. Applebaum, Coffee Lump, and 32 Fathom Banks were compared to south Texas fishing banks with respect to the hard-bottom assemblage (Antipatharian Zone) of organisms. Low diversity and abundance of benthic biota on Diaphus and Fishnet Banks were attributed to chronic turbidity and sedimentation. Nevertheless, snapper and other game fishes were numerous in the vicinity of these banks. Mapping, geological sampling, and physical and chemical studies established a background for biological studies at the Florida Middle Ground. A unique biotope and a habitat of particular concern because of the extremely fragile biota, it supports both a Caribbean eurythermal species complex and a Caribbean restricted species complex of algae, invertebrates, and fishes. This study explored the possibility of using selected cryptofaunal hosts as quantitative sampling units, and elucidated which faunal groups would yield the most useful results. It was speculated that during extremely cold winters, a combination of storm surge and cold water (12 to 13°C) remaining in the area for several days could bring about depauperation of the more tropical species that inhabit the Florida Middle Ground.

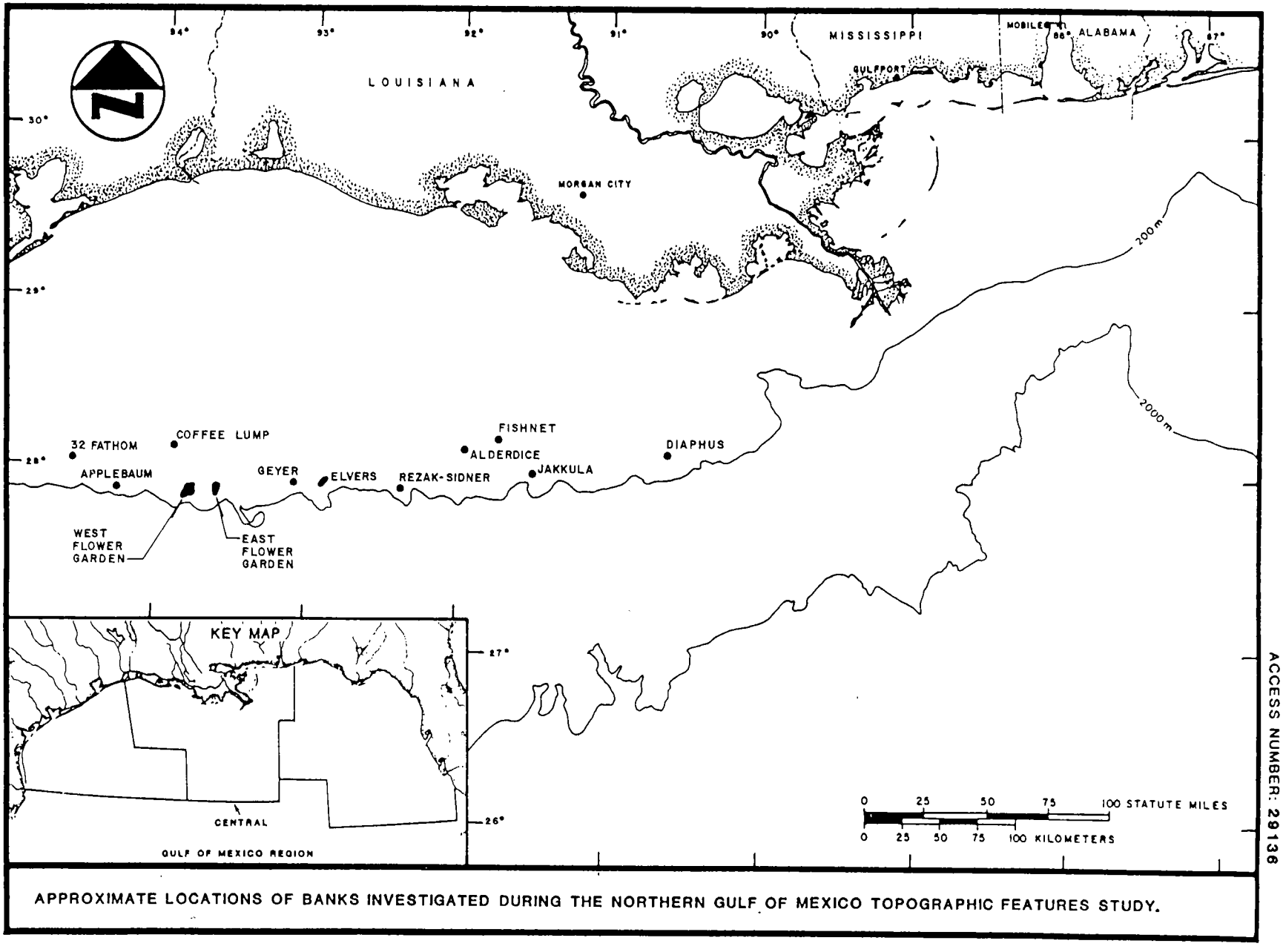
STUDY PRODUCT(S): Rezak, R. and T. J. Bright. 1981. Northern Gulf of Mexico Topographic Features Study. A final report by Texas A&M University Department of Oceanography for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. Vol. I (Introduction, Geology, Biotic Zones and Banks, Water and Sediment Dynamics, Summary and Recommendations) - NTIS No. PB81-248650 (PC/A07); Vol. II (Methods, Sediment Dispersal, Chemical Analyses) - NTIS No. PB81-248668 (PC/A08); Vol. III (Flower Garden Banks) - NTIS No. PB81-248676 (PC/A09); Vol. IV (Coffee Lump Bank, Fishnet Bank, Diaphus Bank, Jakkula Bank, Elvers Bank, Rezak-Sidner Bank, Alderdice Bank, 32 Fathom Bank, Applebaum Bank) - NTIS No. PB81-248684 (PC/A09); Vol. V (Florida Middle Ground) - NTIS No. PB81-248692 (PC/A12); Vol. VI (Executive Summary) - NTIS No. PB81-248643 (PC/A07); Set (6 Vol.) - NTIS No. PB81-248635 (PC/E99). Contract No. AA551-CT8-35. Tech. Rept. No. 81-2-T.

STUDY TITLE: Gulf of Mexico Topographic Features Study.

COMPLETION DATE OF REPORT: March 1981.

CUMULATIVE PROJECT COST: $2,891,344.

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; Alderdice Bank; Coffee Lump Bank; Diaphus Bank; Elvers Bank; Fishnet Bank; Geyer Bank; Jakkula Bank; Rezak-Sidner Bank; Applebaum Bank; 32 Fathom Bank; East Flower Garden Banks; West Flower Garden Banks; geology; biology; hydrography; Florida Middle Ground; maps; bathymetry; submersible; trace metals; hydrocarbons; sediment; water column; nutrients; fish; monitoring; nepheloid layer; tissue.



APPROXIMATE LOCATIONS OF BANKS INVESTIGATED DURING THE NORTHERN GULF OF MEXICO TOPOGRAPHIC FEATURES STUDY.

ACCESS NUMBER: 29136

REPORT TITLE: Annual Report for Northern Gulf of Mexico Continental Slope Study.

MMS PUBLICATION NUMBER: MMS 85-0058.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

STUDY TITLE: Northern Gulf of Mexico Continental Slope Study.

BACKGROUND: Little information is available concerning the biology, geology, and chemistry of continental slope environments in the Gulf of Mexico. With the growing potential of oil and gas exploration on the slope, additional environmental data will be required by resource managers faced with leasing decisions. The U.S. Department of the Interior has sought to further the understanding of slope habitats by funding a four-year investigation of the continental slope environments of the northern Gulf of Mexico.

OBJECTIVES: (1) To determine the abundance, structure, and distribution of animal communities in the deep sea in the Gulf of Mexico; (2) to determine the hydrographic structure of the water column and bottom conditions; (3) to determine and compare sedimentary characteristics; (4) to relate differences in biological communities to hydrographic, sedimentary, and geographic variables; (5) to assess seasonal changes in biological communities in terms of abundance, structure, animal size, and reproductive state; and (6) to measure present levels of hydrocarbon contamination in sediments and selected animals prior to, and in anticipation of, petroleum resource development beyond the shelf-slope break.

DESCRIPTION: All sampling efforts were confined to the northern Gulf of Mexico, north of 27°N Lat, where physical, chemical, and biological characteristics of the water column and seafloor were obtained. Three transects were established perpendicular to the slope, each comprised of five stations. One transect was located in each of the three Gulf of Mexico Planning Areas (Eastern, Central, and Western). Average sample depths along each transect were 348, 657, 839, 1,341, and 2,530 m which correspond to previously proposed faunal zones: Shelf/Slope Transition (150-450 m); Archibenthal, Horizon A (475-750 m); Archibenthal, Horizon B (775-950 m); Upper Abyssal (975-2,250 m); and Mesoabyssal, Horizon C (2,275-2,700 m). In November 1983, only the Central Transect was sampled. During April 1984, all three transects were sampled.

Field sampling consisted of taking water column measurements, sampling bottom sediments for physical/chemical characteristics and meiofauna and macroinfauna, and collecting and photographing demersal fishes, epifauna, and macroinvertebrates and their habitats. Hydrographic measurements included continuous and discrete samples. Discrete sampling employed a 12-bottle rosette sampler which provided water samples for temperature, salinity, dissolved oxygen, and particulate organic carbon (POC) determinations. For sediment sampling, six replicate box cores (24.5 x 24.5 x 44 cm) were taken at each of the Central Transect stations during both cruises; three replicates were taken at each of the Eastern and Western transect stations. Undisturbed and uncontaminated sediment samples for analysis of hydrocarbons, grain size, carbonate, total organic carbon, meiofauna, and infauna were subsampled from each box core. In the laboratory, sediments were analyzed

for grain size, organic carbon, and carbonate carbon content. Epifauna, macroinvertebrates, and demersal fishes were collected using a 9-m, semi-ballon trawl with 3.8 cm stretch mesh and 1.3 cm cod end mesh. A single haul was taken at each station. Benthic photography used a Benthic Underwater Camera System (a Benthos 35 mm camera mounted on a sled equipped with a pinger operated altimeter). Carbon isotopic analyses were performed on sediments and selected organisms to determine carbon source. High molecular weight hydrocarbons in macroepifauna, infauna, fishes, and sediments were determined using total scanning fluorescence followed by gas chromatography/mass spectroscopy.

SIGNIFICANT CONCLUSIONS: After one sampling year, analyses were incomplete and no definite conclusions could be reached. Biological and physical parameters exhibited some spatial and temporal variability among transects. Evidence of anthropogenic hydrocarbon contamination was not found in the slope environment or biota thus far examined. Natural hydrocarbon seeps were prevalent in the vicinity of the Central Transect and may, in fact, provide an additional source of energy to newly discovered chemosynthetic communities in this region.

STUDY RESULTS: Environmental parameters of the water column follow the layers of Gulf of Mexico, Tropical Atlantic Central, Antarctic Intermediate, and Gulf Deep Waters. Water mass characteristics were uniform across the Gulf as observed by temperature, salinity, and transmissometry profiles. Water temperature decreased with depth, ranging from 10.8°C in 346 m to 4.3°C in 2,567 m. Sediment data from the Central Transect revealed clay sized particles from the three shallow stations grading into sandy or silty clays at the deepest stations. The western transect stations graded from sand-silt-clay mixtures to silty clays at the deeper stations. The Eastern Transect contained mostly sandy clay. Eastern and Western Transect sediments contained a higher proportion of sand-sized particles than the Central Transect. Organic carbon levels in bottom sediments were generally higher for the shoreward stations; highest on the Central Transect at all sampling depths, and lowest on the Eastern Transect. The Eastern Transect contained the highest calcium carbonate levels of the three transects. Carbon isotope analyses from Central Transect stations indicated organic carbon derived from planktonic algae with no trends related to depth or distance offshore. Sediments in all three transects contained a mixture of thermogenic, terrigenous, and planktonic hydrocarbons. The influence of riverborne hydrocarbons was greatest at the Central Transect. Hydrocarbon distributions at the Central Transect were consistent with mixed biogenic and thermogenic sources. In general, hydrocarbons were only present in low concentrations, especially at the Eastern Transect. Aliphatic hydrocarbon levels ranged from 10 to 50 ppm.

Meiofaunal samples consisted mostly of nematodes, harpacticoid copepods, polychaetes, ostracods, and kinorynchs. All groups were most abundant on the Central Transect. Nematodes and harpacticoids were the most abundant groups from a total of 36 groups. Meiofaunal densities along the Central Transect ranged from 1,139 to 274 organisms m^{-2}. The most abundant macroinfaunal groups were polychaetes and nematodes, followed by harpacticoids, isopods, bivalves, ostracods, and tanaidaceans. Most macroinfaunal densities ranged from 2,435 to 8,628 organisms m^{-2}. Macroinfaunal densities from the Eastern and Central Transects were greater than the Western Transect. Megafaunal invertebrates collected by trawling included 78 decapod (mostly galatheids and anomurans) species and 33 echinoderm species (not including brittle stars). A total of 94 species of

demersal or benthopelagic fishes in 42 families was collected on the three transects. Species from the families Macrouridae, Rajidae, Ophidiidae, Synaphobranchidae, and Halosauridae accounted for 38% of the total collected.

Benthic photography was refined and developed during this study phase. Preliminary results of photographic analysis, conducted at one station of each transect, indicates that the Central Transect station was characterized by a greater density of both biota and lebensspuren than the other two stations.

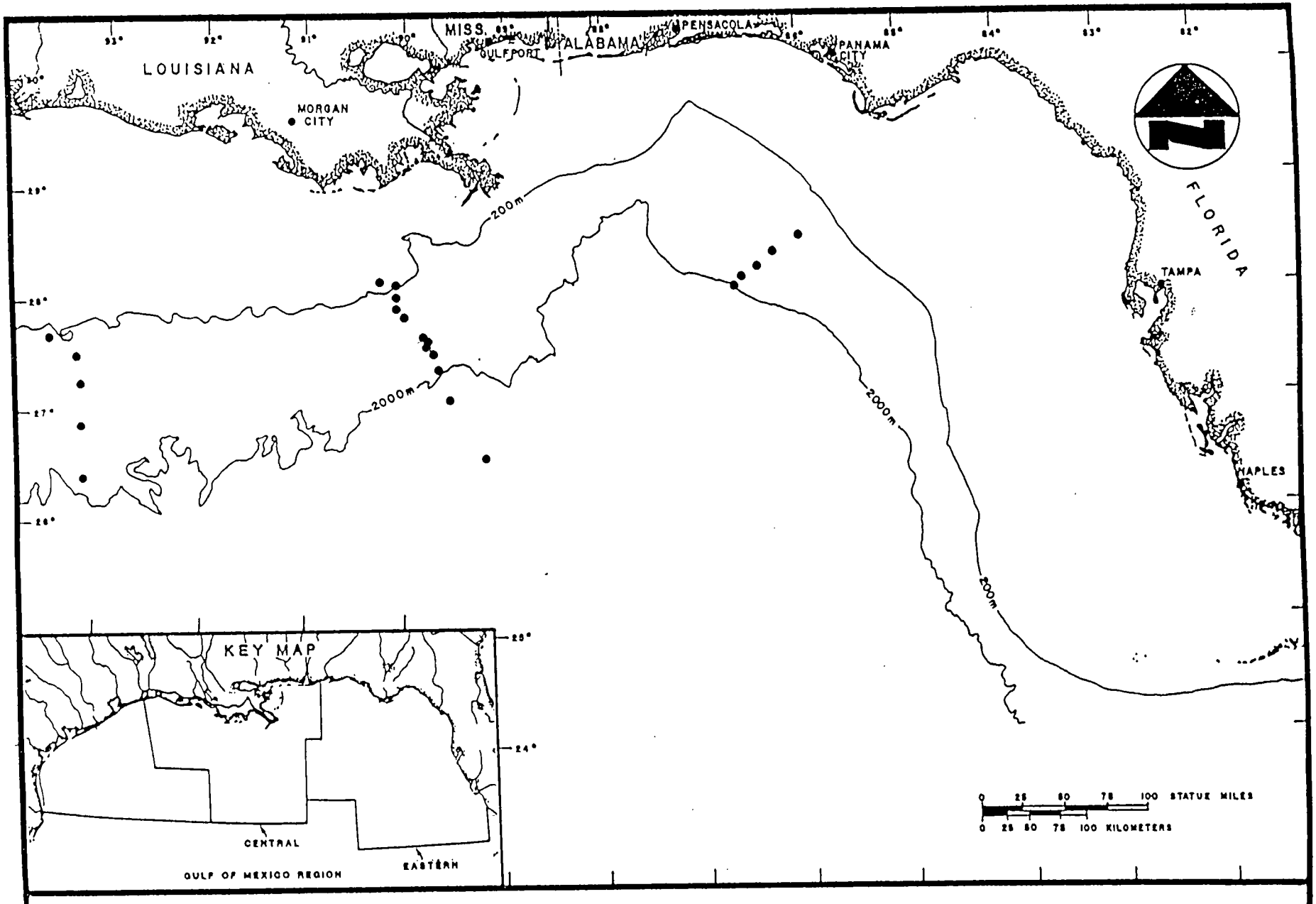
STUDY PRODUCT(S): LGL Ecological Research Associates, Inc. and Texas A&M University. 1985. Annual Report for Northern Gulf of Mexico Continental Slope Study. Vol. II, Annual Report. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB86-246352. Contract No. 14-12-0001-30046. 290 pp.

LGL Ecological Research Associates, Inc. and Texas A&M University. 1985. Annual Report for Northern Gulf of Mexico Continental Slope Study. Vol. I, Executive Summary. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB86-246345. MMS Report 85-0058. Contract No. 14-12-0001-30046. 18 pp.

COMPLETION DATE OF REPORT: May 1985.

CUMULATIVE PROJECT COST: $1,136,128.

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; biology; hydrography; physical oceanography; sediment; seasonality; community; benthos; hydrocarbons; slope; fish; infauna; epifauna; benthic photographs.



SAMPLING STATIONS FOR THE GULF OF MEXICO CONTINENTAL SLOPE STUDY, YEAR 1.

ACCESS NUMBER:30046

REPORT TITLE: Tuscaloosa Trend Regional Data Search and Synthesis Study. Vol. I, Synthesis Report; Vol. II, Supplemental Report.

MMS PUBLICATION NUMBER: MMS 84-0056.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: The Tuscaloosa Trend Region, extending from southern Louisiana into offshore waters of the Chandeleur Islands and eastward to DeSoto Canyon, may prove to be highly productive in terms of recoverable oil and natural gas reserves. The area supports significant recreational and commercial fisheries and a portion lies within Breton National Wildlife Refuge and Gulf Islands National Seashore. Information describing the environment is needed by the Minerals Management Service to make management decisions regarding leasing a particular area and to define lease stipulation terms.

OBJECTIVES: (1) To identify and summarize important information pertaining to the environmental and socioeconomic characteristics of the Tuscaloosa Trend Region of the Gulf of Mexico.

DESCRIPTION: The Tuscaloosa Trend Region is located in the north-central Gulf of Mexico adjacent to Louisiana, Mississippi, and Alabama. The boundaries are defined as South Pass on the west (i.e., southeast corner of the Mississippi River Delta), a line from the DeSoto Canyon head to the Alabama-Florida boundary on the west, and the 200 m contour offshore. This report characterizes the area with respect to physiography, geology, physical oceanography, chemical oceanography, biology, socioeconomics, and an area-wide conceptual ecosystem model. Conceptual representation of physical, chemical, geological, and ecological processes were developed for the Tuscaloosa Trend ecosystem as part of the data search and synthesis effort. These representations were developed to provide a framework for this effort and to direct future research.

SIGNIFICANT CONCLUSIONS: The conceptual representation of the Tuscaloosa Trend Region was hierarchical, consisting of three levels: Level 1, the whole ecosystem; Level 2, individual subsystems (e.g., sedimentological, biogeochemical, and ecological); and Level 3, specific ecological applications (e.g., nekton life history, marsh-estuarine interactions, pelagic and benthic food webs). The conceptual model provides a management device which clearly identifies interrelationships and potential multiple use conflicts among resources. Significant data gaps exist particularly regarding open shelf geology, physical and chemical oceanography, ecosystem structure and function, and interrelationships between open shelf and nearshore ecosystems.

STUDY RESULTS: The coastal portion of the Tuscaloosa Trend Region is separated from the oceanic portion by islands and passes. Chandeleur and Breton Sounds are shallow (2 m average depth) areas behind several clusters of islands associated with subsidence of the now-abandoned St. Bernard Delta complex. Lake Borgne lies north of these features and forms the west end of Mississippi Sound, a shallow (3 m average depth) area behind six barrier islands (Cat, West and East Ship, Horn, Petit Bois, and Dauphin). The sound receives freshwater discharges from the Pearl and Pascagoula Rivers. Shallow (3 m average depth)

Mobile Bay, a submerged river valley, and Bon Secour Bay, behind Ft. Morgan Peninsula, form the eastern coastal portion.

The oceanic portion lies on the Mississippi-Alabama shelf, a triangular shaped region between the Mississippi River Delta and DeSoto Canyon. The shelf width varies: 10 km off the Mississippi Delta, 56 km at DeSoto Canyon, and 128 km at the widest part east of the Delta. The shelf slope break occurs at 55 m average depth.

The primary geologic feature of the Tuscaloosa Trend Region is the Gulf coast geosyncline, a clastic wedge extending from Alabama to northeastern Mexico. The continental shelf topography and sediment distribution results from combined sea level transgressive-regressive episodes and deltaic progradation and destruction. The present Mississippi River deposition seems to be shifting to the Atchafalaya Basin. Little active sedimentation is occurring in the Trend area, which enables the persistence of the DeSoto Canyon, an S-shaped canyon formed by late Tertiary erosion, deposition, and structural control by diapiric activity.

Geological processes in the Trend area include relatively rapid bathymetric changes related to the delta front depositional patterns as well as long-term geologic structure formation and movement (e.g., salt domes and faults). Potential Trend area geohazards result from diapirism, rapid deltaic sediment accumulation, and shelf break wasting.

The Trend area is influenced primarily by the anticyclonic Bermuda High in spring and summer and by continental pressure systems in fall and winter. Seasonal tropical cyclones periodically impact the area. Wave heights are primarily wind speed and direction influenced.

Riverine discharges from the Mississippi, Pearl, Pascagoula, and Mobile Rivers strongly affect the turbidity levels, temperature, and salinity of the Trend area coastal and shelf waters. The Loop Current, a dominant Gulf of Mexico circulation feature, has periodic intrusions into the area. DeSoto Canyon may act as an intrusion conduit. Sustained winds are the dominant inner continental shelf and coastal water circulation driving force, while riverine discharges also influence circulation in shallow Mississippi Sound and Mobile Bay. Semidiurnal tides (average tidal range from 37 cm in the mouth of Mobile Bay, to 47 cm in Chandeleur Sound) influence currents through the passes.

Chemical oceanography of coastal waters is better known than for outer continental shelf waters in the Trend area. Levels of dissolved oxygen, nutrients, sediment trace metals, sediment and water hydrocarbons, suspended particulates, heavy metals, and particulate organics and carbon demonstrate seasonal and geographical trends. Low heavy metal concentrations in biota reflect minimal anthropogenic contamination.

Coastal marshes fringing the Trend area seasonally contribute large amounts of organic material to coastal waters. Net organic material export from the marshes is episodic. The coastal area has three principal food chains: primary production and consumption of marsh and seagrass vegetation; detritus production by the marshes and seagrasses for a detritus-based food chain; and phytoplankton production linked to higher trophic levels by

zooplankton. Coastal area nekton and macroepifauna are relatively well-studied because of their economic importance.

The open shelf ecosystem has two principal food chains: plankton-based (water column) and detritus-based (benthic). Open shelf nekton is a mixture of coastal and marine organisms. Open shelf epifaunal communities are well-described as distinct assemblages.

Trend area socioeconomic resources include waterborne commerce, travel and tourism, sport and commercial fisheries, and oil and gas.

STUDY PRODUCT(S): Barry A. Vittor & Associates, Inc. 1985. Tuscaloosa Trend Regional Data Search and Synthesis Study. Vol. I, Synthesis Report. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB86-245941. MMS Report 84-0056. Contract No. 14-12-0001-30048. 503 pp.

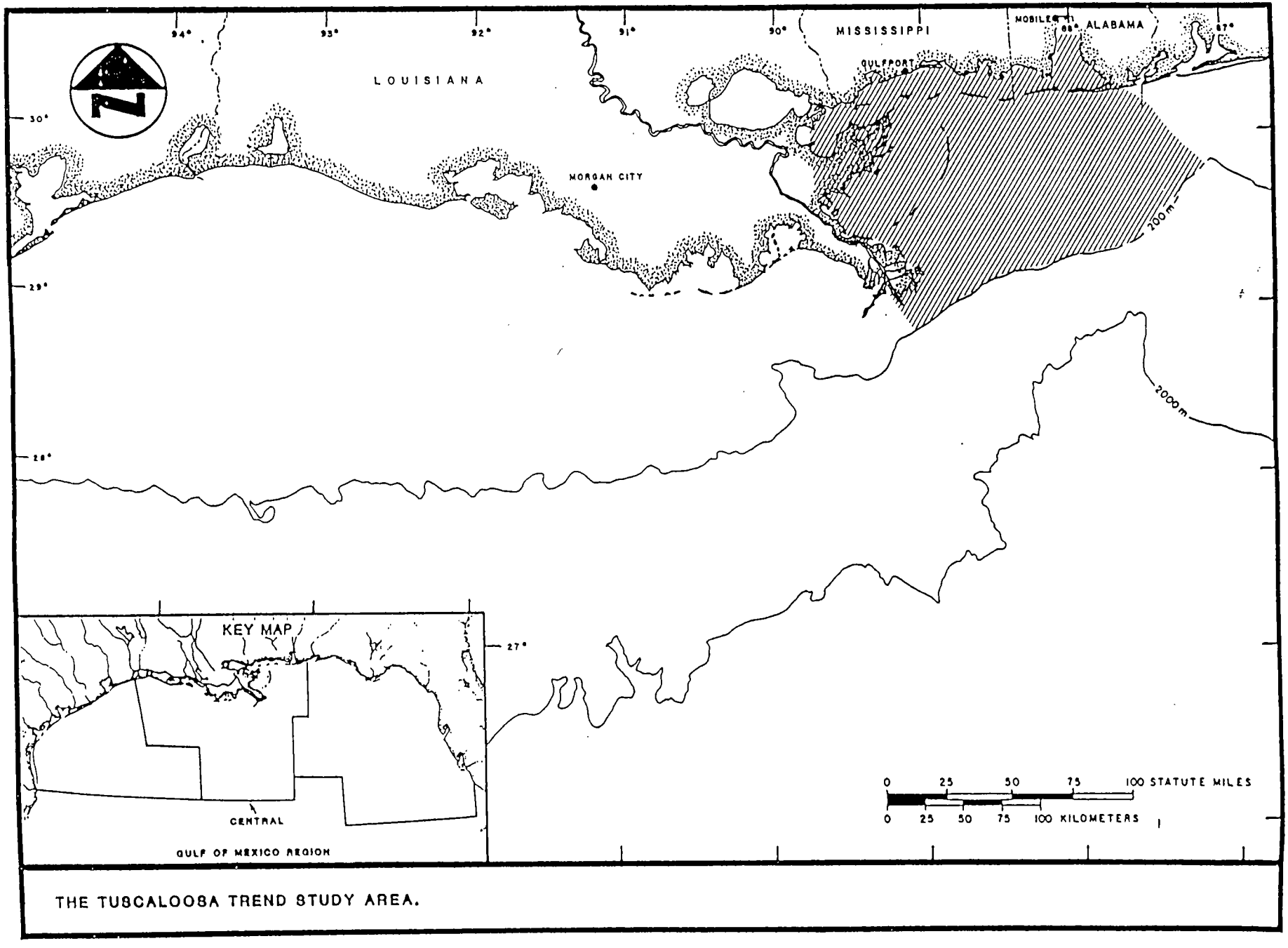
Barry A. Vittor & Associates, Inc. 1985. Tuscaloosa Trend Regional Data Search and Synthesis Study. Vol. II, Supplemental Report. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB86-245958. MMS Report 84-0057. Contract No. 14-12-0001-30048. 374 pp.

STUDY TITLE: Tuscaloosa Trend Regional Data Search and Synthesis.

COMPLETION DATE OF REPORT: June 1985.

CUMULATIVE PROJECT COST: $285,475.

KEY WORDS: Eastern Gulf; Central Gulf; Louisiana; Mississippi; Alabama; Tuscaloosa Trend; biology; physiography; geology; physical oceanography; socioeconomics; ecosystem model; Mississippi-Alabama Shelf; DeSoto Canyon; shelf; estuarine; hydrography; barrier islands.



THE TUSCALOOSA TREND STUDY AREA.

ACCESS NUMBER:30048

REPORT TITLE: Southwest Florida Shelf Benthic Communities Study, Year 5 Annual Report. Vol. I, Executive Summary; Vol. II, Technical Discussion; Vol. III, Appendices.

MMS PUBLICATION NUMBER: MMS 86-0074.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: The Southwest Florida Shelf Benthic Communities Study Program commenced in 1980 to investigate the location, nature, and extent of benthic communities across the southwest Florida shelf. The first three years sought to provide baseline information, geophysical and biological habitat mapping and classification of substrates and projection of relative coverage across the shelf in water depths of 20 to 200 m. The next two study years sought to more accurately predict the impacts of oil and gas activities on the southwest Florida shelf. More information on ecosystem dynamics and physical factors was needed. The present report includes the results of the fourth and fifth year field efforts.

OBJECTIVES: (1) To compare and contrast the community structure of both live-bottom and soft-bottom fauna and flora to determine the differences and similarities between them and their dependence on substrate type; (2) to determine and compare the hydrographic structure of the water column and bottom conditions; (3) to determine and compare sedimentary characteristics and estimate sediment transport; and (4) to relate differences in biological communities to hydrographic, sedimentary, and geographic variables.

DESCRIPTION: Study Years 4 and 5 of the Southwest Florida Shelf Ecosystem Study were designed to provide seasonal data for selected live-bottom and hard-bottom stations and supplemental data for soft-bottom stations. During Year 4, two station groups were sampled. Group I Stations (located in less than 20 m water depths) consisted of five soft-bottom and five hard-bottom stations. Ten replicate infaunal samples were collected at each of the soft-bottom stations. Sediment samples and hydrographic measurements were also collected at each station. Sampling at the hard-bottom stations involved dredging, trawling, underwater television, benthic still photography, sediments, and hydrography. Seven other hard-bottom stations, as well as one Group I hard-bottom station, were selected for detailed biological and physical dynamics studies. During Year 4, five of these stations, designated as Group II were sampled similarly. In situ instrument arrays were installed at these stations. The arrays were equipped with 10 sets of artificial setting plates, three sets of sediment traps (0.5, 1.0, and 1.5 m) above the bottom, and a current meter capable of measuring current velocity and temperature. Two arrays also had wave and tide gauges and all but one, the deepest station, had time-lapse camera/strobe systems. Arrays were retrieved and serviced at three month intervals.

Field efforts during Year 5 included intensive quarterly sampling of the five Group II hard bottom stations and three other stations. These stations were located in water depths ranging from 13 to 125 m. Triangle dredge tows were conducted at only two new stations of the eight. Also, seven of the eight arrays were equipped with time-lapse cameras. At each station, conductivity, salinity, temperature, pH, dissolved oxygen, and transmissivity were recorded at three depths (near-surface, mid-depth, and near-bottom) using a CSTD sonde. Niskin bottle casts were also made at each station to provide a check on the CSTD

measurements. Two new transects were surveyed with underwater television and side-scan sonar to supplement habitat mapping efforts completed in previous years. Transect X-1 ran from the Tortugas Shoals southwest to a depth of 100 m; Transect X-2 ran north-south through Station 55 at an average water depth of 27 m. Underwater television surveys were conducted with a black and white stereo video system at seven stations. Density and percentage cover estimates of attached and/or motile biota were made. From trawl collections, selected fish species were analyzed for reproductive condition and stomach contents analysis.

SIGNIFICANT CONCLUSIONS: The physical environment of the southwest Florida shelf changed with depth across the shelf. Tidal currents and surface wave orbital motion were most responsible for sediment resuspension and transport in shallow (50 m) waters. Loop Current intrusions and tropical storms exerted significant influence on shelf circulation. Biological communities were distributed as mosaics reflecting the patchy nature of the substrate. On sandy bottoms, starfish, conch, and sand dollars were prevalent. Sponges, corals, and other organisms protruded through the sand in some areas providing habitat for other invertebrates and fishes. Attached biota, such as corals (soft and stony) and massive sponges, were numerically dominant on hard-bottoms. Settling plates did not provide information on the structure of the actual recovery of benthic communities (i.e., corals, sponges, octocorals). There was no obvious temporal variability in the abundance of most benthic organisms (except for algae) at most stations.

STUDY RESULTS: Near-bottom currents at the shallow stations on the southwest Florida shelf were dominated by semidiurnal components of the tides. The diurnal component began to predominate in deeper waters. Power spectra for summer and winter currents were similar. Currents at the deeper stations were less consistent with respect to direction, while currents at shallower stations exhibited considerable constancy, usually setting to the south or southeast at less than 2 cm sec^{-1}. The current regime was affected by two phenomena; Loop Current eddies intruding onto the shelf, and passage of major storms. Sediment resuspension and transport was promoted by combined effects of wind-driven currents, tidal currents, and surface wave-induced orbital velocities. Periodically recurring storms did not cause significant amounts of sediment movement or resuspension at depths exceeding 50 m. Stations with the greatest amount of sediment resuspension were also where wave-induced orbital motion exceeded 20 cm sec^{-1}. In general, energy penetration, light intensity, sediment deposition, turbidity obscurations, and wave orbital velocities at the bottom were highest at the stations located in 13 m water depths.

Biological communities reflected the nature of the substrate. Stations located on hard substrate revealed the most attached biota (gorgonians and sponges) and fishes. On hard bottoms, corals, sponges and algae grow, providing shelter for invertebrates and fishes.

Settling plates were fouled most heavily at shallow stations where the most common organisms were hydroids, barnacles, bivalves, bryozoans, ascidians, and serpulids. In deeper water, serpulids were the most abundant settling organisms. The instrument arrays attracted a variety of fishes including jewfish, snappers, and grunts.

STUDY PRODUCT(S): Danek, L. J. and G. S. Lewbel. 1986. Southwest Florida Shelf Benthic Communities Study, Year 5 Annual Report. Vol. I, Executive Summary. A final

report by Environmental Science and Engineering, Inc. and LGL Ecological Research Associates, Inc. for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. MMS Report 86-0074. Contract No. 14-12-0001-30211. 47 pp.

Danek, L. J. and G. S. Lewbel. 1986. Southwest Florida Shelf Benthic Communities Study, Year 5 Annual Report. Vol. II, Technical Discussion. A final report by Environmental Science and Engineering, Inc. and LGL Ecological Research Associates, Inc. for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. MMS Report 86-0075. Contract No. 14-12-0001-30211. 561 pp.

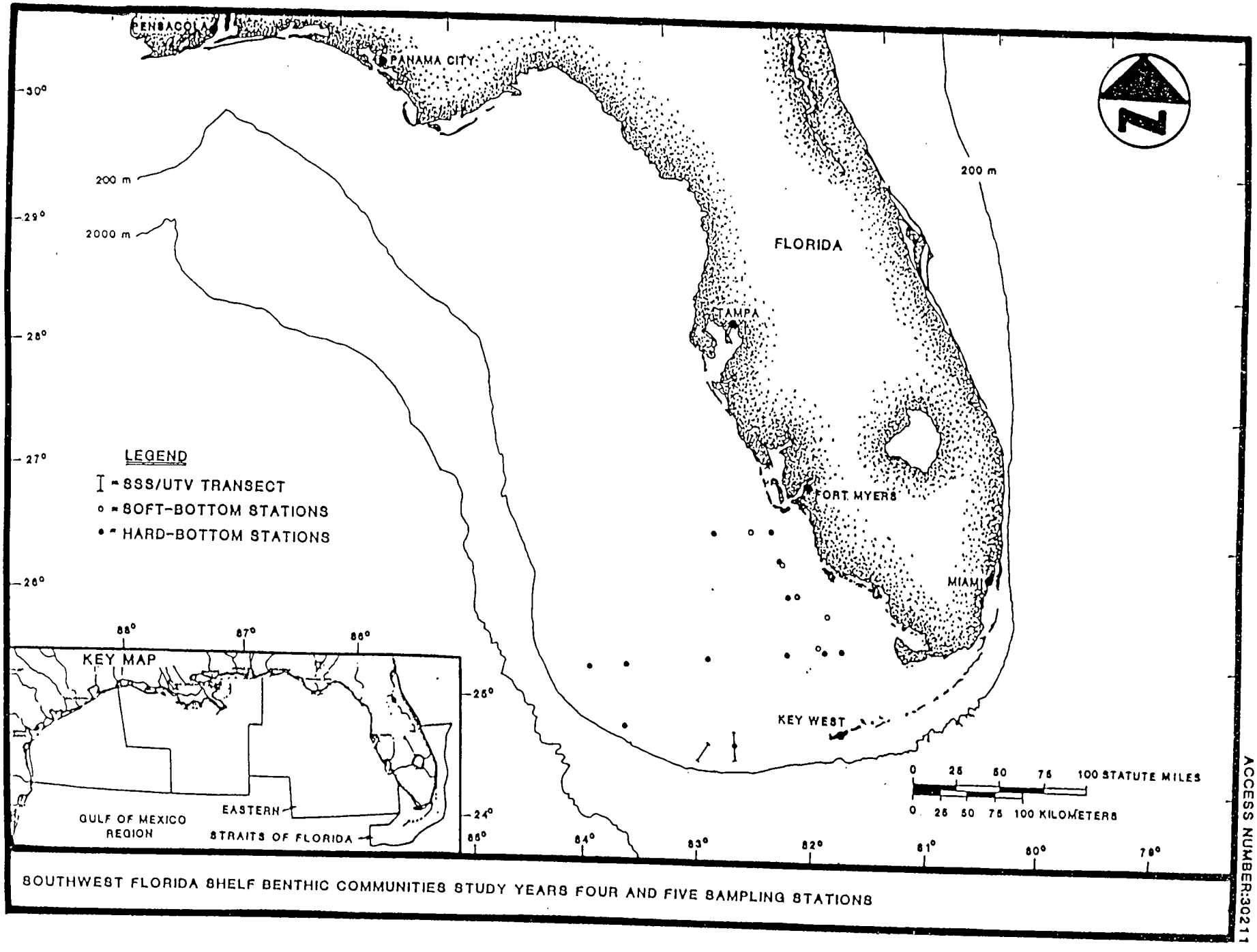
Danek, L. J. and G. W. Lewbel. 1986. Southwest Florida Shelf Benthic Communities Study, Year 5 Annual Report. Vol. III, Appendices. A final report by Environmental Science and Engineering, Inc. and LGL Ecological Research Associates, Inc. for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. MMS Report 86-0076. Contract No. 14-12-0001-30211. 506 pp.

STUDY TITLE: Southwest Florida Shelf Reef Trend Study - Year 2.

COMPLETION DATE OF REPORT: September 1986.

CUMULATIVE PROJECT COST: $992,137.

KEY WORDS: Eastern Gulf; Southwest Florida Shelf; biology; baseline; hydrography; hard-bottom; infauna; sediment; epifauna; videotapes; benthic photographs; currents; eddy; Loop Current; faunal zones; habitat; colonization.



SOUTHWEST FLORIDA SHELF BENTHIC COMMUNITIES STUDY YEARS FOUR AND FIVE SAMPLING STATIONS

ACCESS NUMBER:30211

REPORT TITLE: Gulf of Mexico Continental Slope Study Annual Report, Year 2.

MMS PUBLICATION NUMBER: MMS 86-0089, 86-0090, 86-0091.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: In 1983 (Year I), the U.S. Department of the Interior initiated a four-year study program to investigate the chemical, physical, and biological aspects of the continental slope of the northern Gulf of Mexico. This report details the findings of the second study year, an extension of the Year I effort.

OBJECTIVES: (1) To determine the abundance, structure, and distribution of animal communities in the deep sea in the Gulf of Mexico; (2) to determine the hydrographic structure of the water column and bottom conditions at selected sites within the study area; (3) to determine and compare sedimentary characteristics at selected sites within the study area; (4) to relate differences in biological communities to hydrographic, sedimentary, and geographic variables; (5) to assess seasonal changes in deep-sea biological communities in terms of abundance, structure, animal size, and reproductive state; and (6) to measure present levels of hydrocarbon contamination in deep-sea sediments and selected animals prior to, and in anticipation of, petroleum resource development beyond the shelf-slope break.

DESCRIPTION: All sampling efforts were confined to the northern Gulf of Mexico, north of 27°N Lat, where physical, chemical, and biological characteristics of the water column and seafloor were obtained. One transect, perpendicular to the slope and comprised of five stations, was located in each of the three Gulf of Mexico Planning Areas (Eastern, Central, and Western). Cruises were conducted to examine possible effects of seasonal changes, and stations were located on transects in a sequence of increasing depth. During Cruise I (November 1983), only the Central Transect was sampled at five stations (water depths of 329, 786, 850, 1,440, and 2,450 m). During Cruise II (April 1984), these Central stations were sampled, and five stations on the Western Transect at 342, 653, 828, 1,413, and 2,314 m water depths, and five stations in the Eastern Transect at water depths of 367, 622, 828, 1,172, and 2,857 m were sampled. During Cruise III (November 1984), 12 stations were sampled, all on the Central Transect, at seven intervening depths as well as the original five. Field sampling consisted of taking water column measurements and sampling bottom sediments for physical/chemical characteristics, meiofauna, macroinfauna, and collecting and photographing demersal fishes, epifauna, and macroinvertebrates and their habitat. Hydrographic measurements included continuous and discrete samples. Discrete sampling employed a 12-bottle rosette sampler, which provided water samples for temperature, salinity, dissolved oxygen, and particulate organic carbon (POC). Transmissometry profiles were taken during each cruise. For sediment sampling, six replicate box cores (24.5 x 24.5 x 44 cm) were taken at each of the Central Transect stations during both cruises; three replicates were taken at each of the Eastern and Western sampling stations. Undisturbed and uncontaminated sediment samples for analysis of hydrocarbons, grain size, carbonate, and total organic carbon, meiofauna, and infauna were subsampled from each box core. Meiofauna were defined as those infaunal organisms passing through a 0.3 mm sieve but retained on a 0.63 mm sieve. Epifauna,

macroinvertebrates, and demersal fishes were collected using a 9-m, semi-balloon trawl with 3.8 cm stretch mesh and 1.3 cm cod end mesh. A single haul was taken at each station. Benthic photography was achieved using a Benthic Underwater Camera System (a Benthos 35-mm camera mounted on a sled equipped with a pinger operated altimeter). In the laboratory, sediments were analyzed for grain size, organic carbon, and carbonate carbon content. Carbon isotopic analyses were performed on sediments and selected organisms to determine carbon source. High molecular weight hydrocarbons in macroepifauna, infauna, fishes, and sediments were determined using total scanning florescence followed by gas chromatography/mass spectroscopy. Benthic photographs were processed using a microcomputer driven digitizer.

SIGNIFICANT CONCLUSIONS: Petroleum input was greatest on the Central Transect, but all values on all transects were low. Natural hydrocarbon seepage was considered the major source of petroleum hydrocarbons in sediments of the central and western Gulf of Mexico. Faunal zonation patterns inferred during this study generally agreed with existing schemes.

STUDY RESULTS: Hydrographic measurements at all stations revealed the expected layering of water masses based on previous studies: Tropical Atlantic Central Water (oxygen minimum); Antarctic Intermediate Water (nitrate maximum, phosphate maximum, and salinity minimum); Caribbean Water (silicate maximum); and Gulf Deep Waters. Sediments along all three transects contained a mixture of petrogenic, terrigenous, and planktonic hydrocarbons. In general, sediment hydrocarbons were only present in low concentrations, especially at the Eastern Transect. The dominant normal alkane between n-C_{15} and n-C_{22} was variable; the dominant between n-C_{23} and n-C_{32} was consistently either n-C_{29} or n-C_{32}. Qualitatively, alkane distribution was similar at all sites sampled. Hydrocarbon concentrations in macroinvertebrates and demersal fishes of the slope exhibited considerable variability. Shrimps and crabs had the lowest occurrence of hydrocarbons in muscle while fish had the highest. Tissue hydrocarbons were predominated by pristine (n-C_{17}, n-C_{15}, and n-C_{19}) which are primarily planktonic in origin. Sources of these hydrocarbons include plankton input, terrestrial input of straight-chain biowaxes, and petroleum input. Extractable organic matter, a composite material derived from both biogenic and petroleum sources, was found in low concentrations on all transects except Western Transect Station 1. Carbon isotope measurements made on vent-type organisms (bivalves, tubeworms, and gastropods) were lighter (-27 to -37%) than other benthic slope organisms (crabs, shrimps). These differences were attributed to the chemoautotrophic synthesis occurring symbiotically in the vent animals.

Meiofaunal densities decreased with increasing water depth. Collections were numerically dominated by nematodes followed by harpacticoid copepods, polychaetes, ostracods, and kinorynchs. Macrofaunal densities were maximum in the Archibenthal and Upper Abyssal Zones. An average of 65% of the species are confined to the Upper Abyssal Zone. Polychaetes were the most speciose group followed by the Tanaidacea and Isopoda. One hundred and four crustacean species were collected along all three transects. An average of 70% of the crustacean species occurred at depths in excess of 1,000 m. Of the echinoderms collected in the trawl, asteriods and ophiuroids accounted for about 70% of the total. Only 60% were collected below 1,000 m water depths. About 94% of the holothurians collected occur below 1,000 m water depths. A total of 112 species of demersal or benthopelagic fish in 42 families was collected on the three transects.

Thirty-two of these species were represented by the collection of a single specimen. A preliminary faunal zonation scheme based on cluster analysis of megafaunal collections was proposed. Prominent vent and seep megafauna observed in benthic photographs included vestimentiferan tube worms *Riftia, Escarpia,* and *Lamellibrachia* and vesicomyid clams of the genera *Calyptogena* and *Vesicomya.*

STUDY PRODUCT(S): LGL Ecological Research Associates, Inc. and Texas A&M University. 1986. Gulf of Mexico Continental Slope Study Annual Report, Year 2. Vol. I, Executive Summary. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. MMS Report 86-0089. Contract No. 14-12-0001-30212. 23 pp.

LGL Ecological Research Associates, Inc. and Texas A&M University. 1986. Gulf of Mexico Continental Slope Study Annual Report, Year 2. Vol. II, Primary Volume. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. MMS Report 86-0090. Contract No. 14-12-0001-30212. 220 pp.

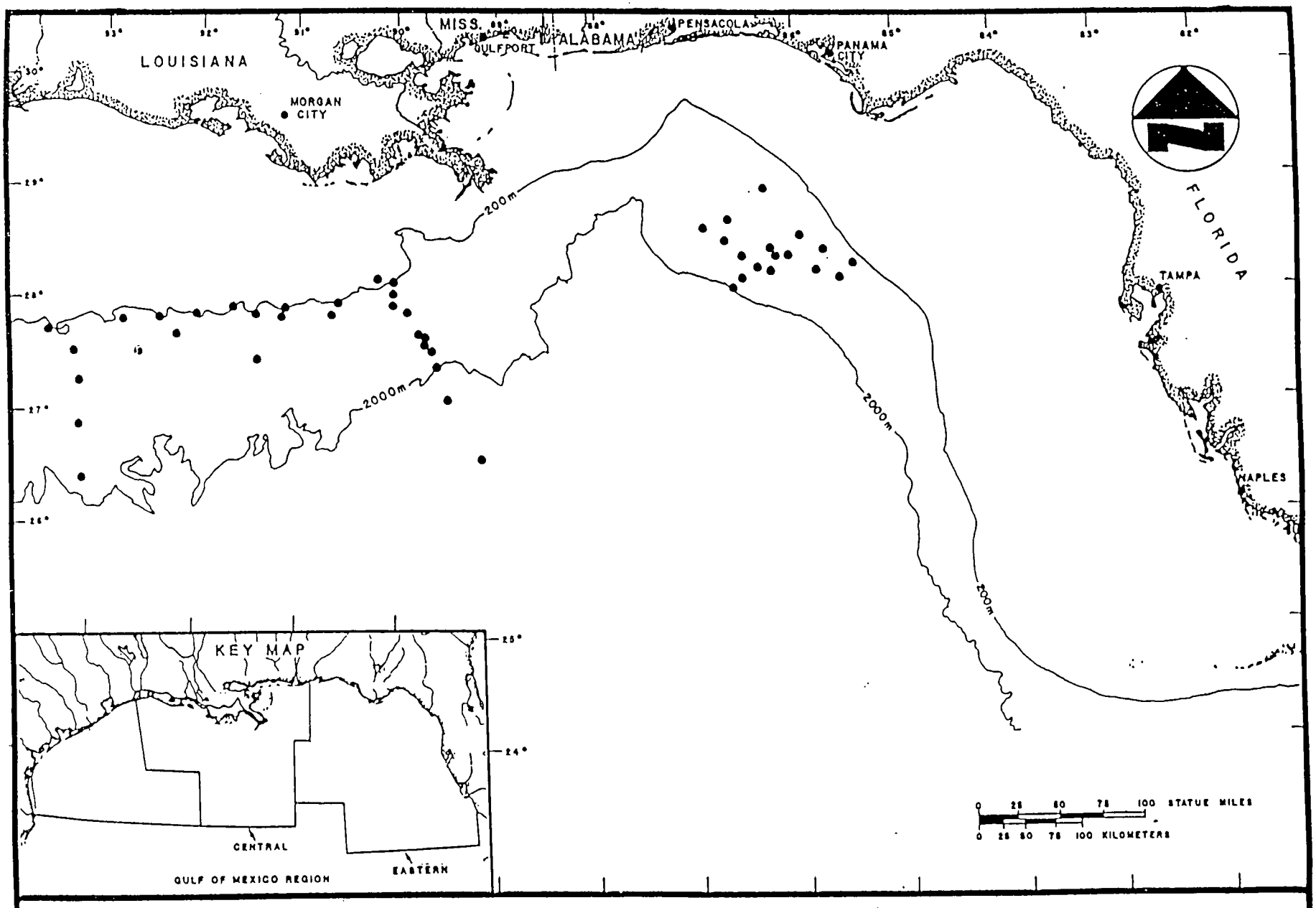
LGL Ecological Research Associates, Inc. and Texas A&M University. 1986. Gulf of Mexico Continental Slope Study Annual Report. Year 2. Vol. III, Appendices. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. MMS Report 86-0091. Contract No. 14-12-0001-30212. 327 pp.

STUDY TITLE: Northern Gulf of Mexico Continental Slope Study-Year 2.

COMPLETION DATE OF REPORT: August 1986.

CUMULATIVE PROJECT COST: $2,224,893.

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; biology; hydrography; physical oceanography; biology; hydrography; sediment; seasonality; community; benthos; hydrocarbons; slope; fish; infauna; epifauna; benthic photographs; faunal zones.



SAMPLING STATIONS FOR THE GULF OF MEXICO CONTINENTAL SLOPE STUDY, YEAR 2.

ACCESS NUMBER:30212

REPORT TITLE: Final Report on the Baseline Environmental Survey of the MAFLA Lease Areas.

MMS PUBLICATION NUMBER: Contract No. 08550-CT4-11.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: Impending oil and gas exploration of the Mississippi-Alabama-Florida (MAFLA) Outer Continental Shelf (OCS) prompted the U.S. Department of the Interior to initiate pre-impact marine environmental assessments of the region. This study concerns baseline investigations conducted during 1974 on the MAFLA/OCS.

OBJECTIVES: (1) To obtain pre-drilling information on hydrocarbon and trace metal levels in the water column, sediments, and benthic organisms within the MAFLA region; and (2) to characterize biological, chemical, and physical parameters of the water column and seafloor in the MAFLA region.

DESCRIPTION: The study area included the MAFLA OCS from 89°W long (south of Pascagoula, Mississippi) south along the inside of the 200-m isobath to approximately 27°30'N lat (west of Clearwater, Florida). Sampling efforts during May and June 1974 were concentrated near five separate lease block areas on the MAFLA shelf. Sediment samples were taken at 65 stations with a box corer (21.5 x 30.5 cm). Forty-three stations were established for diver surveys. Divers collected photographic (still photographs and video) data and samples of epibiota. Capetown dredge samples were taken at each dive station. Zooplankton were collected using 0.5-m Nitex nets (0.202-mm mesh) towed in surface, mid-depth, and bottom waters for 15 min each. Water samples were obtained at each station using 30-l Niskin bottles. Expendable bathythermograph and salinity-temperature-depth casts were made at each station. In the laboratory, sediment samples were sieved, separated into grain size fractions, and examined for carbonate content, clay mineralogy, and skeletal fragments. Trace metal (cadmium, chromium, copper, iron, lead, and nickel) concentrations were determined by atomic absorption spectrophotometry. Barium and vanadium were determined by neutron activation analysis. Gas chromatography was used to analyze water, sediments, benthic organisms, and zooplankton for high molecular weight hydrocarbons. Prepared extracts from water and sediment samples were analyzed for adenosine triphosphate with a scintillation counter. Water samples were also analyzed for dissolved oxygen, particulate and dissolved organic carbon, dissolved low and high molecular weight hydrocarbons, particulate hydrocarbons, suspended matter, trace metals, phytoplankton, chlorophyll, and zooplankton using standard techniques.

SIGNIFICANT CONCLUSIONS: Petrogenic hydrocarbons were not detected in sediments, benthic organisms, or water column phases on the West Florida Shelf. Petroleum-derived hydrocarbon contamination was evident on the Mississippi- Alabama Shelf. This area was characterized by fine fluvial sediments and low diversity epibiotic assemblages. Input from the Mississippi River was the most significant hydrographic feature in this area. Carbonate sediments and high-relief features (Florida Middle Ground) of the West Florida Shelf supported diverse epibiotic communities. Trace metal concentrations were below contamination levels for all areas and organisms.

STUDY RESULTS: On the West Florida Shelf, sediments were high in carbonate content (ca. 80%) and the predominant clay mineral was kaolinite. Calcareous skeletal remains of annelids, bryozoans, echinoids, foraminiferans, and molluscs were major contributors to the carbonate fraction. To the west of Cape San Blas, fine quartz sands, silts, and clays (montmorillonite) were prevalent. Mississippi River influence was responsible for these characteristics. The aliphatic n-alkanes and isoprenoid ratios from sediments of the Mississippi-Alabama Shelf were indicative of petrogeneous contamination. Hydrocarbons from the West Florida Shelf were of biogenic origin. There was no appreciable trace metal contamination in any of the MAFLA sediment samples. Copper and vanadium were concentrated in crustaceans and tunicates, respectively. Sponges were enriched with nickel. Sediment trace metal concentrations were correlated with ambient iron content. Photographic and dredge samples yielded the following epibiotic groups and number of taxa: sponges (260), algae (154), crustaceans (107), molluscs (107), echinoderms (50), hard corals (24), and soft corals (19). Substrate variety dictated epibiotic diversity and relative abundance. The richest sedimentary biotopes within the MAFLA region occurred on the West Florida Shelf. Florida Middle Ground rock outcrops supported diverse epibiotic communities containing many Caribbean elements. Impoverished epibiotic communities inhabited the Mississippi-Alabama Shelf where riverine inputs (i.e., freshwater discharges) exerted continuous natural stress. Infaunal samples were numerically dominated by polychaetes represented by 191 species and 10,020 individuals. A total of 4,281 molluscs, 3,084 gastropods, 190 benthic foraminiferans, and 90 scaphopods were reported. Hydrocarbon contents of benthic organisms were biogenic (i.e., pristane and squalene) and no n-alkanes resembling Gulf crudes were present. Zooplankton biomass ranged from 5 to 60 mg m^{-3}. Bivalve larvae, calanoid copepods, fish larvae, gastropod veligers, *Globigerina*, ostracods, pteropods, shrimp larvae, and tunicates were representative zooplankton. A lack of consistent relationships between concentrations of aliphatics and aromatics in the water column and plankton was observed. Diatoms contributed the highest cell numbers in the shelf phytoplankton fraction and reached maximum values in coastal waters.

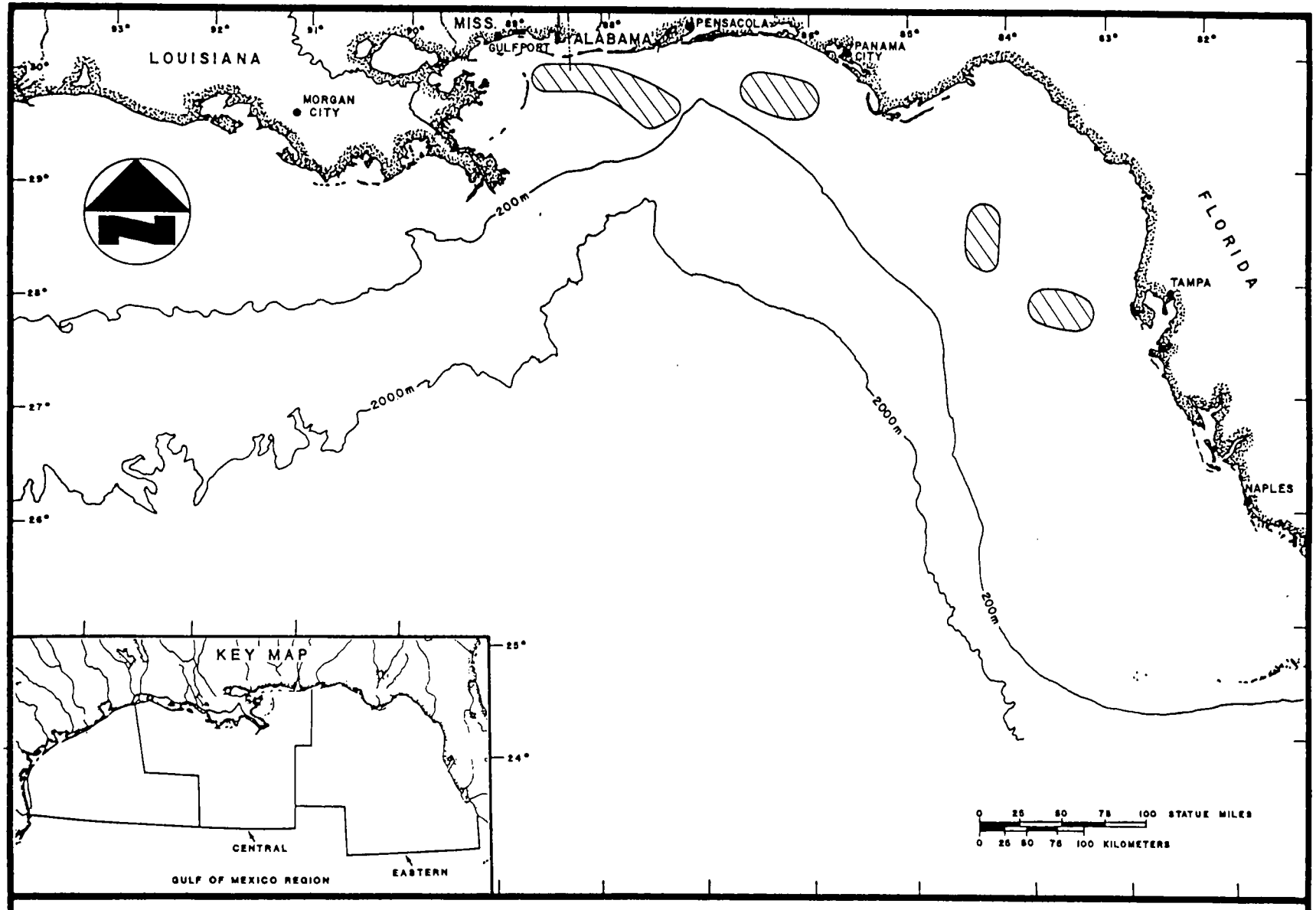
STUDY PRODUCT(S): State University System of Florida, Institute of Oceanography. 1978. Final Report on the Baseline Environmental Survey of the MAFLA Lease Areas. A final report for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. PB293-913/AS. Contract No. 08550-CT4-11. 190 pp.

STUDY TITLE: MAFLA OCS Baseline Study, FY 1974.

COMPLETION DATE OF REPORT: April 1978.

CUMULATIVE PROJECT COST: $961,278.

KEY WORDS: Eastern Gulf; Central Gulf; Mississippi; Alabama; Florida; West Florida Shelf; Mississippi-Alabama Shelf; Florida Middle Ground; baseline; hydrocarbons; trace metals; sediment; water column; tissue; zooplankton; hydrography; phytoplankton; shelf; photographs; epifauna.



GENERAL SAMPLING AREAS FOR THE MAFLA OCS BASELINE STUDY, FY 1974.

ACCESS NUMBER: CT4-11

REPORT TITLE: Final Report on the Quality Control of Trace Metal Analysis for the MAFLA Baseline Environmental Survey.

MMS PUBLICATION NUMBER: Contract No. 08550-CT4-15.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: The importance of understanding and quantifying the baseline chemical composition of water, sediments, and fauna of an area is well recognized, particularly as it relates to assessing potential impacts associated with offshore oil and gas development activities. Because large baseline environmental study programs have often involved chemical analyses by several independent laboratories, quality control procedures must be established to insure that analytical results are comparable between analytical facilities. To accomplish this objective, the present study effort was initiated in support of the Mississippi-Alabama-Florida (MAFLA) Outer Continental Shelf (OCS) Baseline Study to provide appropriate quality control of the trace metals aspects of the program.

OBJECTIVES: (1) To establish a comprehensive quality control program in support of the trace metal phase of the MAFLA OCS Baseline Study program.

DESCRIPTION: Five types of marine environmental samples, chosen at random from samples analyzed by the prime chemical analysis contractor, were submitted for quality control verification. Sample types included surficial bottom sediments, dissolved and suspended metals in the water column, and faunal samples (i.e., zooplankton, benthic invertebrates). A total of 35 sediment samples, 15 filtered water samples, 15 suspended particulate-matter samples, 15 zooplankton samples, and 20 benthic invertebrate samples were tested.

A total of eight different metals or trace metals were determined. Measured metals or trace metals included barium (Ba), cadmium (Cd), lead (Pb), vanadium (V), nickel (Ni), copper (Cu), chromium (Cr), and iron (Fe). Samples were analyzed by flame and/or flameless atomic absorption spectrophotometry.

SIGNIFICANT CONCLUSIONS: The metals present in the greatest quantity in the MAFLA sediments included calcium (20%), magnesium (3%), iron (0.7%), aluminum (0.5%), sodium (0.5%), and potassium (0.15%). Average heavy metal concentrations in the sediments were 4,877 ppm for iron; 22.7 ppm for barium; 15.4 ppm for chromium; 11.4 ppm for vanadium; 6.1 ppm for nickel; 4.7 ppm for lead; 1.8 ppm for copper; and 0.086 ppm for cadmium. Percent recovery was lowest in samples analyzed by flameless atomic absorption spectrophotometry techniques. Good recoveries were obtained for chromium, copper, lead, nickel, and vanadium. Iron was present in the highest concentration in seawater samples analyzed. By comparison, nickel was highest in suspended particulate matter. The lowest concentrations were measured for cadmium and chromium in these latter two types of samples, respectively. Iron was also highest in benthic invertebrates, occurring at an average concentration of over 15,000 ppb. Lead was present at the lowest average concentration of 23 ppb. Similar trends were observed for metals in zooplankton.

STUDY RESULTS: In sediment samples collected from the MAFLA survey area, the analysis for barium content was impossible to perform by flame atomic absorption spectrophotometry due to interference from calcium. Therefore, analysis was performed by graphite furnace atomic absorption techniques. Even this technique resulted in some loss of barium due to a need to dry and char the sample for longer periods of time to eliminate interference from smoking of the sample during testing. Vanadium was easily determined by flame atomic absorption spectrophotometry. A 20% average difference was observed between aqueous versus matrix-matched standards. Cadmium was analyzed by flameless graphite furnace because the detection limit by flame atomic absorption spectrophotometry was exceeded. A 25% loss was observed during dry and char steps. Lead was measured by flame atomic absorption spectrophotometry. Comparison of data found no difference between aqueous and matrix-matched standards. Analyses for nickel required a matrix correction and a nonabsorbing wavelength reading. The difference between aqueous and matrix-matched calibration was approximately 10%. Copper determinations required matrix-matching of standards having a 15 to 20% increase in copper compared to aqueous standard calibration. For chromium, values obtained with matrix-matched standards were 10% lower than for aqueous standards. Average heavy metal concentrations in the sediments were 4,877 ppm for iron; 22.7 ppm for barium; 15.4 ppm for chromium; 11.4 ppm for vanadium; 6.1 ppm for nickel; 4.7 ppm for lead; 1.8 ppm for copper; and 0.086 ppm for cadmium. The presence of iron in greater than trace amounts proved to be the only difficulty encountered for sediment analysis of this element. Large dilutions were necessary in order to use the linear portion of the calibration curve.

With regards to quality control, it was determined that the analyses for cadmium, chromium, copper, lead, nickel, and vanadium were "in control". Iron analyses were not classified (i.e., "in control" versus "out of control") since iron is not a trace component of sediments. It was not possible to apply such decisions to barium since 60% of the barium was lost during flameless atomic absorption spectrophotometry. Recovery of metals in spiked samples ranged from 50.8 to 138.1% for the various elements. Barium gave the lowest recovery, with 99.7% recovery measured for chromium in a matrix-matched sample. Statistical analyses indicated that duplicate analyses were performed with good reproducibility. An average variability of 27.9% was obtained. The highest variability was with cadmium (61.2%) and the lowest with iron (9.9%).

The order of decreasing dissolved metal content was $Fe > Ba > V = Pb > Cr > Cu > Ni > Cd$ for the 15 water samples analyzed. The trace metal content for sediments was $Fe > Ba > Cr > V > Ni > Pb > Cu > Cd$. Chromium and lead showed the most significant difference between the two groups. For suspended particulate matter, metals concentrations in descending order were $Ni > Fe > Cu > Ba > Pb > Cd > Cr$. The average concentration of vanadium was less than the detection limit of 5 ppb. Significant concentrations of nickel were measured for the suspended particulate matter as compared to dissolved nickel. Copper averaged 23.0 ppb in suspended particulate matter versus 2.6 ppb in seawater.

Because sample weight and digestion volume were not available for the analysis, a rigorous interpretation of benthic invertebrate data was not feasible. Large amounts of iron, nickel, and vanadium were found in these samples while lead content was low. The order of elements in these samples, ranging from high to low concentrations, was

Fe > Ni > V > Ba > Cu > Cd > Cr > Pb. Copper concentrations in zooplankton were similar to those for benthic invertebrates. Iron was present at the highest levels of the eight trace metals, while lead was lowest. Barium was higher than that found in the benthic organisms.

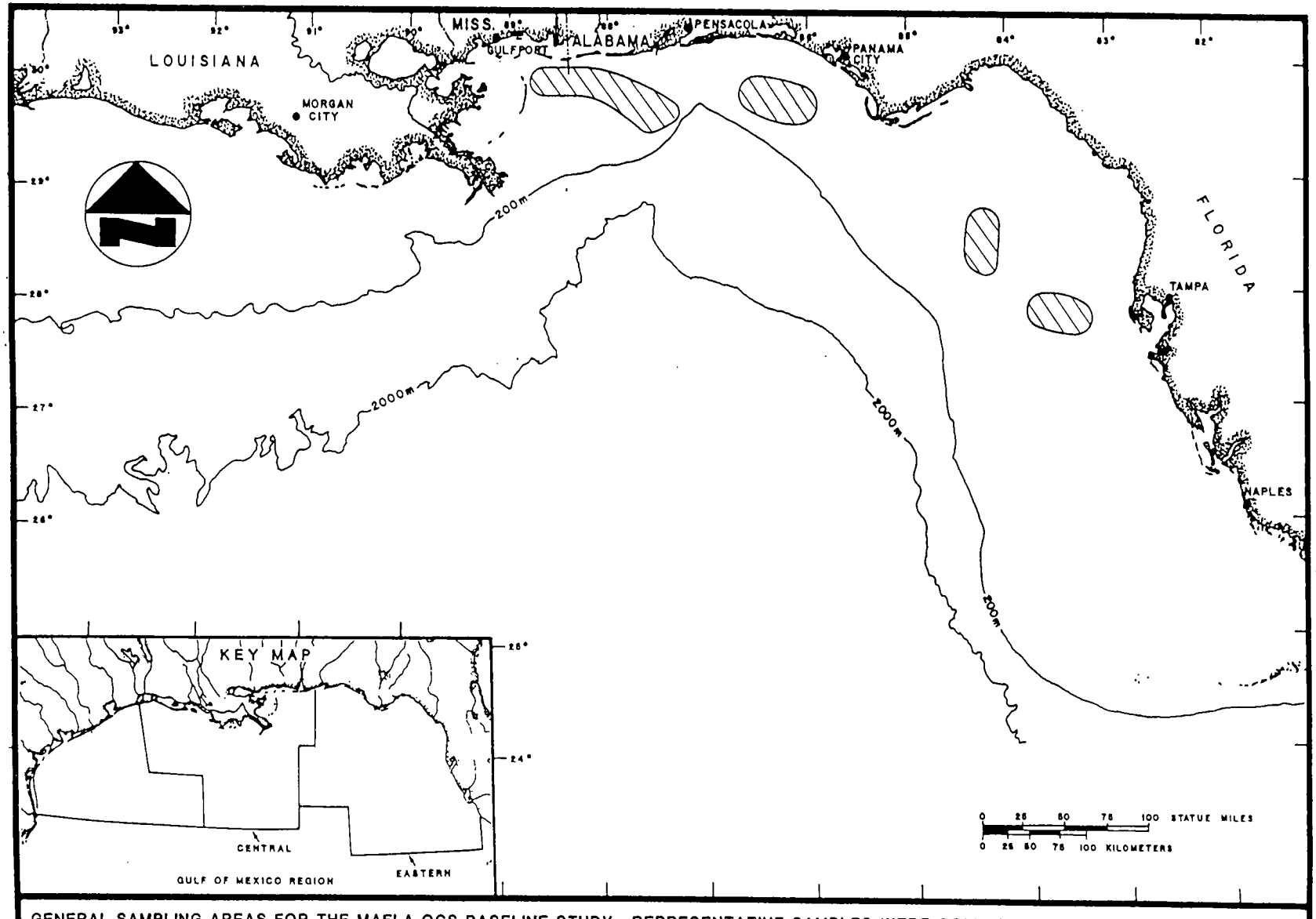
STUDY PRODUCT(S): Gulf South Research Institute. 1975. Final Report on the Quality Control of Trace Metal Analysis for the MAFLA Baseline Environmental Survey. A final report for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. Contract No. 08550-CT4-15. xvi + 171 pp.

STUDY TITLE: Trace Metal Quality Control Analyses.

COMPLETION DATE OF REPORT: August 1975.

CUMULATIVE PROJECT COST: $29,091.

KEYWORDS: Eastern Gulf; Central Gulf; chemistry; trace metals; sediment; water column; fauna; zooplankton; invertebrates; benthos; quality assurance; interlaboratory comparison; spectrophotometry; Mississippi; Alabama; Florida; Gulf of Mexico Region.



GENERAL SAMPLING AREAS FOR THE MAFLA OCS BASELINE STUDY. REPRESENTATIVE SAMPLES WERE COLLECTED FROM THESE AREAS AND ANALYZED DURING AN EVALUATION OF QUALITY CONTROL METHODOLOGY EMPLOYED DURING TRACE METAL ANALYSIS.

ACCESS NUMBER:CT4-15

REPORT TITLE: Multivariate Analysis of the MAFLA Water Column Baseline Data.

MMS PUBLICATION NUMBER: Contract No. 08550-CT5-27.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: The Mississippi, Alabama, Florida (MAFLA) environmental baseline studies sponsored by the U.S. Department of the Interior were intended to provide pre-impact data to support decisions regarding oil and gas development on the MAFLA shelf. The field sampling program focused on biotic and abiotic components of the seafloor and water column. To investigate correlations between zooplankton community and water column environmental parameters, a follow up study using objective multivariate statistical techniques was conducted. The use of multivariate analyses allows a reduction of an otherwise cumbersome data set into smaller, easier understood components.

OBJECTIVES: (1) To determine the relationship between zooplankton community structure and environmental structure; and (2) to determine the relationship between environmental pollution (trace metals and hydrocarbons) and zooplankton levels of pollution (trace metals and hydrocarbons).

DESCRIPTION: The analyses were performed on two multivariate data sets: zooplankton community variables and environmental variables. Data were collected from five different lease tract areas on the MAFLA shelf during 1974. The zooplankton community data set contained 33 taxonomic categories expressed as numbers per m^3. The environmental data set contained physical features of the water column (salinity and temperature) and levels of various water column pollutants (suspended trace metals and dissolved low molecular weight hydrocarbons). The analyses were performed separately on data from two different areas (lease tract areas I, II, III and lease tract areas IV and V). Trace metal data were analyzed using the following techniques: suspended trace metals with multivariate regression, factor analysis, and canonical correlation; zooplankton trace metal analyses with multivariate regression and canonical correlation; and zooplankton trace metal residuals with canonical correlation. Multivariate regression and canonical correlation were used for zooplankton hydrocarbon analyses from both lease tract areas. Zooplankton category association analysis was completed using factor analysis.

SIGNIFICANT CONCLUSIONS: In the MAFLA region, a complex set of interacting variables govern variability in zooplankton populations. Much of the observed variation can be attributed to salinity, temperature, depth, and to a much lesser extent, trace metals and hydrocarbons. Within lease tract areas I, II, and III, variation in trace metal concentration showed no significant correlations with standing crop of zooplankton. Relationships between zooplankton and water column parameters were best suited as indicators of water mass characteristics. Zooplankters were classified as positive, neutral, and negative concentrators in terms of trace metal concentrations. Trace metal levels were higher in lease tract areas IV and V. This was undoubtedly due to the proximity of the Mississippi River. The relationship with zooplankton community structure and trace metal levels in the MAFLA region was not significant. Future studies of this nature should strive for synopticity of sampling efforts for zooplankton and environmental parameters.

STUDY RESULTS: The most important factors influencing zooplankton community structure were salinity, temperature, and water mass origin. Approximately 45% of the zooplankton community variation was correlated with various aspects of the environmental variation. The most important environmental factors related to the structure of the zooplankton community were inshore-offshore considerations and the surface to bottom layering of the water column. Environmental variables related to inshore-offshore factors were station depth, net depth range, and salinity range which were all associated with deeper offshore stations. Surface to bottom layering was expressed by a group of environmental variables including net depth, temperature, temperature range, and salinity range. This was exemplified by the calanoid copepods *Acartia*, *Centropages*, and *Eucalanus*, and chaetognaths which were negatively correlated with salinity and station depth and positively related to temperature and salinity range. Species assemblages found to be correlated with the environment were regulated by depth factors or changes in salinity and temperature. This indicates that the zooplankton community is being influenced by similar forces controlling the water column environment. Results from canonical correlations indicated a strong relationship between the zooplankton community and the water column environment.

Suspended trace metal variation in lease tract areas I, II, and III did not explain zooplankton community variability. In lease tract areas IV and V, factor analysis revealed trace metals were more important features of the environment, but this was expected due to the proximity of the Mississippi River, a source of industrial pollution. Despite this, trace metals were not important in predicting zooplankton community structure. The only appreciable relationships were with lead, cadmium, and iron.

Canonical correlation between suspended trace metals and trace metals concentrated in the zooplankters indicated three types of zooplankter in relation to trace metal concentration: positive concentrators (the larvacean *Oikopleura* and nickel); negative concentrators (the copepod *Centropages* and nickel); and those with no particular relationship. The source of variation in trace metal levels in a zooplankter depends on the type of zooplankter and its physiological mechanisms for handling trace metals.

The variation of hydrocarbon measurements in zooplankton was greatly influenced by the category composition of the population. Canonical correlation total redundancy for lease tract areas I, II, and III was 49.61%, and 49.38% for lease tract areas IV and V, indicating that approximately one half of the hydrocarbon variation in zooplankters was accounted for by the categories of zooplankton encountered.

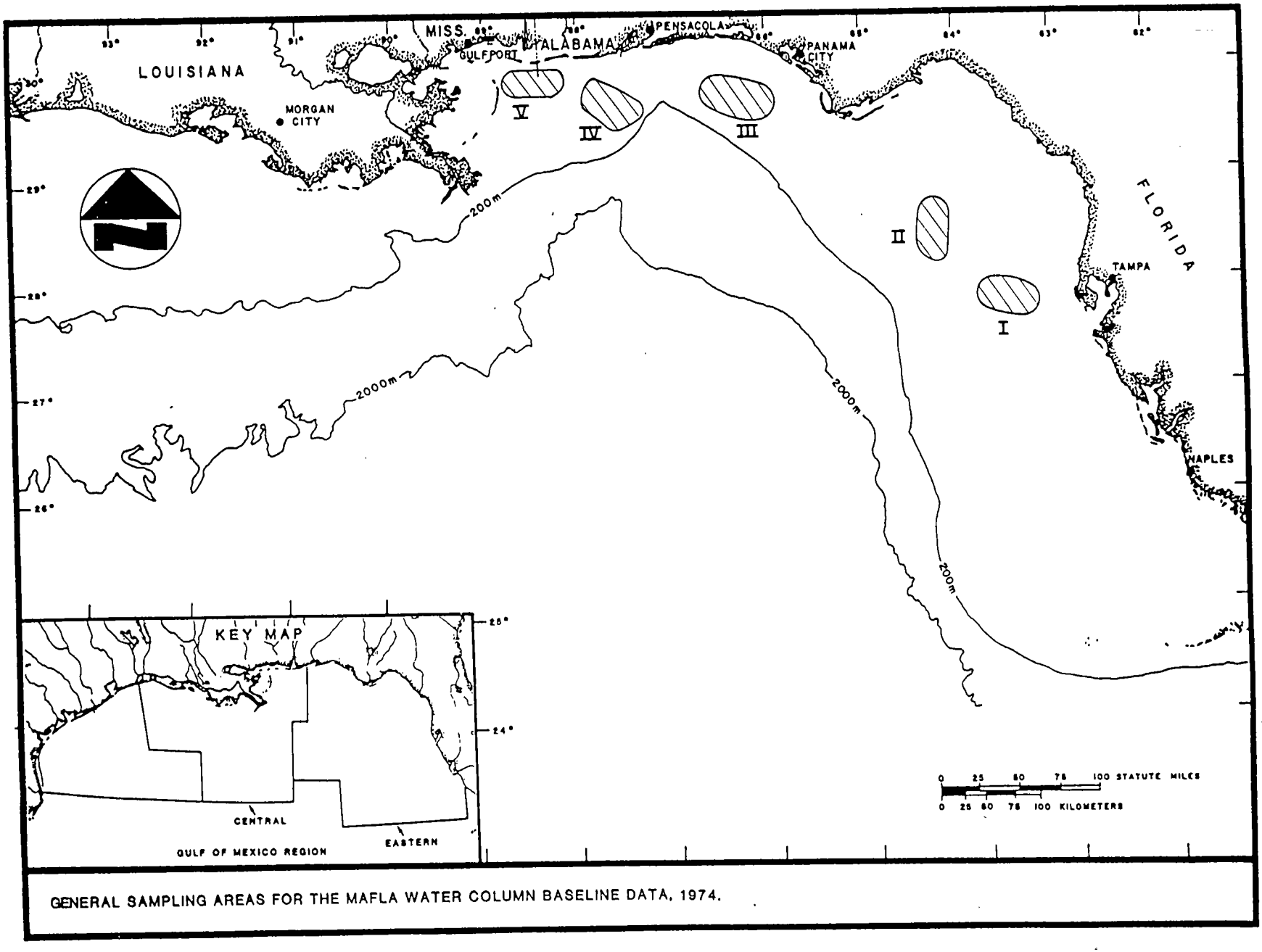
STUDY PRODUCT(S): Maturo, F. J., Jr., J. W. Caldwell, W. Ingram, III, and F. L. Hearne. 1975. Multivariate Analysis of the MAFLA Water Column Baseline Data. A final report by the University of Florida Marine Laboratory for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. PB80-201692. Contract No. 08550-CT5-27. 110 pp.

STUDY TITLE: MAFLA OCS Multivariate Analysis of Water Column Data.

COMPLETION DATE OF REPORT: September 1975.

CUMULATIVE PROJECT COST: $22,063.

KEY WORDS: Eastern Gulf; Central Gulf; Mississippi; Alabama; Florida; Mississippi River; baseline; zooplankton; trace metals; hydrocarbons; water column; hydrography; tissue; shelf; multivariate statistics; community.



GENERAL SAMPLING AREAS FOR THE MAFLA WATER COLUMN BASELINE DATA, 1974.

ACCESS NUMBER:CT5-27

REPORT TITLE: Ichthyoplankton Abundance and Diversity in the Eastern Gulf of Mexico.

MMS PUBLICATION NUMBER: Contract No. AA550-CT7-28.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: Information concerning the early life stages of fishes is important for management of commercial and recreational fisheries. Early life stages of fishes are subject to high mortality and may serve as indicators of spawning period and recruitment strength. To augment environmental baseline information for the Gulf of Mexico, the U.S. Department of the Interior supported a four-year survey of ichthyoplankton abundance and distribution in the eastern Gulf of Mexico.

OBJECTIVES: (1) To determine kinds and abundances of fish larvae that occur in the eastern Gulf of Mexico; (2) to elucidate spatial and temporal spawning patterns of ecologically and economically important fishes; and (3) to determine environmental variables correlated with species success.

DESCRIPTION: The survey area extended from 24°45'N to 30°15'N lat, and west off Florida to 88°W long. Seventeen cruises were conducted from 1971 to 1974 and a total of 869 stations were sampled. Sampling stations were spaced at 28-km intervals and were parallel to latitude lines. Data recorded included position, depth of tow, volume filtered, surface temperature, surface salinity, zooplankton volume, total eggs, and total fish larvae. Collections were made using a 61-cm bongo net and a 1-m diameter plankton net. Oblique tows were made to within 5 m of the bottom or to 200 m depth at deep stations. All ichthyoplankton samples were preserved in 10% formalin in the field, then sorted, counted, measured, and transferred to 5% buffered formalin in the laboratory. Various statistical and numerical techniques were used in data analysis, including index of abundance, estimated total abundance, estimated biomass, and species diversity (Shannon-Weaver), evenness, species richness (Simpson's), and mortality estimates. Bivariate correlation analysis was used to examine associations between $\log^{10}$ abundance of selected larval species and environmental variables.

SIGNIFICANT CONCLUSIONS: Eastern Gulf of Mexico ichthyoplanktonic assemblages were abundant and diverse. Spawning seasons for many species were discerned. There was no positive correlation between environmental variables and larval species abundances. Some species had affinities for the Loop Current.

STUDY RESULTS: A total of 143,034 larvae and 304,620 eggs were collected. Ninety-one families represented by 161 genera and 173 species were recorded. The 10 most common families, ranked in order of abundance, were Clupeidae (sardines and herrings), Gobiidae (gobies), Bothidae (left-eyed flounders), Myctophidae (lanternfishes), Serranidae (seabasses, groupers, and sand perches), Carangidae (jacks and pompanos), Synodontidae (lizardfishes), Ophidiidae (cusk eels, brotulas), Bregmacerotidae (codlets), and Labridae (wrasses). Clupeids and gobiids were most common, contributing 35.6 and 15.6%, respectively, to the total catch in waters <100 m deep. Myctophids were the predominant larval family in waters >100 m. In this study, 59,701 larvae were identified to species, which is 41.7% of all larvae that were collected. Ten species accounted for

46,637 larvae, which is 78.1% of all larvae identified to species. Most common species were the Spanish sardine *Sardinella anchovia,* Atlantic thread herring *Opisthonema oglinum,* round scad *Decapterus punctatus,* and the sand perch *Diplectrum formosum.*

Annual abundances of some common species varied considerably from year-to-year. Mortality estimates were lowest for short-lived species (clupeids) with higher growth rates, and highest for robust perciforms (lutjanids, haemulids, and carangids). Biomass estimates indicate that *O. oglinum, S. anchovia,* and *D. punctatus* exceeded 100,000 MT. Bluefin tuna *Thunnus thynnus* biomass was estimated between 25,000 and 48,000 MT. Total biomass for pelagic fishes was between 1.5 and 3.0 x 10^6 MT while total demersal species biomass was below 1.0 x 10^6 MT.

The largest catches of larval fishes were taken during spring and summer, indicating a peak spawning period. Spring and summer spawners included *O. oglinum, D. punctatus, S. anchovia,* and dusky flounder *Syacium papillosum.* Occurrences of *D. formosum* indicated year-round spawning while another serranid, the black sea bass *Centropristis striata,* spawned from fall to spring. Snappers (*Rhomboplites aurorubens, Lutjanus* spp., and *Ocyurus chrysurus*), and grouper (*Epinephelus morio*) were spring and summer spawners. Mackerels (*Scomberomorus cavalla* and *S. maculatus*) were not common in collections and probably do not spawn much in the eastern Gulf. Bregmacerotids spawn year-round with some depth segregation between species.

Diversity estimates did not show appreciable seasonal or north-south differences. Onshore vs. offshore diversities were different with ichthyoplankton diversity highest in the offshore zone (> 100 m). Evenness was higher at depths > 50 m. From the 94 species employed in the calculations, a mean of 49.8 species per cruise was observed. Diversity estimates could change if more of the unidentified species (i.e., gobiids) were incorporated. Numerical dominance by relatively few species of clupeids caused inshore diversity estimates to be low.

Correlations between abundance of larval fishes and various environmental variables were generally not significant. Sampling artifacts and temperature and salinity measurement procedures may have contributed to the lack of correlation. Species exhibiting positive affinity for the Loop Current included the myctophids *Myctophum nitidulum* and *Diogenichthys atlanticus,* gonostomatids *Gonostoma elongatum* and *Vinciguerria nimbaria,* and bregmacerotids *Bregmaceros atlanticus* and *Bregmaceros* Type A.

STUDY PRODUCT(S): Houde, E. D., J. C. Leak, C. E. Dowd, S. A. Berkeley, and W. J. Richards. 1979. Ichthyoplankton Abundance and Diversity in the Eastern Gulf of Mexico. A final report by Rosenstiel School of Marine and Atmospheric Science, University of Miami and National Marine Fisheries Service for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. PB299-839/AS. Contract No. AA550-CT7-28. 546 pp.

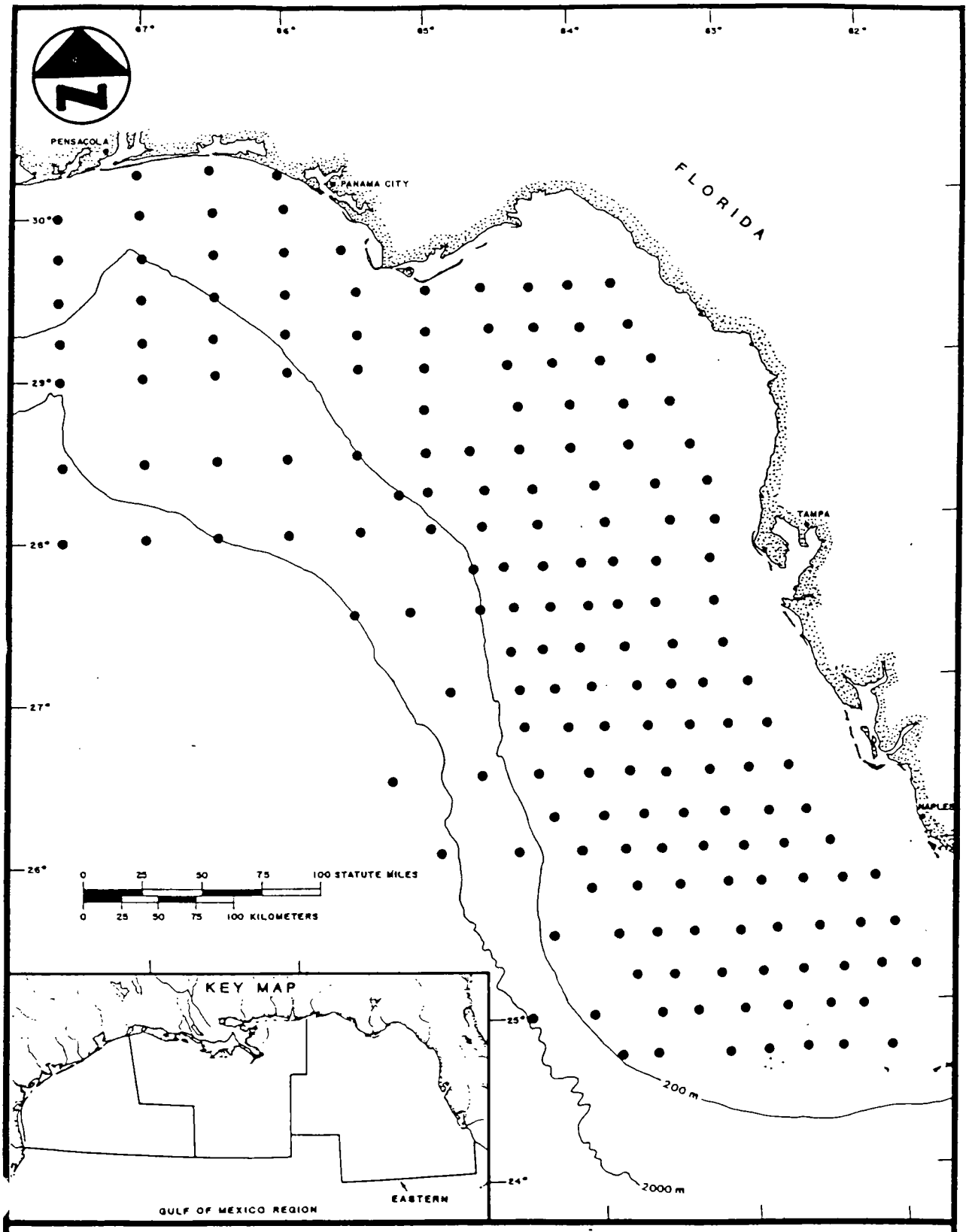
STUDY TITLE: Eastern Gulf of Mexico OCS Ichthyoplankton Study, FY 1977.

COMPLETION DATE OF REPORT: June 1979.

CUMULATIVE PROJECT COST: $88,851.

KEY WORDS: Eastern Gulf; biology; fish; ichthyoplankton; abundance; distribution; spawning; Loop Current; hydrography.

ACCESS NUMBER: CT7-28



SAMPLING STATIONS FOR THE EASTERN GULF OF MEXICO OCS ICTHYOPLANKTON STUDY, FY 1977.

COASTAL STUDIES

These studies compile existing available information utilizing a holistic approach that identifies functional relationships among natural processes and components of coastal ecosystems. An ecological characterization study is designed primarily to integrate environmental and socioeconomic information in a form useful for planning, impact assessment, and analysis, and to identify research needs. A characterization study is a tool that will enable decisionmakers to address problems including planning for urban and industrial developments, determining corridors for pipelines, siting of onshore and offshore facilities for OCS oil and gas activities, and determining priorities for future research.

The products of a characterization study are an ecological atlas, ecosystem models, a narrative report, and an information base or data source appendix. The atlas is a series of maps and diagrams that depicts biological resources, including habitats; factors of potential impact, including land use practices, socioeconomic activities, and environmental perturbations; and ecological processes within the study area. The ecosystem models delineate structural components, the functional process, and their integral relationships to physical/chemical processes characteristic of the region. The narrative report contains descriptions of the study area that emphasize natural socioeconomic interrelationships, major uses of natural resources, and changes resulting from human activities. The information base or data source appendix includes a record of all references, copies of reprints and unpublished information and data acquired, and a report on the locations and nature of unpublished data not acquired.

REPORT TITLE: Rare, Threatened, and Endangered Vertebrates of Southwest Florida and Potential OCS Activity Impacts.

MMS PUBLICATION NUMBER: Contract No. 14-12-0001-30036.

APPLICABLE PLANNING AREA(S): Straits of Florida; Eastern Gulf of Mexico.

BACKGROUND: A consensus of five listings from Federal, State, and private institutions and organizations have considered 68 southwestern Florida vertebrate species to be rare, threatened, or endangered. These vertebrate populations could potentially be reduced to non-sustaining levels by human activities. Leasing of Outer Continental Shelf (OCS) areas for oil and gas activities increases the potential for man-induced impacts upon sensitive vertebrate populations. Information necessary to assess population decline is usually unavailable because of vast amounts of time needed to gather conclusive data. Potential increased human activity due to oil and gas activities makes it imperative to compile information and make recommendations concerning these vertebrate populations.

OBJECTIVES: (1) To identify the rare, threatened, and endangered vertebrate species of southwestern Florida and describe their habitats; (2) to evaluate man-induced and oil and gas activity impacts on these species.

DESCRIPTION: A list of 68 terrestrial and nearshore vertebrate species considered rare, threatened, or endangered was compiled from five listings. The General Map of Natural Vegetation of Florida outlines 13 terrestrial habitats that exist within eight southwestern Florida counties. The habitats were described and the vertebrates that occur within each habitat were listed. Habitat importance to a particular vertebrate species was determined by relative animal density or frequency of occurrence within a habitat. The geographic distribution of vertebrate species by county was determined by calculating the number of species that occur within a county and expressing that number as a percentage of the total listed. The percent of the listed species that occur within a habitat type, and the percent of species for which each habitat is of primary importance, were also calculated. Man-induced impact on existing populations was represented by calculating the percentage of counties and habitats under development. Oil and gas activity scenarios were projected. By using recorded data, potential impacts on vertebrate populations were considered.

SIGNIFICANT CONCLUSIONS: Of the 68 listed vertebrate species, 36 species have broad ranges and have been recorded in all eight counties. The large range of these species makes them less susceptible to isolated impacts. The Florida panther is the only vertebrate of the broad range species to have a declining population. Coastal marine habitats (e.g., mangrove marsh), which harbor the largest number of rare and endangered vertebrates and species restricted to one habitat, are most susceptible to oil and gas activity impact. None of the listed vertebrates have population declines due to natural causes, so efforts should be made to protect the vertebrates from habitat alteration.

STUDY RESULTS: The list of 68 vertebrate species includes all that have been or would be affected by habitat alteration in the eight southwestern Florida counties. Of these vertebrates, 53% are found in all eight counties. The relative small study area (7,200 mi^2) and high mobility of many vertebrates (e.g., birds) probably accounts for the cosmopolitan

range. Monroe County (Florida Keys) harbors 87% (59 species) of the listed vertebrates and 20% (14 species) are restricted to this county. The Florida Keys, being a string of islands, allows for some genetic isolation and potential speciation which probably accounts for the presence of 9 endemic species or subspecies.

Habitat importance, as determined by presence of the listed vertebrates, requires primary emphasis. Mangrove/salt marsh habitat is occupied by 54% (37 species) of the vertebrates and is ranked first in importance. Estuaries, everglades marsh, and marl/rock marsh are second in habitat importance. Coastal and inland wetlands are critical habitats and must be protected from habitat alteration. Destruction of habitat, direct exploitation, and incidental disturbances have been indicated as the major causes of population decline. Potential oil and gas activity in the eight counties can accelerate the increase in these detrimental factors. Onshore facilities should be located as far from the most critical habitats as possible.

STUDY PRODUCT(S): Woolfenden, G. E. 1983. Rare, Threatened, and Endangered Vertebrates of Southwest Florida and Potential OCS Activity Impacts. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB83-250811. FWS/OBS-82/03. Contract No. 14-12-0001-30036. 74 pp.

STUDY TITLE: Southwest Florida Shelf Coastal Ecological Characterization.

COMPLETION DATE OF REPORT: February 1983.

CUMULATIVE PROJECT COST: $1,090,973.

KEY WORDS: Straits of Florida; Eastern Gulf; Southwest Florida Shelf; Florida; baseline; biology; endangered species; terrestrial; characterization; habitat; vertebrates; distribution; impacts; literature review; synthesis.

MAP #30036.7 Unavailable.

REPORT TITLE: Rare, Threatened, and Endangered Plant Species of Southwest Florida and Potential OCS Activity Impacts.

MMS PUBLICATION NUMBER: Contract No. 14-12-0001-30036.

APPLICABLE PLANNING AREA(S): Straits of Florida; Eastern Gulf of Mexico.

BACKGROUND: Certain plant populations of southwestern Florida are designated as rare, threatened, or endangered. Various natural and man-induced factors are responsible for the designations. An increase in man-induced factors may occur as a result of leasing areas of the Outer Continental Shelf (OCS) for oil and gas activities. Exploratory drilling may occur, and consequently oil and gas production and transport and onshore facilities may become a possibility. The most serious impact of oil and gas activities to southwestern Florida's plants would be due to oil spills. Baseline information concerning plants of southwestern Florida coastal counties must be considered so that plant distribution and current status can be related to natural variability and man-induced effects.

OBJECTIVES: (1) To summarize all published information concerning southwestern Florida's rare, threatened, and endangered plant species; (2) to describe natural and man-induced causes of plant rareness; (3) to evaluate impacts of oil and gas activities on rare, threatened, and endangered plants along the southwestern Florida coast.

DESCRIPTION: A list of 274 plants considered rare, threatened, or endangered in southwestern Florida was compiled from six listings. The criterion for plant status designation differed between lists. The Florida Committee on Rare and Endangered Plants and Animals (FCREPA) list was considered the most complete and up-to-date. The 274 plants were categorized by habitat, of which there were 17, and geographical distribution among eight southwestern Florida coastal counties. Plants on the FCREPA list were also categorized and expressed as a ratio to the total listing. The biogeographical distribution of the 274 plants and the FCREPA listed plants were determined by data gathered from various published accounts. The future extent of man-induced impact was projected by estimating population growth and area development. Oil and gas activity scenarios were projected and, by using recorded data (e.g., frequency of oil spills), potential impacts to plant populations were considered.

SIGNIFICANT CONCLUSIONS: Present Florida habitat is the range extremity for many plant species, making these particular species very susceptible to extinction. Habitat requirements for many species are very specific, therefore, habitat alteration by man's activity may be the most severe impingement on these species. The onset of oil and gas activities compounds man-induced impacts on plant habitats by increasing onshore development, water demands, and potential oil spills.

STUDY RESULTS: By expressing the FCREPA listed plants and the total compiled plant listing as a ratio during habitat and county distribution categorization, similarities and dissimilarities between lists could be delineated. The lists were quite similar in species composition within habitats and distribution of species among the eight counties, although the compiled listing may be overinflated.

Reasons for plant rareness within the eight counties were discussed. Life histories and population dynamics are virtually unknown for most plants listed, therefore, most natural causes of rareness could not be elaborated. The geologically recent exposure of coastal Florida allowed for colonization of various tropical plant species. Some of these species are rare due to geographic restrictions and have colonization only in tropical or semi-tropical localities. Man-induced impact is widespread, ranging from plant collection to habitat alteration. Land is under constant uptake for agriculture, urbanization, and mining. With the potential of oil and gas activities, the problem of land uptake and habitat alteration becomes compounded.

STUDY PRODUCT(S): McCoy, E. D. 1981. Rare, Threatened, and Endangered Plant Species of Southwest Florida and Potential OCS Activity Impacts. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. PB82-182452. FWS/OBS-81/50. Contract No. 14-12-0001-30036. 84 pp.

STUDY TITLE: Southwest Florida Shelf Coastal Ecological Characterization.

COMPLETION DATE OF REPORT: November 1981.

CUMULATIVE PROJECT COST: $1,090,973.

KEY WORDS: Straits of Florida; Eastern Gulf; Southwest Florida Shelf; Florida; baseline; biology; characterization; endangered species; plants; terrestrial; habitat; distribution; impacts; literature review; synthesis.

MAP #30036.8 Unavailable.

REPORT TITLE: Alabama Coastal Region Ecological Characterization. Vol. 1, Coastal Bibliography; Vol. 2, A Synthesis of Environmental Data.

MMS PUBLICATION NUMBER: Contract No. 14-12-0001-30037.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: Coastal Alabama and adjacent waters are an important industrial, recreational, and seafood production area in the northern Gulf of Mexico. Discovery of oil and gas in and around Mobile Bay, development of State-owned and outer continental shelf fossil fuel reserves, and completion of the Tennessee-Tombigbee Waterway have enhanced the area and should promote continued urban and industrial expansion. Recognizing the highly productive area along the Alabama coast and the resource planning to maintain these areas, the U.S. Fish and Wildlife Service initiated the Ecological Characterization Program for selected coastal areas.

OBJECTIVES: (1) To summarize all available information on natural resources of coastal Alabama.

DESCRIPTION: Coastal Alabama lies within the Coastal Plain province and the Mississippi-Alabama shelf section of the Continental Shelf province. Part of the study was a literature search and bibliography pertaining to coastal Alabama. The report characterizes the area with respect to geology, hydrology, climate, plant life, animal life, endangered and threatened species, and an area-wide conceptual model. The aim of the conceptual representation is for the information synthesis to present the coastal water environment as integrated systems of physical, chemical, and biological forces. These representations were developed to serve as a reference source of known information about coastal Alabama.

SIGNIFICANT CONCLUSIONS: The holistic conceptual model of coastal Alabama as a single energy system was comprised of two basic units. One unit consisted of four natural ecosystems and their connective pathways. The second unit consisted of manipulated subunits such as agricultural ecosystems and urban/industrial systems that require extensive inputs of external energy. The conceptual model provides a workable hierarchical system that indicates the interrelationships that exist between natural and modified systems. Although some areas need further research, the conceptual model may be used as a management tool for maintaining the balance between individual subunits within the system.

STUDY RESULTS: Coastal Alabama has four physiographic subdivisions. The southern pine hills comprise the elevated east and west lateral portion of coastal Alabama. The alluvial plain, deltaic plain, and coastal lowlands are relatively flat, are adjacent to Mississippi Sound, and extend along margins of Mobile, Bon Secour, and Perdido Bays. These flat physiographic subdivisions also extend northward along the Tombigbee and Alabama Rivers. The coastal boundaries of these relatively shallow bays are defined by various barrier islands and spits. The Mississippi-Alabama shelf is a triangular area seaward of the barrier islands and extends from the Mississippi River Delta to the De Soto Canyon.

Coastal and offshore Alabama are underlain by sediments ranging from pre-Jurassic to Holocene. These rock units are possibly more than 7,620 m (25,000 ft) thick at the coast and decrease southward by 1.9 to 9.4 m/km (10-50 ft/mi). The coastal and continental shelf topography and sedimentation result from tidal and current movements, as well as alluvial and deltaic progradation and destruction.

The prominent structural geological features along coastal Alabama are the peripheral faults, Mobile graben, the Citronelle domal anticline, and the Wiggins uplift. Tectonic hazards are not a problem in coastal Alabama because there are no known active faults.

Oil and gas production is well established in coastal Alabama with developed fields at Citronelle, Chunchula, Hatter's Pond, and South Carlton. There is a high potential for future gas and oil production.

Coastal Alabama has a dynamic hydrologic system with the focal point of the system being Mobile River and Mobile Bay into which it flows. Average yearly (freshwater) discharge from this system into the Gulf of Mexico is 50 km^3 (12 mi^3). Flooding is the worst natural hazard of coastal Alabama and may result from storm surges and heavy rainfall associated with hurricanes and other tropical storms. Flood discharge has a pronounced effect on inland and estuarine water salinity and coastal sedimentation. Climatic and physical oceanographic factors along coastal Alabama are well understood and recorded because of the extent to which they affect this particular area.

Specific studies of coastal Alabama phytoplankton were lacking, however, an intensive study of Mobile Bay phytoplankton has been undertaken. Community diversity and species composition of aquatic vegetation has declined. Habitat types were described and characterized by associated flora. Animal diversity was high in coastal Alabama where the fauna included terrestrial, freshwater, saltwater, and brackish water species characteristic of temperate and subtropical climates. Coastal Alabama has important habitats for many commercially valuable biota (i.e., shrimp, oysters, and fish). This area maintains a highly diversified avifauna (greater than 300 species) which is attributed to the multiple habitats present in coastal Alabama. Fifty-seven mammalian species have been reported from coastal Alabama. Some flora and fauna are considered endangered or threatened.

The natural ecosystems are functionally composed of producers, consumers, and decomposers. Energy within the system is transferred and transformed between trophic levels. This system is considered self-sustaining. The agricultural, urban/industrial, and associated pathways rely heavily on external energy from other systems illustrating their independence on natural ecosystems.

STUDY PRODUCT(S): O'Neil, P. E., M. F. Mettee, E. J. McCullough, L. A. Acker, and D. W. Wilson. 1982. Alabama Coastal Region Ecological Characterization. Vol. 1, Coastal Bibliography. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB83-180661. FWS/OBS-82/21. Contract No. 14-12-0001-30037. 408 pp.

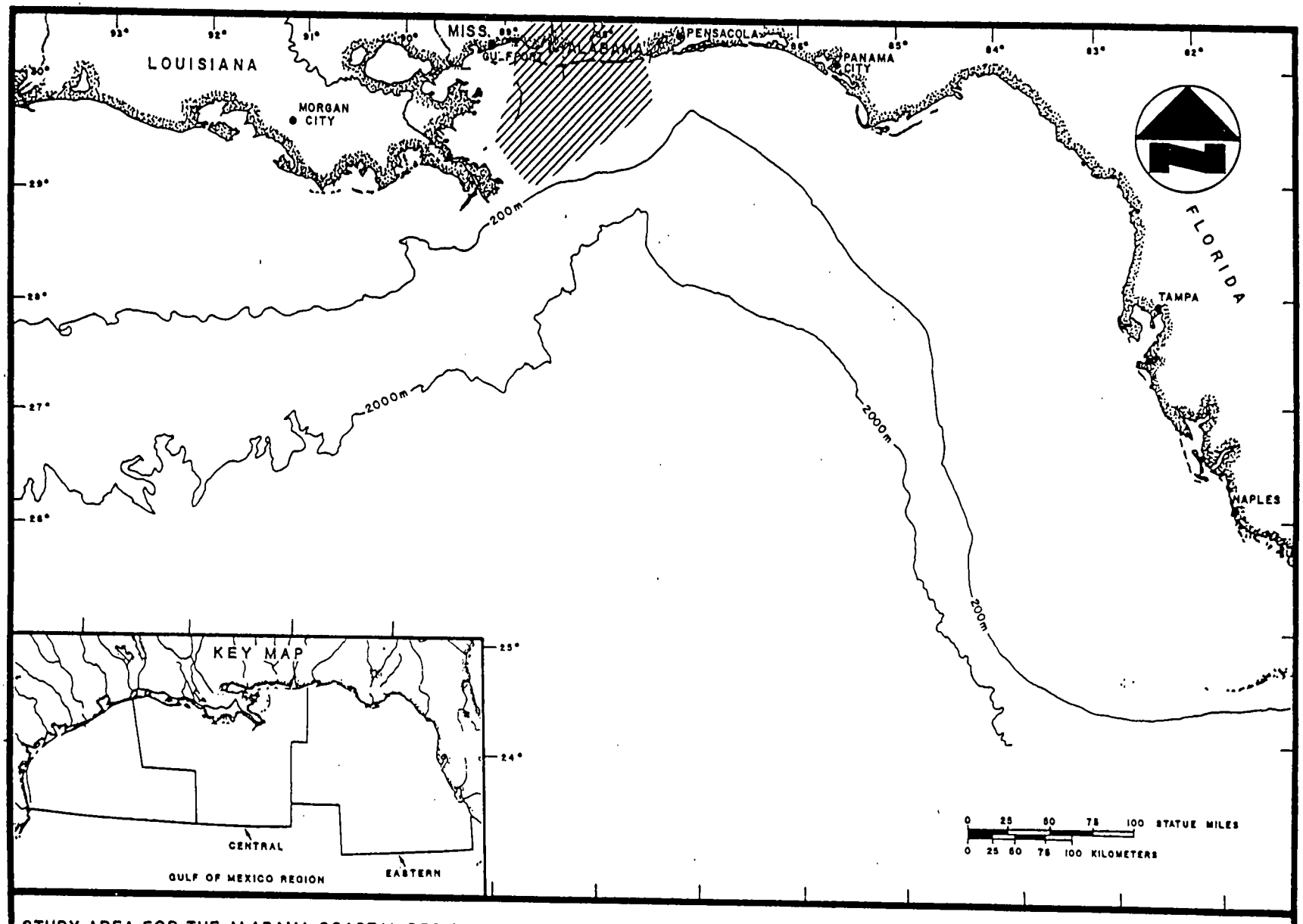
O'Neil, P. E. and M. F. Mettee. 1982. Alabama Coastal Region Ecological Characterization. Vol. 2, A Synthesis of Environmental Data. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB83-190009. FWS/OBS-82/42. Contract No. 14-12-0001-30037. 346 pp.

STUDY TITLE: Northeastern Gulf of Mexico Coastal Ecological Characterization.

COMPLETION DATE OF REPORT: June 1982.

CUMULATIVE PROJECT COST: $1,185,000.

KEY WORDS: Eastern Gulf; Central Gulf; Alabama; baseline; biology; characterization; synthesis; bibliography; literature review; coastal zone; terrestrial; geology; physiography; plankton; birds; commercial fishing; endangered species; literature review; synthesis.



STUDY AREA FOR THE ALABAMA COASTAL REGION ECOLOGICAL CHARACTERIZATION.

ACCESS NUMBER:30037

REPORT TITLE: Alabama Coastal Region Ecological Characterization. Vol. 3, A Socioeconomic Study.

MMS PUBLICATION NUMBER: Contract No. 14-12-0001-30037.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: This study is one of a series of characterizations produced by the U.S. Fish and Wildlife Service and jointly funded with the Bureau of Land Management (presently the Minerals Management Service). The series attempts to describe relationships between human population growth and availability of natural resources in coastal areas. Planners and managers, among others, should find this report and its data base useful for coastal resource planning and management.

OBJECTIVES: (1) To compile and synthesize information from existing sources concerning social, demographic, and economic factors in the Alabama coastal region.

DESCRIPTION: The socioeconomic study consists of a series of chapters containing quantitative and qualitative descriptions of nine regional socioeconomic components. Recommendations for planners and identification of data gaps are given in each chapter. The chapters concern: (1) social and demographic characteristics; (2) industrial and residential development; (3) agricultural and forestry production; (4) mineral production; (5) commercial fishing; (6) transportation; (7) recreation/tourism; (8) multiple use conflicts; and (9) environmental issues and regulations. All figures and tables are given in a data appendix in the order that they appear in the text. Data were obtained from various published documents. Except for evaluation and interpretation, the document is based entirely on secondary sources.

SIGNIFICANT CONCLUSIONS: Coastal Alabama, similar to other coastal areas, has natural resources that cause it to be attractive for recreation, residential, and industrial development. Conflicts arise as development demands alteration to coastal ecosystems. As demand for coastal resources increases, land use and resource planners are confronted with greater challenges in attempts to maintain a proper balance among competing users.

STUDY RESULTS: Coastal Alabama is a fast growing area. Population in Mobile and Baldwin Counties increased from 174,300 in 1940 to 442,800 in 1980. Rapid growth is expected to continue. Population at Mobile, the area's largest population center, currently is about 200,500. Compared to many areas of the Nation, people of coastal Alabama are less affluent and less educated. The coastal population characteristically contains a high percentage of minorities (e.g., blacks). Recent trends indicate that the gap in income is narrowing.

The basic regional industries or services are paper and allied products; shipbuilding and repair; chemicals and allied products; construction; transportation; communication; utilities; lumber and wood products; services; and wholesale and retail trade. The region's employment increased from 131,600 in 1969 to 172,300 in 1978 and could reach 233,400 by 2000. Impetus for future economic expansion will be generated by the Tennessee-Tombigbee Waterway, increased coal shipments through the Port of Mobile, and

expanded production, storage, and transportation of oil and gas. Regional land area is 7,484 km^2 (2,890 mi^2). In 1975, forested lands made up 48% of the total land; agriculture, 19%; transportation, communication, and utilities, 3%; residential, 2%; industrial and commercial, 1%; and undeveloped, 27%.

Although agriculture and forestry are dominant land uses in the region, income from these sectors is relatively low. In 1978, agriculture, directly and indirectly, generated about 11% of total employment and income, and forestry generated only 1%. Principal agricultural products are soybeans, vegetables, cattle, and nursery products. Major forestry products are lumber and pulpwood.

Principal mineral industry products are oil, gas, sand, gravel, clay, and oyster shells. Oil and gas production is economically most important, representing a relatively new but rapidly growing regional industry. In 1979, Alabama ranked 17th nationally in oil production and 20th in natural gas production. Recent natural gas discovery in Mobile Bay has increased interest in bay, nearshore, and offshore exploration. In April 1980, the State leased 13 tracts in Mobile Bay, Mississippi Sound, and the Gulf of Mexico 3-mile offshore area; in the near future, tracts in Federal OCS waters may be offered.

In 1978, 23 finfish species and 7 shellfish species were landed commercially in coastal Alabama. Shrimp have consistently ranked first in volume and value since 1955, accounting for 33 to 50% of total pounds landed and 80 to 85% of dockside value. Oyster ($1.2 million dockside in 1976) and crab ($281,000 dockside in 1976) fisheries are relatively small. Atlantic croaker is the principal regional finfish species. Other commercial saltwater species include spotted seatrout, southern flounder, and striped mullet. Commercial freshwater fisheries exist for channel catfish, smallmouth buffalo, and freshwater drum.

Coastal Alabama is served by a well developed transportation system. Terminal facilities for rail, highway, air, and water are centered in Mobile County. Water transportation centered around Mobile Bay with a system of navigable waterways is dominant and has been the primary contributor to the area's economic development since the 17th century. Mobile Bay ranks 13th among the Nation's ports, handling mostly bulk commodities (coal, grain, and iron ore). The Tennessee-Tombigbee Waterway, scheduled for completion in 1986, will link the Tennessee and Ohio Rivers to the Tombigbee River and Port of Mobile. The Port of Mobile and Mobile Harbor are undergoing expansion to accommodate expected increased transport. Intercity highway transportation is served by I-10 and I-65. Rail service (freight only) is provided by four railroads--Louisville and Nashville, Illinois Central Gulf, St. Louis-San Francisco (Frisco), and Southern. Commercial air transportation is available at Bates Field and Brookley Field.

In 1980, resident and tourist outdoor recreation in Mobile and Baldwin Counties was expected to add up to over 51 million user days. Most of the user participation was near the shore. An estimated 4.4 million tourists visited the two county area and spent $117.8 million. Sportfishing and hunting are major regional sports. The Mobile Delta is the principle freshwater fishing area for largemouth bass, sunfish, crappies, channel catfish, and alligator gar. Marine fishermen use all regional estuaries and bays, as well as Mississippi Sound and Gulf waters. Principal sport species are amberjack, Spanish and king mackerel, southern flounder, striped mullet, and spotted seatrout. Shrimping and crabbing also are major sport

activities. Hunting seasons begin in mid-September and continue to late April. Duck and raccoon are hunted in the lower Delta. Whitetail deer, turkey, and small game are taken in most areas of the region.

Many of the social and economic benefits prevalent in the region are dependent upon natural resources. Competition for these resources causes multiple-use conflicts and environmental stress. Although the conflicts generate some social, economic, and political repercussions, the issues usually are environmental. Major environmental conflicts are dredging, mining, petroleum extraction, construction, transportation, pollution, waste disposal, farming, and logging. Recreation activities most likely to be affected by these multiple uses are commercial fishing, sportfishing, hunting, recreational boating, swimming, hiking, and camping.

Water pollution is a serious problem in and adjacent to Mobile Bay. Spoil disposal from port and channel construction and maintenance has caused environmental concerns. Alteration or destruction of marshes and shallow bay bottoms caused by port, commercial, residential, and recreational development needs to be prevented. Principal point discharges are municipal sewage treatment facilities, paper mills, and chemical plants. Nonpoint discharges include urban storm water runoff and septic chainfields in low lying areas. Air pollution is confined to Mobile County. A major environmental issue is natural habitat loss. Estuaries, marshes, and barrier islands provide storm protection, waste assimilation, and recreation. Threatened and endangered natural lands and waters and other areas of high ecological value to man are the Mobile Delta, coastal barrier islands, submerged grassbeds, tidal marshes, wet acid pinelands, mesic ravine woods, and habitats of endangered and threatened species.

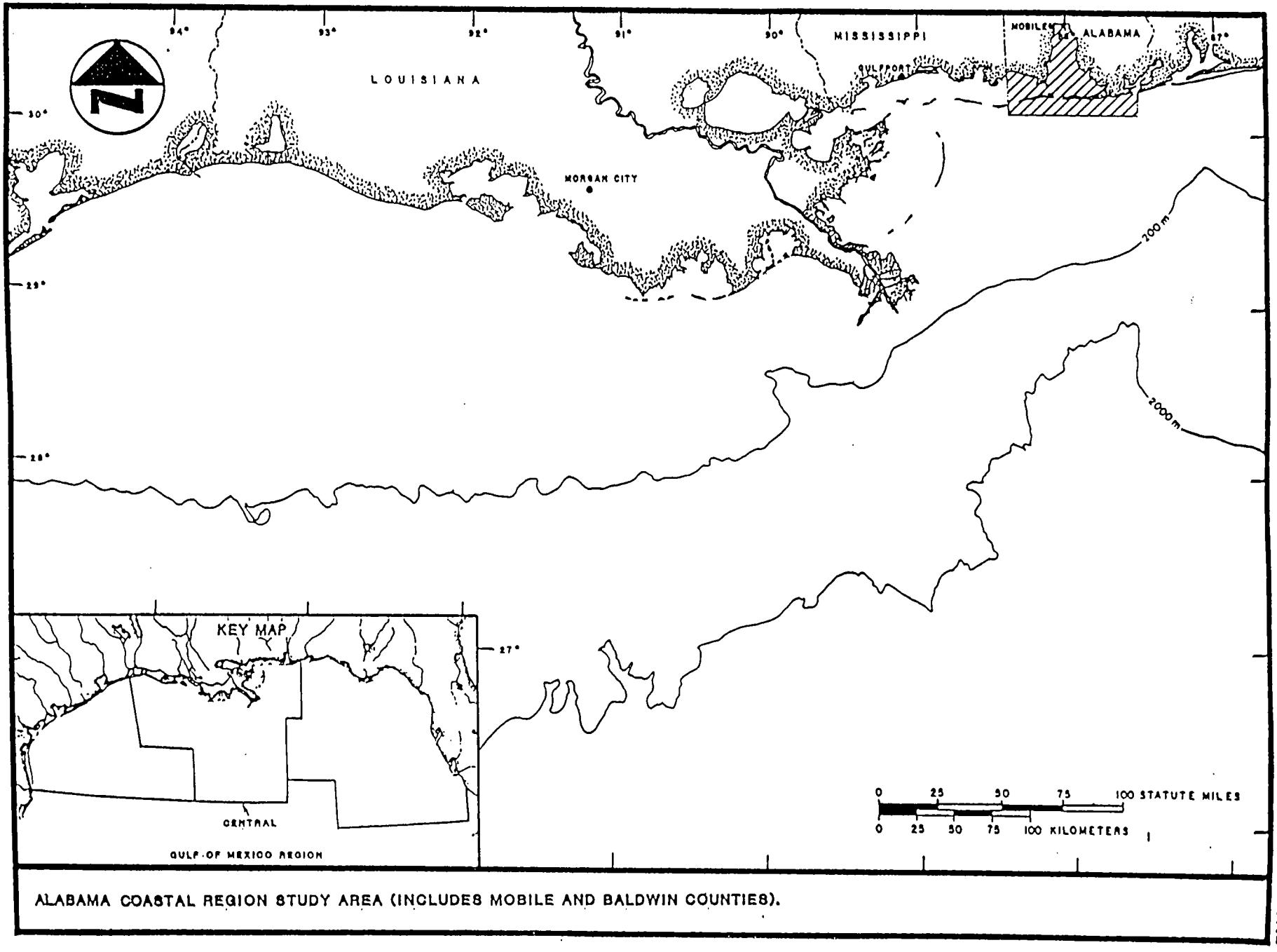
STUDY PRODUCT(S): Friend, J. H., M. Lyon, N. N. Garrett, J. L. Borom, J. Ferguson, and G. C. Lloyd. 1982. Alabama Coastal Region Ecological Characterization. Vol. 3, A Socioeconomic Study. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB83-190017. FWS/OBS-81/41. Contract No. 14-12-0001-30037. 367 pp.

STUDY TITLE: Northeastern Gulf of Mexico Coastal Ecological Characterization.

COMPLETION DATE OF REPORT: October 1982.

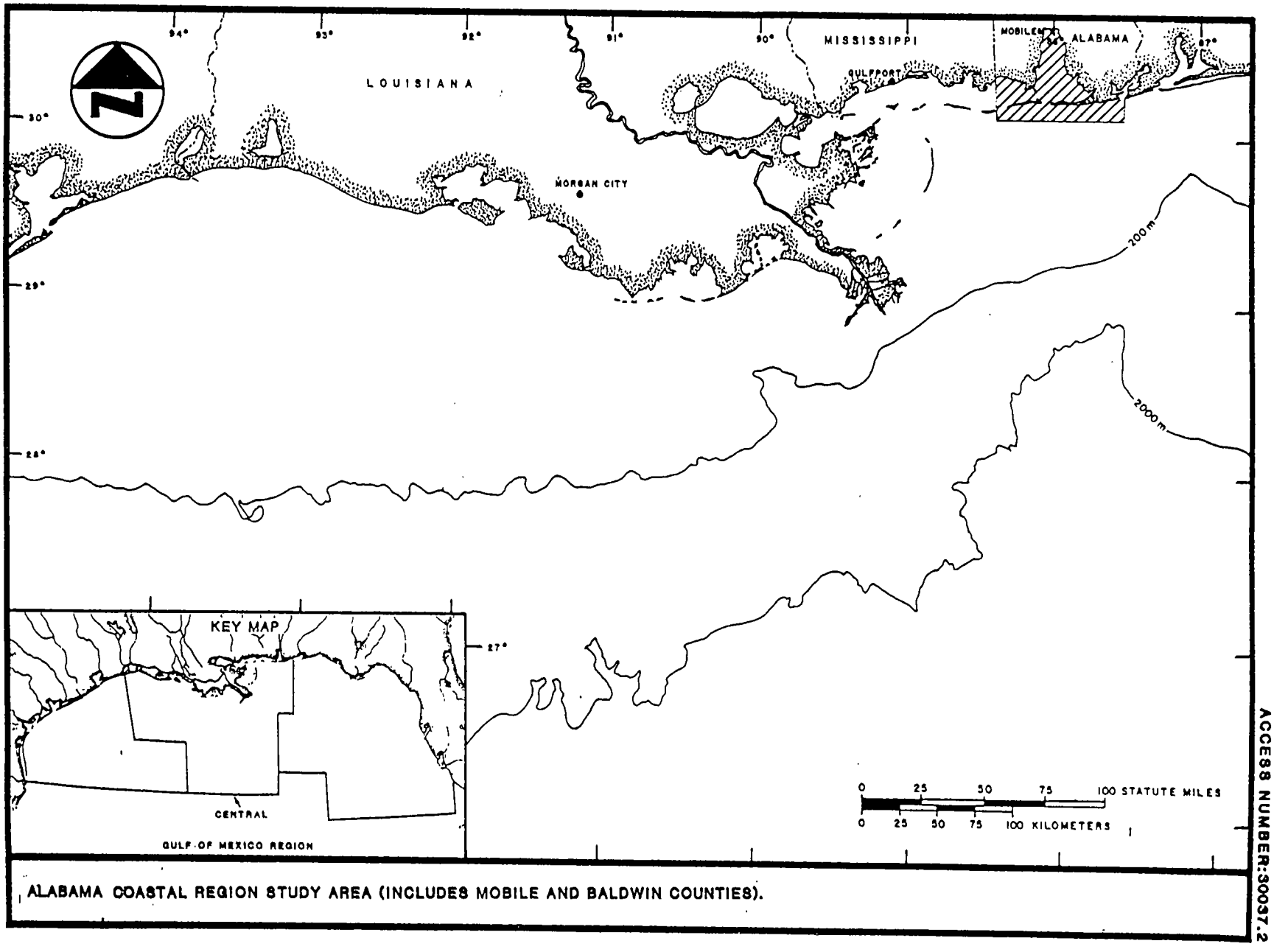
CUMULATIVE PROJECT COST: $1,185,000.

KEY WORDS: Eastern Gulf; Central Gulf; Alabama; baseline; socioeconomics; population; demographics; development; minerals; tourism; recreation; commercial fishing; recreational fishing; agriculture; transportation; pollution; characterization; literature review; synthesis.



ALABAMA COASTAL REGION STUDY AREA (INCLUDES MOBILE AND BALDWIN COUNTIES).

ACCESS NUMBER:30037.2



ALABAMA COASTAL REGION STUDY AREA (INCLUDES MOBILE AND BALDWIN COUNTIES).

ACCESS NUMBER:30037.2

REPORT TITLE: Florida Coastal Ecological Characterization: A Socioeconomic Study of the Northwestern Region.

MMS PUBLICATION NUMBER: MMS 88-0063.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: The Florida Coastal Ecological Characterization: A Socioeconomic Study of the Northwestern Region is one of a series of characterizations of coastal socioeconomic systems produced and funded jointly by the Minerals Management Service and U.S. Fish and Wildlife Service. The series describes the components and interrelationships among complex processes that include population and demographic characteristics, mineral production, multiple-use conflicts, recreation and tourism, agriculture production, sport and commercial fishing, transportation, industrial and residential development, and environmental issues and regulations. This report and data appendix should prove useful for coastal planning and management.

OBJECTIVES: (1) To compile and synthesize information from existing sources about social and economic characterizations of the northwestern coastal region of Florida.

DESCRIPTION: The study is a compilation and synthesis of information from existing sources about the social and economic characteristics of the northwestern coastal region of Florida, including Escambia, Santa Rosa, Okaloosa, Walton, Bay, Gulf, and Franklin Counties. Individual authors have contributed sections in Volume I on the following topics: (1) population and demographic characteristics; (2) transportation; (3) residential and industrial development; (4) socioeconomic trends in agriculture; (5) mineral and oil resources; (6) recreation and tourism; (7) commercial and sport fisheries; (8) multiple-use conflicts; (9) environmental issues and regulations; and (10) energetics models of socioeconomic systems. Volumes II and III comprise data appendices with tables and figures from existing sources on the topics listed above.

SIGNIFICANT CONCLUSIONS: Offshore oil and gas development, deepwater ports, processing and shipping of petroleum products, and other Outer Continental Shelf (OCS)-related activities potentially have major environmental, economic, and social impacts on northwestern Florida's coastal wetlands, natural resources, and communities. A major environmental threat is the potential for spills during drilling or transportation activities. A major oil spill could be devastating because of the vulnerable coastal environment and the region's heavy reliance on tourism. Intensive OCS exploration and development generates considerable onshore activity which is accompanied by environmental, economic, and social impacts that can be either beneficial or detrimental.

STUDY RESULTS: Northwestern Florida is rather sparsely populated and is more rural than urban. Recent population increases are due to natural increases rather than to immigration. The study area is economically weak. In 1970, about 20% of families were at the poverty level and only 10% earned $15,000 or more. Median school years completed are lower than for the State. Unemployment is higher than the State average. Northwestern Florida lacks licensed professionals and adequate medical facilities for its area and population.

Transportation systems that were reviewed included seaports, airports, railroads, highways, bus systems, and pipelines. Three major (Pensacola, Panama City, and Port St. Joe) and two minor (Apalachicola and Carabelle) seaports exist in the study area. The region contains three commercial and nine small public airports. Four freight line railroads serve northwestern Florida. Within the study region, Interstate Highway 10 (I-10) is the major east-west highway facility. The seven counties in the region are served by Greyhound and Trailways intercity bus routes. Major regional pipelines are privately owned and serve primarily to transport natural gas.

Rapid development is taking place along some coastal areas of the region. Increase in housing units, primarily single family homes, in 1970-1980 doubled that of 1960-1970. The region is not heavily industrialized. The amount of land suitable for development near urbanized areas is limited because of extensive wetlands, large public holdings, and because of hurricane surge hazards or riverine flooding. Population growth and industrial development are partially restricted by availability and capacity of public utilities. Agriculture and forestry are among the major industries in the region. Northwestern Florida is a major producer of field corn, soybeans, wheat, peanuts, cotton, poultry, and forest products. Forestry accounts for the major share of land and income.

Regional mineral production has increased substantially during the past few years because of oil fields near Jay. Oil and gas produce greater revenue in the region than all other minerals combined, and they now account for about one-third of the value of all mineral production in the State. Significant amounts of oil and gas were not found offshore. There is expectation of a nearshore gas find in East Bay, but exploration may not begin for years. Nonfuel mineral production includes sand and gravel, ilmenite and rutile from coastal sands, and magnesia from sea water.

Tourism in northwestern Florida has increased sharply since the mid-1960s. Numbers of tourists in 1965-1979 increased nearly 300%. In 1980, public lands contributed more recreation areas (1.63 million acres) than the private sector (8,745 acres) and more beach frontage (423,750 ft compared to 4,030 ft). Data on freshwater sportfishing can be related by licenses issued. Intensity of saltwater sportfishing can only be estimated.

The regional offshore and estuarine waters support extensive sport and commercial fisheries. Catch and value figures for commercial landings are available. Commercial catch includes finfish (snappers and groupers, mackerels, spotted seatrout, striped mullet, and ladyfish) and shellfish (shrimp, blue crabs, oysters, and bay and calico scallops).

Coastal waters and estuaries of the region have been seriously altered by industrial, residential, and commercial developments, partly because of lack of consideration for the integrity of the natural environment. Development of institutional procedures for responding to failures of the market system to consider environmental planning is a difficult task. Trade-offs between economy and environment depend upon society's evaluation of need for maintaining viable coastal ecosystems as opposed to further residential, commercial, and industrial developments. Areas selected for discussion--Apalachicola River, St. George Island, Panama City Beaches, East Bay, and Escambia Bay--are areas of special concern having felt effects of various types of expanding onshore development. Actions have resulted because of the relatively high abundance of environmental data available about

these areas. Environmental research in all regional coastal waters must be expanded to demonstrate environmental values in multiple-use conflicts.

The quality of the ambient air in the region is considered to be good due to scarcity of heavy industry. The study area is an area of great hydrological activity, including dredging, diking, and draining. These alterations result in habitat stress, dune destruction, reduced flow of detrital food sources for aquatic life, decreased dissolved oxygen, increased coliform counts, reduced runoff through natural systems, and increased erosion. Groundwater is seriously depleted in certain areas of the region such as Ft. Walton Beach, but generally the region is rich in quantity and quality of groundwater.

The regional socioeconomic systems are modeled using energy as a common denominator for all flows and storages within the system. Energy circuit models are evaluated by measuring energy quantity flowing in a particular pathway or stored in the system. Because all activities, interactions, and even storages require or represent energy, it is possible and practical to quantify a particular pathway by its energy value.

STUDY PRODUCT(S): French, C. O. and J. W. Parsons (eds.). 1983. Florida Coastal Ecological Characterization: A Socioeconomic Study of the Northwestern Region. Vol. I, Text. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB84-174200. FWS/OBS-83/15. Contract No. 14-12-0001-30037. 306 pp.

French, C. O. and J. W. Parsons (eds.). 1983. Florida Coastal Ecological Characterization: A Socioeconomic Study of the Northwestern Region. Data Appendices. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. Vol. II (Data Appendix, Part 1, 309 pp.)-NTIS No. PB84-174218; Vol. III (Data Appendix, Part 2, 375 pp.)-NTIS No. PB84-174192. FWS/OBS-83/15. Contract No. 14-12-0001-30037.

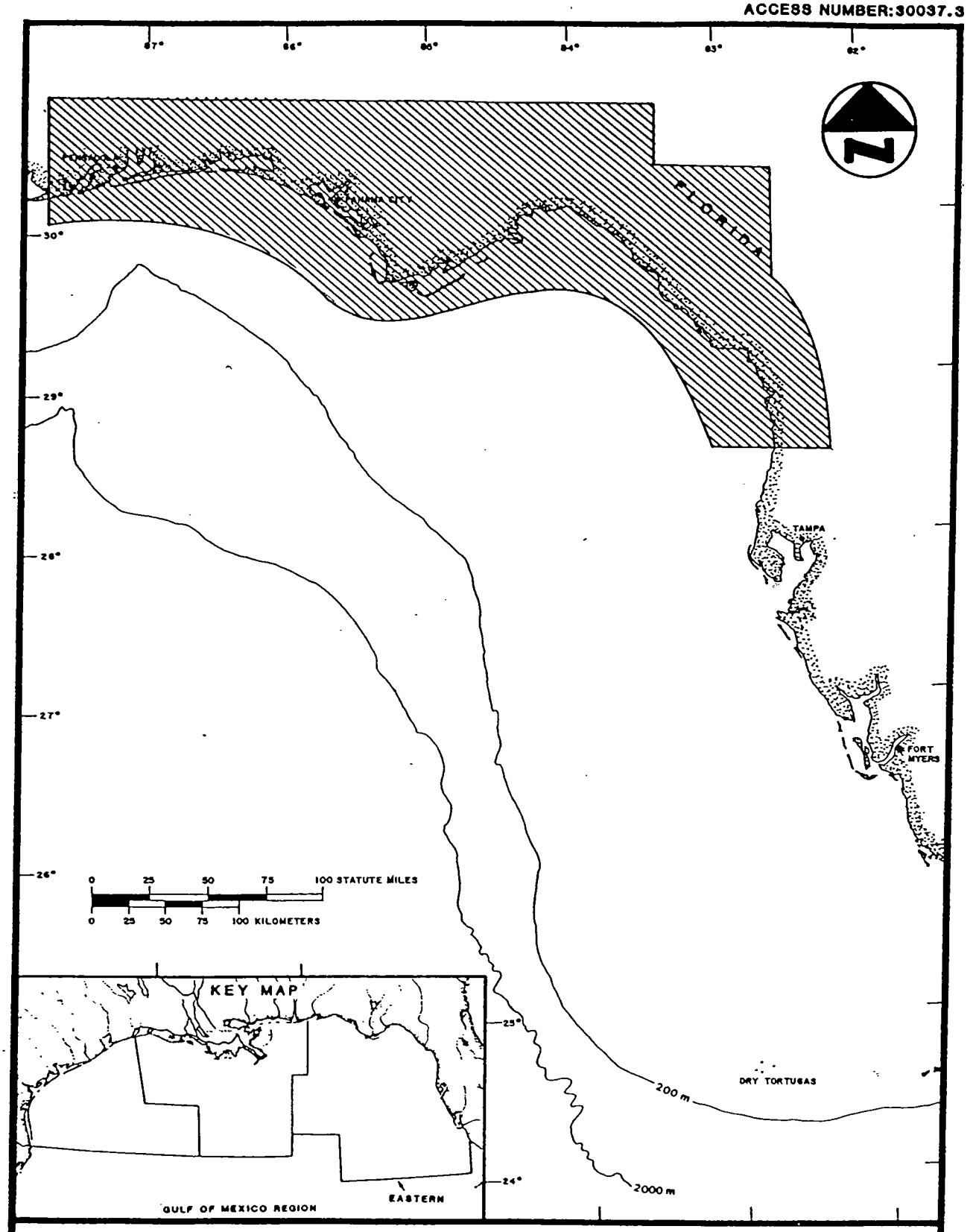
STUDY TITLE: Northeastern Gulf of Mexico Coastal Ecological Characterization.

COMPLETION DATE OF REPORT: August 1983.

CUMULATIVE PROJECT COST: $1,185,000.

KEY WORDS: Eastern Gulf; Florida; baseline; socioeconomics; characterization; coastal zone; synthesis; population; demographics; development; minerals; tourism; recreation; commercial fishing; recreational fishing; transportation; pollution; agriculture; modeling; literature review.

ACCESS NUMBER:30037.3



STUDY AREA FOR THE FLORIDA COASTAL ECOLOGICAL CHARACTERIZATION: A SOCIOECONOMIC STUDY OF THE NORTHWESTERN REGION.

REPORT TITLE: The Ecology of Irregularly Flooded Salt Marshes of the Northeastern Gulf of Mexico: A Community Profile.

MMS PUBLICATION NUMBER: Contract No. 14-12-0001-30037.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: Marsh areas dominated by *Juncus roemerianus* (black needlerush) occur along Atlantic and Gulf of Mexico coasts of North America between 25°N and 40°N Lat. *J. roemerianus*-dominated marshes comprise over 50% of the marshland present along the northeastern Gulf (western Florida, Alabama, and Mississippi). These marshes provide food and nutrient sources, faunal habitat, water purification systems, and shoreline stabilization. Wide distribution and close proximity to open water of *J. roemerianus*- dominated marshes makes them highly susceptible to man-induced impacts (e.g., oil spills). Large information gaps are present concerning many aspects of marsh habitats. To help understand and build awareness of marshland importance, information concerning the role and interrelationships of this habitat with natural and man-induced factors is vital.

OBJECTIVES: (1) To describe *J. roemerianus*-dominated marsh systems and the biological and ecological components within the systems; and (2) To evaluate the marsh systems and various impacts.

DESCRIPTION: The report concerns irregularly flooded *J. roemerianus* marshes along shores of the northeastern Gulf of Mexico from the Pearl River, Mississippi to Cedar Key, Florida. The marsh community profile provides "state-of-the- knowledge" synthesis of information and literature of this community. The profile includes information concerning structural and functional community aspects; its environmental setting, zonation, vascular and non-vascular plant communities, marsh fauna, ecology, and human impact.

SIGNIFICANT CONCLUSIONS: Presentation of existing data related to the marsh community emphasizes the paucity of information concerning various aspects of marsh ecology. Significant data gaps concern: overall biotic concepts (i.e., community dynamics), marsh hydrology, nutrient contributions, mitigation options, and impact studies. These large data gaps that exist are of special concern when considering *J. roemerianus*- dominated marshes. This is due in part to research emphasis being placed on marsh community structure and function dominated by species other than *J. roemerianus* (e.g., *Spartina alterniflora*).

Data confirm the relatively high primary productivity of marsh communities; however, productivity is probably underestimated because no data are available concerning the algal productivity component. Marshes are also ecologically important as a base for detrital food chains. Pollutants (e.g., oil spills) have the potential to alter community structure and affect aspects of ecological importance. Marshes must be protected because of their unique and critical role amongst coastal ecosystems. Mitigation options are limited, therefore, marsh preservation and restoration, where possible, is imperative.

STUDY RESULTS: *J. roemerianus*-dominated marsh distribution and development are dictated by a number of physical parameters (e.g., substrate conditions) that occur along

the northeastern Gulf of Mexico. These variable physical parameters account for relatively low species diversity among marsh plant communities. Few plant species are adapted to the high stress conditions that exist in marsh environments.

A general zonation pattern applies to the *J. roemerianus*-dominated marsh. A *S. alterniflora* zone borders open water within the intertidal area. Moving landward, *J. roemerianus* becomes dominant. The *Juncus* zone is the largest and comprises the bulk of marsh biomass. Inside the *Juncus* zone, salt flats prevail where hypersalinity causes colonization of sparse halophytic plants. The most landward zone, called the high meadow, is not normally susceptible to strong tidal fluxes and, therefore, has a plant community of relatively high species diversity.

Marsh substrates provide for epiphytic microfloral communities. Blue-green benthic algae have low species diversity. Blue-green algal distributions are determined by light intensity, therefore, habitat alteration that affects marsh canopy may impact community structure by altering algal composition. Little information is available concerning marsh non-vascular plants.

Eighty-eight species of macroinvertebrates (excluding insects and oligochaetes) are reported from northeastern Gulf of Mexico marshes. Macroinvertebrates show marked seasonal fluctuations due to plankton recruitment. Larval decapods dominate meroplankton and, as adults, are critical to detrital energy flow.

Fish populations are highly diverse and abundant due to availability of numerous habitats. Temporal population changes are related to breeding patterns of fish that utilize the marsh as nurseries. Marsh fish have little commercial importance, however, by functioning in energy transfer to other habitats, they indirectly affect commercial species.

Marsh avifauna are diverse (125 resident species). Large seasonal population changes are due to influxes of migratory species. Birds occupy high trophic levels within the marsh ecosystem and are very important in nutrient cycling.

Marshes are highly productive and have high nutrient turnover rates. Ecological linkages between marshes and adjacent habitats are obvious, however, data are unavailable to indicate mechanisms and pathways.

Man-induced impacts on marsh habitats include: alteration, destruction, petroleum pollution, effluents, and mitigation. Oil pollution impacts can be acute and of long duration. Mitigation options consist of replanting and fertilization of existing marshes, and establishment of new marshes by planting on dredge material disposal sites.

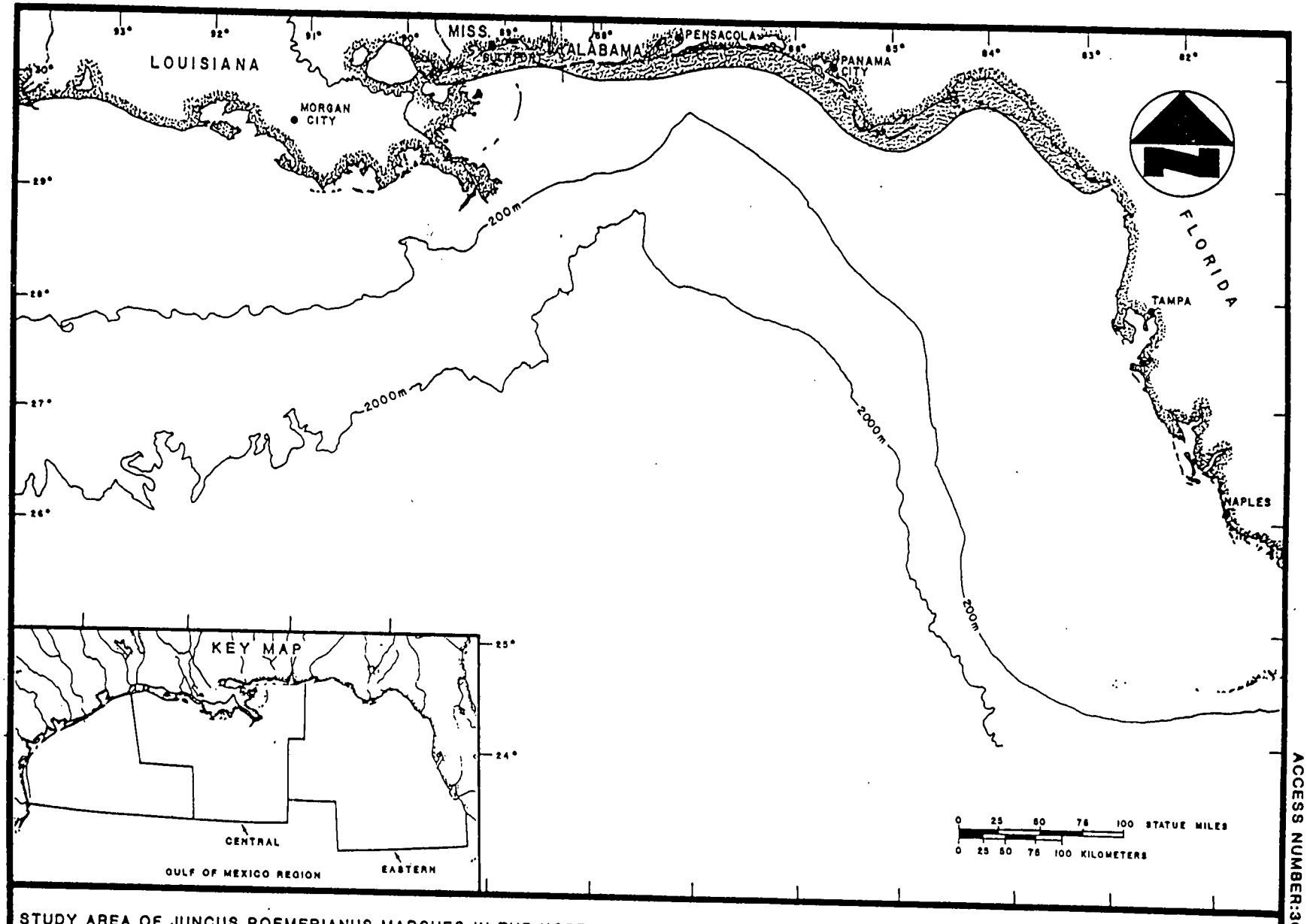
STUDY PRODUCT(S): Stout, J. P. 1984. The Ecology of Irregularly Flooded Salt Marshes of the Northeastern Gulf of Mexico: A Community Profile. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. FWS Report 85(7.1). Contract No. 14-12-0001-30037. 98 pp.

STUDY TITLE: Northeastern Gulf of Mexico Coastal Ecological Characterization.

COMPLETION DATE OF REPORT: December 1984.

CUMULATIVE PROJECT COST: $1,185,000.

KEY WORDS: Eastern Gulf; Central Gulf; baseline; biology; characterization; community; salt marsh; needlerush; *Juncus*; Mississippi; Florida; Alabama; floral zones; macrofauna; fish; birds; impacts.



STUDY AREA OF JUNCUS ROEMERIANUS MARSHES IN THE NORTHEASTERN GULF OF MEXICO.

ACCESS NUMBER:30037.4

REPORT TITLE: Northwestern Florida Ecological Characterization: An Ecological Atlas.

MMS PUBLICATION NUMBER: MMS 85-0011.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: The Northwestern Florida Ecological Characterization study is one of a series of characterizations of coastal ecosystems being produced by the U.S. Fish and Wildlife Service (USFWS). Funding was provided by the USFWS and the Minerals Management Service. Federal and State decisionmakers, among others, may use these maps and narratives for coastal planning and management, and in planning for Outer Continental Shelf oil and gas development.

OBJECTIVES: (1) To compile existing information about the biological, social, and physical sciences for the Gulf of Mexico coastal counties of Florida from Escambia County to Hernando County.

DESCRIPTION: The study area is the northeastern Gulf of Mexico coastal region of Florida from the western boundary of Escambia County and southeast to the Hernando-Pasco County line. The offshore area includes the region from the State-Federal demarcation to the shoreline. The inland area includes Escambia, Santa Rosa, Okaloosa, Walton, Washington, Bay, Calhoon, Gulf, Franklin, Wakulla, Jefferson, Taylor, Dixie, Levy, Citrus, and Hernando Counties. The products of the atlas include 18 U.S. Geological Survey maps with the topic information in overlays, producing 90 maps and a map narrative. The information in the atlas is previously existing data on biological resources; socioeconomic features; soils and landforms; and oil, gas, and mineral resources.

SIGNIFICANT CONCLUSIONS: The northwestern Florida study area is located in the Outer Continental Shelf Plain Forest Ecological Province, characterized by gentle slopes and numerous sluggish rivers and creeks. Swamps, marshes, and lakes are abundant and support a wide variety of animal life.

STUDY RESULTS: Five habitat types are depicted on the biological resources maps and described in the narrative: estuarine tidal marshes, estuarine scrub/shrub (mangrove forest), palustrine freshwater marshes, palustrine forests, and seagrass beds. Tidal marshes are dominated by black needlerush and smooth cordgrass. Mangrove forests are composed of red, black, and white mangroves. Palustrine freshwater marshes include all nontidal wetlands dominated by persistent emergents and all such wetlands that occur in tidal areas where salinity is below 0.5 ppt. Dominant vegetation includes sawgrass, cattail, bulltongue, spikerush, or maidencane. Palustrine forests include all nontidal and low salinity (less than 0.5 ppt) wetlands dominated by trees such as cypress, bay, elm, willow, ash, oak, tupelo, and maple. Seagrass beds are dominated by six seagrass species; turtle grass, manatee grass, shoal grass, widgeon grass, and two *Halophila* species.

Other habitats and plant assemblages indicated on the maps and described in the narrative include existing artificial reefs; oyster beds; finfish spawning nursery, and harvest areas; sensitive plant species; colonial bird nesting sites; and threatened and endangered animals. Shellfish harvest areas include oyster beds, scallop beds, clams, shrimp, and blue crab.

Finfish spawning, nursery, and harvest areas include estuarine dependent, reef, and coastal pelagic fishes and commercial fisheries. Sensitive plant species include those listed (or under review) as threatened or endangered by the USFWS and the Florida Committee on Rare and Endangered Plants and Animals. Colonial bird nesting sites include nesting sites for seabirds, shorebirds, wading birds, and migratory waterfowl. Threatened and endangered animals include those listed (or under review) by the USFWS and Florida Game and Freshwater Fish Commission.

Within the northwestern Florida region, Citrus and Hernando Counties are rapidly growing retirement areas while the remaining counties are predominantly rural. The described and mapped socioeconomic features include National lands (Natural wilderness areas, National wildlife refuges, National marine and estuarine sanctuaries, military lands, and National seashores); State lands (State parks, recreation areas, wilderness areas, wildlife management areas, aquatic preserves, and conservation lands), recreation lands, intensively utilized recreational beach access points, marinas, charter and head boat locations, public boat ramps, Florida canoe trail systems, major public fishing piers, artificial reefs, shipwrecks, major offshore structures, land use, landfills, dredge spoil disposal sites, industrial and municipal point source discharges, national natural landmarks, historic places designated on the national register, archeological and historic sites, and Nature Conservancy lands.

Study area soils are described and mapped according to the U.S. Soil and Conservation Service classification reflecting patterns of soil associations. Associations include one or more major soil and at least one minor soil. Study area soils are derived from recent beach deposits, river alluvium, marine terrace deposits, or directly from a particular geologic formation.

The study area has been divided into two major physiographic zones; central or mid-peninsular zone, and northern or proximal zone. The former is characterized by discontinuous highlands as sub-parallel ridges separated by broad valleys; the latter, a broad upland extending westward into panhandle region highlands. The northern zone is divided into two major physiographic regions--Gulf Coastal Lowlands and Northern Highlands--and several physiographic provinces--Western Highlands, Escambia Valley, Gulf Coastal Lowlands, Gulf Barrier Chain, Marianna Lowlands, New Hope Ridge, Greenhead Slope, Fountain Slope, Grand Ridge, and Northern Highlands. Current data on beach erosion, existing active dunes, and faults are described and depicted in the study products with soils and landforms.

Florida is the sixth largest non-fuel producing state in the nation. In dollars, phosphate is the leading mineral source, followed by petroleum, cement, and stone. In the study area, oil and gas, sand and gravel, clay, limestone, dolomite, peat, and shell deposits are leading mineral resources. Quantity and location of surface mineral resources, oil and gas pipelines, and drilling sites are described and depicted in the study products.

The study area climate is warm subtropical and includes a summer and winter rainy season. The rainy seasons cause fluctuations in the area surface water hydrology and to some extent groundwater. The Floridan Aquifer is the important groundwater feature in the study area. The study products provide potentiometric contour maps of the aquifer. Surface

wind patterns for the three primary wind seasons--fall/summer, spring, and summer--and annual wind roses are provided in the products. There exists a lack of reliable current data in the study area. Available current data are plotted as current roses on the atlas maps. Florida is the most vulnerable State in the U.S. to hurricanes during the season from June through November. Atlas maps depict maximum area subject to flooding for Saffir/Simpson category 1-5 hurricanes. The hydrologic unit water budget, the storage capacity of each hydrologic unit, is calculated using available data. Data are provided and depicted on the maps from U.S. Geological Survey stream gauging station including water stage, specific conductivity, and chloride levels. Estimated water use by primary users--agriculture, municipal water supply systems, and industry--is estimated by county.

STUDY PRODUCT(S): Palik, T. F. and J. T. Kunneke. 1984. Northwestern Florida Ecological Characterization: An Ecological Atlas. Map Narratives. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. FWS/0BS-82/47.1. Contract No. 14-12-0001-30037. 302 pp.

Palik, T. F. and J. T. Kunneke. 1984. Northwestern Florida Ecological Characterization: An Ecological Atlas. A map series by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. FWS/0BS-82/47.1. Contract No. 14-12-0001-30037. 90 maps (1:100,000): A1 through E18.

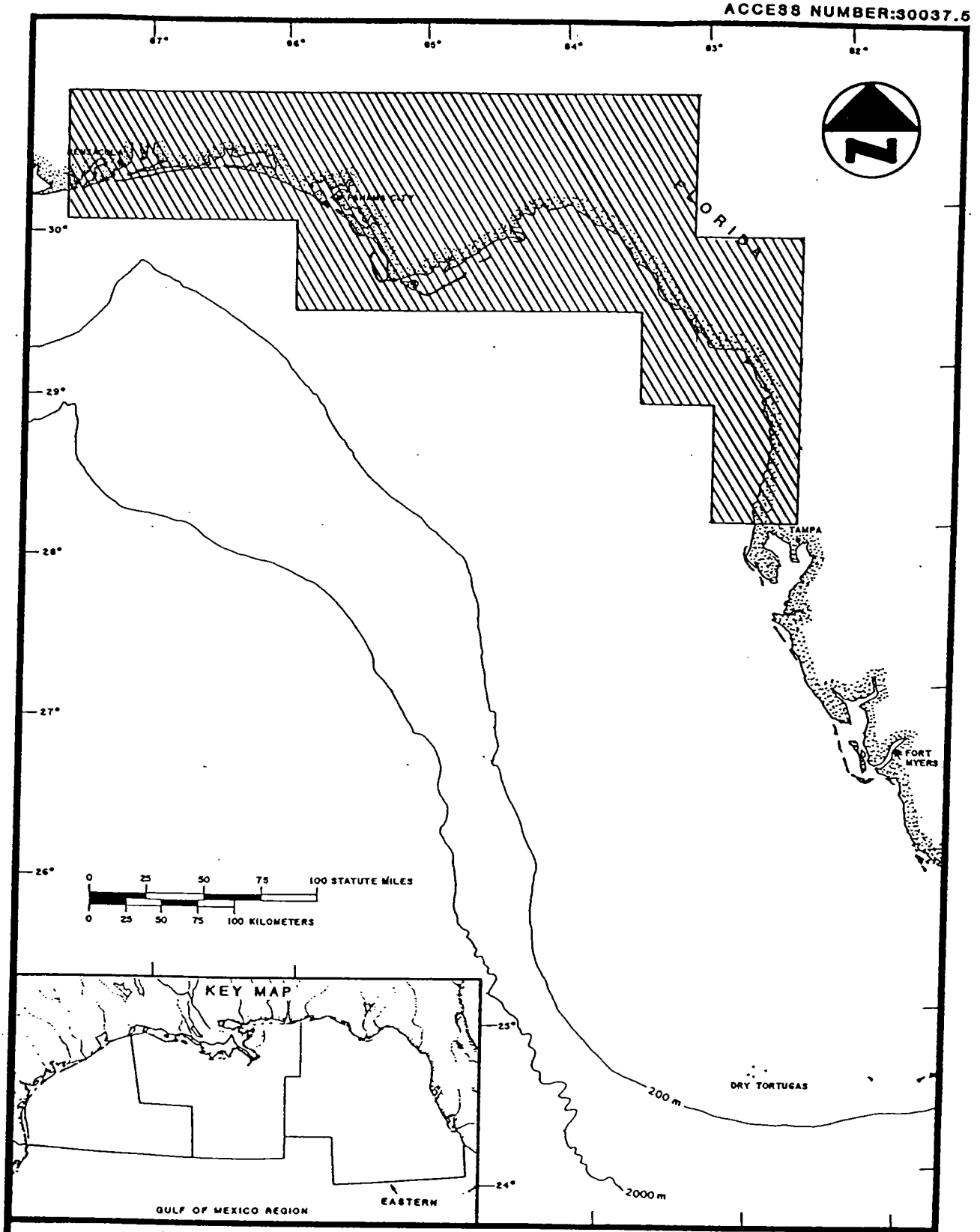
STUDY TITLE: Northeastern Gulf of Mexico Coastal Ecological Characterization.

COMPLETION DATE OF REPORT: September 1984.

CUMULATIVE PROJECT COST: $1,185,000.

KEY WORDS: Eastern Gulf; Florida; baseline; biology; characterization; terrestrial; habitat; estuarine; freshwater; marine; seagrasses; mangroves; birds; endangered species; commercial fishing; socioeconomics; recreation; recreational fishing; soil; minerals; hydrology; maps; narratives; literature review; synthesis.

ACCESS NUMBER:30037.5



STUDY AREA FOR THE NORTHEASTERN GULF OF MEXICO COASTAL ECOLOGICAL CHARACTERIZATION.

REPORT TITLE: Ecological Characterization Atlas of Coastal Alabama: Map Narrative.

MMS PUBLICATION NUMBER: MMS 84-0052.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: The Ecological Characterization Atlas of Coastal Alabama is one of a series of characterizations of coastal ecosystems cosponsored by the Minerals Management Service and produced by the U.S. Fish and Wildlife Service to provide coastal planning and management personnel with information relative to coastal ecology.

OBJECTIVES: (1) To provide a compilation of existing information concerning the biological, physical, and coastal conditions in Mobile and Baldwin Counties, Alabama.

DESCRIPTION: The study area includes the region from the State-Federal demarcation line to the shoreline, and the inland area of Mobile and Baldwin Counties. The atlas consists of composite overlay information provided on six 1:100,000-scale base maps with five main subject maps, totaling thirty maps. A narrative accompanying the maps discusses the mapped topics. Atlas topics include biological resources; socioeconomic features; soils and landforms; oil, gas, and mineral resources; and hydrology and climatology.

SIGNIFICANT CONCLUSIONS: Total wetland acreage in the study area is 692,000 acres, or 38% of the area, and is dominated by palustrine forest and scrub/shrub. Topics discussed and mapped in the biological resources section include bird nesting sites, submerged aquatic vegetation, shellfish harvesting areas, and recreational and commercial finfish. Topics discussed and mapped in the socioeconomic section include man-made and natural areas having ecological or economic significance. Topics discussed and mapped in the soils and landforms section include regional surface landforms, soils, beach erosion and accretion, faults, high-energy beaches, and active dunes. Past and existing oil, gas, and minerals mining activities are discussed and mapped in that section. Information on availability and use of water is provided in the climatology and hydrology section.

STUDY RESULTS: Wetland habitats are essential nesting, breeding, rearing, nursery, and feeding grounds for many species of fish, birds, and other wildlife in coastal Alabama. Three wetland categories are mapped and described in the atlas; estuarine intertidal emergent wetlands, palustrine emergent wetlands, and combined palustrine forested and scrub-shrub wetlands. In the study area, total wetland acreage was calculated to be 692,000 acres, or about 38% of the two counties. Palustrine forest and scrub-shrub is dominant, occupying 621,000 acres or 34% of the area. Nesting sites for seabirds and wading birds, shorebirds, and migratory waterfowl are located on the atlas maps. The most important wading bird nesting site is Cat Island. The Point Aux Chenes-Grand Bay Swamp and Lower Mobile Bay are important wintering locations for migratory waterfowl. Submerged aquatic vegetation occurs within the study area and is indicated on the atlas maps. Tape grass is a freshwater species. Widgeongrass, shoalgrass, and turtlegrass are estuarine species. Shellfish harvest areas indicated on the atlas maps include shrimping areas, blue crab harvesting areas, and oyster reefs. Recreational and commercial finfish include Florida pompano, mackerels, Gulf menhaden, southern flounder, croaker, groupers,

snappers, mullets, red drum, sardines, and sea trout. Study area endangered and threatened species are not mapped but listed in the atlas narrative.

Socioeconomic elements mapped and discussed include man-made features and natural areas having either ecological or economic significance, such as wildlife refuges, State park recreational areas, barrier islands, and historical or archeological sites. Man-made features include solid waste landfills, navigation channels, and dredge-spoil disposal areas. Four land use categories are mapped; forested, urban, agricultural, and uncategorized (mostly wetlands). Other mapped and discussed socioeconomic features include intensively used recreational beaches; charter and head boat services; permitted artificial fishing; public piers; public access areas and marinas; barrier islands and spits; point source discharges; solid waste landfills and onshore disposal sites; man-made land; historic places; archeological sites; navigation channels; dredge spoil disposal areas; and offshore obstructions and structures.

The soil and landforms atlas topic deals with regional surface landforms, soils, beach erosion and accretion areas, faults, high-energy beaches, and active dunes. The basic soil unit in the atlas is soil associations, a group of soil series found in the same geographic area. The study area is located in the lower Coastal Plain of the Gulf Coastal Plain physiographic province. Offshore, coastal waters belong to the Mississippi-Alabama Shelf Section of the Continental Shelf physiographic province. The lower Coastal Plain is subdivided into the Southern Pine Hills and Coastal Lowlands. The lowlands include both alluvial and deltaic plains. Coastal areas experiencing critical and non-critical erosion are mapped and described in the atlas. Faults shown on the atlas maps are marked as to their upthrown and downthrown sides. Several faults exist in the area, but probability of damage from an earthquake is unlikely. Active dunes are sand landforms influenced by wave action and/or aeolian (wind) processes that are in a constant state of change. Active dunes areas are delineated on the maps.

The oil, gas, and mineral section provides information on these activities in coastal Alabama including pipeline routes, refineries, and drilling sites. Significant mineral deposits (e.g., clay and gravel) are located and discussed.

The climatology and hydrology section relates information on water availability and use in the study area. Climate is primarily humid subtropical, due to the warming influence of the Gulf of Mexico. Normal annual rainfall for the study area is the State's highest and among the highest in the U.S., averaging 162.5 cm (64 in). Prevailing surface winds are southerly for March through July, easterly for August and September, and northerly for remaining months. Annual wind roses are given on the maps. Coastal Alabama is susceptible to hurricanes; information on the probability of hurricanes striking the area and past hurricane damage is discussed in the atlas. Hydrologic units are geographic areas representing part or all of a surface drainage basin or distinct hydrologic feature delineated by the U.S. Geological Survey (USGS). Stream flow of each unit is measured at USGS gauging stations (indicated on maps). Summaries of flows are in the atlas. Surface water quality is measured at these stations and data are summarized in the atlas. Quantities of high quality groundwater are available in the study area. Groundwater quantity and quality are summarized from USGS wells (indicated on maps) in the atlas. Currents and circulation patterns along the Alabama coast are influenced by tides, freshwater discharges, shoreline

configurations, winds, longshore currents, and the Coriolis effect. Currents within Mobile Bay and Mississippi Sound and coastal areas are summarized in the atlas.

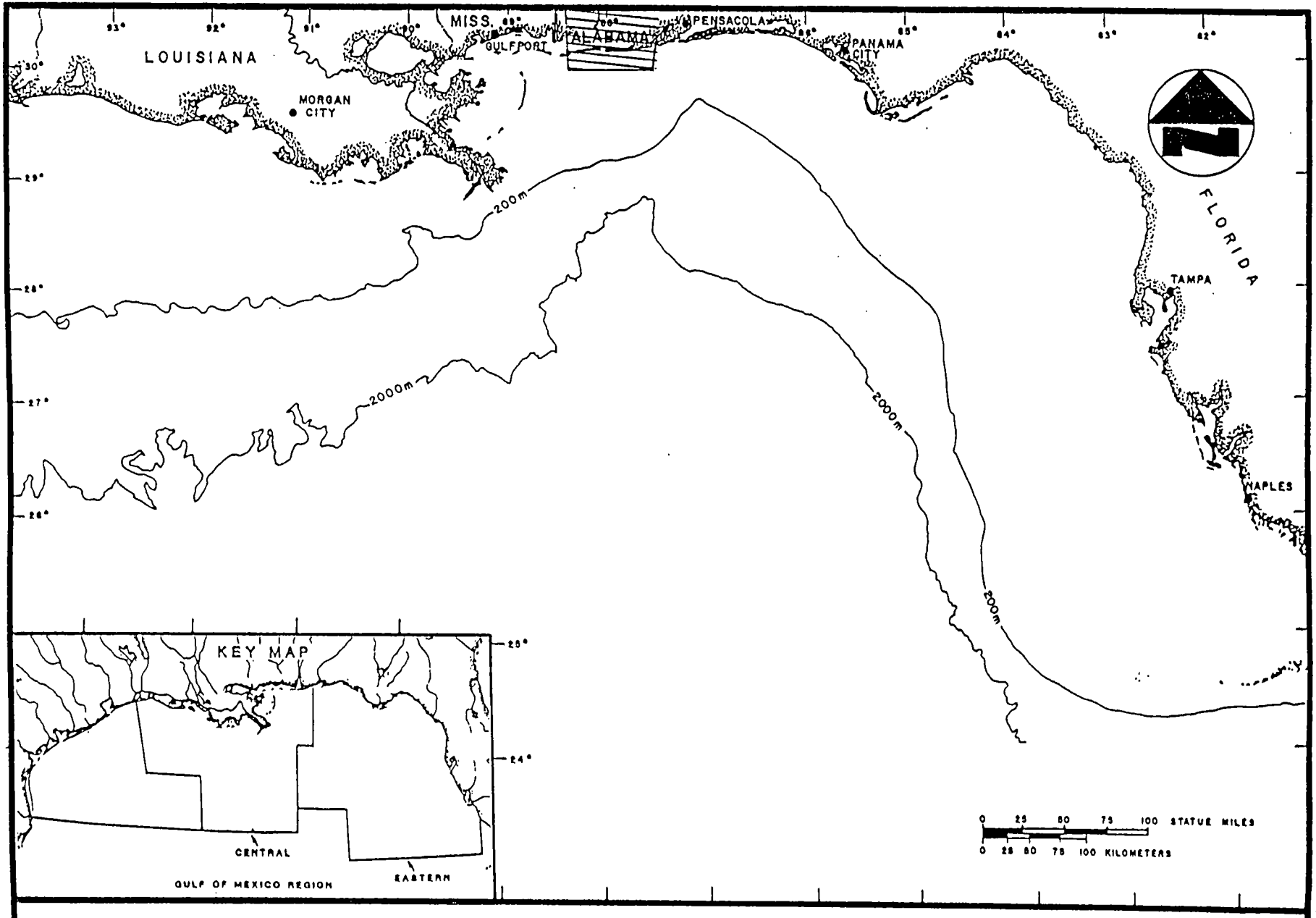
STUDY PRODUCT(S): Smith, M. F., Jr. (ed.). 1984. Ecological Characterization Atlas of Coastal Alabama: Map Narrative. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB85-247492. FWS/OBS-82/46. MMS Report 84-0052. Contract No. 14-12-0001-30037. 189 pp. + 30 maps (1:100,000).

STUDY TITLE: Northeastern Gulf of Mexico Coastal Ecological Characterization.

COMPLETION DATE OF REPORT: August 1984.

CUMULATIVE PROJECT COST: $1,185,000.

KEY WORDS: Eastern Gulf; Central Gulf; Alabama; baseline; biology; characterization; terrestrial; habitat; socioeconomics; recreation; tourism; commercial fishing; recreational fishing; soil; minerals; birds; hydrology; wetlands; endangered species; maps; narratives; literature review; synthesis.



STUDY AREA FOR THE ECOLOGICAL CHARACTERIZATION ATLAS OF COASTAL ALABAMA (INCLUDES MOBILE AND BALDWIN COUNTIES).

ACCESS NUMBER: 80037.6

LIVING MARINE RESOURCES

The OCS oil and gas operations have the potential to affect certain endangered and marine mammal species and their habitats in the coastal zone and offshore areas. Oil spills and construction activities are the two principal impacting agents; however, other impacts are also possible (for example, noise and other disturbances, aircraft and vessel traffic, etc.). The objectives of the endangered species studies are (1) to obtain an adequate database describing the locations, activities, and statuses of individual endangered species and (2) to determine the potential effects of OCS oil and gas operations on endangered and vulnerable marine mammals, birds, and turtles in the Gulf of Mexico. The logical procedure to determine potential effects is two-tiered: first, study the distribution, migratory patterns, habitats, and critical time periods for these species to determine if/when conflicts or impacts occur; then, study specific species and impact agents to establish mitigation measures.

REPORT TITLE: A Review of the Ecology, Behavior, and Life History of the Bottlenose Dolphin.

MMS PUBLICATION NUMBER: Contract No. 14-12-0001-29118.

APPLICABLE PLANNING AREA(S): South Atlantic; Straits of Florida; Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: The bottlenose dolphin, *Tursiops truncatus*, is perhaps the marine mammal species most likely to be affected by oil and gas exploration and production in the Gulf of Mexico. Despite the fact that this species is relatively well known among the Cetacea, serious gaps remain in our understanding of the animal and our ability to predict the effects of oil and gas development.

OBJECTIVES: (1) To assess our current level of knowledge concerning *Tursiops truncatus* in order to guide future avenues of research.

DESCRIPTION: Existing literature was reviewed to discuss the behavior, social organization, movement patterns, and ecology of bottlenose dolphin. Based on the available data, discussions were presented concerning the potential impacts from oil and gas development. The applicability and usefulness of research techniques was also determined from the available data.

SIGNIFICANT CONCLUSIONS: In spite of the availability of a large volume of information on the ecology, behavior, and physiology of the bottlenose dolphin, it is not yet possible to predict the potential impacts of offshore oil and gas development. It is suggested from the data that oil exploration and drilling could have effects ranging from positive to neutral to adverse. This uncertainty is largely due to a lack of baseline data on populations likely to be affected by the oil and gas operations.

STUDY RESULTS: There is a need to determine the discreetness of bottlenose dolphin stocks through consideration of behavior, morphology, and biochemical genetic factors. This need is due to the fact that impacts from oil and gas development would be much different on a small, local, discrete population than it would be on a large population over a wide area.

Bottlenose dolphins appear to have quite complex patterns of social organization. Relatively permanent social units that are closely tied to definable home ranges seem to be formed in at least some portions of the species' range. Within populations, social associations and individual movements are based on the age and sex of the individuals. Displacement of dolphins from particular portions of their ranges could affect social structure and population recruitment. Learning within the context of the social unit is also critical.

Group size for dolphins varies according to the physiography of an area and the activity of the group. Group size can change frequently during the course of the day as well as seasonally. Group size increases with water depth or openness of the habitat and is possibly related to foraging techniques and protection from predation.

Potential impacts that should be avoided include disturbance of feeding, reproduction, and other types of behavior; displacement from critical habitat; disruption of food resources; and physical damage such as auditory injury and effects from direct contact with oil.

Some generalizations exist concerning the behavior of bottlenose dolphin. Dolphins appear to be active both day and night. Feeding peaks have been noted in early morning and late afternoon. Time devoted to feeding increases in fall and winter. Feeding strategies are flexible and adapted to habitat and food available. Social behavior is a major component of the daily regime.

Short-term and long-term movements appear to be related to food availability, protection from predators, reproduction, and thermoregulation. The overriding theme in these movements is variability. At least some coastal bottlenose dolphins maintain home ranges which can include individual and herd as well as permanent and seasonal ranges. The social mechanisms which exist between dolphin populations to maintain home range boundaries are not known. Animals could be severely affected if they are forced from an area which is familiar to them and which supplies their needs.

Due to the confused state of *Tursiops* taxonomy, it is difficult to determine normal reproduction and growth patterns. This information is of utmost importance in assessing the potential impacts of oil and gas development on dolphin populations. Reproduction occurs in spring to early summer in the Gulf of Mexico with a secondary peak in October to November in southern Florida. The number of years of reproductive activity is unknown. Males mature at about 10 years and females at 5 years. Gestation is 11 to 12 months with a single calf born every 2 to 3 years. Both sexes live about 25 years.

If dolphins use particular regions within their ranges for protection from predators, then loss of these areas could be detrimental. In areas where large group size is critical for protection from predation, activities which disrupt group behavior could also decrease survival rates. Additionally, activities which introduce disabilities through water pollution or acoustic activities could also increase susceptibility to predation.

Human-dolphin interactions result from boats, capture, fisheries activities, direct contact, and from habitat alteration.

Existing data suggest that short-term exposure to oil may have minimal effects. Chronic oil ingestion and chronic exposure to noise may pose potentially greater threats. Field observations contradict laboratory findings that dolphins will avoid oil spills.

Dolphins may prove to be a good indicator species for assessing potential impacts on other marine mammals less amenable to study. However, due to the bottlenose dolphin's adaptability and flexibility, they may be less affected by potential disturbance than other more specialized cetaceans. In order to assess impacts from oil and gas development, research projects should be designed to study behavior in areas of established petroleum activities, planned activities, and unaffected areas. Comparisons should be made in each area of respiration rates, times at and below the surface, and time spent in basic behaviors such as traveling, feeding, resting, and socializing. Also needed are observations on shifts in group size, group composition movement patterns, and home range use. The most

profitable study technique will involve long-term monitoring of behavior and social patterns using photographic recognition, capture, tagging, and radio tracking.

STUDY PRODUCT(S): Shane, S. H., R. S. Wells, B. Würsig, and D. K. Odell. 1982. A Review of the Ecology, Behavior, and Life History of the Bottlenose Dolphin. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB84-117613. MMS-GM-PT-83-011. Contract No. 14-12-0001-29118. 72 pp.

STUDY TITLE: Distribution and Abundance of Endangered and Vulnerable Mammals, Birds, and Turtles.

COMPLETION DATE OF REPORT: November 1982.

CUMULATIVE PROJECT COST: $100,000.

KEY WORDS: South Atlantic; Straits of Florida; Eastern Gulf; Central Gulf; Western Gulf; endangered species; bottlenose dolphin; *Tursiops*; literature review; behavior; life history; range; population; oil spill; industrial sound; impacts.

Map #29118 Unavailable.

REPORT TITLE: Proceedings of a Workshop on Cetaceans and Sea Turtles in the Gulf of Mexico: Study Planning for Effects of Outer Continental Shelf Development.

MMS PUBLICATION NUMBER: Contract No. 14-12-0001-29118.

APPLICABLE PLANNING AREA(S): South Atlantic; Straits of Florida; Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: Several Federal agencies, including the Bureau of Land Management (now the Minerals Management Service) and the U.S. Fish and Wildlife service, have, historically, expressed concern that adequate information be available to address the effects of offshore oil and gas development on endangered and protected vertebrates. As a means of establishing the current state of knowledge regarding individual species and their susceptibility to development-related impacts, and to solicit research recommend-ations, a workshop was conducted involving scientists knowledgeable about cetaceans, sea turtles, and various physical and biological aspects of the Gulf of Mexico region.

OBJECTIVES: (1) To identify ways in which cetaceans and sea turtles have been or could be affected, either directly or indirectly, by activities and events associated with offshore oil and gas development; (2) to identify the types and specificity of data needed to predict, detect, and mitigate possible adverse effects; (3) to identify and discuss the advantages and disadvantages of various methods that might be used to obtain needed data; and (4) to identify specific research and monitoring programs that would be required to obtain needed data, including the necessary expertise, level of effort, equipment, and facilities.

DESCRIPTION: A workshop was conducted during 6-8 April 1982 at the University of Southern Mississippi. A total of 49 representatives from government, academia, and private industry participated in the workshop. Working groups were convened on cetaceans and sea turtles. Discussion sessions were summarized by the chairperson and reviewed by participants.

SIGNIFICANT CONCLUSIONS: Information on the occurrence, distribution, behavior, and ecology of cetacean and marine turtles in the Gulf of Mexico is generally lacking. These species can be affected by oil and gas development in various ways, including mortality from contact with or ingestion of oil, disruption of behavioral patterns from noise associated with OCS activities, and fouling of nesting and feeding habitats, among others. Various opportunities currently exist to use existing facilities to conduct qualitative surveys of cetacean populations in the Gulf of Mexico. Additional information can be obtained from radio tagging and tracking studies to obtain data on the movements of these species. An important data gap exists relative to the early life history of sea turtles. To address these needs, a series of studies were recommended to: collect data on the effects of oil on the early life stages of turtles and their habitats; and compile biological information for turtle species found off Florida and in the northeast Gulf of Mexico.

STUDY RESULTS: The Gulf of Mexico is influenced by Mississippi River discharges in the north and by high salinity water from the Caribbean Sea in the southwest. Soft bottom communities predominate within the Gulf of Mexico, where as pelagic communities are little

known and have few commercially valuable species. While direct effects from oil and gas development are spatially limited, effects over time are less well known. A key problem lies in separating man-induced changes in marine and coastal systems from natural changes.

Sperm whales, beaked whales, and pilot whales have been spotted in waters deeper than 200 m off south Texas. Risso's dolphin have also been observed in the western Gulf of Mexico, while short-finned pilot whales were also noted in a narrow zone in waters ~350 m deep off the southern coast of Texas. Bottlenose dolphins (*Tursiops truncatus*) appear to be restricted in the Gulf of Mexico to shallow water, whereas striped and spotted dolphin (*Stenella* spp.) distribution was less obviously correlated with water depth. The *Stenella* species were observed most frequently in moderately shallow waters off southwest Florida.

The major concentrations of marine turtles in the Gulf of Mexico are located off Florida. The offshore regions of southwest Florida had large numbers of turtles and low levels of nesting in relation to eastern Florida. The role of these feeding habitats in the recovery or continued decline of marine turtles in the U.S. waters has not been determined. Oil and gas development may affect cetaceans and turtles in various ways. Seismic surveys employing explosive charges (rarely the case) can be lethal at close range. Surface contact with oil can threaten those species of cetaceans which rely on hair or fur for thermal insulation.

The long-term effects of accumulation of petroleum fractions through the food chain is unknown. The ability of marine mammals to detect and avoid oil slicks is critical to assessments of the potential impacts of oil. It was suggested that oil fouling creates significant harm for small sea turtles. Petroleum impacted turtles have been found from the Florida Keys to Cape Canaveral, an area associated with the Florida current. The widespread dispersal of young turtles and petroleum residues in the ocean suggests that an indeterminate number of turtles may die at sea.

Only a few scientific surveys assessing marine mammal distribution and abundance have been conducted within the Gulf of Mexico. Twenty-six species of whales and dolphins reportedly occur in the Gulf of Mexico based on historical records. The reported sightings of baleen whales may be questionable. Sperm whales do occur in the Gulf, predominantly outside the 200-1,000 m depth contours. The best understood cetacean species is the bottlenose dolphin (*T. truncatus*), however, little is known about this species' behavior and interactions. Systematic surveys are the only means of quantifying the presence of species and the extent of their occurrence over a wide geographical area. Such surveys must be made with adequate frequency to document daily, seasonal, and annual use of important habitats. Radio tagging/tracking of individual cetaceans should provide information which could be representative of populations as a whole. This technique and the monitoring of the tagged individuals over the lifespan of a development should be given a high priority. Qualitative information can be obtained over long periods of time from stranding records, platforms of opportunity, hydrophones, and satellites. The southeastern stranding network should be expanded. Because of the lack of information on many cetacean species, studies should focus on bottlenose dolphins (*T.truncatus*), one or more species of *Stenella*, sperm whales, and baleen whales. Future studies should be coordinated efforts designed to address Federal and State agency needs; these efforts should include sampling in areas previously or currently under development, in areas where development is anticipated, and in areas that may always remain pristine. The studies should be undertaken in order to

better understand cetacean distribution, abundance, behavior, and ecology. Physiological effects of oil and gas development activities on cetaceans occur from a variety of sources, including shock waves from the detonation of explosives; noise associated with all phases of exploration and production; and surface contact and ingestion of oil. Three approaches to gathering data on these effects include implementation of a stranding/necropsy program, sampling of live caught *T. truncatus*, and a contingency oil spill investigation plan.

Effects of oil and gas activity on marine turtles can range from direct contamination and mortality (associated with oil contact) to increased predation on neonates (due to attraction to light on platforms where birds and large fish congregate). Several studies were recommended to address these potential impacts, including a program to determine the impact of oil on neonatal and juvenile sea turtles and their habitats. A second priority identified was a study to evaluate the effects of crude oil on sea turtle eggs, embryos, hatchlings, and nesting females. It was also suggested that another program address the feeding biology, population structure, and seasonality of turtles off western Florida. In addition, it was recommended that a study be initiated to determine habitat use and effects of oil on sea turtles (especially Kemp's ridley turtle, *Lepidochelys* kempi; in Louisiana and east Texas waters. Further, it was recommended that a synthesis of the data generated in these studies (i.e., data regarding the interaction between OCS development and sea turtles) be completed.

STUDY PRODUCT(S): Keller, C. E. and J. K. Adams (eds.). 1983. Proceedings of a workshop on Cetaceans and sea Turtles in the Gulf of Mexico: Study Planning for Effects of Outer Continental Shelf Development. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB84-I13265. FWS/OBS-83/03. Contract No. 14-12-0001-29118. v + 42 pp.

STUDY TITLE: Distribution and Abundance of Endangered and Vulnerable Mammals, Birds, and Turtles.

COMPLETION DATE OF REPORT: February 1983.

CUMULATIVE PROJECT COST: $100,000.

KEY WORDS: South Atlantic; Straits of Florida; Eastern Gulf; Central Gulf; Western Gulf; endangered species; cetaceans; turtles; workshop; development; impacts; mitigation; Mississippi River; whales; dolphins; Florida; Texas; Florida Current; Kemp's ridley turtle; *Lepidochelys*: bottlenose dolphin; *Tursiops*; *Stenella*; Gulf of Mexico Region.

Map #29118.2 Unavailable.

REPORT TITLE: Marine Birds of the Southeastern United States and Gulf of Mexico. Part I, Gaviiformes through Pelecaniformes; Part II, Anseriformes; Part III, Charadriiformes.

MMS PUBLICATION NUMBER: Contract No. 14-12-0001-29134.

APPLICABLE PLANNING AREA(S): South Atlantic; Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: This report summarizes the status of marine birds in the southeastern United States and examines potential effects of Outer Continental Shelf (OCS) petroleum resource development on these species. The information enables the Minerals Management Service to identify aspects of OCS development that threaten marine bird populations and allows managers to decide on energy resource development alternatives that minimize damage to these populations.

OBJECTIVES: (1) To determine most likely occurrence of marine birds in future oil and gas production areas; (2) to ascertain species most at risk from oil, gas, and ancillary activities related to resource development; (3) to evaluate importance of southeastern United States populations in relation to entire species distribution and abundance; and (4) to summarize life history information of each species, emphasizing southeastern data.

DESCRIPTION: This report is a literature search, synthesis, and analysis emphasizing literature and data concerning marine bird populations in the southeastern United States and the Gulf of Mexico from North Carolina to Texas. Part I contains compiled information and distribution maps concerning Gaviiformes (loons), Podicipediformes (grebes), Procellariiformes (albatrosses, petrels, and shearwaters), and Pelecaniformes (tropicbirds, frigatebirds, cormorants, gannets, boobies, and pelicans); Part II, Anseriformes (ducks, geese, and swans); and Part III, Charadriiformes (phalaropes, gulls, terns, and skimmers).

SIGNIFICANT CONCLUSIONS: Susceptibility of birds to oil depends not only on their juxtaposition in time and space, but also on currents, climatic factors, life history or annual cycle stage, and general species behavior. Oil contamination may result in matted feathers; death may soon follow from chilling or starvation or from the toxic effects of oil ingested when preening is attempted. Oil from feathers may be transferred to incubating eggs and may greatly reduce reproductive success.

STUDY RESULTS: Part I contains information on seasonal distribution and abundance of 39 marine birds species of the Orders Gaviiformes, Podicipediformes, Procellariiformes, and Pelecaniformes that occur off southeastern shores of the United States and in the Gulf of Mexico; Part II, 41 species of waterfowl in the Order Anseriformes; and Part III, 22 marine bird species in the Order Charadriiformes. Additionally, each volume summarizes world-wide distribution, habitat, food, and various aspects of the life history for species surveyed. From this information, the susceptibility of the bird species to oil from oil and gas development in the study area is predicted. Among the birds covered in Part I, loons and grebes are considered most susceptible to oil pollution; cormorants, pelicans, and boobies are moderately susceptible; and truly pelagic birds (most Procellariiformes, tropicbirds, and frigatebirds) are least susceptible. Among the birds covered in Part II, seaducks and diving ducks are most susceptible to oil pollution; other ducks, geese, and swans are relatively

insusceptible because they are seldom found in areas where oiling is likely to occur. Large concentrations of wintering, breeding, and migrant gulls and terns, covered in Part III, occur within the survey area and in instances, comprise large proportions of worldwide or North American populations. Consequently, Part III includes most of the marine birds that are most likely to be detrimentally affected by oil resource development.

STUDY PRODUCT(S): Clapp, R. B., R. C. Banks, D. Morgan-Jacobs, and W. A. Hoffman. 1982. Marine Birds of the Southeastern United States and Gulf of Mexico. Part I. Gaviiformes through Pelecaniformes. A final report by the U.S. Fish and Wildlife Service, Office of Biological Services for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB82-195850. FWS Report FWS/OBS-82/01. Contract No. 14-12-0001-29134. 648 pp.

Clapp, R. B., D. Morgan-Jacobs, and R. C. Banks. 1982. Marine Birds of the Southeastern United States and Gulf of Mexico. Part II. Anseriformes. A final report by the U.S. Fish and Wildlife Service, Office of Biological Services for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB82-264995. FWS Report FWS/OBS-82/20. Contract No. 14-12-0001-29134. 505 pp.

Clapp, R. B., D. Morgan-Jacobs, and R. C. Banks. 1983. Marine Birds of the Southeastern United States and Gulf of Mexico. Part III. Charadriiformes. A final report by the U.S. Fish and Wildlife Service, Office of Biological Services for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB84-158773. FWS Report FWS/OBS-83/80. Contract No. 14-12-0001-29134. 869 pp.

STUDY TITLE: South Atlantic and Gulf of Mexico Marine Birds Literature Synthesis and Analysis.

COMPLETION DATE OF REPORT: March 1982 (Part I); July 1982 (Part II); September 1983 (Part III).

CUMULATIVE PROJECT COST: $190,000.

KEY WORDS: South Atlantic; Eastern Gulf; Central Gulf; Western Gulf; birds; seabirds; biology; literature review; life history; abundance; synthesis; maps; distribution; Gaviiformes; Podicipediformes; Procellariiformes; Pelecaniformes; Anseriformes; Charadriiformes; impacts; oil spill; census.

Map #29134 Unavailable.

ECOLOGICAL EFFECTS

These studies are designed to characterize the effects of oil and gas activity either through comparison of current ecosystem data with earlier "benchmark" data or through special studies oriented toward monitoring specific agents or activities or groups of agents or activities. These latter studies have examined the discernible impacts to the marine environment caused by offshore oil and gas activities, both short-term effects in the vicinity of selected exploratory drilling rigs and long-term effects in the Louisiana shelf region where offshore activities have occurred in increasing densities for decades. The results of these studies are important in understanding the actual impacts of offshore oil and gas activities, including both the nature of the impact and a real extent of the impact. Information of this sort is used to develop mitigating measures, where needed, to reduce or otherwise limit adverse impacts due to oil and gas activities.

REPORT TITLE: Habitat Impacts of Offshore Drilling: Eastern Gulf of Mexico.

MMS PUBLICATION NUMBER: MMS 93-0021.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; South Atlantic.

BACKGROUND: More than 30 offshore exploratory wells have been drilled in the eastern Gulf during the 1970s, 1980s, and early 1990s. Little was known about the aerial extent of impact to the marine environment. As a result of concern about possible impacts, a moratorium was placed on all OCS areas south of parallel 26° N. A National Academy of Sciences panel review report in 1989 highlighted the lack of knowledge, as did a 1989 State of Florida Governor's Report. A drilling moratorium for the northeastern Gulf of Mexico is being sought by a coalition of many interested parties. This report presents the finding of studies of six abandoned exploratory well sites in various environments ranging in depths from 21 to 149 m.

OBJECTIVES: (1) To locate and systematically sample, video, and photograph six different drill sites in the eastern Gulf of Mexico (the age of these sites ranged from 15 months to 17 years since drilling took place), (2) to conduct grain-size, mineralogical and elemental analyses in order to map aerial extent of benthic impact, and (3) to determine whether drill sites recovered to predrilling conditions over time.

DESCRIPTION: Six drill site locations provided by MMS were located using GPS and examined using a 2-person research submersible. Using the submersible's collecting arm, samples were taken in radial transacts extending outward from the borehole. Samples were seived into 16 separate grain sizes and the percent of grains larger than 2 mm was used to circumscribe a halo of impact surrounding the borehole. The mud fraction was analyzed for barium, the weighting component of drill mud, and trace metals Cr, Fe, V, and Zn, using Induction Coupled Neutron Activation Analysis(INAA). XRD was used to detect barite. A continuous video record was made at each site along with selected still photographs.

Sites ranging in depth from 21 to 149 m consisted of Pensacola Block 996 No. 1 drilled in 1988, Destin Dome Block 56 No. 1 drilled in 1989, Gainesville Block 707 No. 1 drilled in 1985 Main Pass Block 255 No. 1 drilled in 1990, Florida Middle Ground 455 No. 1 drilled in 1986, and Florida Middle Ground Block 252 No. 1 drilled in 1974. Bottom habitats included medium quartz sand, carbonate mud, coarse biogenic carbonate sand, hard limestone with corals and gorgonians (tropical organisms), and relict reefs (pinnacle reef trend with deep-water gorgonian fauna).

SIGNIFICANT CONCLUSIONS: Areas impacted by cuttings and drilling debris, especially used welding rods, ranged from as little as a few meters to over 13,000 m^2 (over 3 acres). Barium at levels above background (200 ppm is considered natural background) extended beyond the range of our sampling pattern but clearly show a bullseye distribution of decreasing values away from the borehole. High levels near boreholes were on the order of 50,000 to 150,000 ppm. At the shallow Gainesville Block 707 site, which had been affected by two post-drilling hurricanes, barium was at background level except in one sample taken at the borehole where the level was 8 times background level. Tropical fish were abundant and 11 groupers were counted in and around the borehole.

At the oldest site (Middle Ground Block 252 No. 1 drilled 17 years ago), only background barium levels were detected. Cuttings mixed with biogenic sand were rippled and little debris was detected. No fish life was seen.

Main Pass Block 225, in 104 m of water, had been drilled adjacent to a pinnacle reef and a reentry device with provisions for 4 wells was attached on the bottom. The site is within a nepheloid layer. The bottom was dusted with fine rust-colored mud and water visibility was very poor. The greatest impact at this site was a series of zigzag trenches apparently made by the legs of a jack-up rig during either mobilization or demobilization. Large fish had been attracted to the reentry structure.

The well head at Destin Dome Block 56 No. 1 was covered with a steel pyramid-shaped protection device. This was the most heavily impacted site observed. The well was a very deep test and produced more cuttings than the other wells. Fish were abundant.

Only one dive was made at Middle Grounds Block 455 No. 1, which was the deepest site examined. The bottom consisted of burrowed lime mud with no plant life. The water was 149 m deep. Very large groupers hovered around the borehole, which was in the center of a hexagon-shaped steel template half buried in the mud. In general, sites with structures, open boreholes and/or debris served as artificial reefs and harbored the most diverse fish fauna. Our observations indicate that sites in shallow water return more quickly to predrilling conditions than do sites in more than 50 m of water. Storm waves and currents can more easily remove drilling debris and barium, and the organisms that live in shallow water grow much faster than those in deep cold waters.

STUDY PRODUCTS: Shinn E.A., Lidz, B.H., and Reich C.D. 1993, Habitat Impacts of Offshore Drilling: Eastern Gulf of Mexico, OCS Study MMS 93-0021, and a 12-minute Open-File video produced by USGS.

STUDY TITLE: Impact of Offshore Exploratory Drilling: Eastern Gulf of Mexico.

COMPLETION DATE OF REPORT: September 1993.

CUMULATIVE PROJECT COST: $152,856.

KEY WORDS: Cuttings, Drill Mud, Barium, Barite, Wellhead, Trace Metals, Pinnacle Reef, Destin Dome, Pensacola, Main Pass, Gainesville, Florida Middle Ground, Grain Size, Template, Jack-Up Rig.

Map #14737 Unavailable.

REPORT TITLE: Dispersed Oil Toxicity Tests with Species Indigenous to the Gulf of Mexico.

MMS PUBLICATION NUMBER: MMS 94-0021.

APPLICABLE PLANNING AREA(S): Straits of Florida; Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: Testing on the fate and effects of oil and dispersed oil on marine organisms can be traced back to large spills which occurred during the 1960's. Anderson *et al.* (1974) identified the low molecular weight aromatic hydrocarbons as the primary contributors to oil toxicity and described a method by which a water soluble fraction (WSF) of the oil could be prepared for testing the effects of oil. "Water accommodated fraction" (WAF) has also been used to reflect those hydrocarbon fractions which are water soluble and the microscopic oil droplets found in suspension. Regulatory agencies are frequently faced with decisions on how best to respond to oil spills, including the potential use of dispersants. Decisions to use dispersants can result in tradeoffs that must weigh the amount of oil which will be dispersed into the water column, thus affecting pelagic organisms. In commercially-important fishery areas, such decisions can have environmental, economic, and political implications.

OBJECTIVES: 1) To expose the eggs and/or larvae of seven Gulf of Mexico fish and shellfish species and one Atlantic fish species to the WAF of two different Gulf of Mexico oils, dispersed oil mixtures, and a single dispersant in controlled, flowthrough or static 96-hr acute toxicity tests; 2) to characterize the chemical composition of the test oils and exposure media (i.e., WAF, dispersed oil, dispersant) during various phases of acute toxicity testing; 3) to summarize the results of acute toxicity testing and parallel chemical analyses of exposure media on each of the species using gas chromatography (GC), GC/mass spectrometry (GC/MS), and GC/MS with selected ion monitoring (GC/MS-SIM).

DESCRIPTION: Static and flowthrough exposure methods were utilized on egg and larval stages of commercially-important species from the Gulf of Mexico including brown shrimp (*Penaeus aztecus*), white shrimp (*P. setiferus*), blue crab (*Callinectes sapidus*), eastern oyster (*Crassostrea virginica*), red drum (*Sciaenops ocellatus*), inland silverside (*Menidia beryllina*), and spot (*Leiostomus xanthurus*). As attempts to secure eggs and larvae of gulf menhaden (*Brevoortia patronus*) were unsuccessful, a congener (Atlantic menhaden, *Brevoortia tyrannus*) was evaluated using study-specific acute toxicity testing protocols. Mysids (*Mysidopsis bahia*) were also evaluated in a chronic toxicity assessment. Test organisms were exposed to the WAF of two different oils (i.e., Western and Central Gulf of Mexico OCS) and dispersed oil mixtures, as well as a single dispersant (Corexit 9527). Specially-designed flowthrough exposure chambers were developed, evaluated, and utilized during the study. LC_{50} values and Toxicity Index (TI) determinations were made for all species. The TI is a relative measure of toxicity calculated from the product of exposure concentration and time (e.g., ppm x hours = ppm-hrs). TI values were determined for total naphthalenes, total petroleum hydrocarbons (TPH), and BTEX compounds (i.e., benzene, toluene, ethylbenzene, xylenes).

SIGNIFICANT CONCLUSIONS: Replication between flowthrough exposures was good, particularly with regard to hydrocarbon exposures. Agreement in the static exposures was less evident, suggesting that greater variability is likely in toxicity results originating from this exposure method. Embryonic stages of the species tested exhibited lower sensitivity than early larval stages. The overall sensitivity of fish versus invertebrates appeared to be similar. Invertebrates performed better as test organisms, as overall control survival was better. The naturally high mortality of fish larvae compounded efforts to obtain acceptable test results. Significantly higher concentrations of total naphthalenes and TPH were measured in the dispersed oil mixtures compared to the WAF; however, the dispersed oil did not reflect a correspondingly greater toxicity. BTEX was measured at levels an order of magnitude higher in the WAF than in the dispersed oil mixtures. These results suggest that the BTEX compounds were a possible source of toxicity in the WAF exposures, whereas naphthalenes may have been the primary cause of toxicity in the dispersed oil exposures. In most exposures, a majority of the toxicity occurred within the first 24 hrs.

STUDY RESULTS: The two oils showed minor chemical differences. The Central Gulf oil exhibited higher concentrations of chrysenes, phenanthrenes, fluorenes, and dibenzothiophenes. Naphthalenes were present in the highest concentrations in both oils (i.e., 420-510 μg/g) and were generally several times greater than the other polynuclear aromatic hydrocarbon compounds analyzed. Hydrocarbon concentrations at the end of the study (i.e., in Month 19) revealed several basic differences from the initial analyses. Naphthalenes and fluorenes were generally higher, while the phenanthrenes, dibenzothiophenes, and chrysenes exhibited lower or similar concentrations when compared to initial measurements. Differences in concentrations may suggest variability within the testing method rather than being indicative of any real change in the oils over time. Dispersant characterization indicated minimal naphthalene and phenanthrene concentrations of 0.16 and 0.012 μg/g, respectively. Static tests tended to have the highest overall TPH concentrations with the dispersed oil levels being 4-5 times greater than that measured in the WAF. Flowthrough concentrations tended to be more variable without the clear distinctions seen in the static tests. BTEX concentrations integrated over 96-hr exposures did not differ markedly between the two oils tested. BTEX concentrations in the static system were at least an order of magnitude higher than in the flowthrough system. Similarly, concentrations in the WAF were an order of magnitude greater than in the dispersed oil mixtures. The range of variation between samples was generally less than 30%. In spite of the order of magnitude differences in concentrations, the majority of the BTEX determinations noted for both the dispersed oil mixtures and the WAF in the flowthrough system were lost within the first 6 hrs, with concentrations close to detection limits within 24 hrs. Brown shrimp were tested with the Western Gulf WAF and dispersed oil. All of the toxicity in the two exposures occurred within the first 24 hrs with little to no toxicity observed in subsequent days, consistent with hydrocarbon patterns where the majority of the materials were lost within the first 24 hrs of exposure. White shrimp tests were conducted with both the Western and Central Gulf oils using postlarvae at ages of 15 days (Central Gulf oil) and 22 days (Western Gulf oil). The dispersant itself had a measured LC_{50} of 11.9 mg/l. As with the oil exposures, the majority of the toxicity occurred within the first 24 hrs. After the 96-hr exposures were completed, surviving shrimp were grown for an additional 30 days in clean seawater and weighed. Control weights in the two sets of test were consistent but slightly higher in the Central Gulf oil exposures, suggesting effects of stress. Effects on growth from the exposures themselves

were noticeable in the surviving shrimp at the highest concentration in the Western Gulf dispersed oil and to a lesser extent in WAF. No effects were seen on growth in the 50-ppm concentration of the dispersant, consistent with the findings from the acute toxicity testing. In the Central Gulf exposures, reduced growth was noted in the 25-ppm dispersant concentration and in the 100% WAF. Slightly lower (though not significant) weights were observed in the 25-ppm concentration of the dispersed oil. These results also closely paralleled toxicity testing results. Blue crab exposures were conducted with both Central and Western Gulf oils. Based on results of two dispersant only tests, similar sensitivities to the dispersant were obtained. Similarly, the results from WAF exposure did not differ greatly. While most of the toxicity in the dispersed oil tests appeared to occur within the first 24 hrs, mortalities in the WAF and dispersant mixtures were most evident after the first 24 hrs, suggesting a greater sensitivity to the dispersed oil. However, it was also suggested that molting may have occurred at a particularly critical period with regard to the severity of effects and may explain the differences observed between the two oils. Oysters were exposed in static tests to the dispersant and to dispersed oil mixtures; no tests were conducted with WAFs due to difficulties encountered during spawning. In addition to the determination of an EC_{50} value for oysters, lowest observed effect concentrations (LOEC) and no observed effects concentrations (NOEC) were calculated using the Kruskal-Wallis method. The dispersant was particularly toxic to the embryo/larval stages, resulting in an EC_{50} <6.25 ppm. Similarly, the dispersed oil mixtures had statistically significant effects at the lowest concentrations tested. In exposures to the Central Gulf dispersed oil, the EC_{50} was <6.25 ppm dispersed oil. The Western Gulf dispersed oil had a lower toxicity than the Central Gulf dispersed oil with an NOEC of 6.25 ppm and an LOEC of 12.5 ppm.

Tests with embryos and larvae of inland silverside were conducted under both static and flowthrough exposures. Numbers of surviving embryos and larvae were similar after 96 hrs in the three different exposure media. The 96-hr toxicity tests were followed by recovery to Day 9, at which time the fewest survivors overall were found in the WAFs and dispersant exposures. When compared to controls, the 50% and 50 mg/l concentrations showed a similar rate of mortality in the three exposures, suggesting a delayed response. A subsequent test confirmed the relative insensitivity of the fish when the exposure was begun in a late embryonic stage. In these tests, equally high hatching rates were measured in all of the exposures. No effects on fry survival were measured in the three exposures at the end of the 96-hr tests. By comparison, a static test exposure had effects in reducing hatching rates in a 75% and 50% WAF, possibly due to the effects of higher exposure concentrations than those observed in flowthrough tests. Tests which had begun with the larvae produced similar results during exposures to Western and Central Gulf oils. Atlantic menhaden were subjected to static exposure conditions because of sensitivity to flowthrough testing protocols. Test specimens were received as embryos within approximately 36 hrs after their release from females. Tests were initiated with embryos and hatching occurred within the first 24 hrs of the test. Results were obtained in 48-hr exposures because of the significant control mortality. In spite of the shortened exposure, test results provided clear patterns of toxicity. Two oils were tested and produced similar results in a comparison of the WAF and dispersed oil; only one acceptable test was achieved in the dispersant exposures. Sensitivity of this species was comparable to that observed for spot. Toxicity testing of spot was conducted under similar conditions as those realized for Atlantic menhaden. Spot appeared to be more sensitive to the Central Gulf oil. As with Atlantic menhaden, test results were obtained for 48-hr exposures due to significant control

mortalities. Hatching success and fry survival were evaluated in various exposures to Central and Western Gulf oils. In both sets of tests, similar results were obtained, indicating that hatching success was similar between WAFs and dispersed oil exposures and that effects were most evident in only the highest exposure concentrations after 48 hrs. In both cases, 96-hr survival was lowest in the dispersed oil mixtures. Tests with red drum were limited due to difficulties encountered in maintaining controls. In those tests where acceptable results were obtained for the two oils, this species proved to be relatively insensitive. Hatching success realized by test organisms exposed to the Western Gulf oil in a flowthrough system was also evaluated. Hatching success was affected only at the highest concentration of the dispersed oil and in the higher concentrations of the dispersant. The WAF did not appear to significantly affect hatching success. In summary, significantly higher concentrations of total naphthalenes and TPH were measured in the dispersed oil mixtures compared to the WAF; however, the dispersed oil did not reflect a correspondingly greater toxicity. BTEX was measured at levels an order of magnitude higher in the WAF than in the dispersed oil mixtures. Results suggest that the BTEX compounds were a possible source of toxicity in the WAF exposures, whereas naphthalenes may have been the primary cause of toxicity in the dispersed oil exposures.

STUDY PRODUCT(S): Fucik, K. W., K. A. Carr, and B. J. Balcom. 1994. Dispersed Oil Toxicity Tests with Biological Species Indigenous to the Gulf of Mexico. OCS Study/MMS 94-0021. A final report prepared by Continental Shelf Associates, Inc. for the U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. MMS Contract No. 14-35-0001-30617. 97 pp. + appendices.

STUDY TITLE: Dispersed Oil Toxicity Tests with Species Indigenous to the Gulf of Mexico.

COMPLETION DATE OF REPORT: August 1994.

CUMULATIVE PROJECT COST: $272,795.

KEY WORDS: Straits of Florida; Eastern Gulf; Central Gulf; Western Gulf; acute toxicity testing; chemistry; invertebrates; fish; larvae; eggs; hydrocarbons; dispersant; Gulf of Mexico Region.

Map #30617 Unavailable.

REPORT TITLE: Quality Control for MAFLA IV and South Texas II Investigations.

MMS PUBLICATION NUMBER: Contract No. 08550-CT5-49.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: A comprehensive quality control program was conducted in support of the Mississippi, Alabama, and Florida (MAFLA) Outer Continental Shelf (OCS) Monitoring Study and South Texas OCS Baseline Program. Such quality control programs are needed in order to be able to make comparative assessments of chemical analyses from different laboratories and for individual studies.

OBJECTIVES: (1) To provide trace metals analyses and quality control for samples of suspended particulate matter, biota, and sediment from the MAFLA Monitoring Study and South Texas OCS Baseline Program.

DESCRIPTION: A total of 241 samples including 10 suspended particulate, 31 zooplankton, 19 paint chip samples, 75 sediment, and 106 epifauna samples were analyzed for quality control trace metal testing. Suspended particulates, zooplankton, epifauna, and sediments were analyzed from the South Texas OCS Baseline Program. Zooplankton, paint chips, sediments, and epifauna were tested from the MAFLA area, and sediments and epifauna from the MAFLA Rig Monitoring Study. All samples were measured for cadmium, copper, lead, nickel, and vanadium with additional analyses on specific samples for barium, iron, and zinc.

Analytical methodologies which were investigated included hot nitric acid digestion, liquid fire digestion, and a 10-day procedure based on the principle of the Parr bomb. Testing of the procedures was accomplished by digesting aliquots of four biota pools (i.e., shrimp, oysters, sand dollars, and flounder). Based on results of an accuracy test, the 10-day procedure was selected for digestion of epifauna and zooplankton samples. Flame and flameless atomic absorption spectrophotometry (AAS) were used to make the metals determinations.

SIGNIFICANT CONCLUSIONS: Average concentrations of cadmium and copper in zooplankton samples tended to be higher in the MAFLA area while chromium, lead, and vanadium were higher in South Texas. Nickel levels were similar in the two areas. Concentrations of these metals in suspended particulate samples were generally two or more orders of magnitude less than those in the zooplankton. Metals concentrations in epifauna samples were generally lowest in South Texas, intermediate from the MAFLA Rig Monitoring Study, and highest in the MAFLA area.

Sediment samples in the South Texas, MAFLA, and MAFLA rig monitoring areas gave similar results with a few exceptions. Barium was lower in the MAFLA area as compared to the other two study sites. Chromium was higher in the rig monitoring samples, and vanadium was lower in the MAFLA area.

Good agreement was reached between the measured and actual concentrations in reference samples received from the National Bureau of Standards (NBS).

STUDY RESULTS: Suspended particulate matter samples were all obtained from the South Texas baseline area. Metals determinations were made for vanadium, cadmium, lead, nickel, copper, chromium, and zinc.

In analyzing biota, several experiments were conducted. A hot nitric acid digestion procedure was attempted in the first experiment which gave poor results and was lengthy. Good agreement was obtained on NBS standard reference materials but poor precision was obtained on shrimp pool samples. Precision was better for Food and Drug Administration (FDA) oysters and NBS tuna than for the shrimp.

Experiment two was designed to determine whether a 32-h acid digestion was required for accurate analysis. Analyses for cadmium, chromium, lead, and nickel did not demonstrate sufficient sensitivity or reproducibility to provide comparable time-dependent data. Copper, iron, and zinc determinations suggested that the optimum digestion time was 8 h.

In experiment three, another digestion method was attempted because of poor results with the nitric acid digestion. This digestion involved a perchloric acid-nitric acid procedure. Poor results were obtained with this method which included lack of precision and accuracy. In addition, the method was hazardous for use with biota samples and was therefore abandoned.

In the fourth experiment, a Parr bomb principle was employed to test digestion efficiency. The actual procedure employed was the 10-day procedure which used pressure development by the action of nitric acid on the biota. The procedure gave the best precision of all the methods tested and gave good recovery of spikes for all metals tested, with the exception of zinc. A follow-up experiment was designed to determine if the 10-day nitric acid procedure could provide accurate data for an NBS reference standard. Observed precision with the method was good.

Sufficient sample volume for zooplankton analysis was provided only for the South Texas region. Precision in the samples was very good for all trace metals of interest and the recovery of spikes was good. This indicated that the analyses for zooplankton were in control. In South Texas samples, only copper and zinc were present in sufficient concentrations to be detected by flame AAS. In the MAFLA area samples, the majority of the trace metals analyzed could be detected by flame AAS. Cadmium, chromium, lead, nickel, and vanadium required flameless AAS. A graphite furnace was used for all trace elements except copper and iron in the MAFLA Rig Monitoring Study. Vanadium and chromium could be detected in most of these samples. Percent recovery of spikes in these samples ranged from 86% to 95%.

Partial and total digestion methods were attempted for sediment samples. The partial method used nitric and hydrochloric acids for leaching of metal content, whereas the total method used hydrofluoric and perchloric acids. Comparison of the two methods showed similar values for copper, lead, nickel and zinc. Chromium, vanadium, and especially barium

were higher in the total digestion samples. Precision and accuracy of the two techniques were similar.

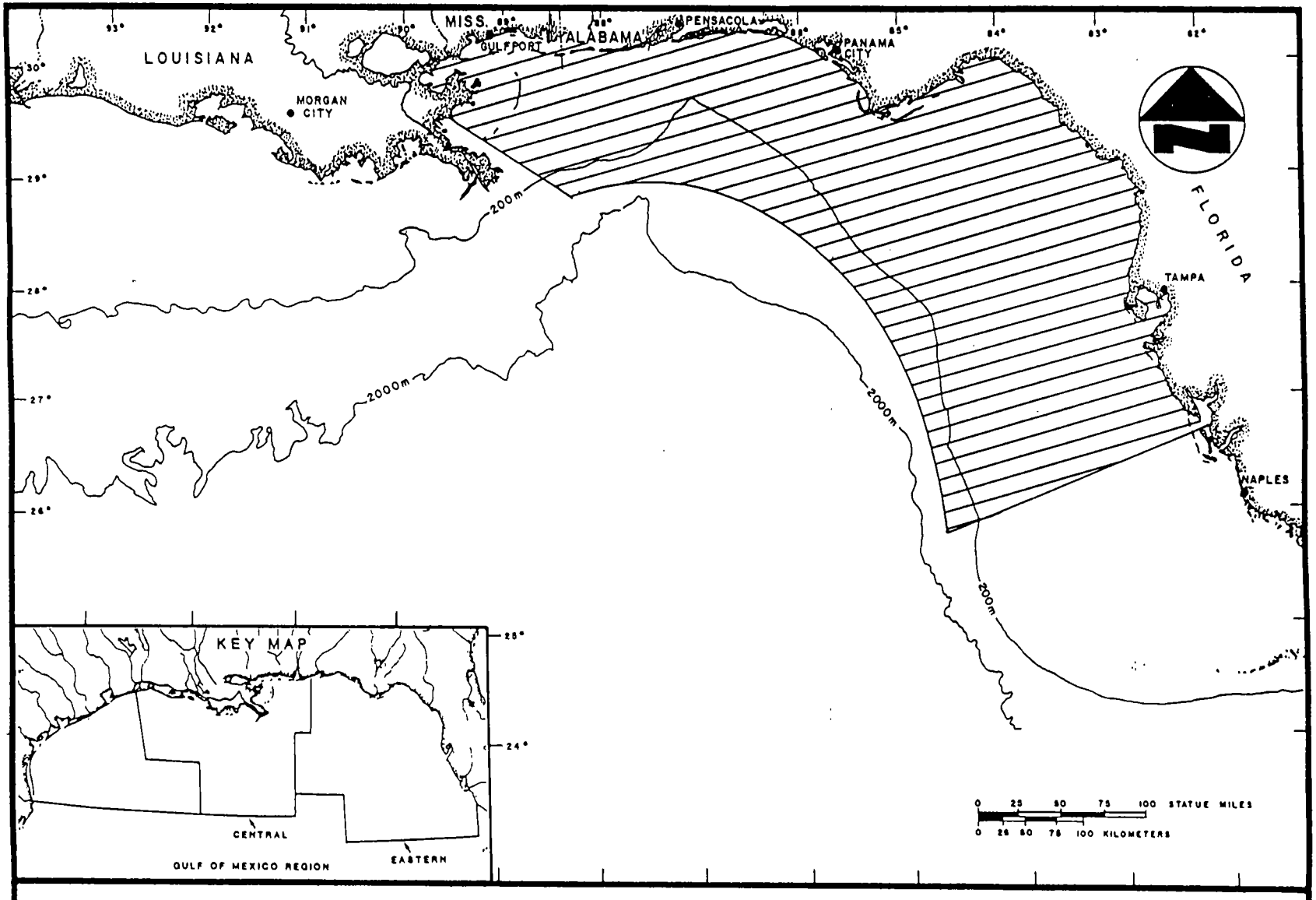
STUDY PRODUCT(S): McKown, M. M. and J. G. Montalvo. 1976. Quality Control for MAFLA IV and South Texas II Investigations. A final report by the Gulf South Research Institute for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. PB80-216302. Contract No. 08550-CT5-49. 189 pp.

STUDY TITLE: Trace Metals Quality Control Analyses.

COMPLETION DATE OF REPORT: 1976.

CUMULATIVE PROJECT COST: $110,000.

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; Mississippi; Alabama; Florida; Texas; baseline; quality assurance; trace metals; suspended particulates; sediment; epifauna; zooplankton; spectrophotometry; interlaboratory comparison.



STUDY AREA FOR TRACE METALS QUALITY CONTROL ANALYSES, MAFLA AND SOUTH TEXAS OCS INVESTIGATIONS.

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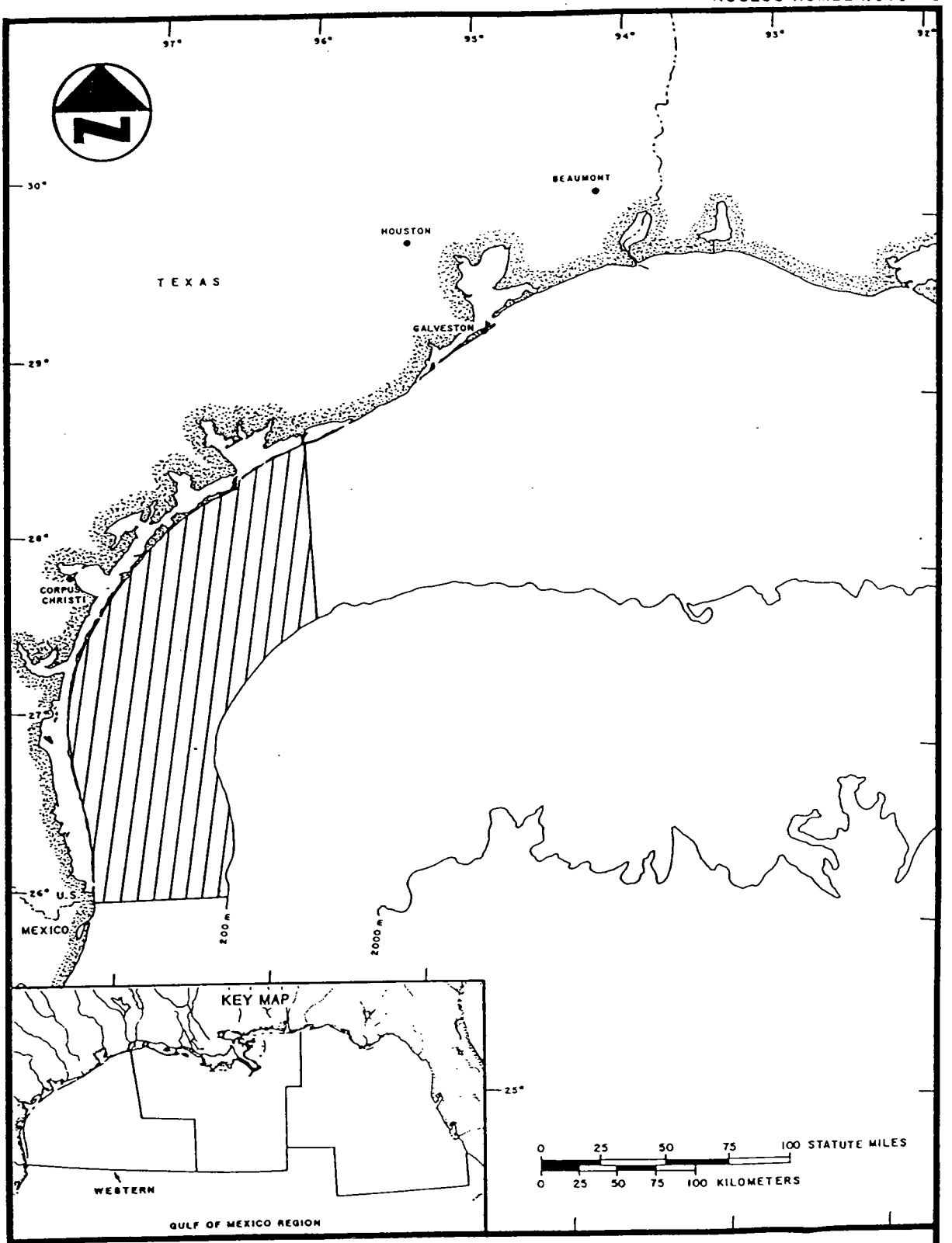


STUDY AREA FOR TRACE METALS QUALITY CONTROL ANALYSES, MAFLA AND SOUTH TEXAS OCS INVESTIGATIONS.

REPORT TITLE: A Numerical Modelling and Observational Effort to Develop the Capability to Predict the Currents in the Gulf of Mexico for Use in Pollutant Trajectory Computation: A Guide to a General Circulation Model of the Gulf of Mexico.

MMS PUBLICATION NUMBER: Contract No. 08550-IA5-26.

APPLICABLE PLANNING AREA(S): Straits of Florida; Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: Increasing levels of offshore oil and gas development have subsequently increased the probabilities for accidental releases of oil. Such spills can have significant environmental effects. In order to anticipate and mitigate the effects of such spills, it is necessary to be able to predict the trajectory and possible landfalls of released oil. Since such trajectories are largely a function of ocean surface currents, predictive capabilities can be developed through the use of numerical models which simulate currents in the vicinity of a spill. This predictive capability, which may be applied further to a modeling of the movement of an oil spill, was determined to be of particular concern within the Gulf of Mexico, a region of historic and future oil and gas development activity.

OBJECTIVES: (1) To modify an existing numerical model for application to the Gulf of Mexico; (2) to evaluate the ability of the model to adequately simulate the circulation of the Gulf of Mexico using various types and distributions of data; and (3) to describe the Gulf of Mexico circulation using the results of the model.

DESCRIPTION: In order to model or predict circulation patterns within the Gulf of Mexico, a mathematical model was developed using a series of approximations. First, the ocean was assumed to be a Boussinesq fluid (i.e., the density of the ocean differs only slightly from a reference state in which entropy and salinity are constant and there is no motion). Secondly, the ocean was assumed to be in hydrostatic balance. By definition, this means that the vertical balance of forces differs only slightly from a reference state of no motion. The third approximation was based on the fact that the surface of the ocean does not coincide with the geoid even if wind waves and tidal fluctuations are neglected. Fourthly, the equations which were used governed only large scale motion. Finally, the model assumed that the frictional drag of flow on the bottom was negligible over most of the basin. It was recognized that this assumption was not applicable (i.e., was incorrect) in those situations where strong currents extend to the bottom. In these cases, a simple bottom drag coefficient was included. The actual computer program was a modification of a previously developed model.

The interior and boundary conditions for the model were derived from data provided by the National Oceanographic Data Center and from cruises conducted as part of the present study. Monthly circulation of the Gulf of Mexico was simulated using a broad range of input and boundary conditions. Specifically, test calculations were performed on a grid with seven vertical layers (70, 151, 297, 500, 703, 849, and 930 m) and a horizontal resolution of 0.5 degree of longitude and latitude. Time step was kept constant at 0.5 hours and the vertical coefficient of eddy viscosity was 1 cm^2/s. Variable parameters included transport, horizontal coefficient of viscosity, boundary conditions, wind stress, and wide shelf. The

ability of the model to simulate the observed circulation was demonstrated through a series of comparisons of circulation model solutions with results from a geostrophic model.

This report is a companion to the final report entitled "A Numerical Modelling and Observational Effort to Develop the Capability to Predict the Currents in the Gulf of Mexico for Use in Pollutant Trajectory Computation: Model Studies of the Circulation in the Gulf of Mexico," also prepared under this contract.

SIGNIFICANT CONCLUSIONS: A numerical model was developed to characterize general circulation patterns within the Gulf of Mexico. Results of simulations compared favorably with results obtained from a geostrophic model. Sensitivity of the models to transport, horizontal coefficient of viscosity, boundary conditions, wind stress, and a wide shelf were tested. Changing boundary conditions in the model had only a minor effect on model results. Among the most important results noted was the fact that large changes in the applied wind stress and in the transport through the Straits of Yucatan and Florida had relatively little effect on interior circulation of the Gulf of Mexico basin. At the same time, a 17% reduction of transport through the Straits of Yucatan and Florida caused significant changes in the transport only near the Cuban coast, suggesting that the interior balance remains unchanged and adjustment to the transport boundary conditions occurs only in a narrow boundary layer along the Cuban coast. Increasing the vertical viscosity had a significant effect in decreasing transport in the Gulf and changing the characteristics of the Loop Current. Improbable currents were predicted when the model was extended onto the shallow shelf which led to the expanded grid being rejected from the model. Instead, a small amount of bottom friction is added to the model whenever the grid is only one layer thick.

STUDY RESULTS: Under varying boundary conditions, only minor differences were seen between zero gradient and geostrophic boundary conditions. In another experiment, flow through the Straits of Yucatan and Florida was tested under two conditions. The results were essentially the same in the western Gulf and remarkably similar in the eastern Gulf. It was determined that the main effect of under-specifying the transport by 17% was to cause a recirculation of water within the Loop Current and a northwestern flow of water along the northwestern coast of Cuba. Away from the Cuban coast, the circulation is affected only slightly. This led to the conclusion that small errors in transport specified at the boundary does not radically affect the interior circulation in a diagnostic experiment.

Under conditions with and without wind stress, close similarity between the two simulations was obtained. For the most part, wind stress had a negligible effect. The differences were mainly in regions where circulation was weakest. Differences in velocities for the surface and deeper layers was negligible. Several small differences were also noted in the current on the Campeche Bank where wind stress caused some enhancement in flow.

Several experiments were run to test the sensitivity of the model to viscosity changes. Increasing viscosity by a factor of five reduced transport in the central western gyre by 35% and the transport in the Loop Current by 28%. Mean kinetic energy was decreased by 29%. Changing viscosity also caused the Loop Current to become smoother and broader, coupled with reduction in the stream function gradients.

In another experiment, the effect of extending the shallow shelves on the model was tested. To do this, the top layer of the model simulation was extended shoreward to the 15 m isobath. In the expanded grid, a strong current appeared flowing from the Mississippi Delta southward across the west Florida Shelf. This flow replaced a much weaker southward flow in a test without the expanded shelf. The strong Delta current, with velocities as large as those in the Loop Current, were determined to be unrealistic. In both tests, strong currents were defined along the Campeche Bank west of 88°W Long. Although predicted current speeds were probably too large, current direction was consistent with the interior flow. Based on these results, the expanded grid was rejected.

STUDY PRODUCT(S): Behringer, D. W., R. L. Molinari, and J. F. Festa. 1976. A Numerical Modelling and Observational Effort to Develop the Capability to Predict the Currents in the Gulf of Mexico for Use in Pollutant Trajectory Computation: A Guide to a General Circulation Model of the Gulf of Mexico. A final report by the Atlantic Oceanographic and Meteorological Laboratory, National Oceanic and Atmospheric Administration for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. Contract No. 08550-IA5-26. iv + 80 pp.

STUDY TITLE: Model Studies of the Circulation in the Gulf of Mexico.

COMPLETION DATE OF REPORT: May 1976.

CUMULATIVE PROJECT COST: $187,763.

KEY WORDS: Straits of Florida; Eastern Gulf; Central Gulf; Western Gulf; physical oceanography; modeling; model; currents; eddy; shelf; Florida Straits; Yucatan Straits; wind; wind forcing; Loop Current; Gulf of Mexico Region.

Map #IA5-26.2 Unavailable.

SOCIOECONOMICS

The basis for the socioeconomic studies is the implementation and fulfillment of the requirements of the OCS Lands Act Amendments and the need for socioeconomic information for multiple resource management on the OCS in accordance with the purposes of this Act. The Act provides for assistance to anticipate, plan, and protect from impact the human environment in those State and local governments in which potential changes in the social, governmental, or economic infrastructure may occur from oil and gas exploration, development, and production activities.

Subsequent to the leasing and developing of any area or region, studies must be conducted to monitor the human, marine, and coastal environments "in a manner designed to provide time-series and data-trend information that can be used for comparison with any previously collected data for the purpose of identifying the causes of such changes."

REPORT TITLE: Indicators of the Direct Economic Impacts Due to Oil and Gas Development in the Gulf of Mexico. Results of Year I. Executive Summary; Vol. I, Narrative; Vol. II, Exhibits.

MMS PUBLICATION NUMBER: MMS 86-0014, 86-0015, 86-0016.

APPLICABLE PLANNING AREA(S): Straits of Florida; Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: Primary economic impacts from outer continental shelf (OCS) leasing include the employment, wages, and salaries accounted for by the companies that are directly involved in the exploration for and development of OCS hydrocarbon resources. Secondary impacts include the expenditures by these companies for contracts, services, and other purchases, and the associated employment and salary impacts. Primary and secondary economic impacts affect socioeconomic conditions such as population, demographic and commute-to-work patterns. The collection of economic data is necessary to evaluate the socioeconomic impacts related to oil and gas development in offshore areas.

OBJECTIVES: (1) To measure the primary direct economic impact of offshore oil and gas exploration, development, and production in 1984; (2) to determine the geographic distribution of primary direct impacts of offshore oil and gas activity; (3) to document the relationship between place of work and place of residence for personnel employed by offshore producers; (4) to measure the direct secondary economic impact of contracts, services, and other purchases made by offshore oil and gas exploration and production companies; and (5) to develop a framework and set of reference data for estimating the combined direct primary and direct secondary economic impacts per unit of activity.

DESCRIPTION: Data for this project were supplied by nine offshore operators in the Gulf of Mexico acting as a Socioeconomic Subcommittee to the Offshore Operators Committee. Information was provided on producer employment records for 1984, producer expenditure records for 1984, and budget documents for specific projects or activities undertaken in 1984. The data were then used to generate numbers on direct producer employment and wages at the county/parish level. County/parish allocations of employment and income were based on the residence zip code of each employee. Application of key business ratios for each service industry to total expenditures by offshore producers was used to derive employment resulting from the purchases of goods and services. Physical descriptions of activities were converted to expenditures based on actual detailed project records supplied by the participating companies. All data supplied by the offshore producers was exclusively for expenditures and employment associated with activities in the Gulf of Mexico region.

SIGNIFICANT CONCLUSIONS: The direct primary effect of oil and gas operations in the Gulf of Mexico measured in employment, wages, and salaries. These totaled $853 million in wages, $8.75 billion in expenditures for purchased goods and services, and 23,935 person-years of employment with oil companies. Secondary effects were associated with the handling, refining, and processing of offshore oil and gas. These economic impacts included $637 million in wages and salaries and 21,572 person-years of employment. In all states, an estimated 142,860 person-years of employment were associated with Gulf operations.

STUDY RESULTS: Louisiana accounted for 21,857 of the 23,935 employee positions associated with Gulf offshore oil and gas producers. This generated a payroll of $776,696,436 in the State in 1984. More than 80% of the offshore and 90% of the onshore Gulf of Mexico workers reported to work sites in Louisiana. An estimated 14,054 onshore producer employees reported to work sites throughout the region with 13,500 in Louisiana and 500 in Texas. In Louisiana, approximately 10,000 came from the New Orleans area. Offshore producer employees came from 26 states with 20 states having very slight employment impacts of two to eight persons. Georgia, Oklahoma, and Tennessee supplied approximately 20 persons each. Louisiana provided 20,000, Mississippi had 1,960, Texas had 1,413, Alabama had 475, and Florida had 205.

The 1984 producer purchases, expenditures, and contracts resulted in an estimated $2.59 billion in wages and salaries to employees of contractors and other general businesses. These businesses had an employment impact of 97,500 full-time positions. Of these, 28,955 were located offshore, 20,085 had an offshore component, and 48,347 were located exclusively on land. Expenditures by producers resulted in purchases by the contract and support firms of $3.9 billion. These purchases included raw materials, operating expenses, capital purchases, and subcontracts with other offshore support industries. The purchases were significant because many were made locally and resulted in subsequent indirect and induced economic impacts.

Approximately 10,566 person-years of employment were generated at oil refineries as a result of offshore oil and gas activities. Of this, 9,054 were in Louisiana and 1,512 were in Texas. This resulted in $306 million in wages in Louisiana and $51 million in Texas. Gas processing plants supported an estimated 11,006 person-years of employment which was almost equally split between Texas and Louisiana. This resulted in $137 million in wages in Louisiana and $142 million in Texas.

STUDY PRODUCT(S): Centaur Associates, Inc. 1986. Indicators of the Direct Economic Impacts Due to Oil and Gas Development in the Gulf of Mexico. Results of Year I. Executive Summary. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB86-246188/AS. MMS Report 86-0014. Contract No. 14-12-0001-30178. 33 pp.

Centaur Associates, Inc. 1986. Indicators of the Direct Economic Impacts Due to Oil and Gas Development in the Gulf of Mexico. Results of Year I. Vol. I, Narrative. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB86-246196/AS. MMS Report 86-0015. Contract No. 14-12-0001-30178. 100 pp.

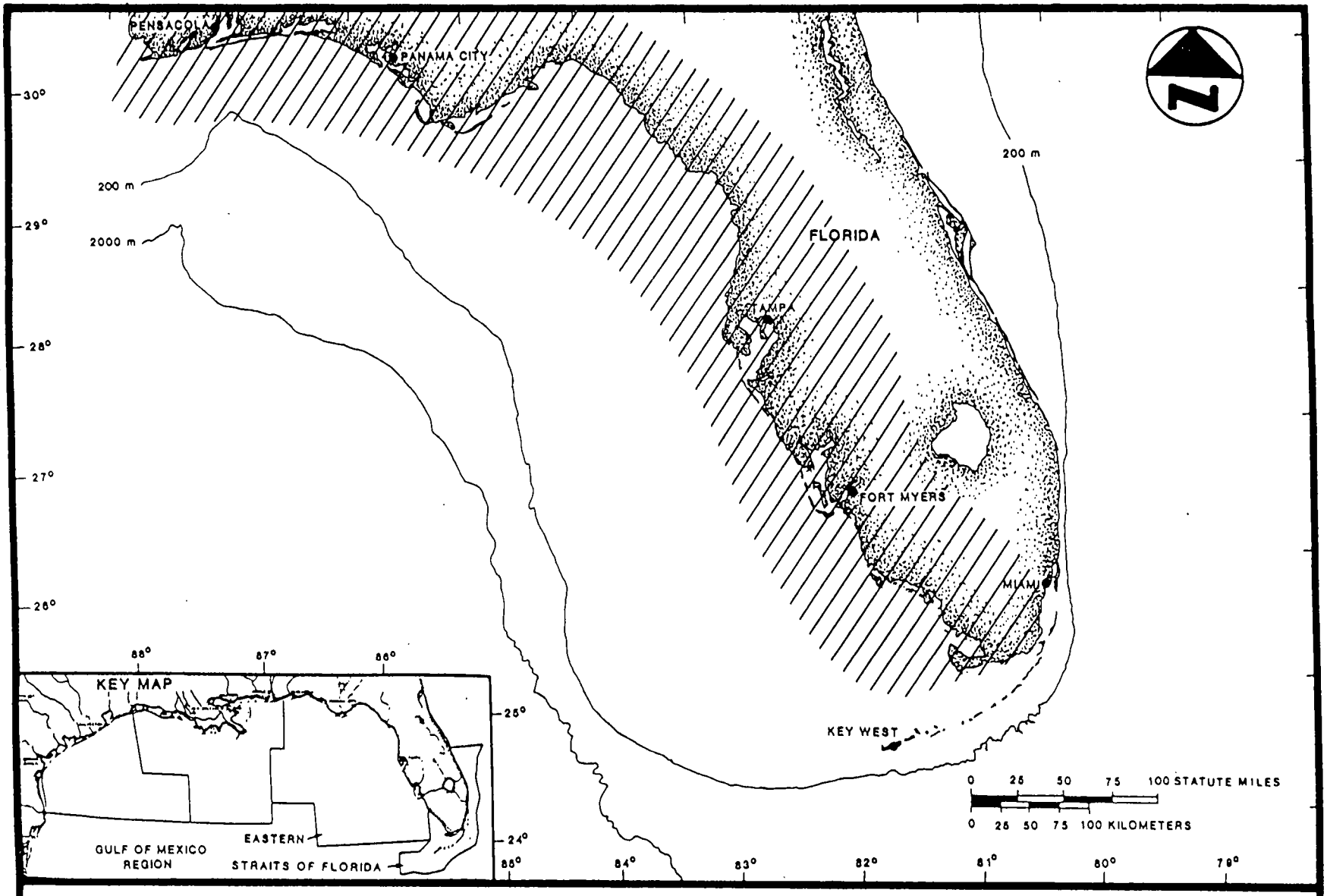
Centaur Associates, Inc. 1986. Indicators of the Direct Economic Impacts Due to Oil and Gas Development in the Gulf of Mexico. Results of Year I. Vol. II, Exhibits. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB86-246204/AS. MMS Report 86-0016. Contract No. 14-12-0001-30178. 700+ pp.

STUDY TITLE: Analysis of Indicators for Socioeconomic Impacts Due to Oil and Gas Activities in the Gulf of Mexico.

COMPLETION DATE OF REPORT: January 1986.

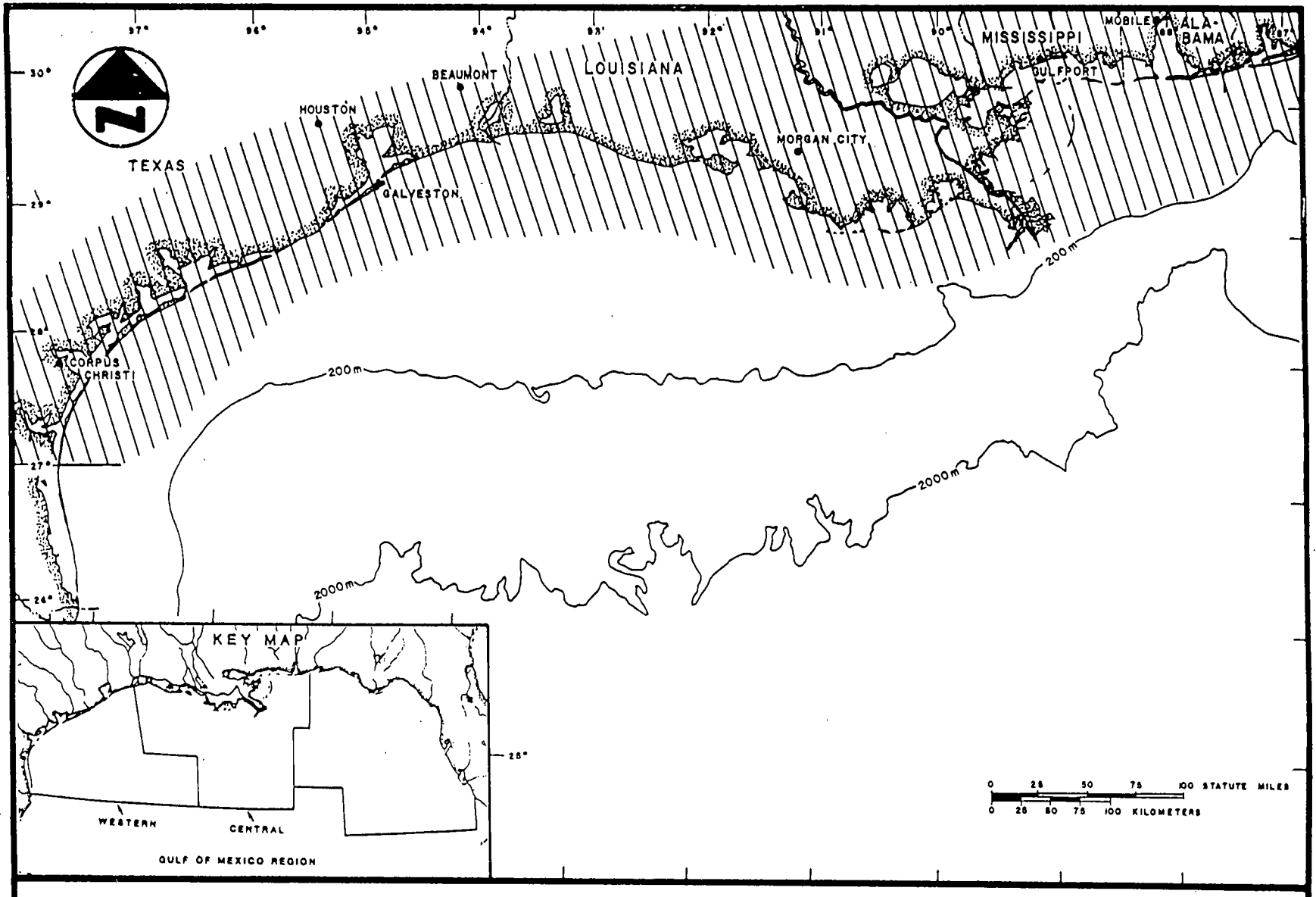
CUMULATIVE PROJECT COST: $270,465.

KEY WORDS: Straits of Florida; Eastern Gulf; Central Gulf; Western Gulf; Louisiana; Texas; Alabama; Florida; cultural impacts; exploratory drilling; development; impacts; employment; expenditures; labor.



STUDY AREA FOR ANALYSIS OF INDICATORS FOR SOCIOECONOMIC IMPACTS DUE TO OIL AND GAS DEVELOPMENT IN THE GULF OF MEXICO.

ACCESS NUMBER:30178



STUDY AREA FOR ANALYSIS OF INDICATORS FOR SOCIOECONOMIC IMPACTS DUE TO OIL AND GAS DEVELOPMENT IN THE GULF OF MEXICO.

ACCESS NUMBER:30178

CULTURAL RESOURCES

All Federal agencies are required to ensure that Federal undertakings affecting properties included in, or eligible for inclusion in, the National Register of Historic Places be submitted to the Advisory Council on Historic Preservation for review and comment prior to the agency's approval of any such undertaking. To determine whether properties eligible for the National Register will be affected by proposed lease offerings, Executive Order 11593 requires Federal agencies to locate, inventory, and nominate properties under their jurisdiction or control to the National Register. On the OCS, compliance with this legislation has been accomplished by taking a protective stance based on avoidance of areas potentially containing significant cultural resources. To carry out such a program, predictive models for uninventoried cultural resources are a basic management tool built into MMS's cultural resource management program. These predictive models are generated by using information on site locations from extensive literature searches and through comparison with terrestrial site analogues.

REPORT TITLE: Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf. Vols. I through III.

MMS PUBLICATION NUMBER: Contract No. 08550-MU5-40.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: In 1974, the Interagency Archeological Services Division in conjunction with the U.S. Department of the Interior initiated investigations of potential impacts of offshore oil and gas leasing activities on submerged archeological resources. From these studies, it was surmised that each lease block need not be surveyed intensively, but that a system should be developed to identify areas of probable cultural resource occurrence (e.g., shipwreck and prehistoric human habitation sites). This information would allow managers to develop site-specific archeological hazards surveys in areas such as the Gulf of Mexico before damage from exploration activities occurred.

OBJECTIVES: (1) To identify potential aboriginal habitation sites based on particular geological indicators on the Outer Continental Shelf (OCS) and coastal geology and prehistoric archeology from the Gulf of Mexico; (2) to locate probable and existing shipwreck sites; (3) to develop a map of cultural resource zones for the OCS; and (4) to recommend search and recovery procedures for shipwrecks and submerged habitation sites.

DESCRIPTION: A review of pertinent literature concerning Quaternary geology, prehistoric archeology, and shipwreck archeology was completed. From the geological synthesis, geometric models of frequently occurring coastal physiographic features were developed and used to classify and identify similar but relict features on the OCS. The late Quaternary was investigated using maps and published descriptions to locate particular relict physiographic units. The eustatic sea, isostatic, and tectonic compounds of level fluctuations that resulted in the exposure of habitable area were studied. For prehistoric archeology, the Gulf of Mexico was divided into eastern, central, and western areas. From archeological literature concerning land areas, cultural manifestation (time and type) were identified and used to predict the occurrence of similar features on shelf areas that were concurrently exposed. Cultural manifestations were investigated for index artifacts, environmental use patterns, and particularly land forms favored as habitation sites. An inventory of known archeological sites, occupied from 55,000 to 3,500 years BP and covering all three regions, was completed for Preprojectile Point, Paleo-Indian, Archaic, and Poverty Point periods. To assess the occurrence and distribution of shipwrecks, all information (maps, charts, logs, and literature descriptions) from colonial settlement to World War II (1500 to 1945) was examined. Several criteria based on destinations, home ports, and routes of ships traversing the Gulf of Mexico were used to select usable records of shipwreck occurrence. Finally, present methods of site-specific cultural resource surveys were described and improvements in protocol were recommended.

SIGNIFICANT CONCLUSIONS: Some relict landforms can be used as indicators of cultural resource presence, consequently, once located, they should be considered high probability areas. Survey techniques included direct observation by diving archaeologists and remote sensing techniques that search for characteristic signatures. Site-specific surveys should

employ tight line spacing, and towing speeds should not be more than 6 kn. Records from archeological surveys should be periodically reviewed by a panel of qualified archaeologists. More detailed pilot studies are recommended to develop appropriate methodology for site-specific surveys. There is a shortage of qualified marine archaeologists to meet the growing survey needs of the offshore oil and gas industry. Two thirds of the total shipwrecks located occurred within 1.5 km of the coast; most of these ships sank during the 19th century and the most important group was from the 16th, 17th, and 18th centuries.

STUDY RESULTS: Eleven geomorphic landforms were identified as high probability cultural resource sites. These 11 discrete site indicators were: quarries, salt domes, springs (sinkholes), valley margins, natural levees, point bars, bay margins, coastal dune lakes, shell middens, conical earth mounds, and crescentic an circular villages. These sites were assigned characteristic signatures based on location, artifacts, fossil remains, and geomorphology to facilitate their location on the OCS. Culture periods or stages were classified as: Poverty Point, Late Archaic, Middle Archaic, Early Archaic, Paleo-Indian, Pre-Fluted Point. The occurrence of site type by cultural stage was investigated, indicating that: all 11 sites probably occurred during the Poverty Point and Late Archaic periods; all sites except crescentic and circular villages also occurred during the Middle Archaic period; and shell middens, conical earth mounds, and crescentic and circular villages did not occur during the Early Archaic, Paleo-Indian, or Pre-Fluted Point periods. Confirmation of one of these sites should rely on direct observation and remote sensing techniques. Remote surveys should include fathometer, subbottom profiler, side-scan sonar, and sampling for artifacts should employ box, bucket, corer, drag, and grab samples. Still photography and video tapes should be taken in conjunction with diver observations at verified sites.

An estimated 2,500 to 3,000 shipwrecks were confirmed for the region; about 70% of these wrecks were from the 19th century and the remaining, more historically significant wrecks were from the 16th, 17th, and 18th centuries. Two thirds of the total number of wrecks were found within 1.5 km of the coastline in the northern Gulf of Mexico; another 500 wrecks were located between 1.5 and 10 km from the coastline. Other debris, including military ordnance and discarded materials from fishing and offshore petroleum activities were found on the shelf. Magnetometers are the best remote sensing instruments for detecting shipwrecks and submerged debris. Side-scan sonar and subbottom profilers should augment a shipwreck survey. When not precluded by depth, direct observation by diving archaeologists is strongly recommended when investigating a wreck site. From the interpreted ages of relict land forms and shipwreck distributions, a zone map was developed for the northern Gulf OCS. Zone 1 includes areas of high probability for prehistoric cultural remains from 12,000 to 3,000 years BP. The seaward limit of Zone 2 delimits the extent of Paleo-Indian habitation sites. The seaward limit of Zone 3a lies on the maximum low stand of sea level during the Wisconsin glacial stage. Zone 3b includes a series of banks probably exposed during the Wisconsin maximum low stand. Zone 4 displays relict shoreline features in water depths of 90 to 200 m of uncertain age.

STUDY PRODUCT(S): Coastal Environments, Inc. 1977. Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf. Vol. I, Prehistoric Cultural Resource Potential. A final report for the U.S. Department of the Interior, National Park Service,

Office of Archeology and Historic Preservation. NTIS No. PB276773/AS. Contract No. 08550-MU5-40. 361 pp.

Coastal Environments, Inc. 1977. Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf. Vol. II, Historical Cultural Resources. A final report for the U.S. Department of the Interior, National Park Service, Office of Archeology and Historical Preservation. NTIS No. PB276774/AS. Contract No. 08550-MU5-40. 171 pp.

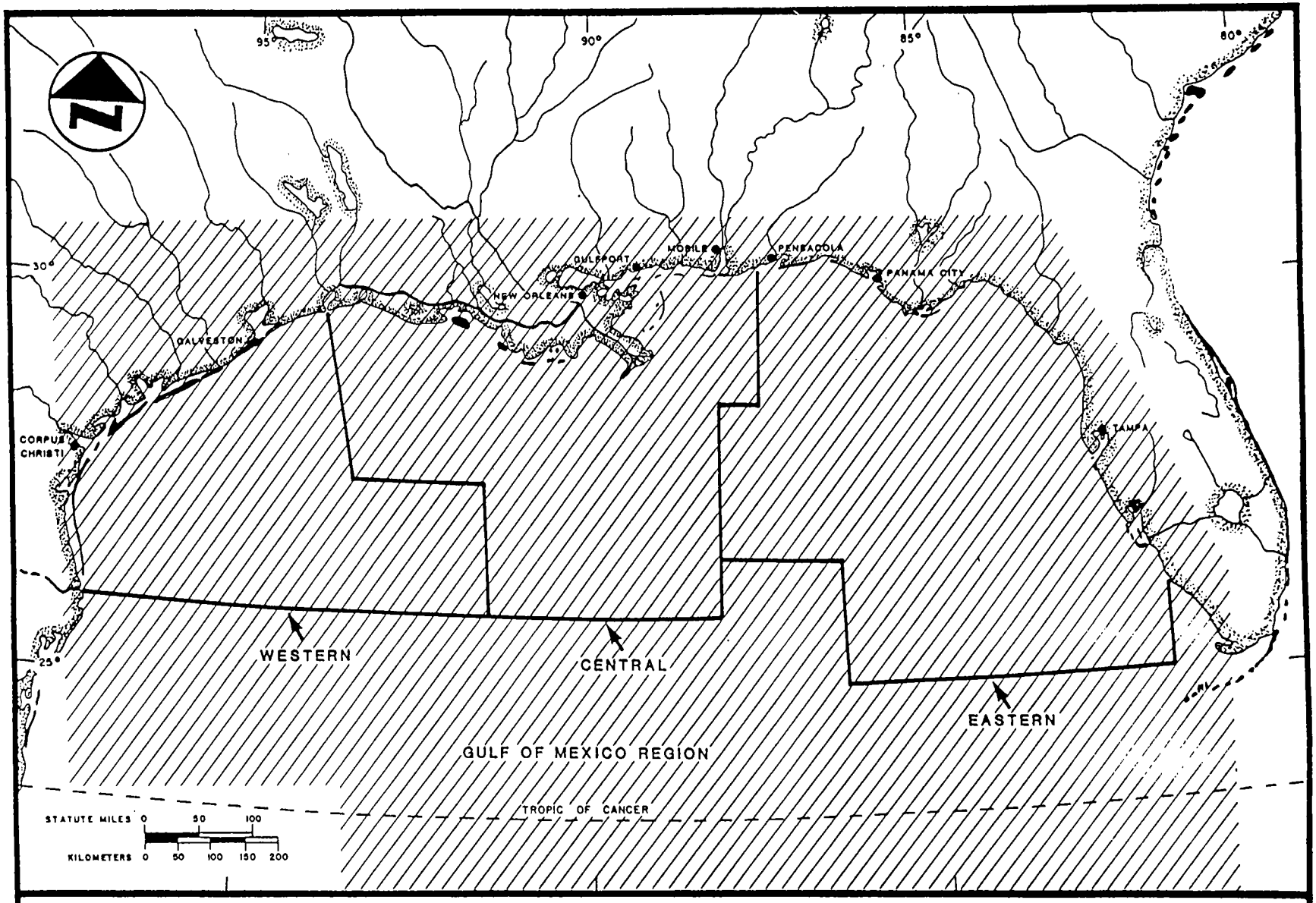
Coastal Environments, Inc. 1977. Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf. Vol. III, Maps. A final report for the U.S. Department of the Interior, National Park Service, Office of Archeology and Historic Preservation. NTIS No. PB286874/AS. Contract No. 08550-MU5-40.

STUDY TITLE: Gulf of Mexico OCS Cultural Resources Sensitivity Zone Mapping.

COMPLETION DATE OF REPORT: 1977.

CUMULATIVE PROJECT COST: $500,000.

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; cultural resources; archeology; geology; shipwrecks.



STUDY AREA FOR SHIPWRECK SITE COMPILATION AND CULTURAL RESOURCES EVALUATION OF NORTHERN GULF OF MEXICO.

ACCESS NUMBER:MU6-40

INFORMATION MANAGEMENT

Since the inception of the Environmental Studies Program, more than $136 million has been invested in the Gulf of Mexico for obtaining environmental data and information necessary for Federal oil and gas management activities. This considerable body of study reports available at present occupies some 60 feet of shelf space, encompassing literally millions of pieces of data. Information management occurs at several different levels; information development occurs at the synthesis level, where separate comparisons, presentations, and analyses from a broad region are integrated into broad characterizations; at the management tool level, source level and synthesis level technical information is integrated with law, regulations, and policy to produce the everyday working documents of the agency.

REPORT TITLE: Bibliography of Benthic Studies in the Coastal and Estuarine Areas of Florida.

MMS PUBLICATION NUMBER: Contract No.14-12-0001-29037.

APPLICABLE PLANNING AREA(S): South Atlantic; Eastern Gulf of Mexico.

STUDY TITLE: Review and Annotated Bibliography of Benthic Studies in the Coastal and Estuarine Areas of Florida.

COMPLETION DATE OF REPORT: August 1984.

CUMULATIVE PROJECT COST: $9,981.

KEY WORDS: South Atlantic; Eastern Gulf; Florida; benthos; bibliography; estuarine; sediment; algae; macrophytes; coral reef; macrofauna; meiofauna; fish; intertidal; subtidal; pollution; impacts.

BACKGROUND: Benthic ecology, the study of bottom dwelling flora and fauna, has flourished in the State of Florida in the last two decades. The abundance and diversity of benthic habitats in and around the State and the pressures of water use and waterfront development have both contributed to the advancement of research in this field. Almost 75% of the research on benthic habitats and organisms conducted in the last decade has been done to either evaluate or mitigate an environmental problem. The State of Florida's Department of Environmental Regulation has enacted a "biological integrity" rule which utilizes the relative health of benthic communities as a criterion for regulating dredge and fill activities. Seagrasses, intertidal wetlands, oyster reefs, and hard-bottom patch reefs are routinely considered as valuable benthic habitats, and activities in these habitats are stringently regulated by local, State, and Federal agencies. Soft-bottom habitats and their fauna, although studied more extensively, do not enjoy the same protection, but are used as excellent indicators of various types of pollution. The utility of benthic communities in the assessment of various types of pollution is definitely recognized; time factors and the lack of ease in obtaining historical information have often hampered utilization of benthic data for pollution assessment. Over 70% of benthic information from Florida is in the form of technical reports and unpublished material. This report provides a compilation of all published and most unpublished literature of benthic studies in coastal and estuarine waters of Florida through 1982. Project funding support was provided jointly by the Florida Sea Grant College, Minerals Management Service, and Mote Marine Laboratory. Partial funding support for publication was provided by the State of Florida Department of Environmental Regulation, Office of Coastal Management, and State of Florida Department of Natural Resources, Bureau of Marine Research.

OBJECTIVES: (1) To provide an annotated bibliography of papers and reports on benthic studies relevant to Florida; (2) to provide a compilation of methodological references; and (3) to provide citations of taxonomic descriptions and identification keys which are relevant to marine and esruarine benthos of Florida.

DESCRIPTION: This bibliography includes all available literature on the benthos (and its environment), except freshwater benthos, through the year 1982. Study geographic limits were: all of the continental shelves bordering Florida (Atlantic and Gulf of Mexico) and all estuaries and bays within Florida. All benthic components (sediments, algae, macrophytes, coral reefs, macrofauna, meiofauna, microfauna, and demersal fishes) were included in the bibliography. Both intertidal and subtidal environments were included. Literature search was accomplished by the following means: (1) computer searches on various biological and earth science data bases (Aquaculture, Aqualine, Aquatic Sciences and Fisheries Abstracts, Biosis Previews, CA Search, Comprehensive Dissertation Index, Enviroline, NTIS, Oceanic Abstracts, Pollution Index, Scisearch, SSIE, Current Research); (2) search of individuals', universities', and agencies' libraries; (3) personal and letter contact with private organizations and individuals; and (4) interlibrary loans. This document is divided into four parts. Part A provides a general introduction to the report with a brief review and summary of existing benthic studies in coastal and estuarine areas of Florida. Part B provides an annotated bibliography of published and unpublished reports relevant to Florida. Part C provides a selected compilation of methodological references considered to be useful for benthic studies. Part D Provides citations of taxonomic descriptions and identification keys which are relevant to Florida marine and estuarine benthos.

SIGNIFICANT CONCLUSIONS: Benthic studies in Florida have generally addressed the following aspects of the science: fisheries, pollution, baseline studies, species-specific studies, checklists, and method studies. Bays, estuaries, and embayments have been studied for their importance as nursery areas. More emphasis needs to be placed on methodology in sample collection and analysis to enhance consistency and scientific credibility of benthic studies. Available taxonomic references are scattered in the literature; there is a need for well organized taxonomic guides.

STUDY RESULTS: Benthic studies in Florida have generally emphasized benthic fisheries, pollution effects, baseline studies, species-specific studies, checklists, or methodological studies. Several studies have concentrated on benthic fisheries in Florida, especially on pink shrimp, oysters, blue crabs, stone crabs, and clams. Many studies have assessed and evaluated pollution effects, especially from power plants, dredge and fill projects, sewage discharges, and stormwater runoff. Other types of pollution have also been studied, such as petroleum, pesticides, metal, and pulp mill effluents. Several background characterizations or baseline studies have been sponsored in anticipation of development activities. Numerous species-specific studies have been conducted primarily as research theses or dissertations of Florida universities. Several checklists, field guides, and taxonomic descriptions have been prepared. Many methodological studies have been conducted, especially as they relate to construction. Bays, estuaries, and embayments have been studied intensively for their importance as nursery areas particularly Tampa, Biscayne, Escambia, and Apalachicola Bays. Charlotte Harbor is the least studied major estuary in Florida. Studies are generally concentrated in areas where universities, marine laboratories, or National Parks exist, or where development pressures are heavy.

Utilizing adequate methodology in sample collection is probably the most important factor in scientific credibility of a study. Many studies did not adequately consider replication, sieve size, taxonomic grouping, statistical analyses, physical factors, and substrate characteristics. Many community-type studies did not contain adequate discussions of life

history characteristics and/or ecological roles of even the dominant species. The compilation of methodological references is included to provide consistency to benthic studies.

Taxonomy adequacy is important in benthic studies; ecological surveys need accurate taxonomy for a reasonable assessment of the environment. Available taxonomic references are scattered in the literature and need to be organized into guides. Few taxonomists are practicing in Florida; therefore, few taxonomic studies of Florida estuarine and coastal fauna are being conducted.

STUDY PRODUCT(S): Mahadevan, S., J. Sprinkel, D. Heatwole, and D. H. Wooding. 1984. A Review and Annotated Bibliography of Benthic Studies in the Coastal and Estuarine Areas of Florida. A final report by Mote Marine Laboratory for the U.S. Department of the Interior, Minerals Management Service, Washington, D.C. Florida Sea Grant College Report No. 66. Contract No.14-12-0001-29037. 576 pp.

STUDY TITLE: Review and Annotated Bibliography of Benthic Studies in the Coastal and Estuarine Areas of Florida.

Map #29037 Unavailable.

REPORT TITLE: The Mississippi, Alabama, Florida, Outer Continental Shelf Baseline Environmental Survey MAFLA 1977/1978.

MMS PUBLICATION NUMBER: Contract No. AA550-CT7-34.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico.

BACKGROUND: In 1974, the U.S. Department of the Interior initiated comprehensive marine environmental surveys of the Outer Continental Shelf (OCS) off Mississippi, Alabama, and Florida (MAFLA). Data were collected for three years to establish a baseline from which to evaluate effects of oil and gas activities in the MAFLA region. This report comprises the final year (1977/1978) results and overall program synthesis.

OBJECTIVES: (1) To determine concentrations of high molecular weight hydrocarbons and selected trace metals in the water column, sediments, and selected benthic macrofauna; (2) to continue seasonal studies of benthic infauna, meiofauna, and foraminifera; (3) to continue histopathological studies to determine tissue conditions of selected benthic macrofauna; and (4) to collect samples and conduct analysis supportive of benchmark data interpretation.

DESCRIPTION: The study area was the MAFLA OCS in the eastern Gulf of Mexico, bounded by 81°30' to 89°W long, and 25°30' and 30°15'N lat. Four cruises were carried out during 1977/1978: August-September 1977, October-November 1977, and February 1978. Sample depths ranged from 10 to 200 m.

Temperature and salinity were recorded using salinity/temperature/depth systems, water samplers, and reversing thermometers. Transmissometers and photometers were used to detect water clarity and light penetration. A box corer (21.3 x 30.5 x 43.2 cm) was used to obtain sediment samples 600 cm^2 in surface area and of 40 cm depth. A 10-m semi-balloon trawl and a rectangular dredge (97 cm x 41 cm) were used to collect macroepifauna and demersal fishes. Forty-nine box core stations and 17 dredge and trawl samples were taken along eight transects. Sediment samples were analyzed for grain size, percent carbonate, clay mineralogy, total organic carbon (TOC), adenosine triphosphate, hydrocarbons, trace metals, foraminifera, meiofauna, and macrofauna. Macroepifauna, zooplankton, and demersal fishes were identified and then analyzed for hydrocarbons and trace metals [with and without barium (Ba) and vanadium (V)] using gas chromatography, atomic absorption spectrophotometry, and neutron activation analysis, respectively. Water samples were analyzed for suspended sediment mineralogy, particulates, trace metals (with and without Ba and V), particulate hydrocarbons, dissolved hydrocarbons, particulate organic carbon, dissolved organic carbon, and salinity. Tissue samples were analyzed from various macroepifaunal groups using standard histological techniques.

Data from the MAFLA surveys were subjected to various univariate and multivariate statistical analyses. Descriptive statistics were obtained, then multivariate techniques (cluster analysis, principal components analysis, stepwise discriminant analysis, and canonical analysis) were used. A suite of resemblance measures and diversity indices were used to determine species associations and community parameters.

SIGNIFICANT CONCLUSIONS: Ecological, histophathological, and histochemical evidence indicated that the MAFLA area was pristine and healthy. In many parts of the MAFLA region, sediments were essentially free of any detectable petrogenic or anthropogenic hydrocarbons, and the water column showed only biogenic sources. Sediment and water column trace metal levels were low and reflected animal tissue levels.

STUDY RESULTS: The Mississippi River and Loop Current are major oceanographic influences in the MAFLA area. The Loop current is variable, causes short-term changes in vertical temperatures, and tranports tropical larvae and trace metals into the area. The water column is often stratified in the northern portion of the study area and more variable over the west Florida shelf. The shelf off Mississippi and Alabama is dominated by fine sediments with low carbonate content. The Mississippi River is the major source of these fine sediments. The west Florida shelf has little active sedimentation with predominantly carbonate sand offshore and quartz inshore. The two sediments intermix in the vicinity of Cape San Blas.

MAFLA area sediments were grouped into three geochemical provinces based upon hydrocarbon source. No evidence of anthropogenic or petrogenic hydrocarbons was found in nearshore area (<50 m) of the west Florida shelf. Deeper sections were characterized by accumulations of fine sediments and high TOC. The Alabama-Mississippi shelf showed traces of petrogenic content.

Trace metal pollution was not detected for any station. Metals analyzed were representative of possible pollutants associated with crude oil and offshore construction activities. Sediment trace metals increased offshore and to the northwest. Regression analysis indicated that the effects of independent variables on concentrating trace metals was % fines > TOC > $CaCO_3$. Trace metals in demersal fishes were related to bioavailable trace metals in sediments. Dusky flounder (*Syacium papillosum*) had trace metal concentrations related to ambient sediment concentrations. Generally, trace metal values were low in the water column, sediments, and animal tissues.

Foraminiferans increased in abundance offshore and to the north resulting in a positive correlation with fine sediments. Sources of stress were apparently natural (salinity, temperature, or sedimentology). Meiofauna exhibited an extremely patchy spatial and seasonal distribution throughout the MAFLA area. Abundances were moderately correlated with sediments. Taxonomic problems made meiofauna poor indicators of environmental stress. Species diversity and density of infaunal species (60% polychaetes) decreased offshore and to the west. Macroepifauna also followed the pattern of decreasing diversity in an offshore direction. A total of 292 fish species were collected. Pattern analyses revealed fish species groups to be aligned along the 40-m, 100-m, and 200-m isobaths. About 400 taxa of zooplankton were recorded from the MAFLA area. Oceanic, slope, and shelf species interchanged on the west Florida shelf but no coastal species were collected.

No occurrences of pathology were found. The MAFLA area was considered generally healthy and an excellent region for conducting monitoring studies before, during, and after oil and gas exploration and development activities.

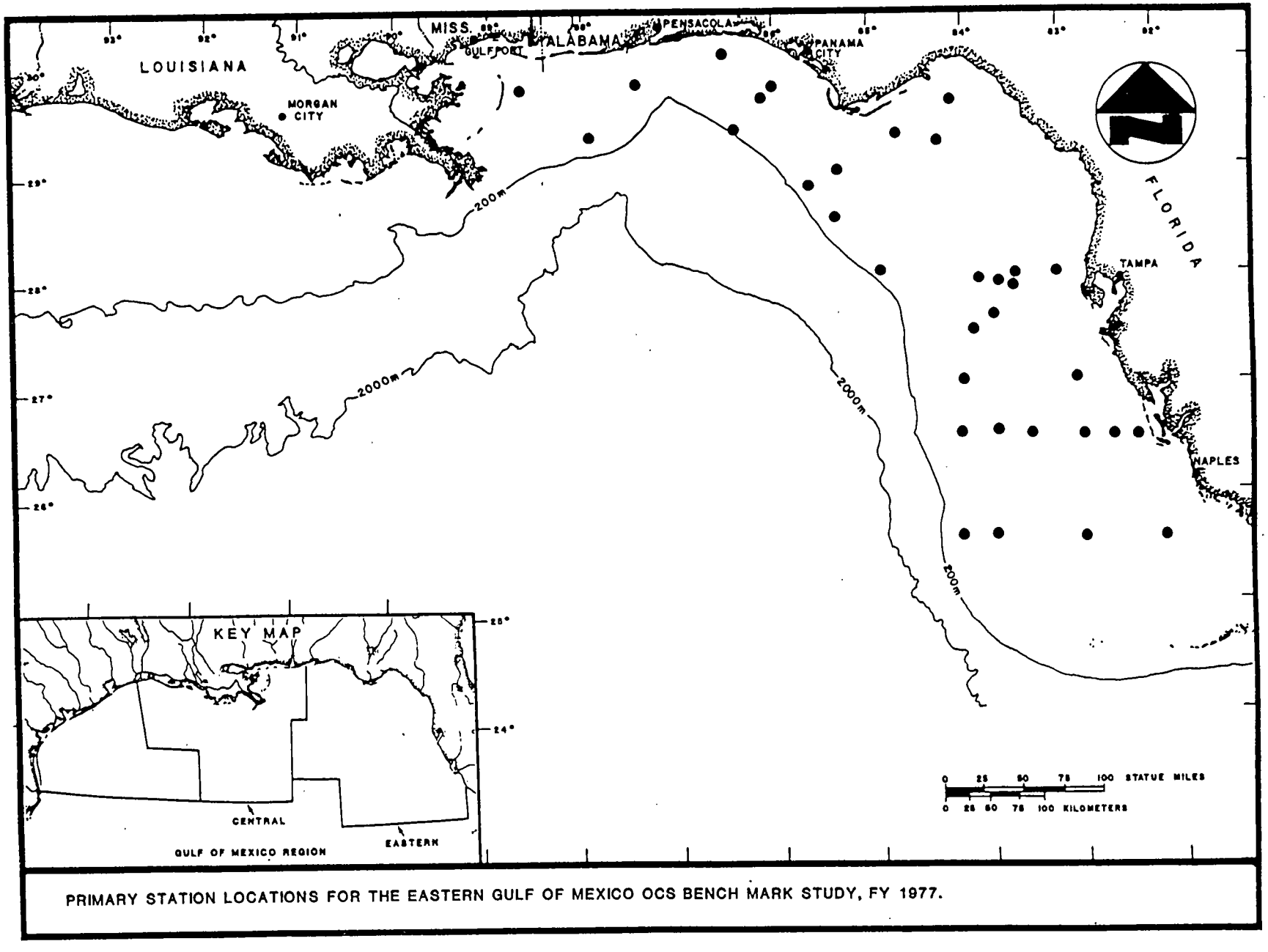
STUDY PRODUCT(S): Dames and Moore. 1979. The Mississippi, Alabama, Florida, Outer Continental Shelf Baseline Environmental Survey MAFLA 1977/1978. A final report to the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. Vol. IA (Program Sythesis Report) - NTIS No. PB294-277: Vol. IB (Executive Summary Report) - NTIS No. PB294-228; Vol. IIA (Compendium of Work Element Reports) - NTIS No. PB299-686; Vol. IIB (Compendium of Work Element Reports) - NTIS PB299-687. Contract No. AA550-CT7-34.

STUDY TITLE: Eastern Gulf of Mexico OCS Benchmark Study.

COMPLETION DATE OF REPORT: January 1979.

CUMULATIVE PROJECT COST: $3,783,010.

KEY WORDS: Eastern Gulf; Mississippi; Alabama; Florida; baseline; benchmark; biology; hydrocarbons; trace metals; water column; sediment; tissue; macrofauna; meiofauna; histopathology; hydrography; fish; epifauna; Loop Current; shelf; seasonality; diversity.



PRIMARY STATION LOCATIONS FOR THE EASTERN GULF OF MEXICO OCS BENCH MARK STUDY, FY 1977.

ACCESS NUMBER: 29041

REPORT TITLE: Taxonomic Guide to the Polychaetes of the Northern Gulf of Mexico.

MMS PUBLICATION NUMBER: Contract No. 14-12-0001-29091.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico.

BACKGROUND: Biological baseline studies carried out on the Gulf of Mexico Outer Continental Shelf (OCS) routinely include infaunal samples taken from soft substrates. Polychaete worms usually predominate these benthic samples, however, taxonomic inconsistencies preclude the incorporation of polychaete assemblages in meaningful ecological evaluations. When proper identifications allow, polychaetes are valuable as indicators of distinct faunal assemblages or environmental stress. Hence, polychaetes are of great interest to environmental managers. Recognizing the taxonomic consistency problem, the Bureau of Land Management (BLM) funded a study to standardize all polychaete identifications from major BLM OCS studies conducted in the northern Gulf of Mexico to develop a general polychaete identification guide. The study was expanded and completed under funding from the Minerals Management Service (MMS).

OBJECTIVES: (1) To provide taxonomic standardization and develop an identification guide for polychaetes collected during major BLM/MMS projects from the northern Gulf of Mexico OCS.

DESCRIPTION: Polychaete specimens were secured from voucher collections of the following BLM/MMS studies: South Texas Outer Continental Shelf Study (STOCS), Mississippi-Alabama-Florida Study (MAFLA), Ecological Investigations of Petroleum Platforms in the Central Gulf (CTGLF), IXTOC Oil Spill Study (IXTOC), and Southwest Florida Shelf Ecosystems Study (SOFLA). A breakdown of polychaete taxa and families initially reported by each study is as follows: MAFLA: 586 taxa, 58 families; SOFLA 250 taxa, 46 families; CTGLF 158 taxa, 56 families; STOCS 312 taxa, 44 families; IXTOC 103 taxa, 36 families. Geographical coverage of these studies includes the continental shelf of the northern Gulf of Mexico from Brownsville, Texas to the Florida Keys and offshore to the 200-m isobath. Inner, middle, and outer shelf water depths were covered during the efforts of most studies. Sediment type reported for each study generally reflected geographic location; the eastern Gulf (MAFLA and SOFLA) consisted mostly of medium to coarse grained sands while the central and western Gulf (CTGLF, IXTOC, and STOCS) sediments were mostly finer sands, silts, and clays. Initially, voucher specimens obtained from the contractors of individual studies were sorted to family then re-examined by taxonomists using various microscopes and mounting techniques. Following examination and detailed taxonomic description of the material, representative specimens were deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. and any additional material was kept in the museum of Barry A. Vittor & Associates, Inc.

SIGNIFICANT CONCLUSIONS: A total of 593 polychaete taxa were recognized from the collections; 41% were new to science. The guide is an accumulation of diagnostic keys, based on external features (i.e., setae and parapodia), for the identification of polychaetes from soft bottom areas in the northern Gulf of Mexico. Numerous inconsistencies were

discovered during this project that would hinder ecological or zoogeographical analyses. Numerous animal-sediment relationships were also discerned during the course of the study.

STUDY RESULTS: The efforts of this study resulted in identification of 593 species in 228 general and 59 families. Forty one percent of the examined polychaetes were new to science or previously undescribed. Numerous misidentifications were uncovered which will improve geographical and ecological analyses. The identification guide, assembled using the reexamined material, is arranged by polychaete family, into chapters. The chapters, arranged in phylogenetic order, each treat a single family and provide diagnostic characters of the family, biological notes on the family followed by a taxonomic treatment. The taxonomic section of each chapter includes generic keys, generic diagnoses, species keys, and species descriptions. Biological notes include characteristic life history, feeding strategy, reproduction, substrate preference, tube construction, locomotion, behavior, commensalism, parasitism, and larval development are given when possible. Each species description gives a list of BLM/MMS-OCS and any supplementary material examined, a synonymy and ecological and geographical information when available. Figures are given showing distribution of species in the northern Gulf of Mexico and detailed drawings of characters useful in the identification of particular species are also provided. In addition, figures are given showing the distribution of species in the northern Gulf of Mexico.

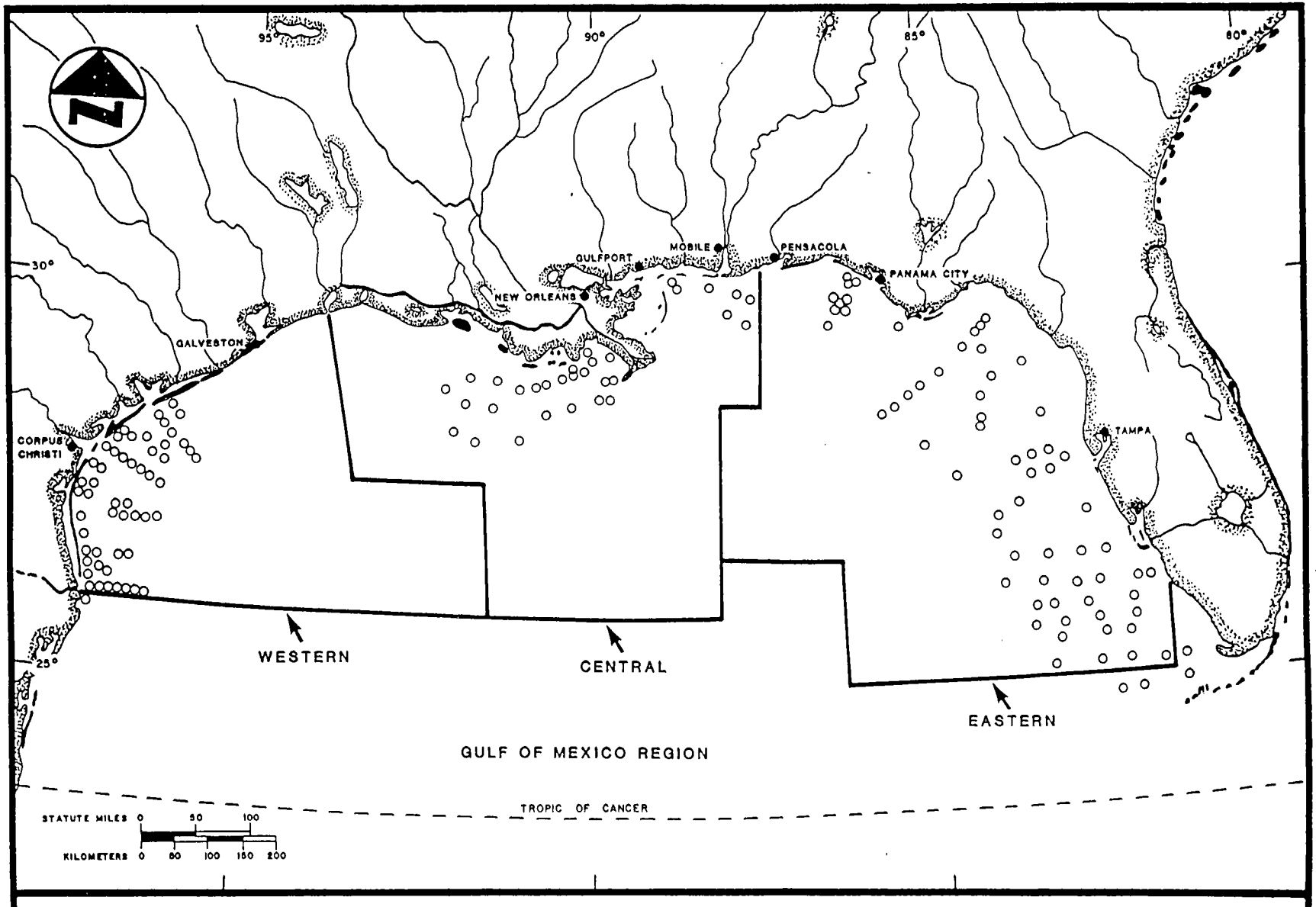
STUDY PRODUCT(S): Uebelacker, J. M. and P. G. Johnson. 1984. Taxonomic Guide to the Polychaetes of the Northern Gulf of Mexico. A final report by Barry A. Vittor & Associates for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. Vol. I - NTIS No. PB85-150752; Vol. II - NTIS No. PB85-150761; Vol. III - NTIS No. PB85-150779; Vol. IV - NTIS No. PB85-150787; Vol. V - NTIS No. PB85-150795; Vol. VI - NTIS No. PB85-150803; Vol. VII - NTIS No. PB85-150811. Contract No. 14-12-0001-29091. 7 Vols.

STUDY TITLE: Gulf of Mexico Polychaeta Standardization Study.

COMPLETION DATE OF REPORT: 1984.

CUMULATIVE PROJECT COST: $257,602.

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; Texas; Mississippi; Alabama; Florida; Florida Keys; biology; Southwest Florida Shelf; polychaete; standardization; voucher; specimens; shelf; sediment; diagnostic key; life history.



INFAUNAL STATION LOCATIONS FROM U.S. DEPARTMENT OF THE INTERIOR OUTER CONTINENTAL SHELF STUDIES USED DURING THE GULF OF MEXICO POLYCHAETA STANDARDIZATION STUDY.

ACCESS NUMBER:29091

REPORT TITLE: Mississippi-Alabama Shelf Pinnacle Trend Habitat Mapping Study. Final Report.

MMS PUBLICATION NUMBER: Contract No. 14-35-0001-30494.

APPLICABLE PLANNING AREA(S): Eastern Gulf of Mexico; Central Gulf of Mexico.

BACKGROUND: Significant topographic features were identified during the Mississippi-Alabama Marine Ecosystem Study performed by Texas A&M University (1987-1990) in adjacent areas west of those where geophysical mapping occurred. As a result of these findings, the MMS determined a need for further geophysical mapping and biological characterizations in this western area.

OBJECTIVES: (1) To geophysically survey and map significant topographic features and substrate trends located within the study area; and (2) to characterize the biological communities associated with these topographic features.

DESCRIPTION: Data collection was divided into two separate field sampling efforts. The first field effort (Survey 1) was planned and conducted with the intent of collecting geophysical data (i.e., side-scan sonar and subbottom profiler data) throughout the entire study area. This collection procedure required 100% coverage of the seafloor within the study area using side-scan sonar to locate and plot significant topographic features. Following analysis of the geophysical data and the development of draft features and substrate maps, a second field effort took place (Survey 2). The purpose of Survey 2 was to verify the side-scan sonar target interpretations and to characterize the biological communities associated with these previously mapped features. A remotely operated vehicle (ROV) equipped with video and still cameras was utilized to conduct the biological characterizations.

The geophysical characterization survey (Survey 1) was conducted between 11 September and 10 October 1990. A total of 92 survey lines, including 86 east-west lines and 6 north-south tie lines, were investigated using side-scan sonar and subbottom profiler. Bathymetric data was collected simultaneously with the geophysical data.

The biological characterization survey (Survey 2) was conducted between 11 October and 7 November 1991. Using the data collected during Survey 1, significant and representative topographical features and substrates were selected and prioritized for investigation.

SIGNIFICANT CONCLUSIONS: Detailed maps of hard bottom, pinnacles, prominences, and sediment reflectivity were produced based on an OCS lease block grid. The presence of extensive pinnacle complexes south and southwest of the previously mapped areas of the Mississippi-Alabama shelf were confirmed and biological data on the community structure of organisms inhabitating that environment were collected. Two distinct areas of hard bottom and pinnacle features were noted which probably show differing geologic origins.

STUDY RESULTS: Two physiographically different areas of the Mississippi-Alabama shelf and slope were surveyed under this research effort. A large portion of the study area was above the shelf break which is generally considered to be the 75 m (245 ft) isobath in this

part of the Gulf. The Mississippi-Alabama shelf is divided into two sedimentary provinces. In the eastern province there is a thin, well-sorted layer of fine- to medium-grained quartzose sand transported to the shelf by rivers during the Pleistocene and early Holocene (1.6 million to 100,00 YBP). To the west, the shelf in this area is covered by a layer of fine silts, sands and clays associated with Mississippi River disposition. The present study straddles these provinces. In the east, sediment reflectivity is high and penetration poor. Toward the west where the silts and clays of the old St. Bernard Delta overlap the quartzose sediments, subbottom profiler penetration increases and bottom reflectivity drops. Buried channels are also evident in this area. A series of low-relief hard bottom features are seen at or near the shelf break in the eastern portion of the study area which appear similar to inner shelf hard bottom features described from the Alabama shelf.

Beyond the shelf break on the upper slope (75 to 400 m; 246 to 1,300 ft), two major areas of hard bottom, shelf-edge prominences were mapped. These included (1) an area of large pinnacle development between the 80 and 90 m (260 to 295 ft) bathymetric contours termed Area 1; and (2) an area of low relief hard bottom and small pinnacles or mound type features between the 110 and 130 m (360 to 426 ft) bathymetric contours termed Area 2. Pinnacles observed in the first area were large features which were seen singly or in clumps often reaching a height of 20 m (60 ft) or more above the seafloor. These features were oriented in a northwest to southwest direction and were surrounded by a sand bottom. The features seen in Area 2 were different in appearance on the geophysical record. Area 2 features were smaller in overall height than Area 1 features, although some individual features reached heights similar to the smaller features seen in Area 1. Small mound-like features were also evident which were much wider and did not show the same subbottom characteristics as pinnacle features, although they reached the same height above bottom. In addition, the general substrate in this deeper area appeared to be continuous low-relief hard bottom.

A total of 19 ROV dives were conducted at separate locations during the biological survey. Nine of these dives were in the major pinnacle area described above (Area 1), and three dives were in shallow water areas on the Mississippi-Alabama shelf above the 75 m (246 ft) depth contour. Biological communities occurring on the major pinnacles were dominated by tropical and subtropical suspension-feeding invertebrates. Communities were similar on all features investigated, but very subtle differences were noted based on individual pinnacle size. Generally, the horizontal surfaces in the upper areas of the pinnacle supported the most diverse and abundant communities. Near the base of a feature, the associated biological community was reduced both in numbers of individuals and in terms of community diversity.

No true hard bottom was seen at any of the three sites investigated above the 75 m (246 ft) contour, suggesting that these features were artifacts of side-scan sonar interpretation. Hard bottom and similar signatures were removed from the final map products produced. If these low-relief features were present and were subsequently covered by shifting sand, it is very likely that the epibiota and fishes associated with them would be minimal. Further investigations are needed to verify the possible hard bottom signatures seen in other upper shelf areas covered by this survey.

STUDY PRODUCT(S): Continental Shelf Associates, Inc. 1992. Mississippi-Alabama Shelf Pinnacle Trend Habitat Mapping Study. Final Report. A final report for the U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study/MMS 92-0026. Contract No. 14-35-0001-30494. 75 pp + app.

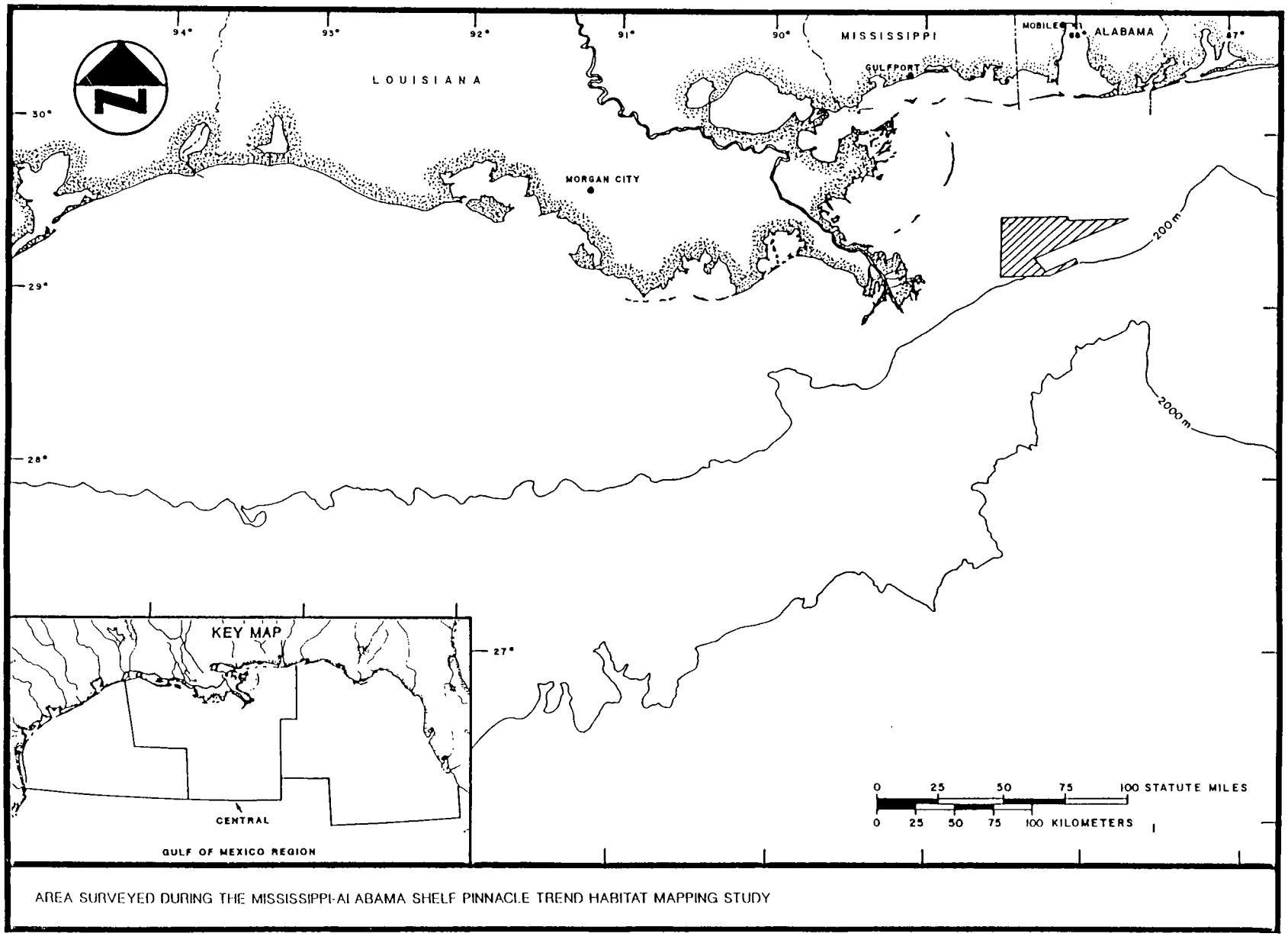
A two-part map set (scale: 1:120,000) was also prepared under this study effort.

STUDY TITLE: Mississippi-Alabama Shelf Pinnacle Trend Habitat Mapping Study.

COMPLETION DATE OF REPORT: August 1992.

CUMULATIVE PROJECT COST: $444,827.

KEY WORDS: Eastern Gulf; Central Gulf; geology; biology; pinnacles; prominences; survey; characterization; maps; abundance; diversity; community; hard bottom, ROV; side-scan sonar; substrate mapping; habitat mapping.



AREA SURVEYED DURING THE MISSISSIPPI-ALABAMA SHELF PINNACLE TREND HABITAT MAPPING STUDY

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the 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 by encouraging stewardship and 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. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.

Minerals Management Service
Gulf of Mexico OCS Region

Managing America's offshore energy resources

Protecting America's coastal and marine environments