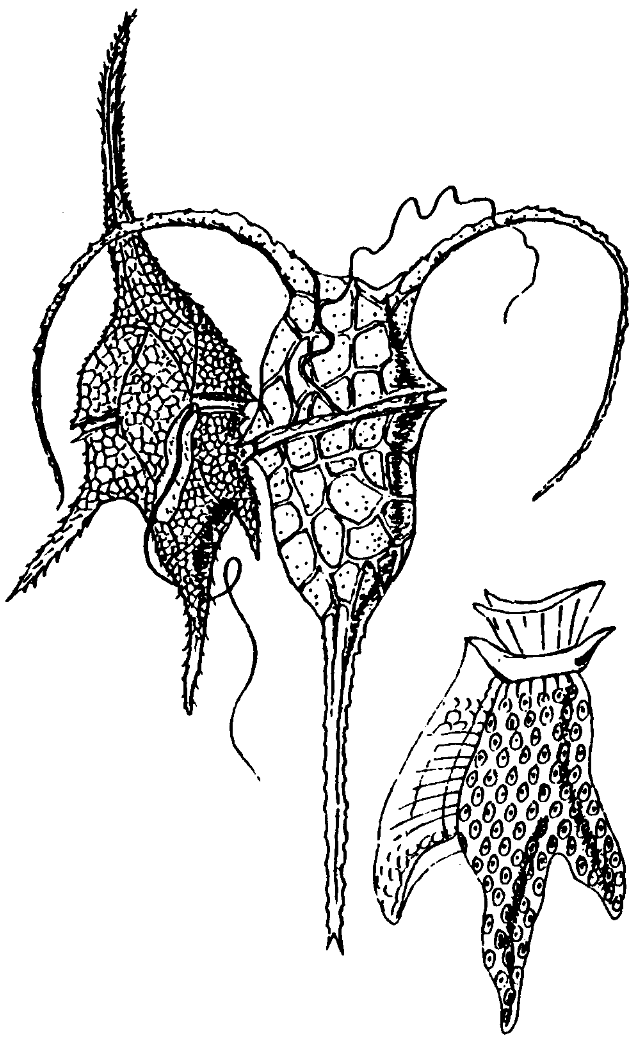
OCS Study
MMS 87-0057

Proceedings
Spring Ternary
Gulf of Mexico Studies Meeting

March 1987



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

This report has been technically reviewed according to contractual specifications. It, however, is exempt from review by the Minerals Management Service Technical Publications Unit and the Regional Editor.

OCS Study
MMS 87-0057

Proceedings
Spring Ternary
Gulf of Mexico Studies Meeting

March 1987

Minerals Management Service
New Orleans, Louisiana
March 23, 1987

Geo-Marine, Inc.
1316 14th Street
Plano, Texas 75074

Prepared under MMS Contract
14-12-0001-30305

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Regional Office

April 1987

REPORT AVAILABILITY

Preparation of this report was conducted under Contract between the Minerals Management Service and Geo-Marine, Inc. Extra copies of the report may be obtained from the Public Information Unit (Mail Stop OPS-3-4) at the following address:

Minerals Management Service
Gulf of Mexico OCS Region
U.S. Department of the Interior
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394
Attn: Public Information Unit
Phone: (504) 736-2519

DISCLAIMER

This report has been reviewed by the Minerals Management Service and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Service, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Table of Contents

MEETING SUMMARY

1.0 Introduction

On March 23 the Minerals Management Service (MMS), Gulf of Mexico Regional Office, convened the first Ternary Meeting of 1987. These public meetings are held as a forum for information exchange between interested and involved parties. This generally includes MMS personnel, representatives of various MMS funded programs, state representatives, public interest groups, other federal agencies, and invited investigators working on problems similar to or supportive of those of the MMS.

The meeting consists of a representative from most of the MMS funded programs and other invited speakers making a presentation variously defining the program goals, schedule, methodology, present status and any important or relevant insights recently developed. The meeting schedule is such that there is ample opportunity for exchange between the speakers and audience. In addition, sufficient "unallocated" time is usually available for discussion between those in attendance.

2.0 Meeting Abstracts

At the meeting each speaker provides an abstract of material to be discussed prior to the scheduled talks so that others have an opportunity to become familiar with what is to be presented. This also allows question formulation without trying to simultaneously listen to an ongoing presentation. These abstracts form the basis for this Meeting Summary Report.

Abstracts included in this volume are copies of those provided by each speaker. No adjustments have been made to the form and substance of these submissions.

This report contains the agenda, presentation abstracts, and list of attendees.

Any questions regarding presented material should be directed to the appropriate speaker. General questions regarding the Ternary Meeting or the Gulf of Mexico Environmental Studies Program should be directed to the Environmental Studies Section in the MMS Gulf of Mexico Regional Office (504-736-2897).

2.1

AGENDA

AGENDA

MINERALS MANAGEMENT SERVICE

ENVIRONMENTAL STUDIES TERNARY MEETING

MARCH 23, 1987

NEW ORLEANS, LOUISIANA

Time	Speaker	Topic
9:00 a.m.	Mr. J. Rogers Pearcy Regional Director Minerals Management Service and Mr. Ruben G. Garza Geo-Marine, Inc.	Welcome
9:05 a.m.	Dr. Evans Waddell Science Applications International Corporation	Gulf of Mexico Physical Oceanography Program
10:00 a.m.	Dr. Larry Danek Environmental Science and Engineering, Inc.	Southwest Florida Shelf Ecosystems Data Synthesis
10:45 a.m.	Dr. Benny Gallaway LGL Ecological Research Associates	Northern Gulf of Mexico Continental Slope Study
11:30 a.m.	Lunch	
1:30 p.m.	Dr. Donald Cahoon and Dr. Eugene Turner Center for Wetland Resources, Louisiana State University	Outer Continental Shelf Development and Potential Coastal Habitat Alteration Study: Project Overview and Status
2:00 p.m.	Dr. Karen Wicker Coastal Environments, Inc.	Impacts of the Outer Continental Shelf (OCS) Related Activities on Sensitive Coastal Habitats
2:30 p.m.	Dr. Charles Giammona Division of Environmental Engineering, Texas A&M University	Reevaluation of Cultural Resource Management Zone 1 in the Gulf of Mexico
3:00 p.m.	Adjourn	

2.2

EXTENDED ABSTRACTS

ABSTRACT
for the
GULF OF MEXICO
PHYSICAL OCEANOGRAPHY PROGRAM

Funded under an MMS contract with

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
Raleigh, North Carolina

Ternary Meeting
March 23, 1987
New Orleans, Louisiana

Since 1982, Science Applications International Corporation(SAIC) has been under contact with the Minerals Management Service(MMS) to conduct a multiyear, physical oceanographic field measurement program with the various program years having a differing regional emphasis. The technical objective has been to provide observations which are used to develop an improved understanding of key circulation patterns or conditions in the various areas.

The regional emphasis has been:

- Year 1, 2 and 4 in the eastern Gulf.,
- Year 3 in the western Gulf,
- Year 5 in the north central Gulf.

At present, field measurements in Years 1, 2, 3 and 4 have been completed. Year 5 observations will begin in April 1987 and continue through April, 1988. To date the available data has provided the basis for accomplishing the specific program goals.

The goal of Years 1, 2 and 4 was to develop an improved understanding of circulation on the west Florida shelf and the adjacent Loop Current. The Year 3 objective is to develop an improved understanding of the western Gulf circulation especially as it relates to Loop Current eddies and their interaction with the western Gulf continental slope. The Year 5 objective is to document circulation patterns and related processes on the shelf, slope and rise offshore of Louisiana. This latter includes measuring not only the circulation and hydrographic characteristics, but also aspects of the marine optical environment

The Final Report for Years 1 and 2 was submitted in February 1986 with the Year 4 addendum to that report submitted in February 1987. Interpretation and synthesis of the Year 3 data base is ongoing and providing unique insights to the western Gulf dynamics. A submission date for a Year 3 final report has not been established, however it is expected to be toward the end of 1987.

A summary of key eastern Gulf measurement sites and associated observations is presented in Figures 1 and 2a,b. The primary variables measured in the eastern and western Gulf included:

- Subsurface Currents
- Hydrographic Surveys
- Drifting Buoys
- Satellite Imagery
- Ship of Opportunity Data

The Year 3 quick response measurement scheme was based on a probable scenario for breakoff and westward translation of a Loop Current eddy. In this case, "playing the odds" paid off and a uniquely comprehensive multivariate database has been developed. This happened only as a result of the effort and cooperation of several entities. An essential element was the support and cooperation of the Mexican Navy and Capt. A. Vazquez in particular. The fundamental importance of this cooperative effort is clearly indicated by the mooring locations and the area encompassed in the several hydrographic cruises e.g. Figure 3.

The tentative subsurface mooring sites for Year 5 are shown in Figure 4. On two of four shelf cruises, hydrographic observations will be supplemented by a suite of marine optical measurements. These latter cruises will focus on the Mississippi River spring flood discharge as it moves westward on the Louisiana shelf, and on the winter well mixed conditions. Drifting buoys will characterized and document Loop Current eddies which may move along the northern slope as they migrate westward. Satellite imagery will provide synoptic information for cruise planning as well as independent realizations of the surface thermal which will be used in explaining the observed circulation patterns. The MMS Inverted Echo Sounders(IES) will provide information and verification of the passage of major thermal features such as eddies. This is particularly important during summer when surface thermal gradients disappear.

The Year 4 Final Report(Addendum) identified and discussed several important west Florida shelf(WFS) and Loop Current circulation patterns. On the WFS inertial currents are a major contributor to shelf kinetic

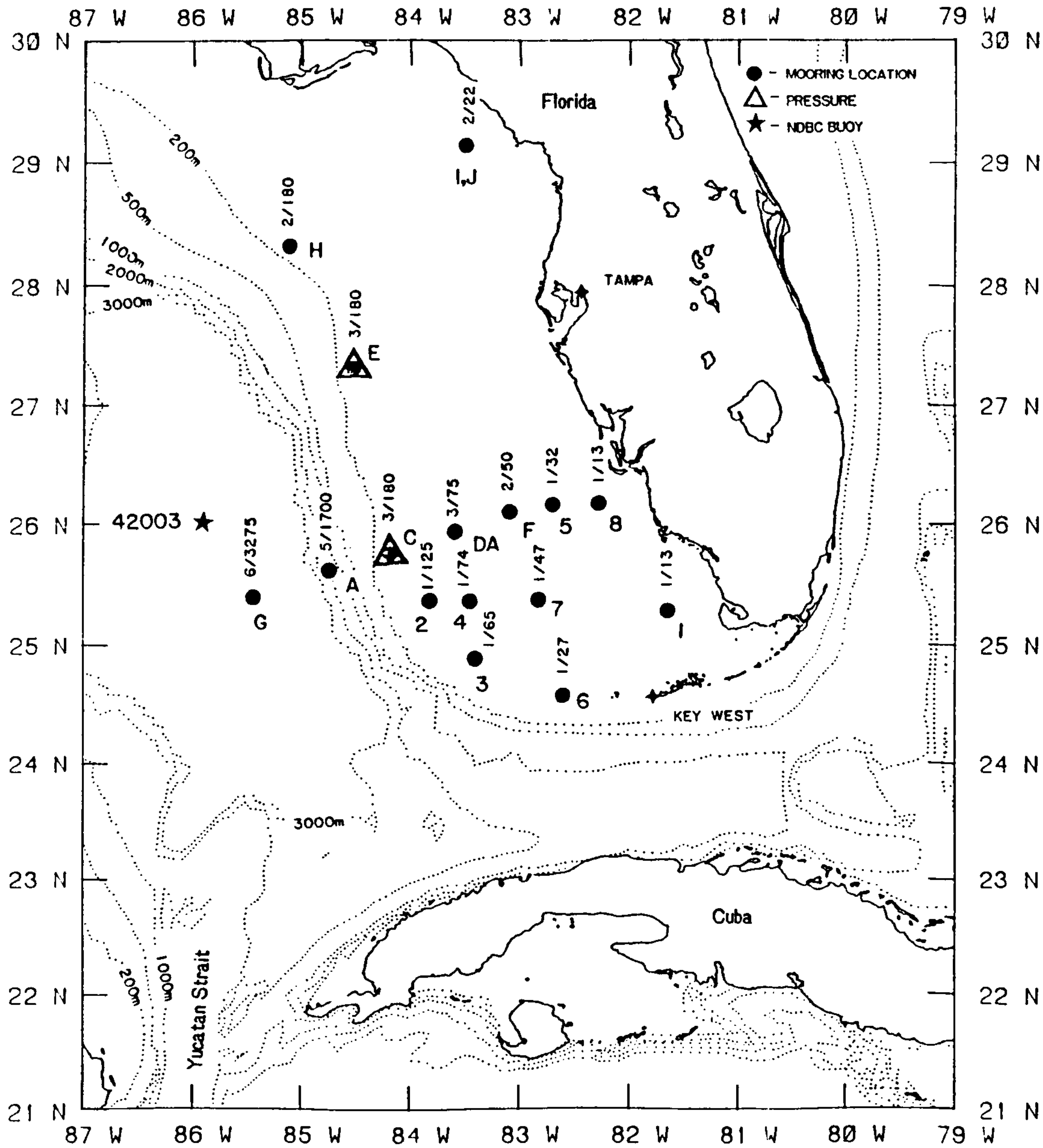


Figure 1. Locations of subsurface current moorings. Moorings A-J were associated with the eastern Gulf physical oceanography program. Mooring H was taken as part of a joint MMS/NFS funded program involving Dr. W. Sturges. Moorings I and J were provided to SAIC by MMS. Moorings 1-8 were near-bottom instruments maintained by ESE as part of their MMS-funded southwest Florida shelf ecological study.

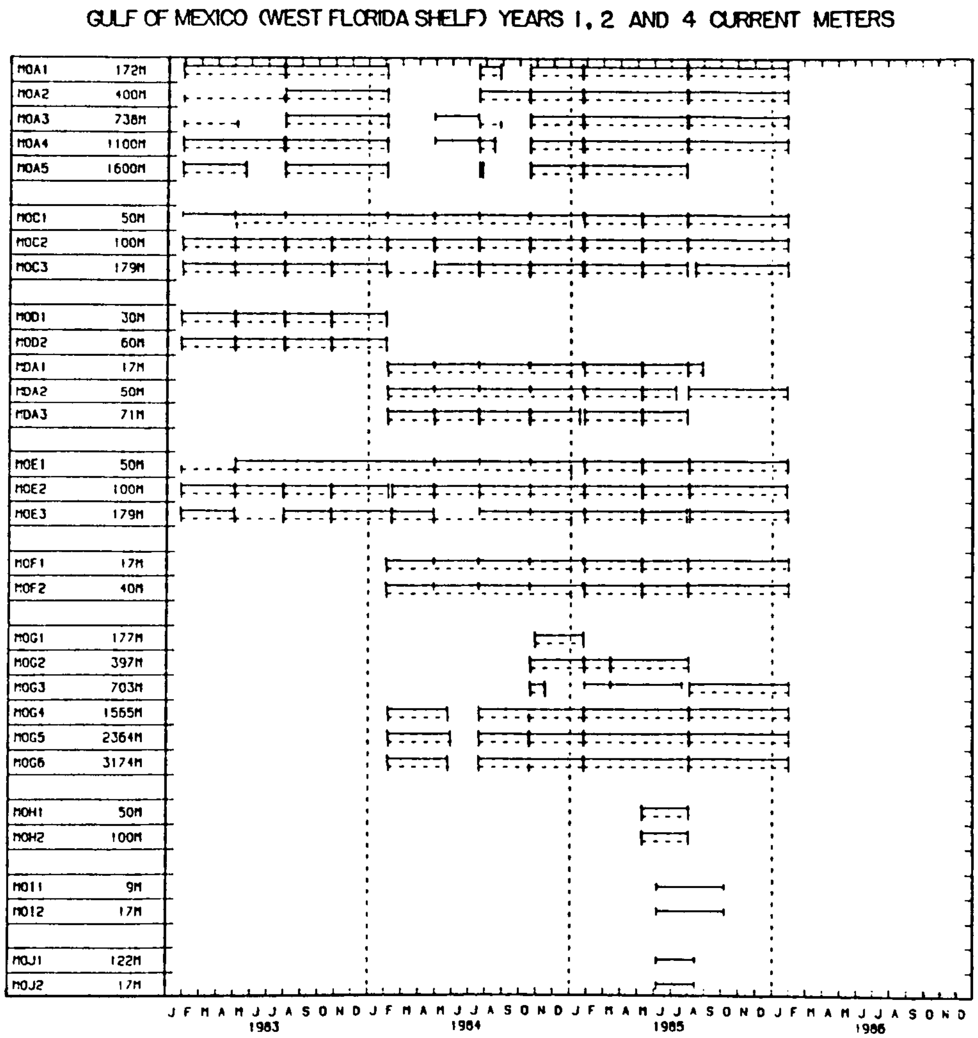


Figure 2a. Time line for subsurface current measurements used during the three eastern Gulf years. See Figure 1 for a location reference. Figure 2a are the measurements primarily associated with the PO Program. Figure 2b are the ESE data. In both figures, the solid line represents a good current speed and direction taken and the dashed line indicates a good temperature time series was taken.

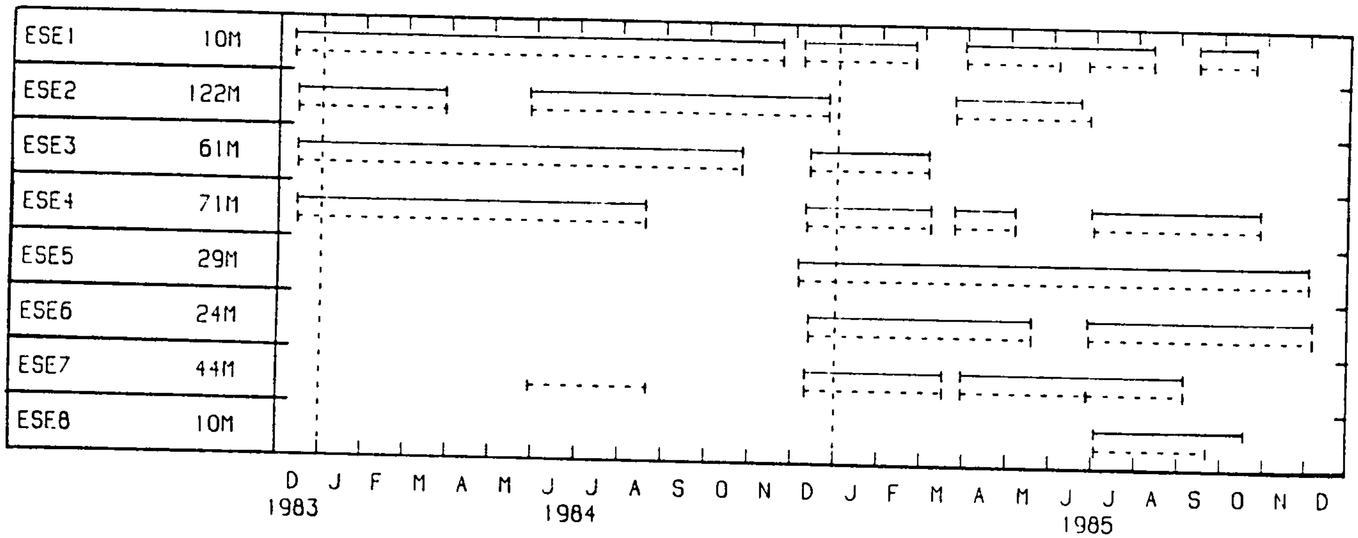


Figure 2b. See caption for Figure 2a.

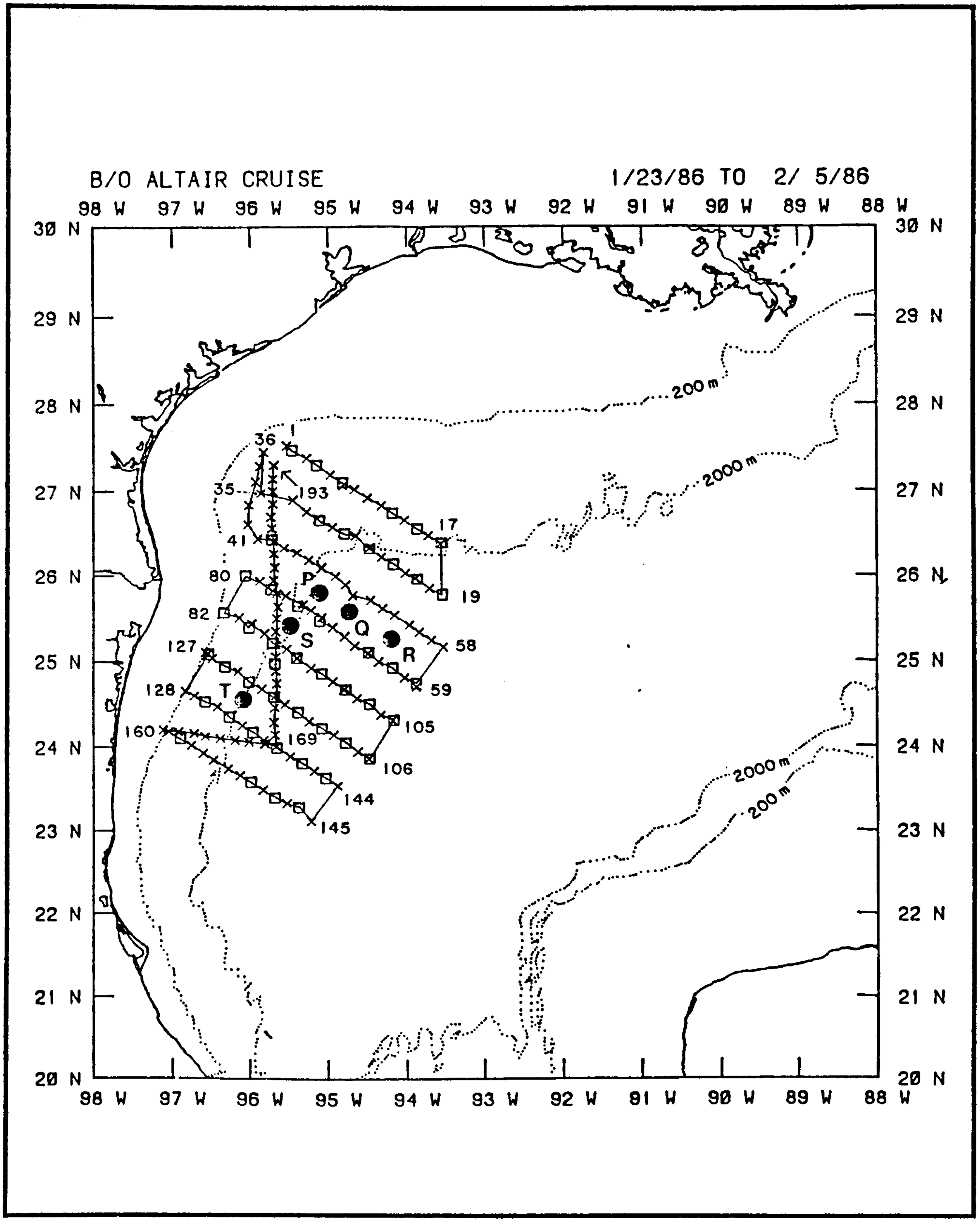


Figure 3. Mooring and selected cruise station locations during the Year 3,western Gulf measurement program. Note that north to south, the along shelf moorings are P, S and T. The isobath normal moorings are P, Q and R going from shallower to deeper water.

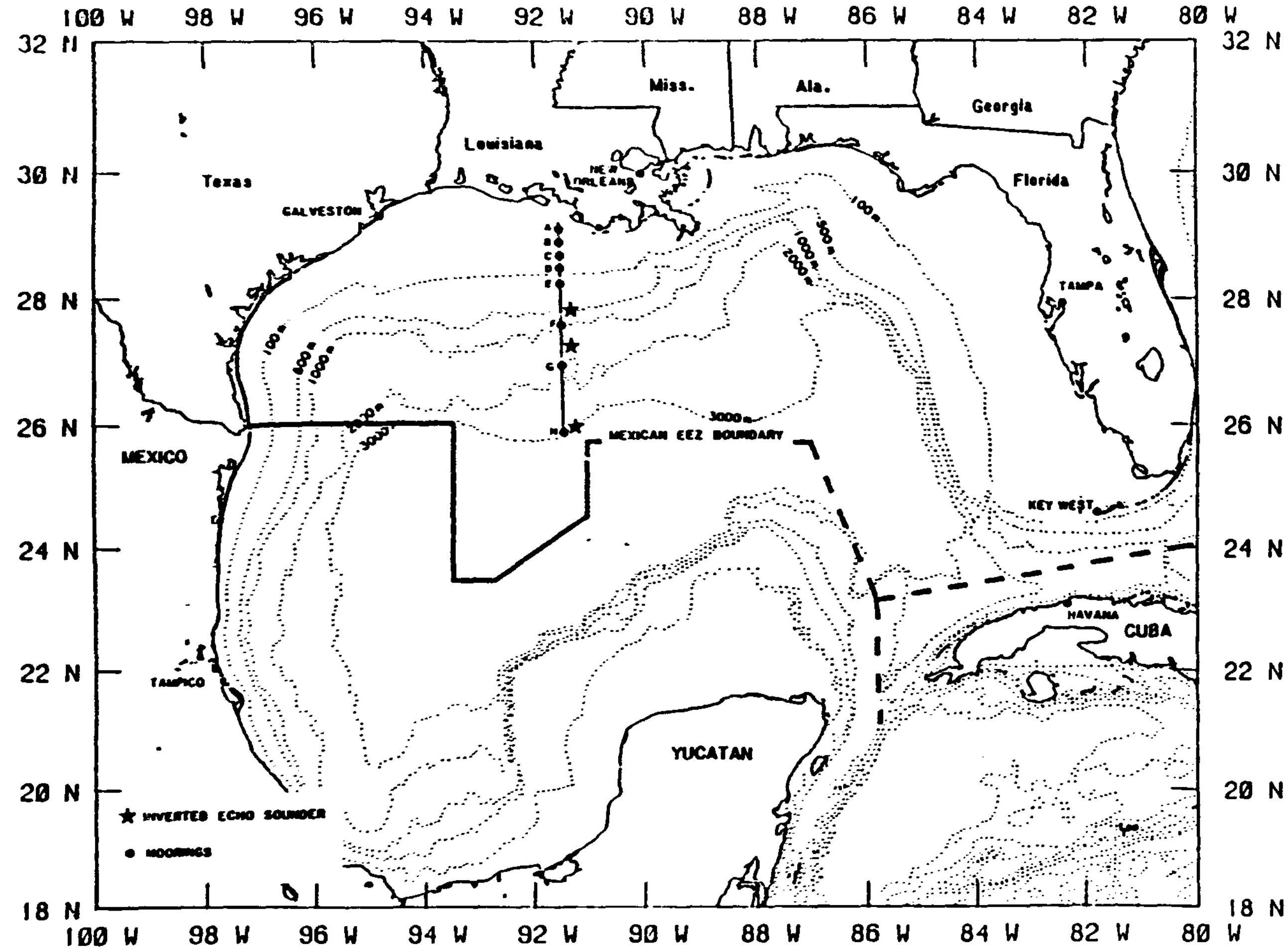


Figure 4. Year 5 mooring locations. Note that this pattern has been adjusted so that four shelf stations will be occupied and two inverted echo sounders will be deployed at the seaward most locations.

energy. These short spatial and temporal scale circulation patterns often accounted for over half of the observed kinetic energy. A possible forcing mechanism is the wind, however, other mechanisms are being investigated. Analysis of a drifting buoy documented the kinematics of a closed circulation which occurred and may regularly occur within the inner portion located to the right of the higher velocity region near the LC boundary.

The combined Year 3 database documents the westward translation and modification of a major anticyclonic LC eddy. Drifter data identifies the relaxation and adjustment as the eddy moves westward. In addition, ship and plane-based hydrographic surveys documented the eddy and the development and evolution of an associated cyclone. Subsequent surveys showed the intensification of the cyclone and corresponding adjustment of the primary eddy. The available data will allow evaluation of analytical and numerical characterizations of the eddy-slope interaction process. It is of importance that the surface temperature field did not indicate conclusively the presence of the cyclone; however, temperature profiles and subsurface current data clearly indicated the presence and development of this large and important feature.

Year 3 subsurface current measurements indicate the presence of strong inertial currents throughout the vertical water column both before and after the arrival of the above mentioned eddy. The cause of these is not clear, however, they are often the dominant contributor to the kinetic energy, especially below several hundred meters depth where even eddy related currents are attenuated(Figure 5). The the persistence of these circulation patterns is often considerable (see Figure 6) although the horizontal and vertical coherence scale seems to be rather limited.

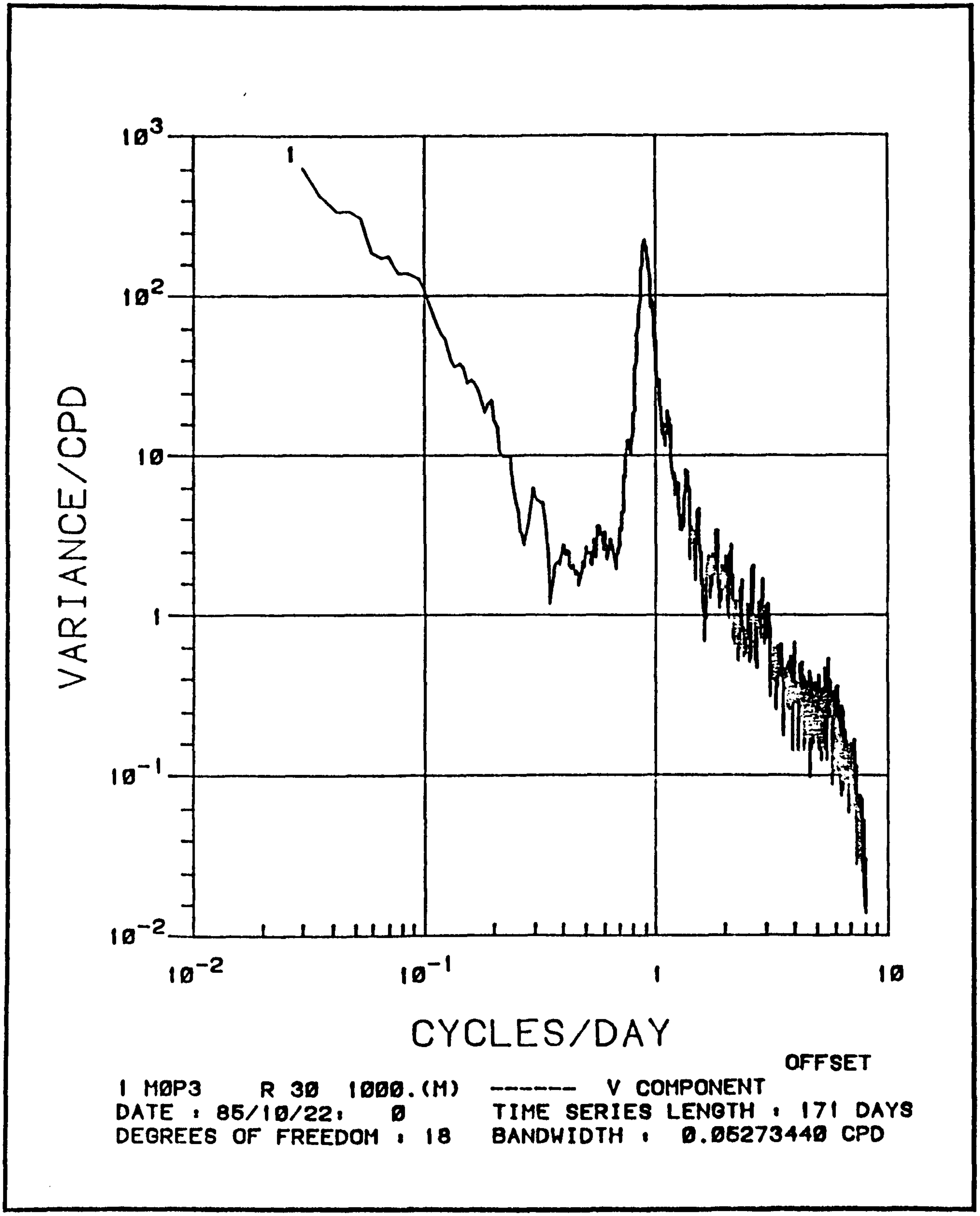


Figure 5. Spectra taken in deep water in the western Gulf. Note the clear dominance of the "almost " diurnal peak. This peak is due to inertial motions which can have peak-to-peak amplitudes of 30 to 40 cm sec^{-1}. In the absence of eddies, the inertial motions are considerably more vigorous than other observed motions.

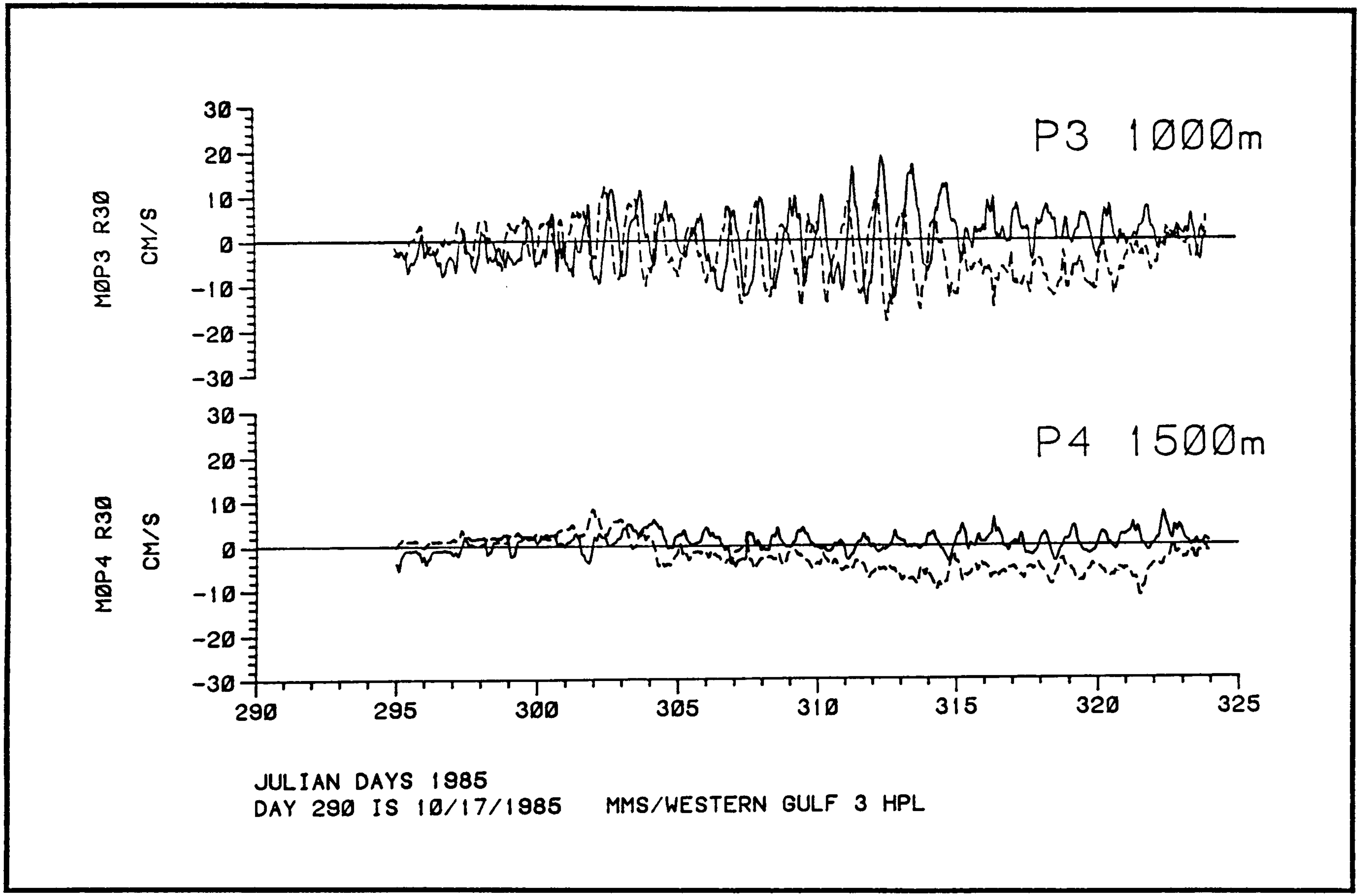


Figure 6. Time series of U(across isobath, solid line) and V(along isobath, dashed line) showing strong inertial currents at a depth of 1000 meter in water depth of 2000 meters. Such strong eposides were documented before and after the intensively studied eddy arrived in the area. However, another older and decaying eddy may have been present during this pre-arrival period.

ABSTRACT

SOUTHWEST FLORIDA SHELF ECOSYSTEMS DATA SYNTHESIS STUDY

prepared by
ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
LGL ECOLOGICAL RESEARCH ASSOCIATES, INC.
and
CONTINENTAL SHELF ASSOCIATES, INC.

prepared for
MINERALS MANAGEMENT SERVICE
TERNARY MEETING (MARCH 23, 1987)

INTRODUCTION

Environmental Science and Engineering, Inc. (ESE), LGL Ecological Research Associates, Inc. (LGL) and Continental Shelf Associates, Inc. (CSA) are currently completing the sixth and final year of the Southwest Florida Shelf Ecosystems Program. The objectives of this sixth year of the program were to:

1. Synthesize data collected during the 5-year field study and data from other sources whether published or unpublished.
2. Produce a concise and coherent description of the biota, conditions, and processes in the study area.
3. Assess potential impacts of oil and gas exploration, development, and production on the southwest Florida soft-bottom and live-bottom shelf communities.

PROGRAM STATUS

The Annual Reports for Years 1 through 5 have been submitted to MMS; the second draft of the Data Synthesis Report (Year 6) has also been submitted to MMS. The final version of the Data Synthesis Report will be submitted to MMS within the next month.

METHODS

The field data collection and analytical methods and the synthesis methods have been described in detail in the aforementioned reports; only a brief synopsis of these methods will be presented in this abstract. A variety of remote sensing techniques (side-scan sonar, precision depth recording, subbottom profiling, underwater television, and benthic still photography) were employed along Transects A through M (Figure 1) to survey substrate types, epifauna, macroalgae, and demersal fish. In addition, detailed sampling of sediments, macroalgae, infauna, epifauna, demersal fish, and water column data were obtained from 55 discrete stations throughout the southwest Florida shelf (Figure 1) using corers, grabs, dredges, trawls, underwater television, benthic still photography, water sampling bottles, and CTDs. Eight stations (Figure 1) were selected for intensive study to ascertain the cross-shelf and latitudinal variation of important physical and biological processes. An

STATION	YEAR 1	2	3	4	5	STATION	YEAR 1	2	3	4	5
1	●	●				29	●	●		●	●
2	●					30	●				
3	●	●				31		●			
4	●	●				32		●			
5	●	●				33		●			
6	●	●				34		●			
7	●	●			●	35		●			
8	●					36		●		●	●
9	●	●				37		●			
10	●					38		●			
11	●	●				39		●			
12	●	●				40			●		
13	●	●				41			●		
14	●	●				42			●		
15	●	●				43			●	●	
16	●	●				44			●	●	●
17	●					45			●	●	
18	●					46			●	●	
19	●			●		47			●	●	
20	●	●				48			●	●	
21	●	●		●	●	49			●	●	
22	●	●				50			●	●	
23	●	●		●	●	51			●	●	
24	●	●				52			●	●	●
25	●	●				53			●		
26	●					54			●		
27	●					55					●
28	●	●									

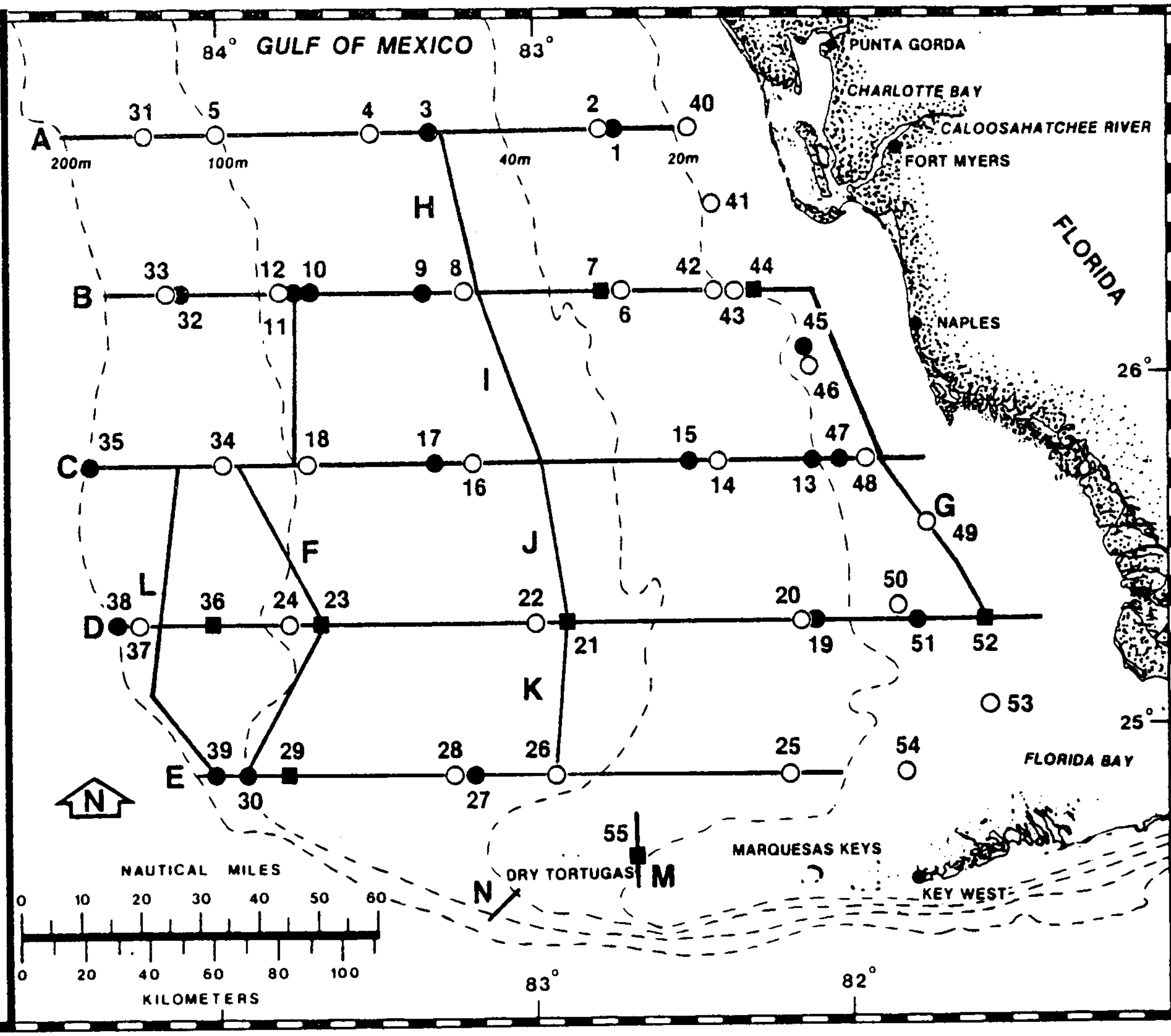


Figure 1 Southwest Florida Shelf Ecosystems Program study area with Years 1 through 5 geophysical and towed underwater television transects (A-N) and discrete stations (1-55) indicated. Inset indicates years during which stations were sampled; ○ = soft-bottom, ● = live-bottom, and ■ = intensively sampled station.

instrumented array was deployed at each of these stations; these arrays were equipped with current meters (continuously monitored near-bottom current velocity and temperature), sediment traps (sediment deposition rate), biofouling plates (epifaunal recruitment), and, at all but the deepest station, time-lapse cameras (to monitor sediment transport, epifaunal recruitment, and animal behavior). The two shallowest stations were also equipped with wave and tide gages.

The field data collected during the first five years of the program, data collected from outside sources (e.g., NOAA Data Buoy Center, National Climatic Data Center, University of Florida Coastal Data Network, etc.), and historical data (published and unpublished) were subjected to additional analysis and synthesis during the sixth (final) year of the program. This information was used to provide a comprehensive and coherent description of the physical and biological components of the southwest Florida shelf ecosystems. Following this characterization, a series of valued ecosystem components (VECs) were selected by representatives from the U.S. Department of the Interior (MMS and USFWS), U.S. Department of Commerce (NMFS), the State of Florida (Office of the Governor), and the project team. The following VECs represent producers and consumers at all trophic levels; all ecosystems from nearshore through the continental shelf; benthic and nektonic elements; as well as species of commercial and recreational interest, ecosystem dominance, environmental sensitivity, and rare and endangered species:

*Seagrasses (Halodule, etc.)
*Anadyomene menziesii
*Coralline Algal Nodules
*Sponges (Ircinia, etc.)
*Hermatypic Corals (Agaricia, etc.)
*Gorgonians
*Crinoids (Comactinia, etc.)
*Pink Shrimp (Penaeus duorarum)
*Rock Shrimp (Sicyonia spp.)
*Spiny Lobster (Panulirus argus)
*Stone Crab (Menippe mercenaria)
*White Grunt (Haemulon plumieri)
*Snappers and Groupers
*Spanish and King Mackerels
*Sea Turtles (loggerhead, etc.)

Conceptual submodels, presented as flow diagrams connecting the initial activities of oil and gas development, through intermediate steps, to the final presumed impacts, were then developed for each VEC. The final refinement to the potential impact assessment was the integration of these submodels into a single summary impact matrix. This matrix indicates not only the relative impact level, but the relative probability of occurrence and the probable impact radius. The physical and biological characterizations and impact projections were then presented in the Data Synthesis Report.

RESULTS

Detailed results of the 6-year Southwest Florida Shelf Ecosystems Program are presented in the Years 1-5 Annual Reports and the forthcoming Year 6 Data Synthesis Report. Only a brief synopsis of those results is presented here.

Physiography, Geology, and Sedimentology

- The broad (250 km), westward sloping (0.3 m/km nearshore to 17 m/km offshore), southwest Florida shelf is a limestone platform with relatively few areas of high relief.
- Sand-sized particles predominate on the shelf; however, there are isolated areas (e.g., the Tortugas shrimp grounds) where the sediments are predominantly silt-sized (Figure 2).
- Shoreward of the 10-m isobath, sediments are predominantly detrital quartz; seaward of the 10-m isobath, the carbonate content of the sediments is generally in excess of 95% (Figure 2).
- Sediment resuspension, which occurs episodically as a result of waves and currents, can attain deposition rates as high as 1,000 metric tons/km^2/day in shallow water (13 m); however, seaward of the 50-m isobath, deposition rates are very low (Figure 3).
- Sediment hydrocarbon analyses indicate that generally the area is relatively free of petrogenic hydrocarbons; a few of the deeper stations exhibited low levels of petrogenic hydrocarbons which were attributed to pelagic tars transported by the Loop Current.

Meteorology and Physical and Chemical Oceanography

- Generally, southwest Florida has a subtropical climate punctuated with tropical storms and hurricanes and, occasionally, by the passage of successive cold fronts; these phenomena can dramatically affect the ecosystem through increased wave activity and precipitation, upwelling, and, with the passage of cold fronts, water temperatures can decrease by as much as 10°C in 24 hours.
- Currents are dominated by the tides, with both diurnal and semidiurnal components, however, the latter decreases offshore.
- Residual currents are weak and variable with very little coherence across the shelf, thereby making it difficult to identify seasonal circulation patterns.
- The general flow on the shelf is to the south, with clockwise circulation in Florida Bay and water exiting the shelf to the west north of, and through, the Florida Keys (Figure 4).
- The Loop Current and its boundary phenomena dominate the circulation on the shelf; intrusions can cause a 2° to 4°C increase in water temperature, a two-fold increase in current speed, current direction reversals, and induce upwelling, which introduces nutrients to the nutrient-poor shelf waters.
- The inner shelf light compensation depth (1% of surface intensity) ranged from 5 to 45 m, middle shelf compensation depth was about 50 m, and values ranged between 60 and 85 m on the outer shelf.

Soft-Bottom Ecology

- Infaunal densities on the shelf ranged from 1,000 to 14,000 individuals per square meter and generally declined with increasing water depth.
- Species composition of infaunal communities was controlled primarily by water depth and secondarily by grain size distribution.

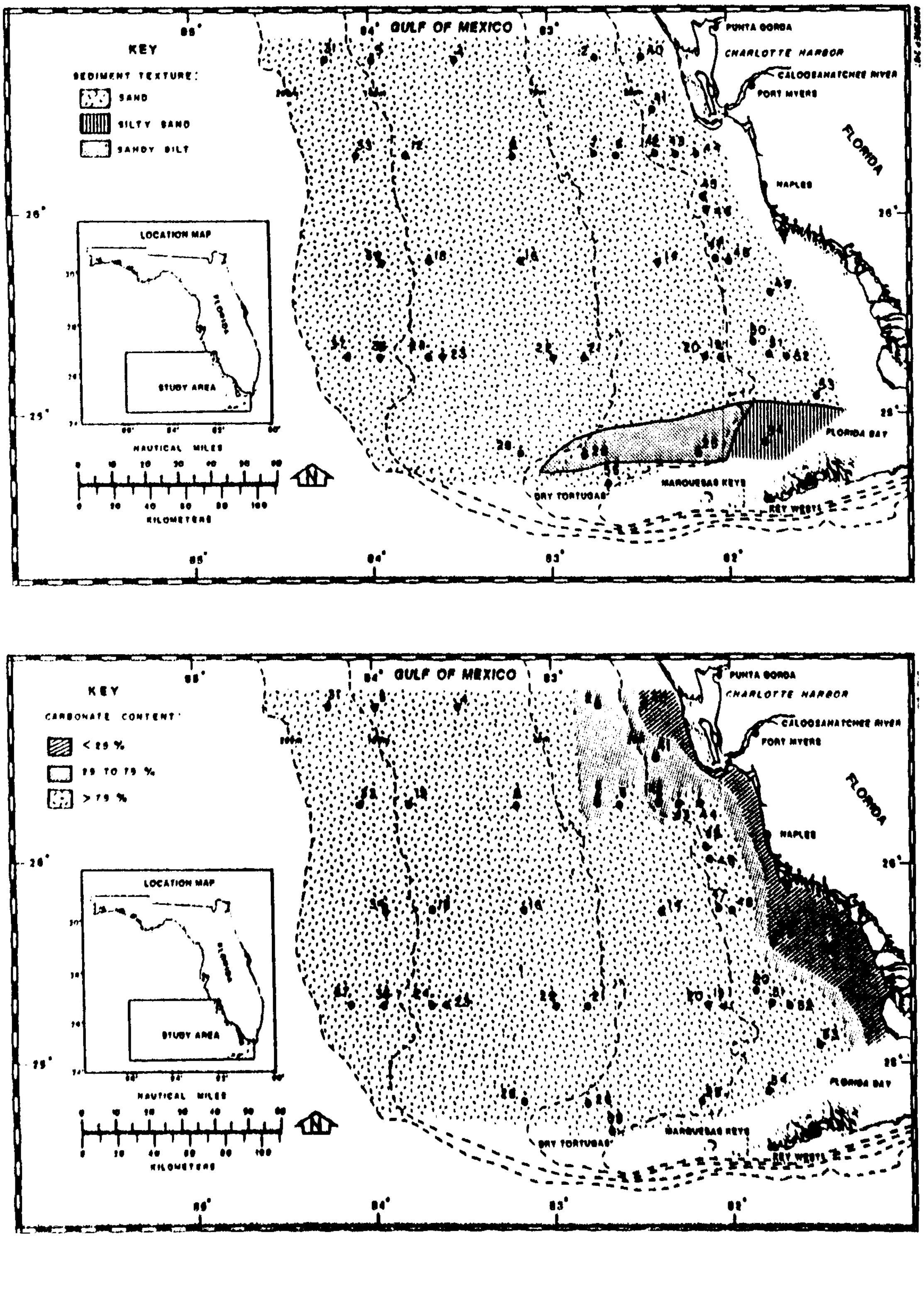


Figure 2 **Southwest Florida shelf sediment texture (top) and calcium carbonate content (bottom).**

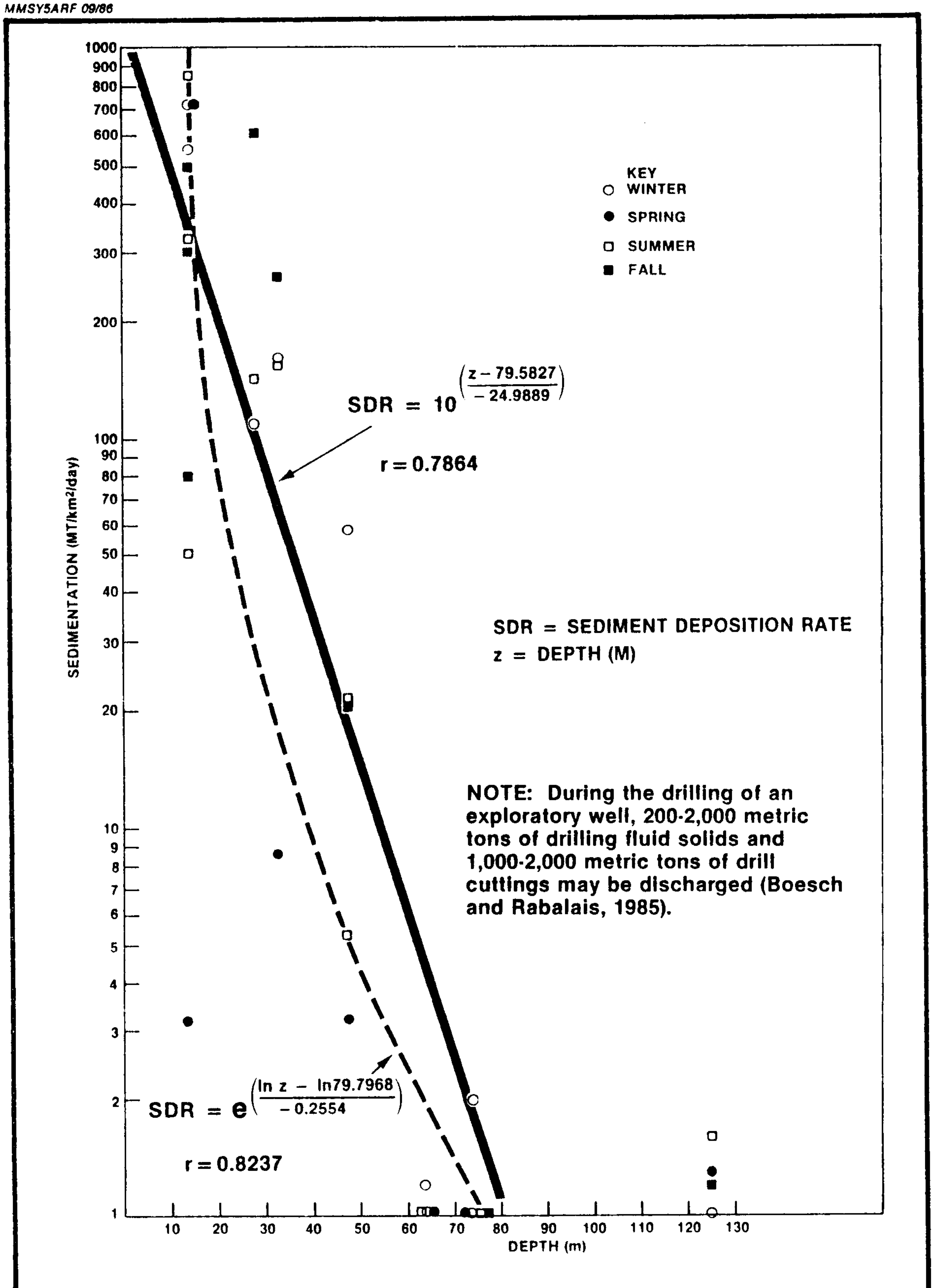


Figure 3 Sedimentation rates versus depth (calculated from instrumented array sediment traps).

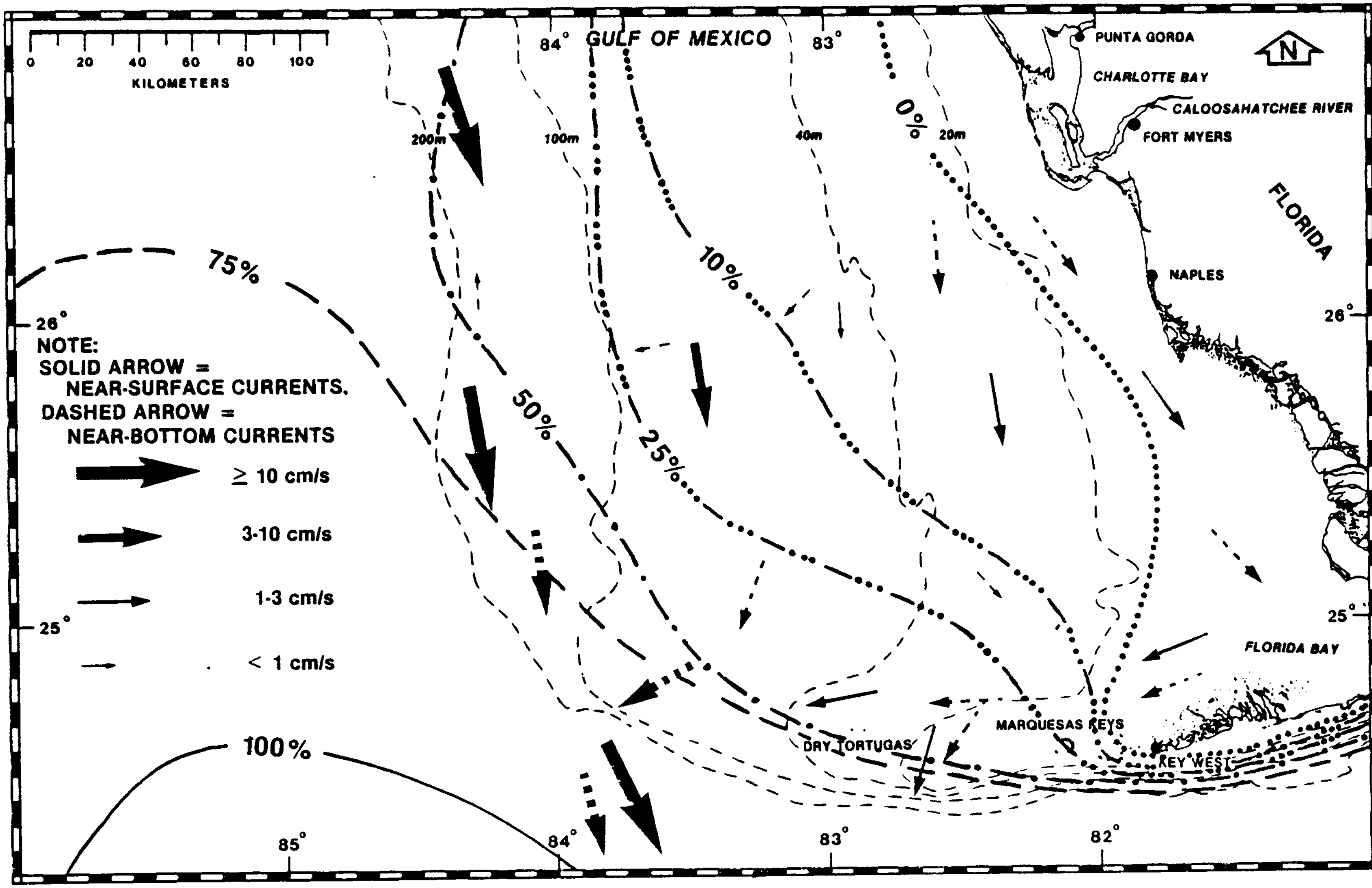


Figure 4 Estimated annual residual current pattern based upon Eulerian current data collected by ESE and LGL (1986) and SAIC (1986) as well as historical Lagrangian current data. Also shown is the probability of Loop Current maximum boundary phenomena incursion (April, according to Vukovich *et al.*, 1979).

- Polychaetes were the most abundant group collected and comprised 64% of the individuals counted, followed by crustaceans (17%) and molluscs (10%).
- A total of 1,121 species were identified; 452 crustaceans (40%), 413 polychaetes (37%) and 231 molluscs (21%).
- The predominant motile epifauna associated with the soft bottoms include asteroids, echinoids, holothurians, portunid and calappid crabs, large hermit crabs, stone crabs (seagrass areas) and conchs.
- Predatory, cryptic fishes (e.g., lizardfishes and flatfishes) are the most frequently collected demersal species in the soft-bottom areas; other fish which school near high-relief features (e.g., snappers and grunts) during the day, feed over sand areas at night.

Live-Bottom Ecology

- Live-bottom communities cover approximately 30% of the shelf and include a variety of substrate types, including: high- and low-relief limestone outcrops, coralline algal nodules and pavement, agariciid plate corals, and sand.
- Substrate type, exposure to sand scour and burial, and light (as a function of depth) are considered the most important factors influencing species abundance of habitat-forming sessile benthic organisms that determine community composition.
- Where thin or transitory sands cover hard substrates, gorgonians, algae, antipatharians, large sponges, scleractinian corals, and other large, sessile organisms are abundant; thick, more permanent sands favor soft-bottom communities.
- Motile species associated with the larger sessile species found in areas not subject to sand inundation include brachyuran and anomuran crabs, bivalves, spiny and slipper lobsters, ophiuroids, echinacean echinoids, and gastropods.
- Many of the sessile live-bottom organisms exhibit pronounced depth zonation (Figure 5), apparently in response to decreasing light levels with increasing depth; epibiotic and smaller motile species associated with these sessile forms show the same depth zonation.
- Photosynthetic scleractinians and gorgonians, hydroids, tunicates, sponges, bivalves, sabellid and serpulid polychaetes, and large algae are associated with inner shelf (<40 m) high-profile outcrops; also common near these outcrops are puffers, damselfishes, groupers, jacks, grunts, triggerfishes, wrasses, and butterflyfishes.
- Within the inner shelf, low-profile hard substrates, often covered with thin sand, are much more common; dense (150,000 individuals per hectare) beds of zooxanthellate gorgonians, sponges, foliose algae, and low-lying scleractinian corals, grunts, snappers, scrawled cowfishes, and porgies are common, and where the sand is thicker, seagrasses and algae predominate.
- Within the middle shelf (45 to 100 m), as the depth increases, photosynthetic corals and gorgonians are replaced with non-photosynthetic varieties; also found are large sponges (e.g., loggerheads, shoreward of the 70-m isobath), agariciid plate corals and Anadyomene menziesii (abundant on southern middle shelf), sea basses, squirrelfishes, scorpionfishes, damselfishes and bigeyes.

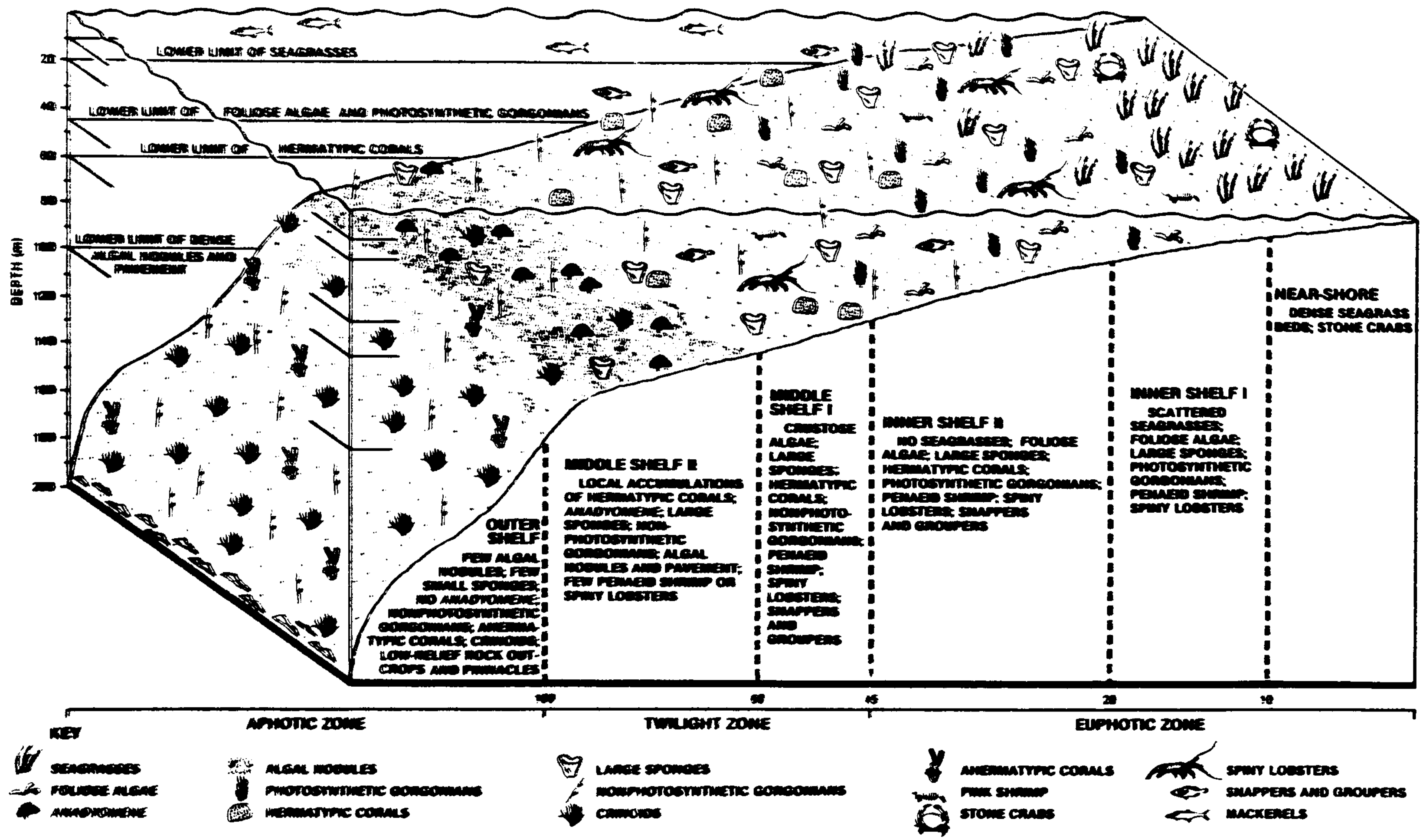


Figure 5 Biotic zonation of the southwest Florida continental shelf (southern transect) showing general distribution patterns of major components of the flora and fauna.

- The aphotic outer shelf (100 to 200 m), covered with thick sand, includes many small hexactinellid (glass) sponges, antipatharians, azooxanthellate scleractinians and gorgonians, and crinoids (most abundant large benthic organism), searobins, small sea basses, bigeyes, and bothid flatfishes.

Impact Projections

- Conceptual submodels were prepared for the 15 previously described VECs; an example (snappers and groupers) is presented in Figure 6. In this example, there are two potential impacts of primary concern: (1) attraction and concentration and (2) reduction of food supply. The first impact has the potential to be beneficial or harmful; beneficial, in that new habitats are now available for the fish and harmful, if overfishing should result. In addition, there are other secondary and tertiary impacts (toxicity, gill damage, etc.).
- All 15 submodels were integrated into a summary matrix of the impacts of oil- and gas-related activities (Figure 7). This matrix not only indicates the level of impact, but the relative probability of occurrence and the probable impact radius.

Considerations and Recommendations

- The southwest Florida shelf ecosystems differ from other Gulf of Mexico ecosystems in that live-bottom areas are not associated with significant topographic highs and the distribution of the live bottoms are more patchy, therefore, mitigative strategies such as shunting and exclusion zones may not be effective. Nevertheless, remote sensing surveys of the individual sites and optimal location of oil and gas structures will mitigate many adverse effects.

- Particularly sensitive areas include:
    - Florida Bay,
    - mangroves,
    - Florida reef tract, and
    - live-bottoms (e.g., *Anadyomene*, *Agaricia*, or grass beds).

- Offshore oil and gas development activities, should they occur, will cause measurable impacts, but the impact radius will generally be substantially less than 2,000 m.

- The biological stipulations presented in the EIS for the Eastern Planning Area are appropriate.

- The impacts resulting from a major oil spill (>1,000 bbl) could be severe particularly if the spill occurred near shore, however:
    - less than one major spill is expected for MMS Scenario M (0.06 billion bbl over assumed 18-year production life);
    - there is less than a 10% chance of a spill impacting southwest Florida within 10 days, if it occurs;
    - spills that occur on the middle shelf are unlikely to impact the shore; and
    - the prevailing winds and currents would have a tendency to transport the oil away from southwest Florida.

MMSREP 2/87

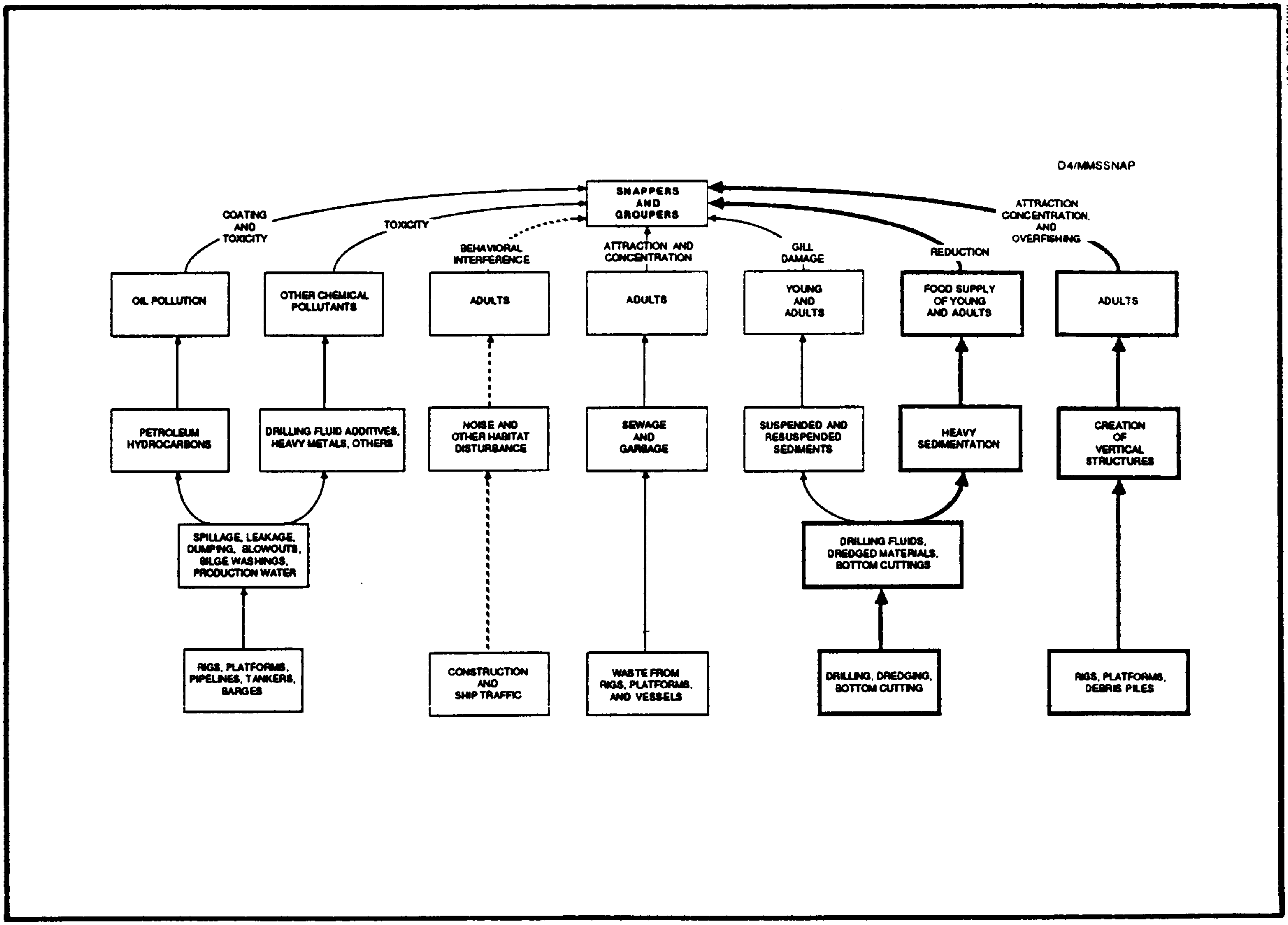


Figure 6 Example of a conceptual submodel of potential impacts of oil- and gas-related activities on a valued ecosystem component (snappers and groupers).

VALUED ECOSYSTEM COMPONENT

POTENTIAL IMPACT OF OIL- AND GAS-RELATED ACTIVITIES

FACTORS	POTENTIAL IMPACTS	SEAGRASSES	ANADYOMENE	ALGAL NODULES	SPONGES	HERMATYPIC CORALS	GORGONIANS	CRINOIDS	PINK SHRIMP	ROCK SHRIMP	SPINY LOBSTERS	STONE CRABS	WHITE GRUNTS	SNAPPERS AND GROUPERS	SPANISH AND KING MACKERELS	SEA TURTLES
OIL POLLUTION	COATING	3	3	3	3	3	3	3	3	3	3	3	3	3		3
	TOXICITY								3	3	3		3		3	3
	AVOIDANCE														3	
OTHER CHEMICAL POLLUTANTS	TOXICITY	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEWAGE AND GARBAGE	NUTRIENTS	1	1													
	ATTRACTION										1	2	2	2		2
NOISE AND OTHER DISTURBANCE	BEHAVIORAL INTERFERENCE												1	1	1	1
SUSPENDED SEDIMENTS	INHIBITION OF PHOTOSYNTHESIS	1	1	1		1										
	EFFECTS ON FOOD AND FEEDING				1	1	1	1	1	1	1	1			1	
	DAMAGE AND MORTALITY				1	1	1	1	1	1	1	1	1	1		
HEAVY SEDIMENTATION	EFFECTS ON FOOD AND FEEDING								1	1	1	1	1	1	1	1
	HABITAT REDUCTION				1	1	1	1			1	1				
	SUFFOCATION	1	1	1	1	1	1	1	1							
HARD SURFACES	PROVISION OF ATTACHMENT SURFACES		1		1	1										
MECHANICAL BOTTOM DAMAGE	LOCAL POPULATION DESTRUCTION	1	1	1	1	1	1	1								
VERTICAL STRUCTURES	ATTRACTION										2	2	2	2	2	2
LINEAR BARRIERS	INTERFERENCE WITH MIGRATION								1		1	1				1

PROBABILITY OF OCCURRENCE: HIGH, MEDIUM, LOW

IMPACT LEVEL: HIGH, MEDIUM, LOW

IMPACT RADIUS: (1) < 2,000 m; (2) 2,000 to 10,000 m; (3) > 10,000 m

Figure 7 **Matrix summary of potential impacts of oil- and gas-related activities on VECs.**

NORTHERN GULF OF MEXICO CONTINENTAL SLOPE STUDY

by
Benny J. Gallaway
LGL Ecological Research Associates, Inc.
1410 Cavitt Street
Bryan, Texas 77801

ABSTRACT

Beginning in 1983, the Gulf of Mexico Regional Office of Minerals Management Service (MMS) initiated a multiyear study of the continental slope of the northern Gulf of Mexico. The overall purpose of this program was to develop a basic knowledge of the components of the deep Gulf fauna, their environment and ecological processes in advance of pending petroleum development.

The scope of the program includes physical-chemical characterization of water masses overlying the bottom at depths between 200 and about 3000 m; the sedimentary characteristics of the bottom; and the abundance, structure and distribution of the bottom-associated animal communities at these depths. The groups of animals being investigated include the meiofauna (infauna passing through a 300 micron seive but retained on a 63 micron seive), macrofauna (infauna retained on a 300 micron seive) and the megafauna (organisms large enough to be captured in trawls or observed in photographs). The program also includes the charge to characterize present levels of hydrocarbon contamination in the sediments and selected biota in anticipation of petroleum resource development beyond the shelf-slope break.

Our sampling strategy was organized around three, five-station transects with one located in each of the three Gulf of Mexico Lease Planning Areas. Stations were located along each transect such that one was sited in each of Pequegnat's (1983) faunal zones found within the depth limits of the study: namely the shelf/slope transition zone (150-450 m), the archibenthal zone - horizon A (475-740 m), the archibenthal

zone - horizon B (775-950 m), the upper abyssal zone (975-2250 m); and the mesoabyssal zone - horizon C (2275-2700 m).

During Cruise I the Central Transect was sampled and each of the three was sampled on Cruise II. During Cruise III, the five original Central Transect stations were sampled once more and seven additional stations were sampled at depths that interdigitated those of the original station locations. The locations for the additional stations were chosen on the advice of the Science Advisory Committee (SAC) so as to collect information that would more precisely determine differences in physical, chemical, and faunal features that occur with depth.

On Cruises IV and V we sampled stations along depth contours in both the eastern and west-central Gulf to measure lateral variability in order to evaluate depth differences. Some of the stations were also paired to provide specific contrasts (e.g., seep areas versus non-seep; substrate differences, etc.). Cruise VI was conducted to make observations from a submersible of chemosynthetic communities at hydrocarbon seep sites.

The types of samples collected were water column samples, box core samples of the bottom sediments, trawl samples of the megafauna and benthic photographs of the megafauna and their environment. The box core samples were divided to provide material for identification of the biota, sediment grain size determination, hydrocarbon concentrations and carbon isotope measurements.

All physical and chemical samples collected as part of this program have been analyzed and reported. Additionally, all of the 59 trawl collections, 324 macrofauna replicates, 648 meiofaunal replicates and 60 benthic photography film strips have been analyzed. Polychaete taxonomy required much more time than originally estimated because of their small size and diversity. The polychaete analysis has only recently been completed and has resulted in a delay in submittal of the Year III Annual Report. Further, the fist stomach sample analysis is not yet completed, but this is a far less serious problem than has been the case for polychaetes. Most of the specimens remaining to be analyzed were taken during Cruises IV and V and are representatives of species which were well represented on Cruises I-III. Additionally, most of the specimens will probably prove to have empty stomachs.

Physical and chemical characteristics of the water column can be used to identify specific water masses, which, in turn, may influence the composition and nature of biological communities. On the Gulf slope, three deep-water masses are present; Tropical Atlantic Central Water (~250-500 m), Antarctic Intermediate Water (~500-800 m), and Deep Gulf Water (>800 m). At least one historical, independent biological assemblage classification shows a rough correspondence between water mass distribution and the major groupings of animal communities. A Shelf/Slope Transition Zone was noted at depths of 150 to 450 m; the Archibenthal Zone was classified as lying between 475 and 950 m, and the Abyssal Zone was believed to begin at about 975 m. It is also at about this depth that temperature variation ceases. The vertical distribution of water masses appears rather uniform across the Gulf.

Data from Cruises I and II provide comparative data for seasonal and regional differences. On Cruise I, bottom sediments collected at Stations C1, C2, and C3 were all comprised of clay-sized particles grading to sandy and/or silty clays at Stations C4 and C5. On Cruise II, five of the six samples collected at Station C1 were once more classified as clay, but at Stations C2 and C3 either all or most of the replicates were silty clays. Sediments taken at the deeper stations on the Central Transect (C4, C5) during Cruise II were again dominated by silty clays. Whether the differences in grain size composition observed for Stations C2 and C3 between cruises represents a seasonal affect or one of spatial variability is unknown. Based upon other data presented below, the former may be more likely.

On the Western Transect, sediments at Stations W1 and W2 graded from sand-silt-clay mixtures at W1 to sandy clays at Station W2. Silty clay predominated at both of Stations W3 and W4; but at Station W5, sediments were all sandy clay. On the Eastern Transects, sand-silt-clay mixtures were predominant at each of Stations E1 through E4. At the deepest Station, E5, two of the samples were comprised of sandy clay and one was sand-silt-clay. Sediments on both the Eastern and Western Transects, particularly the former, contained a higher proportion of sand-sized particles than was found on the Central Transect.

Levels of organic carbon in the sediments on the Central Transect were higher on Cruise II (April 1984) than on Cruise I (November 1983) with the degree of difference being least for Station C1. In general, organic carbon levels were slightly higher at the most shoreward stations along the transects, highest on the Central Transect at all sampling depths, and lowest on the East Transect at all sampling depths, except at the deepest station. The lower organic carbon levels on the East Transect were associated with higher percent sand/silt and carbonate-containing sediments.

Calcium carbonate levels in sediments at stations along the Central Transect were lower in the samples taken in November 1983 than in samples obtained from the same areas during April 1984. Central Transect levels were lowest of the three areas sampled, Western Transect levels were intermediate and the Eastern Transect was characterized by sediments of high carbonate content.

Soft sediments predominate over most of the slope. They exhibit a high degree of biological reworking and activity. Only occasionally are megafauna observed, but burrows dot the bottom suggesting a much higher than observed density of biota. Hard substrate is rare, but when present, unusual communities are sometimes in attendance.

Sediment and organism hydrocarbon levels were typically low except in the immediate vicinity of hydrocarbon seepage. Outside these areas, levels exhibited as much variation along isobaths as was observed across depths. No trends were discerned.

For most of the biological groups investigated, significant faunal breaks were observed near 1000 m in depth, and along isobaths in the northwestern Gulf at a location approximating the western edge of the Mississippi Fan.

One area of hydrocarbon seepage was observed to have a spectacular and diverse chemosynthetic biological community present. It was estimated to rival some of the shelf-edge banks in terms of standing crop biomass and diversity--and perhaps productivity.

OUTER CONTINENTAL SHELF DEVELOPMENT AND POTENTIAL COASTAL HABITAT ALTERATION:
Project Overview and Status

R. Eugene Turner
Program Manager

Donald Cahoon
Science Manager

Coastal Ecology Institute
Center for Wetland Resources
Louisiana State University
Baton Rouge, Louisiana 70803

OUTLINE OF THE PROJECT

The Minerals Management Service project "Outer Continental Shelf Development and Potential Coastal Habitat Alteration" is in the 18th month of a 27-month contract. The primary objective of the project is to determine the extent of the contribution of OCS development to coastal landloss. To do that the causes of coastal landloss must be examined. Sixteen subtasks are involved, including investigations of: 1) sediment source changes, distribution and deposition; 2) salinity changes, impacts, and synergistic interactions with geologic and biologic factors; 3) aerial imagery analyses of the spatial and temporal distribution of landform changes as a function of OCS and non-OCS development; and, 4) direct impacts, primarily those impacts related to OCS pipelines and support facilities.

The Task One report "Methodology Development" has been completed, and work on all 16 subtasks is on schedule. Current emphasis is on field and laboratory studies. The next major administrative goal is a review by the Scientific Review Board on April 1-3, 1987. A brief outline of some preliminary findings and activities are discussed below.

The participants in the subtasks are divided among seven colleges at Louisiana State University. Working groups have been formed for related research studies in salinity (4), sedimentation (4), aerial imagery (2), subsidence (1), and direct impacts (3). The individual subtasks and personnel responsible for each are listed below:

- Direct Impacts of OCS Pipeline and Navigation Channels (Baumann, Reed and Turner)
- Saltwater Intrusion in OCS Related Channels (Wang)
- Historic Salinity Records and Bayou:Wetland Couplings (Wiseman and Swenson)
- Interactions of Saltwater and Submergence (Mendelssohn and McKee)
- Inventory of Historical Sediment Loads in the Mississippi River (Kesel)
- Marsh Sediment Accretion Rates (Cahoon, Delaune and Knaus and Turner)
- Spatial Trends in Wetland Loss (Hill, Leibowitz and Turner)
- Long-term Sea Level and Subsidence Rates (Suhayda)

DIRECT IMPACTS WORKING GROUP

The Direct Impacts Working Group is attempting to determine the relative contribution of direct impacts of OCS activities on wetland loss within the study area (Bolivar Roads, TX to Waveland, MS). Those OCS activities that directly contribute to wetland loss are the construction of pipelines, navigation channels, and related facilities.

The direct impact of pipeline construction per unit length is variable. Factors being assessed to account for this variation include: age of line, diameter of line, number of lines per corridor, habitat type, construction technique and geologic conditions (i.e., relative age and depth of sediments).

To date, inventory and analysis have been completed for 79 pipelines (approximately 31% of total population) geographically confined to that portion of the study area from Vermilion Parish eastward through Lafourche Parish. The total direct impact area (direct change of habitat) of those 79 pipelines is 4,358 ha over a total pipeline distance of 1480 km (Table 1). On a per unit length basis, wetland habitats are directly lost to open water, spoil and facility construction at a rate of 4.7 ha/ km of pipeline constructed (Table 2). Non-wetland habitats have a substantially lower rate of impacts per unit length.

Table 1. Preliminary analysis of OCS pipeline total impacts (79 lines measured, to date)

	Length (km)	Area (ha.)
Canal	1473	2973
Spoil	355	1373
Facilities	7	12.7
Total	1480	4358

Avg. Impact Area Per Unit Length = 2.95 ha/km
Prorated Total Length = 4,868 km
Prorated Total Area = 14,336 Ha. (53.76 mi2)

Table 2. Preliminary Analysis of OCS pipeline direct impacts by habitat

Habitat	Length (km)	Area (Ha)	Ha/km
Dune/Beach	2.2	0.4	0.2
Salt Marsh	278.0	1409.0	5.1
Brackish Marsh	160.0	651.0	4.1
Intermediate Marsh	118.0	540.0	4.6
Forested Wetlands	109.0	475.0	4.4
Fresh Marsh	224.0	1134.0	5.1
Total Wetlands	891.2	4,209.4	4.7
Open Water	454.0	111.0	0.2
Non-wetland	132.0	3.4	0.1
Spoil	2.4	33.4	13.7

On a per unit length basis, both diameter of pipeline and age of pipeline appear to be important factors in accounting for direct impact variation. Impacts per unit length tend to increase with increasing pipeline diameter and increasing age of line, although not in a linear fashion. Differences in construction equipment required for different groups of diameter size may explain the former, while improvements in method of construction, new construction regulations, and the effects of canal widening over time may contribute to the former. Multiple factor analysis, along with case study investigations requiring operator assistance (knowledge of construction techniques used), will be conducted to further resolve these possible sources of variation.

The direct impacts of navigation channels are being treated separately from pipelines because of the substantially greater impact per unit length and impact allocation questions. A total of 25 navigation channels have been identified as avenues for OCS traffic based on U.S. Army Corps of Engineers (USACOE) vessel count data.

A preliminary estimate of the percentage of all wetland losses (1955-1978) due to direct OCS impacts is 10% or less.

SEDIMENT SOURCES AND DISTRIBUTION WORKING GROUP

The sediments working group has the task of determining changes in the supply of sedimentary source materials and the distribution and rate of new sedimentation around various geomorphic structures. This group has basically been interested in determing if minerals supplied by the Mississippi River have changed in recent history and how man-made changes in the wetlands have affected the rate of sedimentation which maintains the vertical position of a wetland.

Sediment Source Changes

The sediment discharge of the Mississippi River has historically been a major source of sediment for the coastal wetlands in Louisiana and has been affected by both natural events and man-made structures. Many of the factors influencing the sediment discharge are largely man-made and have occurred after 1900. These factors have altered both the bedload and the suspended load regimes of the channel. The river prior to 1900 has been considered generally to be unaffected by man-made structures.

Systematic measurements of sediment discharge on the Mississippi River are available since 1951. Based on these data, it has been suggested that there has been a 50% decrease in the suspended load of the Lower Mississippi River during the past 35 years which has been attributed to revetment construction and the subsequent reduction in bank caving. Any analysis based on such a short period of record cannot, however, recognize longer term cyclic changes that may be present. Because only sporadic sediment data is available prior to 1950, it is difficult to extend this analysis back in time. Some indirect estimates of historic changes in the sediment regime of the river have been made using channel geometry and various stage-water discharge relationships. There is general agreement, based on this evidence, that the channel has been deepened, indicating degradation in the upper and middle portions, possibly extending as far downriver as Memphis. In some reaches the river bed has been lowered an average of 3.4 m, with depths exceeding 5 m being recorded and largely the result of the high concentration of training dikes located throughout this portion of the river. Downriver from Memphis there has been an increase in stage readings, which suggests aggradation of the river bed. This has resulted in reduced sediment carrying capacity of the channel and increased maintenance dredging for navigation. This appears to represent a down-valley movement of bedload sediment from the upper and middle reaches of the Mississippi River. Since 1900, levees have played an increasing role in confining sediment loads that, under natural conditions, would have passed overbank on the flood plain and into coastal wetlands. This confinement has increased sediment movement downriver.

Analysis of the historic evidence can be used to document changes or trends in the sediment discharge of the Lower Mississippi River. The available data base for this analysis is limited largely to maps and file data from the USACOE and the Mississippi River Commission beginning in 1851, followed by a series of hydrographic surveys of the river published from 1880 to the present by the Mississippi River Commission. File data is quite variable. Before 1930, sediment and hydraulic measurements are scarce, although some observations were obtained on suspended load as early as 1851. Collection of sediment data between 1930 and 1962 was intermittent and was generally gathered at major gaging stations along the river (e.g., USACOE Waterways Experiment Station, 1931, 1935). A major effort to collect sediment discharge and hydraulic data began in 1963 when the USACOE initiated its potamology program. The focus of the program, however, is limited to the Vicksburg District between the Arkansas River and Natchez, Mississippi. Data gathered include hydrographic surveys, bed form profiles, current direction, water surface profiles, and sediment samples of suspended and bed load. Much of the data gathered under this program has yet to be analyzed.

Several approaches are being attempted to achieve the objectives of this study. First, any changes in the amount of sediment discharge passing through a given portion of the river should be reflected in the sediment storage capacity and morphology of the channel. The major area of sediment storage within the channel are point bars, channel islands, and crossings or bars in the channel. A major change in the amount of sediment discharge should be reflected in these parameters. Any such changes are being assessed by measuring the composite cross-sectional area of channel reaches and the volume of exposed (active) channel and point bars.

The volume of sediment stored on point bars along 200 miles of the Mississippi River channel from Cairo to Memphis have been measured. The results of this are summarized in Table 3.

Table 3. Mississippi River point bar volume changes, Cairo to Memphis.

	1911	1948	1963	1973	1880-73
$Ft.^3 \times 10^8$	86.66	-77.18	-23.24	-33.96	-57.52
% change	32	-22	-8	-13	-21

change from 1948 to 1973 = -21%

These data suggest that the river between 1880 and 1911 was aggrading its channel and may represent conditions prior to manmade changes. Since 1911, the channel has undergone degradation. The greatest period of erosion occurred between 1911 and 1948 when most channel modifications were initiated. The period from 1948 and 1973 was marked by a 21% decrease in sediment load, which is equal to the over-all changes noted from 1880 to 1973. Data will continue to be analyzed through the summer of 1987.

Sediment Distribution

The rate of submergence of these wetland areas is directly linked to the ability of land building processes (organic matter and mineral matter accumulation) to keep pace with the present rate of sea level rise (i.e., eustatic sea level rise plus land subsidence). Recent investigations have shown that deteriorating interior marshes are experiencing an aggradation deficit (i.e., sea level is rising faster than the marsh surface is aggrading). It has been suggested that canals may exacerbate the aggradation deficit by altering local hydrology and thus affect the accumulation of organic and mineral matter.

Rates of sediment accumulation and vertical accretion are being measured in back marsh areas behind OCS pipeline canal spoil banks, oil and gas access canal spoil banks, and natural streambanks. Both recent and long-term sedimentation rates are being analyzed by three techniques. Recent sedimentation rates are being evaluated by two marker techniques, inert clay and inert rare earth stable isotopes. These methods give reliable estimates of sediment deposition during the immediate past, with the clay best suited for salt and brackish marshes and the chemical isotope best suited for fresh marshes. Long-term vertical accretion rates are being determined by ^{137}Cs and ^{210}Pb analysis of soil cores, which provides a 25-year and 100-year integrated annual accretion estimate, respectively. Whenever feasible, all three techniques are used together at a site.

The field work has been designed to compare sedimentation rates behind canal spoil banks to rates behind natural streambank levees. To do this, sediment markers were placed in the marsh 50m behind the natural or man-made levee. Whenever feasible, small wooden platforms were constructed for this purpose (with appropriate controls) in order to minimize disturbances to the marsh surface during marking. Also, the influence of canals on sediment distribution and vertical accretion across the marsh is being investigated at selected sites by sampling every 10m along a 50m-125m transect beginning immediately behind the natural or man-made levee. Sedimentation rates are being analyzed in impacted salt, brackish, and fresh marshes along the coast, including both the Mississippi River Deltaic and Chenier Plains.

Sampling from the first six months has just been completed, and analyses are underway. Because data collection and analysis is ongoing, it is too soon to draw significant conclusions from this study. It should be noted, however, that all three techniques are well-suited to this analysis, give reliable data, and are working as expected.

SALTWATER WORKING GROUP

The purpose of this working group is to determine how much, if any, the salinity of the coastal zone has changed in recent history, whether that change is local or regional, and how any increases might affect plants. The first part of the task is the analysis of available long term records of salinity within the Louisiana coastal zone to determine the magnitude of changes and their relationships to climatic and oceanographic forces. The major purpose of the analysis is to address the possible impacts of canals (oil field, navigation, OCS pipeline) on salinities in the Louisiana coastal zone.

Salinity Change

To date, all of the data records are on the LSU computer, and the organization of the data base is about 90% complete. The primary data sources for the salinity data are the Louisiana Department of Wildlife and Fisheries (LDWF) and the USACOE. Stream flow data are available from the U. S. Geological Survey (USGS) and weather data are available through the National Climatic Data Center (NCDC). The data we presently have are summarized below (Table 4).

Table 4. Number of data records (stations) of a given length (in years) for each of the data sources. The record length is defined as: (ending data) - (starting date). This table does not reflect reduced lengths due to gaps in the records.

Record Length	3	8	13	18	23	28	33	38	43	48	53	>55
LDWF (Salinity)	6	3	2	4	0	1	0	0	0	0	0	0
USACOE (Salinity)	3	2	5	5	7	7	8	1	0	0	0	0
USGS (Flow)	0	0	1	1	2	2	0	0	4	6	0	2
NCDC (Weather)	0	0	0	0	1	0	0	1	0	0	0	0

The analysis can be divided into 4 general categories:

1. Comparison of the two salinity data bases (COE, LDWF). This will be accomplished by simple linear statistics, using either correlation or regression analysis.
2. Investigation of the temporal changes in the means and variance. This will be accomplished with linear statistics and/or the use of ARIMA models.
3. Investigation of the relation between salinity and the various environmental forcing functions (winds, streamflow, water levels, and precipitation). This will be done through the use of both linear statistics (correlation, ANOVA) and standard time series analysis (spectrum analysis, cross-spectrum analysis) where appropriate.
4. Investigation of canal effects. This will be accomplished through the use of linear statistical comparison of canalled and non-canalled areas and by before-after project comparisons if the data sets available prove to be appropriate to such analysis.

The anticipated results of the above analyses will include a description of the short- and long-term salinity regime as related to climatic influences and an analysis of the long-term salinity changes as related to canal dredging. An additional (new) task to determine the couplings between salinity changes in the bayou with those in the wetland was recently added.

Saltwater Intrusion

The distribution and extent of saltwater intrusion is being assessed in a field-validated modeling study designed to analyze the behavior of saltwater intrusion in the major navigation channels that support OCS development activities along the coast of Louisiana and to determine the degree and extent of saltwater intrusion that may contribute indirectly to wetlands loss. A typical navigation channel is the Houma Navigation Channel, located in south-central Louisiana.

The major forcing functions that affect the length and the shape of salt wedges in channels are fresh water discharge, tidal amplitude, and prevailing wind. Four types of salinity profiles, depending on the physical dimension of the channel and the relative magnitude of the above forcing functions, can be characterized as well-mixed, partially stratified, highly stratified and a saline wedge.

The Houma Navigation Channel, an OCS related canal, was chosen as one pilot study site. The channel connects Terrebonne Bay with the Intracoastal Waterway near Houma City at a distance of 37 km. The channel depth is about 6 m. The channel is subjected to a 30 cm tidal range from the Gulf of Mexico under various river discharge conditions. Field trips here and elsewhere are used to validate the model, which is an intensive computer analysis of the effects of channel morphology on saltwater intrusion characteristics.

Field data indicate that there is a well-mixed water column at the downstream reach (Gulf side) of the channel, and then a gradual shift to partially stratified and highly stratified conditions at the upstream part. A second field site in a different hydrological and geological region, unrelated to the OCS activity, will be selected to study and compare the salt water intrusion problem. The modeling effort will be completed in April.

Vegetation

The major goal of this study is to investigate the effect of increased salinity on the dominant plant species in each of three major marsh types by simulating saltwater intrusion under field and greenhouse conditions. The effects of increased submergence or flooding on these same plant species is also being determined exclusive of and in conjunction with salinity effects. The following hypotheses are being tested in this study:

1. Given that saltwater intrusion occurs in a marsh, the increase in salinity will cause the death of the dominant plant species.
2. Given that subsidence occurs in a marsh, the increase in submergence or flooding will cause the death of the dominant plant species.
3. The interaction of increased salinity and submergence in a marsh causes a more rapid deteriotation of the vegetation than by either factor alone.

Three plant species, one from each major habitat, were chosen for investigation: *Panicum hemitomon*—fresh marsh, *Spartina patens*—brackish marsh, and *Spartina alterniflora*—salt marsh. In the greenhouse each species is being subjected to a range of salinities (depending upon the species) and flooding depths. The investigation of one species—*Panicum hemitomon*—has been completed and another with *Spartina alterniflora* is underway. The results of the experiment with *P. hemitomon* demonstrated that this species could survive an increase in salinity up to 9.5 ppt for a period of one month. However, growth at this highest salinity level was significantly reduced compared to the control at 0 ppt. Stem elongation at intermediate salinity levels (1.2, 2.4, 4.9 ppt) did not appear to be greatly reduced compared to the control. Total live aboveground biomass was reduced from approximately 20 g pot $^{-1}$ in the control to 10 g pot $^{-1}$ in the 9.5 ppt. salinity level. The measurement of proline (which accumulates in plant tissues in response to salinity stress) in the leaf tissue of *P. hemitomon* demonstrated that this species was moderately stressed at 9.5 ppt, slightly stressed at 4.9 ppt, and not at all at lower salinity levels. Increased submergence of *P. hemitomon* under greenhouse conditions did not have a major effect on the growth of this species. Similar experiments which will be conducted with *S. patens* and *S. alterniflora* will be completed by the spring of 1987.

Salinity intrusion was simulated in the field for each of the three species by moving sections of marsh from their natural location to an area of higher salinity. The original marsh was designated as the donor marsh: the higher salinity marsh was designated as the recipient marsh. Subsidence was simulated by removing sections of marsh in the donor marsh and replacing them in the same location but at a lower elevation (10 cm below original elevation.) The interaction of salinity and subsidence was accomplished by transplanting sections of marsh into a higher salinity area at diffrent elevations (10 cm below, equal to, and 10 cm above the normal marsh surface.) Appropriate controls (both disturbed and undisturbed) were established in the original donor marsh. The field experiments were initiated in early May of 1986 and terminated in September and October of 1986. Non-destructive measurements were conducted at all sites 10 weeks after transplantation.

For the fresh marsh species, an increase in salinity to approximately 5-10 ppt was planned. However, due to a major storm event salinities at the recipient marsh, which normally are 6-7 ppt, were increased to 15 ppt just a few days following transplantation of *Panicum hemitomon* to this area. As a result of this unexpectedly high increase in salinity, which lasted for a few days, 100% mortality of the *P. hemitomon* occurred. When this experiment was terminated in September, 1986, no regrowth of *P. hemitomon* had occurred. However, the cores had been invaded by the annuals, *Panicum dicotomiflorum* and *Pluchea camphorata* which were common in this area at this time of year. The *P. hemitomon* controls in the donor marsh (0-2 ppt) did not experience a significant reduction in survival. Although samples from this experiment are still being processed, stem densities indicated that the growth of *P. hemitomon* was also affected by increased submergence.

In contrast to the fresh marsh species, the two salt-tolerant species, *Spartina alterniflora* and *S. patens,* survived an increase in salinity from 10 to 20 ppt. Although *S. patens* was initially affected by the sudden increase in salinity, substantial regrowth had occurred in most cases by October, 1986 when this experiment was terminated. All analyses have not been completed for this species, but initial results indicate that increased salinity alone will not cause the death of this species during one growing season. However, stem densities were reduced by increased salinity. Waterlogging appeared to have some effect on the percent survival of this species, particularly in combination with an increase in salinity. *S. alterniflora* survival was not adversely affected by an increase in salinity level but was substantially reduced by an increase in submergence. In some cases, a decrease in elevation of 10 cm resulted in 100% mortality of this species.

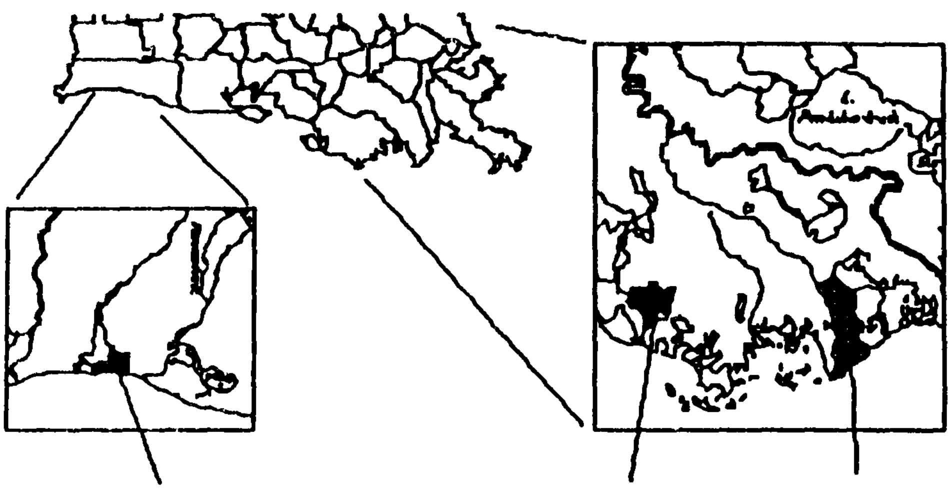
Because this project is not yet completed, definite conclusions cannot be stated at this point. However, preliminary results suggest that the survival of fresh marshes species, such as *Panicum hemitomon,* can be adversely affected by increases in salinity levels above 5 ppt. In contrast, *Spartina alterniflora* survival is not affected by increases in salinity to levels normally found in Gulf coast marshes but is reduced by increased salinity, e.g., its growth is reduced by an increase in salinity but survives for a growing season. The interaction of increased salinity and waterlogging may have a greater effect on this species than by either factor alone.

AERIAL IMAGERY WORKING GROUP

High resolution, digital imagery are being used as part of a study to assess the impacts of OCS activities on wetland loss in coastal Louisiana. We obtained habitat maps for 1956 and 1978, produced by Coastal Environments, Inc., of Baton Rouge and digitized by the U.S. Fish and Wildlife Service for three specific study areas.

Regional Study Site Analysis

Landloss patterns are being studied for three specific study areas (Figure 1): Lafourche, Terrebonne, anc Cameron. The Lafourche study area is located to the east of Bayou Lafourche, a distributary that was recently (ca. 400 years before present) abandoned by the Mississippi River. The Terrebonne study area lies adjacent to the Atchafalaya River. This is the most recent of the Mississippi distributaries, and currently captures 30% of the system's flow. The Cameron study area, in the western part of the state, is outside of the direct influence of Mississippi delta-building processes. Sediments in this region are either reworked from old, abandoned Mississippi deltas, or deposited by local rivers. The three study areas were chosen to represent different geological environments.



Three Regional Study Sites for Aerial Imagery Analysis

Figure 1.

Preliminary analyses have been performed on the Terrebonne and Cameron study areas. Fresh marsh is the most abundant habitat in the Terrebonne area, accounting for nearly 470 km^2 (40% of the study area). Saline marsh accounted for 326 km^2 in 1956 (28%). Between 1956 and 1978, the area experienced a net land loss of 97 km^2. Total land loss was actually higher, however, since this value was partially offset by land-building processes, such as the emergence of the Atchafalaya delta in 1973. By 1978, 14% of the 1956 land was lost. Loss of fresh marsh accounted for 66% of this value, with saline marsh (loss as a percent of 1956 habitat area) were 18 and 11%, respectively.

The Cameron study area, in contrast, is dominated by saline marsh, containing over 246 km^2 (48% of the study area). Fresh marsh accounted for 116 km^2 (23%) in 1956. This study area experienced a net loss of 70 km^2 in the 22-year period. Of the original 1956 land, almost 7%

was converted to water by 1978. Saline marsh accounted for nearly 75% of the total loss in Cameron, with fresh marsh accounting for the remaining 25%. Loss rates for saline and fresh marsh were 23% and 16% of their respective 1956 habitat area. Loss rates for fresh marsh were therefore similar for both study areas (16-18%), whereas loss rates for saline marsh were twice as high in Cameron.

For both study areas, conversion of land to inland open water was the major form of landloss (72% and 93% of all loss for Terrebonne and Cameron, respectively). In Terrebonne, conversion of land to canal and pipeline or loss due to expansion of natural channels accounted for 10-15% each, with shoreline erosion accounting for only 2%. In the Cameron area, conversion to canal and pipeline, expansion of natural channels, and shoreline erosion each accounted for 2-3% of all loss. Thus expansion or creation of new ponds and lakes is the dominant cause of land loss in both of these study areas.

The Cameron data set was analyzed to determine whether canals and pipelines contribute to landloss. It was hypothesized that if canals and pipelines are a cause of landloss, then loss rates adjacent to these features should be higher than rates far from them. To test this, a proximity analysis was performed, with percent land loss plotted as a function of distance to canal and pipelines. As a comparison, loss rates were also plotted as a function of distance to natural channels. It was found that loss rates increase from 11% at 1 km from canal and pipelines to 39% percent at 100 m. Beyond 1 km, the rate becomes random. For natural channels (rivers, streams, and bayous), the opposite trend was found: loss rates decrease from 34% at 1 km to less than 10% at 100 m. This is consistent with our understanding of how natural channels contribute sediment to adjacent land, stabilizing it and making it less prone to loss.

In the near future, the proximity analysis will be carried out on the Terrebonne and Lafourche data sets, in order to determine whether geologically varied areas give similar results. Canals and pipelines are separated into OCS and non-OCS categories, to see whether this has any effect. Initial results seem to indicate that this type of proximity analysis will allow the separation of natural causes of landloss from man-made factors.

Quadrangle Sheet Analysis

A statistical analysis of habitat map data in quadrangle maps (1955-1978) is underway using two approaches. In the first, we are analyzing wetland loss changes as a function of geological substrate types (e.g., depth to the Pleistocene terrace, age, delta sequence), man-made features (e.g., canals and levees) and habitat type. The best models predict about 50% of the changes using only three variables: canal density, substrate depth, and age. In the second approach, we are analyzing the spatial and temporal distribution of new ponds ("holes") as related to pipelines, levees, and canals. An example is shown for the Larose quadrangle map in Figure 2. Basically, the new holes, especially the larger holes, are most likely to form near canals (meaning canal levees) and especially near canals intersecting to partially impound a marsh.

SUBSIDENCE AND SEA LEVEL RISE

Coastal wetlands must accumulate enough sediments and organic matter vertically to offset their change in position relative to the sinking of land (subsidence) and a rising sea level. Data are being accumulated and analyzed to determine the relative rates of subsidence and sea level rise for the last few decades. Sea level rise is obviously not constant and has been rising worldwide for most of this century (Figure 3.)

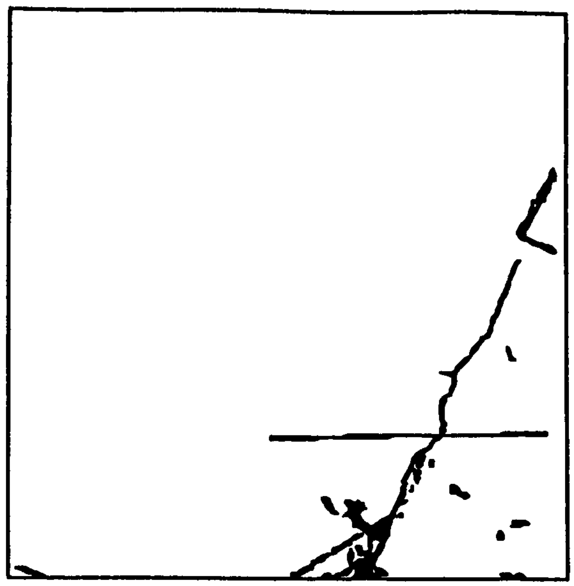


Figure 2. A example of the Larose quadrangle map data being analyzed. Most of the original quadrangle maps was originally marsh. The wetlands converted to open water from 1955 to 1978 are shown in black and the canals are the straight lines.

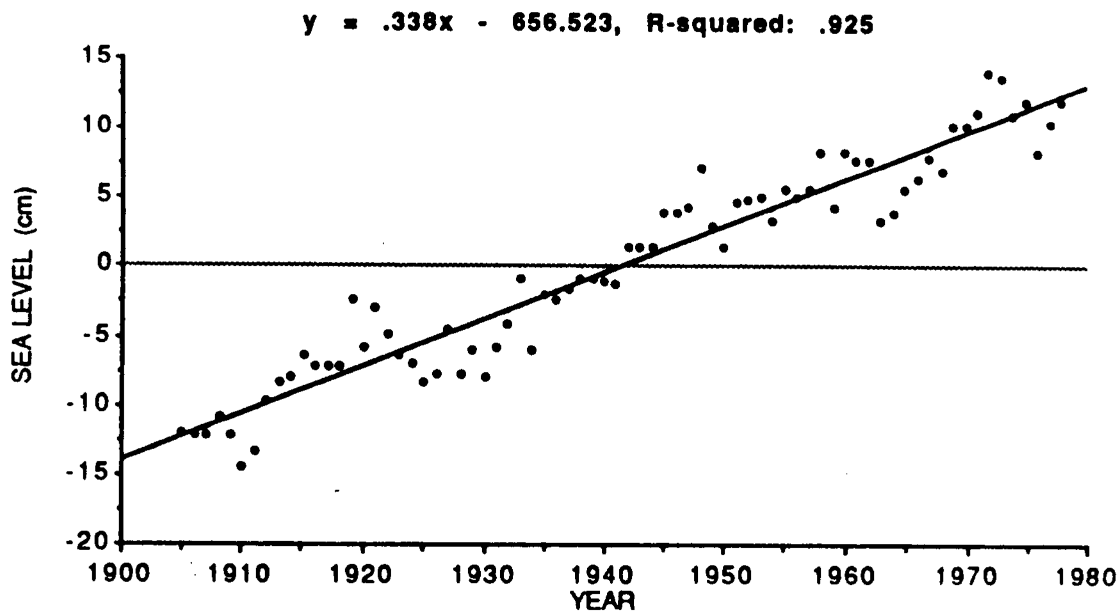


Figure 3. Estimates of world-wide sea level rise since the beginning of this century.

Oil and gas withdrawals may also contribute to subsidence rates and are known to be a significant influence on habitat change in areas with high groundwater withdrawal and relatively shallow reservoirs. We are attacking this issue with a modeling study. Using this modeling result, it presently appears that local oil and gas withdrawal effects on subsidence are relatively small, relative to geological subsidence and sealevel rise for reservoirs less than 6,000 feet deep. The model is still under development, however.

SUMMARY

All analyses and conclusions will be be presented at the end of the project. Each subtask will make a separate concise report on their research activities, and working groups will synthesize a summary of results from their respective subject areas. A summary chapter will deal with the contribution of OCS development activities to overall landloss rates and be addressed by the entire research team in late summer. The draft final report is due September, 30th, 1987 , and the final report will be turned in to MMS on December 31st, 1987.

ABSTRACT

Impacts of the Outer Continental Shelf (OCS) Related Activities on Sensitive Coastal Habitats; MMS Contract No. 14-12-0001-30325. Karen M. Wicker, Coastal Environments, Inc., 1260 Main Street, Baton Rouge, La. 70802. First 1987 Ternary Studies meeting; MMS; New Orleans, Louisiana. 23 March 1987.

Coastal Environments, Inc. is presently conducting a two-part study to determine the impacts of selected Outer Continental Shelf (OCS) activities on sensitive coastal habitats. In Part One, we are researching the impacts of Federal OCS pipelines and associated facilities and navigation channels on barrier beaches and barrier islands along the Gulf of Mexico from Cameron County, Texas to Bay County, Florida and on coastal wetlands within this region, except those located between East Bay, Texas, and Waveland, Mississippi. Information obtained from this phase of the study will be synthesized with that generated by the present LSU study ("OCS Development and Potential Coastal Habitat Alteration") to predict impacts of future OCS activities in the region and to document measures that have been successful in mitigating impacts for specific habitats and environmental conditions.

Part Two of this study consists of a reconnaissance level assessment of the impacts of OCS-produced water discharges in coastal wetlands, primarily Louisiana wetlands. This study extends, updates and improves on an existing record inventory approach and provides a field assessment of the hypothesis that there are existing conditions that may have a locally severe adverse impact. The Louisiana Marine Universities Consortium (LUMCON) and the Louisiana State University, Institute for Environmental Studies are responsible for this research. Both parts of the study are to be completed by September 1988.

This project has been segmented into discrete units of work consisting of the following:

1. Documentation of Federal OCS pipelines and pipeline emplacement techniques, past and present, and regulations governing emplacement.
2. Documentation of OCS navigation channels.
3. General description of physical, biological, and cultural parameters of the study area grouped by major coastal regions (i.e., Texas Barrier Island, Strand Plain-Chenier Plain, Mississippi Delta, and North Central Gulf Coast).

4. Documentation of impacts of OCS pipelines on barrier beaches and coastal wetlands (large-sample, area-wide, air photo study and small sample, site specific field investigations).

5. Documentation of impacts of OCS navigation channels on barrier beaches and wetlands (large-sample, area-wide, air photo study and small sample, site specific field investigations).

6. Documentation of impact of OCS-produced water on Louisiana wetlands.

7. Summary of impacts in terms of construction techniques, environmental conditions, and regulatory constraints.

8. Prediction of impacts of future emplacements in terms of emplacement techniques, environmental conditions, and regulatory constraints.

One major thrust of our study to date has been documentation of Federal OCS pipelines including location, owner/operator, date, and type of emplacement, pipe size and type of materials transported. We have tentatively identified, via consultation with pipeline maps, oil and gas companies and their appointed representatives and U.S. Army Corps of Engineers permits, the following pipelines by state: Alabama (5), Florida (0), Louisiana (171), Mississippi (14), and Texas (23). These pipelines are owned or operated by 42 companies (single or in partnership) and have been emplaced between 1954 and 1986. Completion of the worksheet on each pipeline, verification of all data and location of all pipelines on 1:24,000 topographic maps is continuing.

We have also completed a chapter on identification and documentation of OCS navigation channels. This was done by researching the reason behind congressional authorization for dredging or improvement of navigation channels.

A draft environmental overview of the study area is complete. This chapter is accompanied by draft maps (1:250,000 base) of selected parameters (i.e. geological-sedimentological, hydrological-oceanographic, botanical, and land use).

We are presently reviewing the pipeline and navigation channel data and environmental data to select pipelines for further detailed study. With the help of the National Cartographic Information Service, photographic coverage of each pipeline will be determined in order to select photography for analysis of changes along the selected pipeline route and an adjacent control corridor. This process will aid selection of pipelines for field studies in addition to the air photo analysis.

The OCS produced water part of this study is in a preliminary stage with the consultants having contacted the Louisiana Department of Environmental Quality (DEQ) to determine availability of data. It was learned that produced water is not regulated by DEQ or the Environmental Protection Agency (EPA), but that DEQ does maintain records on voluntary responses to their questionnaires on location and discharge rates of produced water discharges. DEQ has provided access to this data and it is being input on the DEQ Vax computer system for compilation of a map showing location of produced water discharges and discharge rates. This information will be used to select several locations for on-site evaluation prior to selection of a location for detailed field sampling.

1987 TERNARY STUDIES MEETING

ABSTRACT

Reevaluation of Cultural Resource Management Zone 1 in the Gulf of Mexico

The majority of our efforts have been focused on obtaining data. We have acquired and processed seven major data sources. We plan to obtain at least two more major sources in the near future. Our seven sources are: Coastal Environments, Inc. (CEI), a 1977 study done for MMS; Automated Wreck and Obstruction Information Service (AWOIS) of the National Ocean Survey; the Defense Mapping Agencies Hydrographic/Topographic Center (HO) listing; Florida Antiquities Committee shipwreck file; Texas Antiquities Committee (TAC) shipwreck file; List of Merchant Vessels of the United States (MVUS) ships lost file; Hangs and Obstructions of the Texas and Louisiana Coast (Sea Grant), a file catalogued by the Sea Grant office of Texas A&M University.

Each one of these files have advantages and disadvantages. AWOIS, HO and Florida are the only automated files. AWOIS, HO and MVUS are restricted to 20th century wrecks, while Florida and TAC are weighted more towards pre-20th century. Florida, TAC and Sea Grant have restricted their scope of study to their respective coasts. The locations in CEI, TAC, Florida and MVUS are, for the most part, descriptive. All of these files, except MVUS and Sea Grant, rely upon secondary information. MVUS is restricted to United States merchant vessels.

One major secondary study is Seville et l'Atlantique by Hugette et Pierre Chaunu. This is a major statistical study of primary documents of Archivo General de las Indies, Seville and other major Spanish archives, but is not specifically a shipwreck file.

Several data files (CEI, TAC, MVUS, etc.) are primarily descriptive in their location information. These locations will be converted to decimal degrees of latitude and

longitude using large scale charts and recording wreck positions with a digitizer. The digitizer will also be used to create high resolution maps of the Gulf of Mexico and selected subsectional areas for final presentation and analysis of data.

The data files are currently being edited to a standard format compatible with the AWOIS data base. Optional variables, in addition to ship name, location, etc., will enable the data to be sorted by lease block area, wreck type and date, when available. With the completion of this effort, the 10 data files will be concatenated into a single data file of standard format, containing the majority of wreck sites in the Gulf of Mexico.

2.3

LIST OF REGISTERED ATTENDEES

Minerals Management Service
Ternary Meeting
23 March 1987

Dr. Thomas Ahlfeld, U.S. Department of the Interior, Minerals Management Service, Branch of Environment Studies, 18th & C Streets, N.W., Washington, D.C. 20204

Ms. Eileen Angelico, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Office of the Regional Director, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Dr. Robert M. Avent, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Mr. James Barkuloo, Field Supervisor, U.S. Fish and Wildlife Service, 1612 June Avenue, Panama City, Florida 32405

Mr. Richard T. Bennett, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Mr. Rick Billings, Biologist, Geo-Marine, Inc., 1316 14th Street, Plano, Texas 75074

Ms. Jennifer Bjork, Natural Resources Specialist, Padre Island National Seashore, National Park Service, P.O. Box 6015, Corpus Christi, Texas 78418

Mr. Jerry Brashier, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Dr. Murray Brown, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Dr. Larry Danek, Vice President, Environmental Sciences and Engineering, inc., Gainesville, Florida 32602

Mr. Rick Dawson, Resource Management Specialist, National Park Service, Southeast Regional Office, 75 Spring Street, NW, Atlanta, Georgia 30303

Dr. Richard Defenbaugh, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Dr. Marion Fischel, Senior Specialist, Shell Oil Company, Environmental Affairs, P.O. Box 4320, Houston, Texas 77210

Ms. Laura Gabanski, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Dr. Benny J. Gallaway, Biologist, LGL Ecological Research Associates, Inc., 1410 Cavitt Street, Bryan, Texas 77801

Mr. Ruben G. Garza, President, Geo-Marine, Inc., 1316 14th Street, Plano, Texas 75074

Dr. Charles P. Giammona, Associate Research Specialist, Texas A&M University, Civil Engineering Department, Environmental Engineering Division, College Station, Texas 77843

Mr. Lawrence R. Handley, Geographer, U.S. Fish and Wildlife Service, National Wetlands Research Center, 1010 Gause Boulevard, Slidell, Louisiana 70420

Mr. Charles Hill, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Mr. Paul G. Johnson, Government Analyst, Office of the Governor, Office of Planning and Budgeting, The Capitol, Tallahassee, Florida 32301

Ms. Barbara Keeler, Environmental Scientist, U.S. Environmental Protection Agency, Water Management Division, 1445 Ross, Dallas, Texas 75202

CDR. Brian Kelly, U.S. Coast Guard, 500 Camp Street, New Orleans, Louisiana 70130

Dr. A.J. Knight, Director, University of New Orleans, Center for Bio-Organic Studies, New Orleans, Louisiana 70148

Ms. Connie Landry, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Ms. Bethlyn McCloskey, 5113 Bissonet Drive, New Orleans, Louisiana 70003

Mr. Keith E. Miller, Associate Regional Director, Park Operations, National Park Service, 728 Santa Fe, Santa Fe, New Mexico 87501

Mr. Chris Oynes, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Office of the Regional Director, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Mr. J. Rogers Pearcy, Regional Director, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Dr. Edward Pendleton, Ecologist, U.S. Fish and Wildlife Service, National Research Center, 1010 Gause Boulevard, Slidell, Louisiana 70458

Mr. Joe Perryman, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Ms. Nancy Prolman, Community Planner, U.S. Department of the Interior, Minerals Management Service, OEAD-BES (MS 640), 18th & C Streets, N.W., Washington, D.C. 20204

Mr. Tim Randolph, Senior Staff Environmental Engineer, Shell Offshore Inc., Offshore East Sea, P.O. Box 60159, New Orleans, Louisiana 70161

Mr. Villere Reggio, Jr., U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Dr. Richard Rezak, Department of Oceanography, Texas A&M University, College Station, Texas 77843

Mr. Ed Richardson, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Dr. Robert Rogers, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Mr. Mark Rouse, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Mr. Harry Sieberding, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Dr. Brent Smith, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Leasing and Environment, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123

Mr. Everett Smith, Assistant State Geologist, Geological Survey at Alabama, P.O. Drawer O, University Station, Tuscaloosa, Alabama 45486

Mr. Michael S. Tomlinson, Environmental Science and Engineering, Inc., P.O. Box ESE, Gainesville, Florida 32602

Dr. R. Eugene Turner, Louisiana State University, Center for Wetlands Resources, University Station, Baton Rouge, Louisiana 70803

Mr. Harty C. Van, Jr., Petroleum Engineer Associate, Amoco Production Company, Offshore Division, P.O. Box 50879, New Orleans, Louisiana 70150

Dr. Evans Waddell, Division Manager, Science Applications International Corporation, Marine Science and Engineering, 4900 Waters Edge Drive, Raleigh, North Carolina 27606

Mr. Jerry Wermund, Associate Director, Texas Bureau of Economic Geology, Box X, University Station, Austin, Texas 78713

Dr. Karen Wicker, Director, Applied Science, Coastal Environment, Inc., 1260 Main Street, Baton Rouge Louisiana 70802

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 **Minerals Revenue Management** 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.