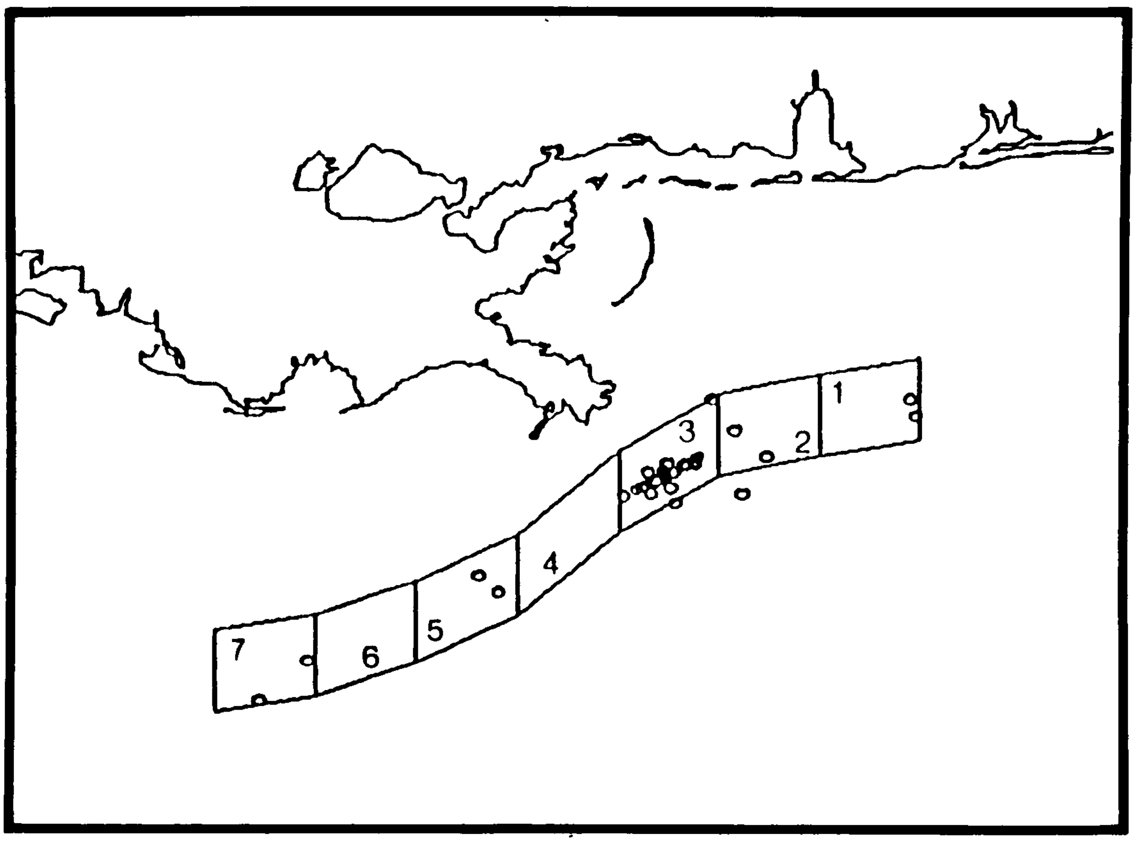
OCS Study
MMS 90-0052

Proceedings: Gulf of Mexico Environmental Studies Meeting

April 4, 1990



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

OCS Study
MMS 90-0052

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ABOUT THE COVER

Cover artwork is taken from the summary of the presentation given by Dr. Keith Mullin of National Marine Fisheries Service, Pascagoula Laboratory at the 1990 Environmental Studies Meeting. The figure, which depicts the seven study blocks and locations of sighted sperm whale herds, is presented in its entirety on page 43 of this report.

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SUMMARY

Introduction

The Minerals Management Service (MMS), Gulf of Mexico OCS Regional Office, convened the Environmental Studies Meeting of 1990 on April 4th in the Region's Main Conference Room, 1201 Elmwood Park Boulevard, New Orleans, Louisiana. The meeting is a compilation of presentations given by several speakers of various MMS-funded studies. The purpose is to provide progress reports on the individual study efforts.

Meeting Agenda and Presentation Summaries

The meeting's agenda is reproduced on page 3. Prior to the scheduled presentations, each speaker provides a presentation summary for distribution so that others have an opportunity to become familiar with the material to be presented. This procedure provides the audience an opportunity to formulate questions before each presentation is given and to attend each presentation with less distraction. These summaries form the basis for this Proceedings volume.

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

Environmental Studies Information

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

ENVIRONMENTAL STUDIES PROGRAM
FOR THE GULF OF MEXICO

SPRING ENVIRONMENTAL STUDIES MEETING

April 4, 1990

The Minerals Management Service (MMS), Gulf of Mexico OCS Region will hold an Environmental Studies Program Meeting the afternoon of April 4, 1990. The meeting will take place in the Region's Main Conference Rooms 111/115, 1201 Elmwood Park Boulevard, Jefferson, Louisiana. The meeting will present progress reports by various Studies Program contractors on their individual study efforts. You are cordially invited to attend this informal meeting, or any of the individual presentations listed below. Please contact the Chief, Environmental Studies Section, (504) 736-2897 for further information (mailing address below, Mail Stop LE-4).

Also, the Gulf of Mexico Regional Technical Working Group, an advisory body serving the MMS, will hold a business meeting at the same location on April 3-4. Agenda topics will include a "Roundtable" report by members on topics of interest to the group, briefing on the 5-year OCS oil and gas program, discussion of oil dispersant studies, and environmental study planning for Fiscal Year 1992. Please contact Ms. Ann Hanks, Regional Director's Office, (504) 736-2589 for further information (mailing address below, Mail Stop ORD).

Agenda

1:00 p.m.	Welcoming Remarks Dr. Richard E. Defenbaugh, Chief, Environmental Studies Section, Leasing and Environment
1:15 p.m.	The Impact of the "Boom and Bust" Cycles of Offshore Petroleum Extraction on Social Institutions Dr. Shirley Laska, University of New Orleans
2:00 p.m.	Socioeconomic Impacts of Declining OCS Oil and Gas Activities in the Gulf of Mexico Dr. Lawrence McKenzie, Applied Technology Research Corporation
2:30 p.m.	Application of Geographic Information System Analyses to OCS Archaeological Survey Issues Dr. Rik Anuskiewicz, Minerals Management Service
2:45 p.m.	Marsh Management Study Dr. Donald Cahoon, Louisiana State University
3:15 p.m.	Mississippi-Alabama Shelf Marine Ecosystems Study Dr. Steve Gittings, Texas A&M University and Dr. Will Schroeder, Dauphin Island Sea Lab
4:00 p.m.	Aerial Surveys for Marine Mammals and Sea Turtles in the North Central Gulf of Mexico Dr. Keith Mullins, National Marine Fisheries Service, Pascagoula Laboratory
4:30 p.m.	Flower Gardens Monitoring Study Dr. Steve Gittings, Texas A&M University
4:50 p.m.	Adjourn

****

Please note that our mailing address is for New Orleans but that we are physically located in Jefferson, Louisiana. This distinction is very important for anyone traveling to our office from the airport by taxicab. Our mailing address is:

Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394
(504) 736-2897; FTS 680-9897

Our office is located at the north end of the Elmwood Shopping Center, which is near the Huey P. Long Bridge, on Clearview Parkway. We are in the south twin tower office building. Please call if you need directions or information on area accommodations.

THE IMPACT OF THE "BOOM AND BUST" CYCLES OF OFFSHORE PETROLEUM EXTRACTION ON SOCIAL INSTITUTIONS

presented at the

Environmental Studies Meeting

Minerals Management Service
Gulf of Mexico OCS Region

by

Dr. Craig Forsyth
USL;
Dr. Sarah Brabant
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Dr. Shirley Laska
University of New Orleans;
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Dr. Ralph Thayer
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Dr. Charles Hadley
University of New Orleans;
Dr. Vern Baxter
University of New Orleans;
and
Dr. Charles Barrileaux
Florida State University

INTRODUCTION

Resource extraction, as a form of sustenance activity, is a topic of interest to social scientists. Sustenance activities form a core component of the activities which a society undertakes. As a sustenance activity, resource extraction has the power to influence many different aspects of a society. This project was developed on the premise that there is a need to ascertain the extent and way in which the various components of the society are impacted by resource extraction. The resource extraction activity which is the focus of the project is oil and gas and the location is the Gulf of Mexico, specifically the State of Louisiana. The components of the society which will be examined to ascertain the effect are five important social institutions: the family, social services, the community, the government, and the political/economic system.

Each of the social institutions is being studied by a separate social scientist or team. The work is being integrated by regular meetings of the group. These meetings will increase during the second year of the project as the studies get closer to completion and the individual projects can better benefit from the findings and analysis of the others. A summary of the progress of each of the projects follows.

COMPONENT PROJECTS

The Family

Resource extraction activities, as with any other human activities, must be done in a particular place. Restrictions as to where they are done are, however, even greater because the activity must take place where the resource is discovered. When the discovery is on land, the settlement comprising the "miners," their families, and the necessary services and related activities encircle the mine for convenience.

Off-shore resource extraction, however, does not permit extensive "settlement" development around the "mine" because of the cost of construction and transportation. Thus, workers must be transported to the sites while families and most support services remain on shore. The high cost of transporting the workers to the "mines" has resulted in work schedules which keep the workers on the rigs for extended periods of time, usually a minimum of seven days.

This work schedule has similarities to those of merchant seamen, military personnel, and fishermen. Research on these occupations as well as a limited amount on oil workers, primarily Canadian, forms the basis for a more in-depth analysis of the ways in which families respond to husbands/fathers working offshore. A typology of five family adaptation types developed from earlier research to describe merchant seamen, military personnel, and fishermen families was examined for its utility in explaining family dynamics of offshore oil workers. It is assumed that these adjustments are <u>not</u> necessarily negative <u>nor</u> are the families who have fathers employed offshore necessarily pathological in some respect.

In-depth interviews have been conducted by Forsyth and a graduate student assistant with an available sample of 147 offshore oil families. The interviews ranged from 20 minutes to 3 hours. They explored: marital satisfaction; contact with kin and the roles of kin, if any; type of family adaptations to father absence/presence; how the absence/presence of the father affects the family; a comparison of associations outside the family when the father is absent/present; job satisfaction; plans for the future and needed services.

Six adaptations to the absence of the offshore worker family are suggested by the data: (1) alternate authority, (2) contingent authority, (3) marginal father, (4) conflict, (5) replacement father, and (6) egalitarian. Intrafamilial problems caused by work scheduling typically occur: (1) when a family is unable to construct a consensual definition of reality, i.e., one of the adaptations or (2) when the construction has behavioral and identity implications that are intolerable to family members.

Social Service Needs and Response

Earlier research on the "boomtown" phenomenon described the difficulty which the boomtown had with providing services--including social services--to the influx of workers and their families. The demand was seen as coming both from an increase in the number of residents and also the stresses placed on boomtown populous by the rapid rate of change which was occurring. Recent research, however, has questioned whether the impact of the boom is as negative as earlier assumed. Some have even suggested that the boomtown scenario itself may be a myth.

A related body of literature has examined the nature of poverty, specifically its profile across time and in the context of a measurable fluctuation of events. Limited research has focused on assessing if, in fact, internal demands on community resources for basic needs covaries with external economic conditions that affect the community as a whole, such as the boomtown scenario. This project examines the need for social services--degree and nature of poverty, and the community response to it--social service provision in both boom and bust phases of oil extraction.

Four parishes were selected for the study: Lafayette, St. Mary, Calcasieu, and Ouachita. They were selected because they provide a broad range of both direct and indirect effects of oil/gas activity. The time frame for the study is 1970-1990, determined because it encompassed the oil embargo and the 1980s decline. The thrust of the data collection is two-fold: (1) 50 interviews with persons who have worked directly with individuals who sought food, shelter, and/or clothing and (2) statistics maintained during the time period by agencies or organizations involved in dispensing food, shelter, and/or clothing.

Early analysis reveals findings about the agencies and the poor. First, the social service response may have been uniquely successful because of the existing infrastructure already put in place within the communities of coastal Louisiana by the Catholic church. In addition, the response to the homeless nationwide may have provided resources for responding to the poor in coastal Louisiana that have not been available in the past nor may confidently be available in future boom/bust scenarios.

A typology of the poor are tentatively identified: (1) the traditional poor; (2) "the Grapes of Wrath revisited"; (3) the rust belt managerial, (4) new poor, (5) cast offs, and (6) poverty in the making. Two and three are associated with the boom; four through six are related to the bust.

Lafayette, St. Mary, and Calcasieu have all demonstrated a similar pattern of poverty types; Ouachita is quite different but reveals a "domino effect" as tertiary industry began to collapse.

Community Impact

Resource extraction activities, as with any other sustenance activities, are seen by social scientists as having potential effects on numerous aspects of a community. Demographers and urban ecologists focus on effects other than purely economic. They include effects on population growth, composition, educational level, income of residents, cost of housing, available tax base, and such quality of life measures as crime rates, poverty rates, and quality of available services.

Work has been done during this decade on examining some of these issues. A study edited by Gramling and Brabant (1984) of USL compiled many of these characteristics for the Louisiana parishes impacted in a primary as well as secondary way by oil and gas extraction. The data used was primarily Census decennial data which was presented in tabular form. Recent research by Gramling and Freudenbert (1989), the latter from the University of Wisconsin, has extended this work into predicting through regression equations unemployment rates for the oil impacted parishes from crude oil prices and international as well as local rig counts. Also, recent work done on Scotland by Seyfrit (1989), at Mississippi State, explores the effect of oil and gas economy--such as agriculture--during the phases of oil extraction.

This research is attempting to extend the earlier work in several days. First, annual and five-year data on sociodemographic and quality of life characteristics will be combined with existing decennial data in order to examine more closely the patterns of change which may occur during the various phases of the oil extraction process. Second, the data will be both graphed and analyzed in time series analyses with production variables as the independent variables. This will permit a clearer "picture" of the response of community characteristics to the extraction activities and also of their interaction effects. Third, the Louisiana parishes will be compared with communities which have been involved in the extraction of other resources, namely copper, coal, and iron ore in order to ascertain similarities and differences. The differences may be due to pre-extraction qualities of the communities affected as well as differential needs of the extraction activities themselves such as the need for fabrication of oil rigs and the offshore, extended duration of work scheduling which occurs in oil and gas extraction. Finally, communities in California and the Carolinas which may be locations of future exploration will be examined in light of the findings of the earlier phases. Planned future extensions of the research include comparing the resource extraction concentrated communities with other comparably sized communities which have experienced growth to consider what differences, if any, exist in terms of the impact on them. Also, when available, 1990 census data will be added to the file.

Literature has been reviewed; the available additional community characteristics have been determined; contacts have been made with geologists locally and nationally to determine ways to systematically select other resource communities; a list of potential communities has been developed; and the data file for analysis of Louisiana parishes is being prepared.

Political and Public Finance Impact

The revenues received by the state of Louisiana from oil and gas extraction were utilized by the state to assist local governments in providing a wide range of public services that might otherwise have been the fiscal responsibility of local governments. The use of enhanced revenues was not equal across services as some services had traditionally been paid for by the state and others designated as local. With the decline in state revenues from oil and gas, local governments have had to make decisions with regard to finding alternative funding sources or have had to restrict or terminate services. These decisions have had to be made by communities impacted directly by oil and gas extraction as well as communities across the state. This component of the project is examining the way in which communities have responded to the revenue decline.

Six questions guide the research: (1) What public services/facilities are being funded by dedicated revenues? (2) What public services have become extremely overburdened or abandoned due to loss of state revenues? (3) What public services have been "privatized" as a means of reducing costs? (4) What services are now being charged a fee and how has that affected their use? (5) Extent to which defaulting on local bond issue-funded projects has been considered, actually done? and (6) Impact of federal agency mandates to increase local government expenditures where they are low due to a lack funding?

While research will be concentrated in those areas most directly impacted by oil and gas activity, research will also be done both on communities inside and outside of the coastal zone.

Energy Policy and Investment Decisions and Their Impact

The political economy component of this project asks: What are the critical political and economic conditions that affect petroleum exploration and development in the Outer Continental Shelf of the Gulf of Mexico; and what are the effects of this offshore development on the social institutions of Louisiana? The hypothesis that guides the investigation is that opportunity for maximum economic gain, as mediated by politically determined incentives and regulations, governs exploration and development offshore. This hypothesis is derived from a synthesis of resource dependence and Marxist theories of organizational and interorganization behavior.

The beginning phase of the project looked at the history of oil exploration internationally, especially the U.S. domination of it. It also examined the shifts in balance of power in the world oil industry. Third, the period of exploration, conservation, and decline in oil prices of the more recent decades, was also researched especially to explore the repositioning, reintegration, and realignment of oil interests.

Interviews have been conducted with executives of Freeport McMoRan, Shell Offshore, Chevron, and McDermott. In addition, literature has been reviewed, both academic and trade, including the reports of the American Petroleum Institute. Also, the raw data file developed by Centaur Associates for their MMS funded study "Indicators of the Direct Economic Impacts Due to Oil and Gas Development in the Gulf of Mexico" has been obtained and reviewed on the University's mainframe. The data of interest are the producer employment records compiled by the Offshore Committee, a committee of oil producing companies.

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Dr. Charles Hadley, University of New Orleans;
Dr. Vern Baxter, University of New Orleans;
and
Dr. Charles Barrileaux, Florida State University

SOCIOECONOMIC IMPACTS OF DECLINING OIL AND GAS ACTIVITY IN THE GULF OF MEXICO

presented at the

Environmental Studies Meeting

Minerals Management Service
Gulf of Mexico OCS Region

by

Dr. Lawrence McKenzie
Applied Technology Research Corporation

DELINEATION OF GOM/OCS IMPACT AREA

The primary objectives of the current project are:

- to determine the socioeconomic impacts of the current price related decline in OCS oil and gas activity; and

- to formulate a set of conceptual cause-effect models that express the relationships between changes in OCS activities and socioeconomic characteristics

The study area covers 49 counties and parishes located in four states along the GOM including select inland counties and parishes encompassing adjacent metropolitan areas (Figure 1).

GOM/OCS Onshore Impact Allocation Model

An onshore impact allocation model developed by the Minerals Management Service was used to assign OCS Central and Western Planning Areas (offshore) activity impacts to Central and Western Coastal Analysis Areas (onshore). During the course of the research, the MMS allocation impact model was refined based on an analysis of data presented in a sample of plans of exploration.

Preliminary Regression Analysis

Independent variables, including the following OCS oil and gas indicators:

- number of exploratory wells drilled;
- number of development wells drilled;
- oil and gas production (barrel equivalents); and
- value of oil and gas produced;

were employed in a regression analysis. The dependent variables included select demographic, economic, and employment data for each of the 49 counties and parishes in the study area aggregated by coastal analysis area.

The initial regression analysis revealed unexpectedly weak correlations and a series of outlyers associated with coastal area W-2 (upper Texas coast). The deletion of coastal area W-2 from the analysis strengthened the r-square from .12 to .50.

The findings from the initial regression analysis pointed to the need to reconsider the defined impact area within the study area and to only include those counties and parishes impacted by OCS activity.

Impact Area Reconsideration

U.S. Bureau of Economic Analysis mining sector employment data (by place of work) was assembled for assessing the magnitude and distribution of oil and gas industry employment within the study area. Of the 206,140 mining sector jobs in the study area (1984), nearly half (100,173) were in Harris County, Texas (Houston). Other high concentrations of mining sector jobs were reported in Lafayette Parish (19,009) and in Orleans Parish (16,283).

The study entitled *Indicators of the Direct Economic Impacts Due to Oil and Gas Development in the Gulf of Mexico* (Centaur Associates, Inc. 1986) contains offshore-related production employment data from member companies of the Offshore Operators Committee. The expanded data indicate an estimated 23,935 person-years of employment associated with GOM offshore oil and gas activities by production companies.

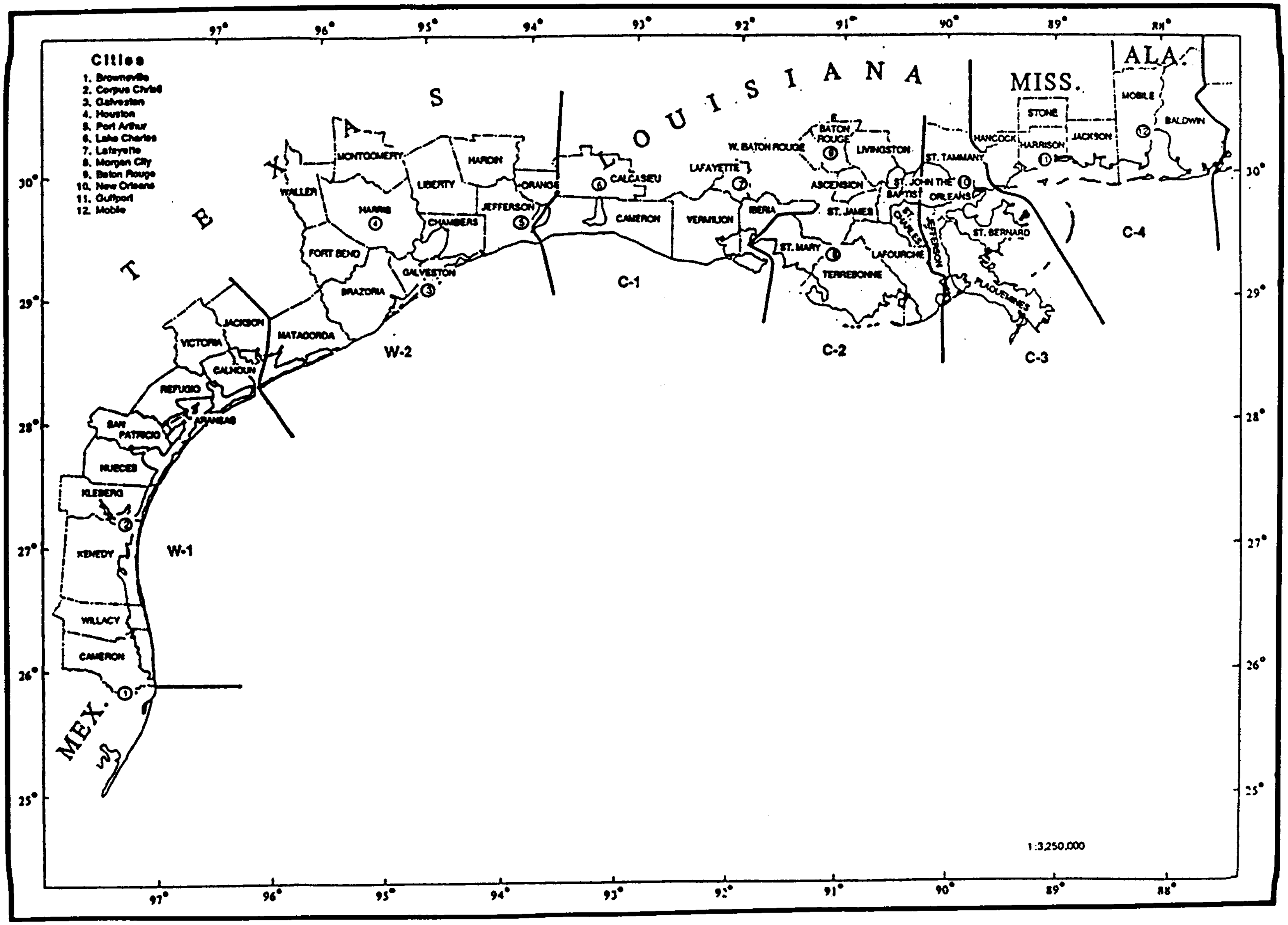

Figure 1. Study area map.

Of the 22,824 person-years offshore production jobs identifiable by work site, most are located in Louisiana--New Orleans area, 10,219; St. Mary Parish, 3,577; Plaquemines Parish, 2,439; Lafourche Parish, 1,669; Lafayette Parish, 1,289; and Harris County, Texas, 301.

When offshore production-related jobs are expressed as a percent of all mining sector jobs by place of work, it become apparent that many mining industry jobs in the study area are not directly associated with GOM/OCS activities.

The place of residence impacts are of particular importance to the study since demographic and economic attributes in those areas are likely to be influenced by OCS activity. Of the total offshore production jobs identified in the Centaur study, 18,682 offshore production jobs were accounted for by employees who reside in the study area. Areas with high concentrations of the offshore production workforce include Orleans Parish, 4,524; Jefferson Parish, 3,665; Lafayette Parish, 1,524; St. Tammany Parish, 1,489; Lafourche Parish, 974; St. Mary Parish, 879; Brazoria County, Texas, 388; and Harris County, Texas, 435.

Earnings from offshore production work was expressed as a percent of total earnings by place of residence to obtain a measure of the relative economic impact on local economy. The values ranged from a low of 0.0% in several counties in coastal area W-1 (lower Texas coast) to 9.29% in Cameron Parish. Thirteen counties located in coastal areas W-1 and W-2 had values of 0.05% or less.

Regression Analysis Based On Revised Impact Area

Deletion of the 13 counties where earnings from offshore production work accounted for 0.05% or less of total earnings by place of residence resulted in stronger correlations between OCS indicators and socioeconomic changes.

CONCLUSION

The area of OCS oil and gas activity impact within the study area is not contiguous. Although most of the counties and parishes within the study area exhibit socioeconomic characteristics closely associated with the oil and gas industry, the association in select areas is more closely aligned with non-OCS oil and gas activity. Data from the Centaur study together with the analyses performed under the current effort have led to a better understanding of the relationship between OCS activities and onshore impacts on counties and parishes along the Gulf coast.

Dr. Lawrence S. McKenzie, III, is president of Applied Technology Research Corporation, a private research and planning firm. Mr. McKenzie holds a Master of Science degree from Louisiana State University.

APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM ANALYSES TO OCS ARCHAEOLOGICAL SURVEY ISSUES

presented at the

Environmental Studies Meeting

Minerals Management Service
Gulf of Mexico OCS Region

by

Dr. Richard J. Anuskiewicz
and
Mr. John R. Greene
Minerals Management Service

INTRODUCTION

The Minerals Management Service (MMS) is presently entering into its third year of a multiyear contractual agreement with Jackson State University (JSU) involving of the Geographic Information System (GIS). This agreement was initially developed to pursue GIS training for both parties and specifically for the MMS to develop current databases and methods of GIS implementation to assist in preparing environmental analyses for the Federal Outer Continental Shelf (OCS). As a part of this contract the MMS archaeological resource management program has had an opportunity to work closely with JSU and the GIS system.

A wide variety of in-house computer hardware, ranging from a cluster of Vax minicomputers to AT&T and IBM microcomputers, and including Tektronic work stations, a large format Calcomp digitizing tablet, and Calcomp 9100 electrostatic plotter (Perryman et al. 1989:297) were used to produce the maps for this presentation.

The MMS archaeological resource management program's involvement in the GIS system began about a year ago as a result of a recently completed historic shipwreck inventory and high probability modeling study with Texas A&M University (TAMU). The large database coupled with the extensive area of focus made the study an excellent candidate for analysis using the GIS. The MMS archaeological resource management program, for the Gulf of Mexico, receives its guidance from the Handbook for Archaeological Resource Protection (MMSM 620.1). This handbook requires that existing prehistoric and historic baseline studies must be periodically updated to reflect a new and expanding data base.

The current MMS Stipulation 1, and archaeological survey requirement was based on a 1977 baseline study (CEI 1977). Essentially this study identified a zone of high probability for the occurrence of historic shipwrecks, and recommended invoking Stipulation 1 survey requirements for all of the lease blocks that fell shoreward of this line. This area roughly falls between the 40 and 60 meter (m) bathymetric contour line and encompasses approximately 3,400 lease blocks. Presently this area is designated as the MMS Archaeological Resource Management Zone 1 (ARMZ1) and considered to be the highest probability area for the occurrence of historic period shipwrecks. Lease blocks located in this zone fall within the MMS Stipulation 1 which requires specific remote-sensing survey requirements along with an archaeological report.

The MMS archaeological resource management program receives its guidance from the aforementioned MMS Handbook for Archaeological Resource Protection. For several years the program sought to update and refine the initial 1977 study, which is the basis for requiring Archaeological Stipulation 1. This effort resulted in the contract with TAMU to comply with the requirement to refine our existing shipwreck loss models (Anuskiewicz 1989; Anuskiewicz and Greene 1990; Greene and Anuskiewicz 1988). The initial contract study objectives were:

1. To reevaluate and make recommendations to change, if necessary, Gulf of Mexico OCS Region's present high probability area for the occurrence of historic shipwrecks (ARMZ1).

2. To determine the relationship between linespacing interval of magnetometer readings and side-scan sonar targets and the detection of objects at or below the seafloor.

3. To establish an interpretive framework to characterize unidentified magnetic anomalies and side-scan sonar targets in an attempt to differentiate between modern marine debris and historic period shipwrecks.

The remainder of this presentation will focus on the first task of the TAMU study which was the reevaluation of the Gulf of Mexico OCS Region's present high probability zone for the occurrence of historic shipwrecks.

The TAMU study utilized both primary and secondary source archival research to record approximately 4,000 total shipwrecks within the Gulf of Mexico region. This new study recorded approximately 2,500 more shipwrecks than the 1977 study by CEI. The larger data base generated by the study provided the opportunity to refine MMS's predictive model for historic period shipwrecks within the Gulf of Mexico region. It was important to the MMS archaeology program to be able to conveniently manipulate this large data set for analytical purposes and also have the ability to visually present the multi-faceted management concepts generated by the TAMU study.

Our analysis of the TAMU study indicates that it provides sound scientific justification for redefining ARMZ1. In addition, the study made recommendations to change existing remote-sensing survey requirements. These two factors could result in changing Stipulation 1 requirements if adopted by MMS. A brief overview of this study may be stated as follows:

- The study identified and delineated specific geographic and culturally related areas in the Gulf (e.g., near shore areas, natural geologic hazards such as islands and, shoals, ports, etc.) where shipwreck clustering or loss traps occurred and;

- The TAMU study specifically focused on offshore shipwreck patterning.

The following archaeological resource management concepts, introduced by the TAMU study, are graphically presented on the following maps produced by the GIS. These managements concepts are the focus of the GIS archaeological mapping project and have been displayed for easy interpretation and analysis by color coding. The GIS basically used a series of MMS supplied overlapping computer data files to map the desired high probability areas for the occurrence of historic shipwrecks. More specifically, the following discussion describes archaeological concepts presented by the study.

10 km From Shore Line

The TAMU study identifies a high probability zone for historic shipwrecks within 10 km of the shore. This zone, for the most part, is **not** in federal waters or jurisdiction. The designation of this zone was based on archival studies which indicated that over 80% of historic period shipwrecks occurred within 10 km of the shoreline. This 10 km zone is color-coded in red with an exception of a small area near the mouth of the Mississippi River which is color-coded in green. This specific area of the Gulf receives an extremely high amount of riverborne sediments. Historic period shipwrecks located within this area are expected to be deeply buried.

High Probability Area Quadrants

The study also identifies a series of 21, 0.5 degree squares designated as high probability quadrants centered around specific geological, geographic and cultural features (e.g., most notably, historic ports). These high probability areas for historic shipwrecks are focused near historic ports which had a higher density of maritime traffic and, a higher incidence of shipwreck losses. These 21 high probability area quadrants are, for the most part, **not** located in federal waters, and tend to overlap with the 10 km high probability zone. As another high probability zone it is also color-coded in red.

High Probability Search Polygons Concept

The TAMU study recognizes the occurrence of individual shipwrecks that are located outside the two aforementioned high probability shipwreck loss areas. This study also recognizes the problem of accurately plotting shipwrecks that have not been verified by diver hands-on or recorded on side-scan sonar. Only general locational information is available for the majority of non-verified shipwrecks. These shipwreck losses have been plotted to the nearest lease block, based on the best and most accurate information available. The most accurate block location for these individual shipwrecks is plotted as a circle of 4.5-mile radius. This area defines a high probability search area for the occurrence of this particular wreck. The 4.5-mile radius generally encompasses the eight immediately adjacent blocks. This forms a nine-lease block high probability search polygon, which is also color-coded in red.

Known Shipwreck Locations

These shipwrecks have either been located and recorded by remote-sensing (i.e., side-scan sonar) and/or physically **verified** by diver hands-on. We have exact coordinates for these shipwrecks and they have been recorded for the MMS in specific lease blocks and have been color-coded in yellow. These known locations do not have an associated search area.

Limit the Magnetometer Surveys to Lease Blocks with Depths of 60 m (197 ft) or less in ARMZ1

The TAMU study and five years of in-house research indicates that it is difficult if not impossible to maintain an accurate magnetometer tow sensor depth of 6 m above the seafloor, and sensor position in water depths greater than 60 m. In discussions with the oil industry, marine survey companies and marine archaeologists all report that as water depth increases more tow sensor cable is needed to maintain the required MMS sensor tow depth. In depths greater than 60 m the magnetometer sensor "swims" off the center survey line thereby losing the accuracy of its position. This problem results in questionable data. To graphically display where high probability shipwreck loss areas are located deeper than 60 m (197 ft) the GIS has color-coded these in blue.

We can easily see from examining these two sets of color-coded shipwreck high probability maps that the overall number of lease blocks that would require invocation of Stipulation 1 is significantly lower as a result of the TAMU shipwreck model refinement study. Analysis with the GIS also provided an area/block listing within the refined high probability zones. With this information in hand, the next step was to examine the current lease block status of all blocks within the refined high probability zones.

In order to make appropriate management decisions about the implementation of the refined high probability areas and associated changes to the archaeological survey requirements it was necessary to compare those blocks which fell within the refined high probability areas with a file containing the current lease status of all blocks in the Gulf of Mexico Region. Only by comparison of these two databases could the total number of lease blocks subject to changes be ascertained. The GIS greatly facilitated this comparison and the graphic representation of this comparison is presented here.

In this map, the lease blocks coded in blue represent those blocks of the Gulf of Mexico Region which do not occur within high probability areas and have active, non-producing status. Those blocks coded in green represent blocks which do not occur within high probability areas and have active, producing status. Blocks seen in yellow indicate that they are within an identified high probability zone and are presently in active, non-productive status. Blocks in red are located within high probability zones and are in active, producing status. Only the tan colored blocks are currently inactive and occur within the refined high probability zones. The GIS has provided an easy, visual reference of those blocks which would fall under a new Stipulation 1 requirement should recommended changes in the archaeological program be adopted.

In summary, the GIS provided the MMS' archaeological management program with the ability to analyze and compare large amounts of data far more efficiently than would have been possible had traditional, and more labor intensive, methods been utilized. The system also provided clear and concise visuals in a matter of a few hours. In addition, specific hard copy computer lists of blocks occurring within the different fields were produced for map verification. Also, unique listings of blocks are available as are listings of blocks which occur in more than one field.

The GIS has proven to be an invaluable tool in facilitating the analysis of the TAMU study results. We strongly feel that the TAMU study in consort with Jackson State University GIS program is an excellent example of how the archaeological resource management program is using scientific data to help in the management of archaeological resources on the OCS.

REFERENCES

Anuskiewicz, R.J. 1989. *A study of maritime and nautical sites associated with St. Catherines Island, Georgia*. Ph.D. Dissertation. The University of Tennessee. Knoxville, TN. 74 pp.

Anuskiewicz, R.J. and J.R. Greene. 1990. *Archaeological resource management on the Outer Continental Shelf*. *In* Toni Carrell, ed. Underwater Arch. Proc. from the Soc. for Hist. Arch. Conf., Tucson, AZ.

Coastal Environments, Inc. 1977. *Cultural resources evaluation of the northern Gulf of Mexico Continental Shelf*. Prepared for Interagency Archaeological Services, Office of Archaeology and Historic Preservation, National Park Service, U.S. Department of the Interior, Baton Rouge, LA.

Greene, J.R. and R.J. Anuskiewicz. 1988. *Management of archaeological resource on the Outer Continental Shelf*, pp. 2-5. *In* Paper presented before Chevron Oil Company. Unpubl. MS. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Regional Office, New Orleans, LA.

Perryman, J.K., J.B. Blake and B.L. Johnson. 1988. *Geographic information system (GIS) and data source: session overview*, pp. 297-298. *In* Proceedings: Ninth Annual Gulf of Mexico Information Transfer Meeting. OCS Report/MMS89-0060. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Regional Office, New Orleans, LA.

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A STUDY OF WETLANDS MITIGATION: MARSH MANAGEMENT

presented at the

Environmental Studies Meeting

Minerals Management Service
Gulf of Mexico OCS Region

by

Dr. Donald R. Cahoon
and
Dr. Charles G. Groat
Louisiana Geological Survey

INTRODUCTION

A wetlands mitigation study is being undertaken for the Minerals Management Service by the Louisiana Department of Natural Resources (DNR) through the offices of the Louisiana Geological Survey and the Coastal Management Division, with assistance of the Sea Grant Legal Program of Louisiana State University. The purpose of this two-year study is to determine the suitability of marsh management practices for mitigating wetland loss in the varied habitats of coastal Louisiana. The study will result in a report summarizing the essential aspects of marsh management in Louisiana - the administrative framework within which it occurs, public interest goals, engineering and construction techniques, an annotated literature review, environmental conditions within which it occurs, historical and field monitoring, and ecological consequences. This abstract presents a summary of our accomplishments since the Information Transfer Meeting in December 1989.

METHODS AND RESULTS

Reports on the administrative framework, public interest goals, annotated literature review, and environmental characteristics of the Louisiana coast were complete by December 1989. We previously presented a summary of the latter two reports as well as a review of progress to date on the monitoring program and the engineering and construction techniques report. Since that meeting, draft narratives have been completed of the monitoring program and the construction techniques report. Presented here is a summary of these two reports, with emphasis on the results of the monitoring program. A review of the ecological consequences of marsh management is being prepared from a synthesis of the information contained in all the above-mentioned reports.

Engineering and Construction Techniques Report

This report describes the operational phases of water level management (drawdown, flood, and maintenance) and the design, engineering, feasibility, construction, and maintenance of all the basic types of water control structures used to manage water levels. Included in this evaluation are passive and active water control structures as well as levees and trenasses. Examples of structures reviewed are wakefield, slotted, and rock weirs (passive structures), plugs, levees, flap-gated culverts, double divergent pumps, and trenasses.

Monitoring Program

A monitoring program was established to evaluate the quality of current monitoring efforts and provide new monitoring data through both historical analysis of habitat change and monitoring of ecological processes. The monitoring program consists of three parts: review of file monitoring data, historical analysis of habitat change through aerial imagery analysis, and field evaluation of management impacts on ecological processes.

Review of File Monitoring Data

Every operator of a permitted marsh management plan is required to submit annual monitoring data to the Louisiana Department of Natural Resources. Approximately 50 management plans have been implemented, at least partially, with about 20 plans fully implemented. However, only nine operators have submitted monitoring data to LDNR. The intensity and quality of monitoring data on file at LDNR varies greatly. The intensity of monitoring efforts varies from intermittent to continuous. Some efforts are dedicated to creating long-term databases; for others monitoring has ceased.

The quality of monitoring efforts varies because not all programs monitor the same variables. More importantly, however, all monitoring programs are limited in their ability to evaluate the effectiveness of management because the variables rarely have been measured in nearby unmanaged marshes for comparison. Consequently, even if the monitoring program was of sufficient intensity and quality to detect important changes within the managed marsh, it cannot be stated unequivocally that management was the cause for the change.

Three monitoring programs provided data on at least one variable of sufficient intensity and quality to evaluate the effectiveness of marsh management. Vegetation composition is becoming less saline and aquatic fauna diversity is lower in the managed marsh at Lafourche Realty Company. Water level management is being used successfully to induce the colonization of open water habitat by vegetation at Amoco West Black Lake management area. The managed marsh at Fina LaTerre is gaining vegetated habitat at a faster rate than the unmanaged marsh.

Historical Analysis of Habitat Change

Changes in marsh:water ratios and dominant vegetation types in sixteen managed marshes as well as sixteen unmanaged marshes located nearby were determined from color infra-red photography for 1956, 1978, 1981/2/3, 1985, and 1988. The imagery was photointerpreted and digitized into the DNR computer. The data were analyzed for changes in habitat type, species dominance, and marsh:water ratios. Several general trends are present in the data. From 1956 to 1978 there was a dramatic increase in the conversion of marsh to open water and of fresh marsh to non-fresh marsh, even in managed marshes. Since 1978, the rate of loss of marsh habitat to open water and the rate of change to non-fresh marsh types has slowed dramatically. The effectiveness of marsh management at mitigating marsh loss (e.g., improving the marsh:water ratio and encouraging the development of specific habitat types) varies greatly for the sixteen management areas. For 50% of the managed areas, management is very effective at mitigating marsh loss while in the remaining areas it is no better or perhaps worse than no management at all. In general, active water level management with adjustable water control structures is more effective at mitigating wetland loss than passive water level management via fixed crest weirs.

Field Monitoring

The ecological consequences of structural water level management on marshes at Fina LaTerre Mitigation Bank site and Rockefeller Refuge, as determined from field monitoring, are presented in summary form in Table 1. Water level management reduces tidal amplitude and frequency compared to unmanaged marshes. The results of the flux and accretion analysis are consistent with this hydrologic pattern and with each other. Only a small quantity of matter enters these two managed marshes and accretion is uniformly low throughout them. The accumulation rate of organic and mineral matter in the managed marshes is not sufficient to keep pace with the local rate of relative sea level rise. Under certain hydrologic conditions, more sediment may flow out of the Rockefeller Refuge management area than flows in. In contrast, the unmanaged marshes experience a regular exchange of matter and more accretion.

Although the impacts of management on hydrology and sedimentology are similar for both managed sites, the impact of management on plant growth and stress differ importantly. At Rockefeller Refuge, plant growth rates are higher and substrate conditions are less stressful in the managed marsh compared to the unmanaged marsh. At Fina LaTerre, however, plant growth rates are lower and substrate conditions are more stressful in the managed marsh compared to the unmanaged marsh. The apparent reason for this difference in plant response is the degree of drawdown achieved at each location. At Rockefeller Refuge, the water table was drawdown 20 to 30 cm below the marsh surface compared to 5 to 10 cm below the marsh surface at Fina LaTerre. The managed marsh at Rockefeller Refuge also had higher plant species diversity than the managed marsh while plant species diversity did not differ between the managed and unmanaged marsh at Fina LaTerre.

There were important differences in fish species composition between managed and unmanaged marshes at both study sites. At Fina LaTerre, more fish species were collected in the unmanaged marsh than in the managed marsh. There were significantly more individuals of resident estuarine and freshwater species and significantly fewer individuals of marine transient species in the managed marsh compared to the unmanaged marsh. However, the total standing crop of fish biomass was the same for the managed and unmanaged marshes. At Rockefeller Refuge, there were fewer individuals of both marine transient and resident species in the managed marsh. Biomass of resident fish species also was lower in the managed marsh.

Table 1. Ecological consequences of marsh management at Fina LaTerre and Rockefeller Refuge, January 1989 to January 1990.

Variable	FINA Managed	FINA Unmanaged	ROCKEFELLER Managed	ROCKEFELLER Unmanaged
FLUX				
Materials	<<		<<	
Sediment loss	no		yes (w/ low water)	
ACCRETION				
Vertical accretion	<<		<<	
Bulk density	<<		<<	
Organic matter content	>>		>>	
Mineral matter content	<<		<<	
Organic matter accumulation	<<		<<	
Mineral matter accumulation	no difference		<<	
Near/far	no	yes		
Burning				
OMC			greater in unburned	
OMA			initially higher in burned	
PLANT GROWTH				
Biomass	<<		>>	
CO2 fixation	<<		>>	
Leaf area index	<<		>>	
Interstitial salinity	>>		<<	
Eh	man=more reduced		man=less reduced	
Sulfides	no difference		<<	
SPECIES COMPOSITION				
Emergent sp.	no difference		>>	
Aquatic sp.	no difference		>>	
FISHERIES				
marine transient total count	<<		<<	
means	no difference		no difference	

Table 1. Ecological consequences of marsh management at Fina LaTerre and Rockefeller Refuge, January 1989 to January 1990 (continued).

	FINA				ROCKEFELLER		
Variable	Managed		Unmanaged		Managed		Unmanaged
resident							
count		>>				<<	
biomass						<<	
HYDROLOGY							
tidal amplitude & frequency		<<		Rock>Fina		<<	

SUMMARY

A factual array of data and data analysis is being prepared for all aspects of marsh management in coastal Louisiana. This analysis will provide an evaluation of the effectiveness of marsh management to mitigate wetland loss. All of the information described above is being synthesized into a report evaluating the impact of marsh management on wetland ecological processes and will be used to develop a suitability index describing the effectiveness of marsh management techniques.

Dr. C.G. Groat is State Geologist and Director of the Louisiana Geological Survey (LGS). He is project director for the Wetlands Mitigation Study being conducted by the Louisiana Department of Natural Resources through LGS and the Coastal Management Division, with assistance of the LSU Sea Grant Legal Program. Dr. Groat, a geologist, holds a Bachelor's degree from the University of Rochester, a Master's degree from the University of Massachusetts, and a PhD degree from the University of Texas at Austin.

Dr. D.R. Cahoon is an Assistant Professor of Research at the Louisiana Geological Survey. He is project manager for the Wetlands Mitigation Study and is charged with coordinating all project efforts. He is experienced in coastal regulatory affairs and is actively involved in scientific research into the causes of wetland loss in Louisiana. Dr. Cahoon, a wetlands ecologist, received a Bachelor of Arts degree from Drew University in Botany, and a Master of Science and PhD degree in plant ecology from the University of Maryland.

GEOLOGICAL AND BIOLOGICAL SURVEYS ON TOPOGRAPHIC FEATURES OF THE LOUISIANA-MISSISSIPPI-ALABAMA CONTINENTAL SHELF

presented at the

Environmental Studies Meeting

Minerals Management Service
Gulf of Mexico OCS Region

by

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The middle and outer continental shelf off eastern Louisiana, Mississippi and Alabama has previously received little attention from marine geologists. There has been only one previous attempt at a comprehensive synthesis of the geology of the outer shelf region (Ludwick and Walton 1957). Other studies have either focused on the inner shelf, omitted discussions of topographic features and hard bottoms, or examined only small, selective areas of the outer shelf (Moore and Bullis 1960; Ludwick 1964; Upshaw et al. 1966; Shipp and Hopkins 1978; Doyle and Sparks 1980; Kindinger 1988; Schroeder et al. 1988a, 1988b). Additionally, a few commercial reports of geologic studies of small areas (usually one lease block) exist.

Ludwick and Walton (1957) found that topographic features, which they called "pinnacles", were found in clusters along the outer Mississippi-Alabama shelf. They noted that these were not like those commonly found farther west in the Gulf of Mexico. In the northwest Gulf, topographic highs generally tend to be the result of uplift caused by salt, or occasionally shale, diapirs (Rezak et al. 1985). However, on the Mississippi-Alabama outer shelf, topographic features are apparently calcareous reef structures built during the Holocene rise in sea level. They also surmised that these reefs were not actively growing, but were instead in an intermediate stage between active growth and fossilization.

Our study has verified many of these conclusions, but more importantly, it has shown that there exists a far greater diversity of topographic features over a more extensive area than envisioned by Ludwick and Walton (Schroeder et al. 1989). The topographic features range from less than two meters to greater than 20 m in height. Most are patch reefs which are more-or-less equidimensional in plan view and occur singly or in clusters often along preferred isobaths. However, there are also numerous linear ridges and scarps, up to eight meters in height, which are probably constructed of indurated sand, shell, and gravel. Additionally, most topographic features are associated with hardbottoms, which are areas of indurated seafloor sediments.

During the first year of geophysical surveying, approximately 1166 nautical miles of side-scan sonar and subbottom profile data were collected (Figure 2). All of these data were collected in a reconnaissance mode with the side-scan sonar imaging a wide swath of seafloor (half-width either 300 or 400 m). The second year surveys were of two types, reconnaissance surveys similar to those of the Year 1 effort and detailed surveys of features observed during the Year 1 cruises. The latter used the side-scan sonar in a narrow swath mode (half-width 100 or 200 m) with closely spaced ship tracks.

The reconnaissance surveys extended east and west from the area surveyed during Year 1 and were positioned to follow the 40 fathom (73.2 m) isobath (see Figure 2), which was found to be the locus of numerous topographic features in the previous survey. Approximately 335 nautical miles of geophysical data were collected in the reconnaissance mode along 20 lines to the west of the Year 1 survey area and three lines to the east. About 19 nautical miles of detailed side-scan sonograms were obtained from four areas. In the northwest portion of the Year 1 survey area, detailed studies were done on a cluster of large flat-topped reefs and on a section of the linear ridges following the 60 meter isobath. Detailed images were also obtained of the patch reef field (previously called "boulder field") in the center of the Year 1 area and of some large reefs along the 40 fathom trend in the southeast portion of the Year 1 area.

Two types of maps were initially planned to be produced from the geophysical data, bathymetry maps and composite mosaics of sonograms recorded by the side-scan sonar. However, a third type of map, reflection character, is also being constructed.

Biological sampling of the pinnacles by Ludwick and Walton (1957), Woodward-Clyde Consultants (1979), and Continental Shelf Associates (1985) suggested that biotic assemblages were of tropical Atlantic origin and dominated by ahermatypic hard corals, octocorals, crinoids, and hydroids. The biotic assemblage was considered by Continental Shelf Associates (1985) to be comparable to that of the "transitional antipatharian zone" described by Rezak et al. (1985) at depths below 82 m at the Flower Garden Banks off Texas.

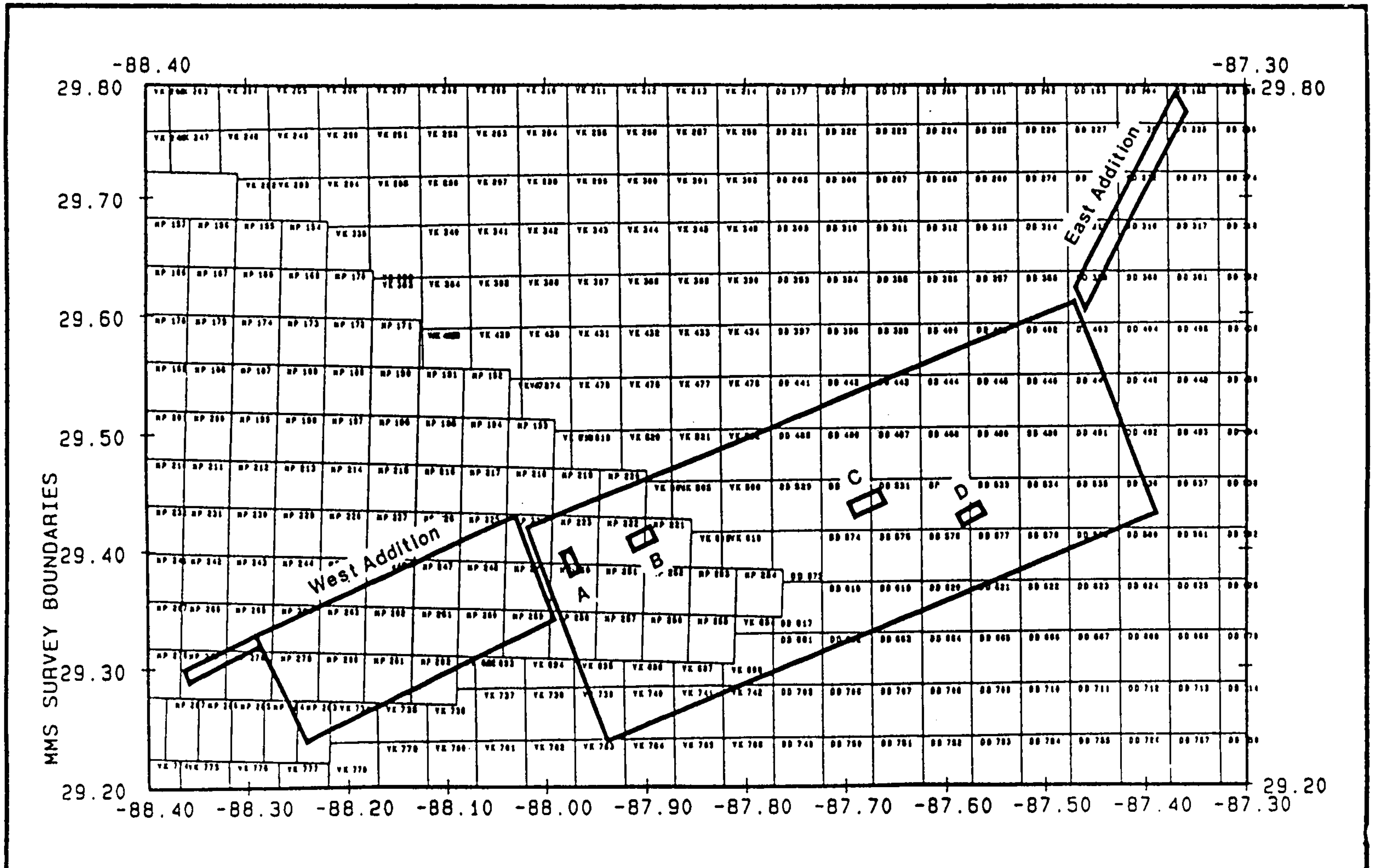

Figure 2. Map of study area, showing preliminary feature interpretation and sample site locations.

Within the boundaries of the Mississippi-Alabama Marine Ecosystems Study, Texas A&M conducted selective video reconnaissance of topographic features in the area shown in Figure 2. Such features often harbor organisms intolerant of unnatural perturbations, which may occur with anthropogenic insult. Such areas are termed "live-bottom areas" by MMS. The reconnaissance carried out by Texas A&M was designed to evaluate the nature and extent of live-bottom assemblages in the area outlined above.

Two reconnaissance cruises were conducted during the first two years of this three-year study. The surveys were performed using a Benthos RPV-2000, medium-sized, remotely operated underwater vehicle (ROV). Sites visited and/or sampled on the first two cruises included two areas of acoustically transparent sediment, one wave field (closely spaced, low relief sand waves), two areas of patchy (polka-dot) sidescan sonar returns, one area that may be part of a "sediment apron" (relatively coarse sand surrounding a topographic feature), one area apparently containing small depressions, four sites on a semi-continuous paleo-shoreline (?), one site along a deeper ridge or paleo-shoreline, two fields of reefs comparable to present-day lagoonal patch reefs, one area with features of low topographic relief, two features of moderate topographic relief, and four features of major topographic relief (three smooth-topped, and one spire-like).

Present-day biological assemblages on features in this area of the northeastern Gulf are dominated by suspension feeding invertebrates. Abundance and diversity on features appear to increase with amount of exposed hard bottom, relief, roughness, and habitat complexity (i.e., the number of habitat types available to hard-bottom organisms). Populations are depauperate on features of low topography, those in habitats laden with fine sediments, and at the base of larger features (where resuspension of sediments limits community development). On larger features, the diversity and development of communities appear to depend mostly on habitat complexity. On reefs containing extensive reef flats on their summits, there are rich assemblages distinguished by a high relative abundance of sponges, gorgonian corals, crinoids, and bryozoans. Small coralline algae crusts were observed on some of these reefs. Other organisms on reef flats include holothuroids, basket stars, and myriads of fishes (particularly roughtongue bass, *Holanthias martinicensis*). On reefs lacking a reef flat habitat, as well as on reef faces of flat-topped features, the benthic community is characterized by a high relative abundance of ahermatypic corals (both solitary and colonial scleractinians). Other frequently observed organisms on these rugged, often vertical reef faces include crinoids, gorgonians, sea urchins, and basket stars.

Though depth limits, and probably eliminated, significant reef development in this area, it appears to play a minor role in present-day community control on these reefs. Depth does, however, appear to affect the distribution of coralline algae within the study area. These algae were not observed below approximately 70 m. In fact, production of calcium carbonate in the area is probably limited to the impoverished calcareous algae population on features above this depth.

Zoogeographic affinities are tropical for most species on these features. The fauna on reefs in this study area is most similar to that on deep portions of topographic features in the northwest Gulf and on hard substrates on the rim of the DeSoto Canyon. Comparable communities in the northwest Gulf are found in the Antipatharian and Nepheloid Zones on outer shelf, mid-shelf, and south Texas banks (see Rezak et al. 1985). Community descriptions in this study are particularly similar to descriptions of fauna inhabiting drowned reefs between 82 and 88 m on northwestern Gulf shelf-edge features.

Coralline algae development is poor on features in the NE Gulf compared to outer shelf banks in the NW Gulf, but development of octocoral, sponge, and crinoid assemblages on some reefs in the study area is higher. The distribution of coralline algae suggests water quality in the study area, particularly with respect to light penetration, is intermediate between shelf-edge and mid-shelf features off Texas and Louisiana.

Human impact in these environments appears to be minimal at present. Discarded debris, though present at many sites, was not abundant, and therefore poses little threat to the environment. Cables and ropes can affect shallower reef communities, but probably have little impact at these depths once they become tangled on or lodged against reefs. Fishing pressure on these relatively small features may reduce the population of the larger, commercially important species, and may explain the abundance of smaller individuals of unprofitable species on heavily fished reefs.

REFERENCES

Ballard, R.D. and E. Uchupi. 1970. Morphology and Quaternary history of the continental shelf of the Gulf coast of the United States. Bull. Mar. Sci. 20(3):547-559.

Continental Shelf Associates, Inc. 1985. Live-bottom survey of drillsite locations in Destin Dome Area Block 617. Rep. to Chevron U.S.A. 40 pp.

Doyle, L.J. and Sparks. 1980. Sediments of the Mississippi, Alabama, and Florida (MAFLA) continental shelf. Jour. Sediment. Petrol. 5:905-9.

Kindinger, J.L. 1988. Seismic stratigraphy of the Mississippi-Alabama shelf and upper continental slope. Mar. Geol. 83:79-94.

Ludwick, J.C. and W.R. Walton. 1957. Shelf-edge, calcareous prominences in northeastern Gulf of Mexico. Bull. AAPG 41(9):2054-2101.

Ludwick, J.C. 1964. Sediments in the northeastern Gulf of Mexico, pp. 204-238. *In* R.L. Miller, ed. Papers in Marine Geology, Shepard Commemorative Volume. Macmillian, NY.

Moore, D.R., and H.R. Bullis, Jr. 1960. A deep water coral reef in the Gulf of Mexico. Bull. Mar. Sci. 10:125-128.

Rezak, R., T.J. Bright and D.W. McGrail. 1985. Reefs and Banks of the Northwestern Gulf of Mexico: Their Geological, Biological, and Physical Dynamics. John Wiley and Sons, NY. 259 pp.

Schroeder, W.W., S.R. Gittings, M.R. Dardeau, P. Fleischer, W.W. Sager, A.W. Shultz, and R. Rezak. 1989. Topographic features of the L'MAFLA continental shelf, northern Gulf of Mexico, pp. 54-58. *In* Oceans '89 Conference Proc. IEEE Publ. No. 89CH2780-5.

Schroeder, W.W., M.R. Dardeau, J.J. Dindo, P. Fleisher, K.L. Heck Jr., and A.W. Shultz. 1988a. Geological and biological aspects of hardbottom environments on the L'Mafla shelf, northern Gulf of Mexico, pp. 17-21. *In* Oceans '88 Conference Proc.

Schroeder, W.W., A.W. Shultz, and J.J. Dindo. 1988b. Inner-shelf hardbottom areas, northeastern Gulf of Mexico. Trans. Gulf Coast Assoc. Geol. Soc. 38:535-541.

Shipp, R.L. and T.S. Hopkins. 1978. Physical and biological observations of the northern rim of the DeSoto Canyon made from a research submersible. N.E. Gulf Sci. 2(2):113-121.

Upshaw, C.F., W.B. Creath, and F.L. Brooks. 1966. Sediments and microfauna off the coasts of Mississippi and adjacent states. Bulletin 106, Mississippi Geological, Economic, and Topographical Survey, Jackson. 127 pp.

Woodward-Clyde Consultants. 1979. Eastern Gulf of Mexico marine habitat study. Rep. to U.S. Dept. of Interior, Bureau of Land Management, OCS Office, New Orleans, LA. Contract No. AA551-CT3-22.

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Mr. Scott Laswell is a Graduate Research Assistant with the Department of Oceanography at Texas A&M University. He is currently working on his M.S. degree studying the distribution of topographic features in the northeast Gulf of Mexico.

DISTRIBUTION, RELATIVE ABUNDANCE AND SEASONALITY OF OUTER CONTINENTAL SHELF CETACEANS IN THE NORTH-CENTRAL GULF OF MEXICO: JULY 1989 - MARCH 1990

presented at the

Environmental Studies Meeting

Minerals Management Service
Gulf of Mexico OCS Region

by

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INTRODUCTION

Except for data from strandings (Schmidly 1981, Odell 1989) and from aerial surveys by Fritts et al. (1983), virtually nothing is known about cetaceans in Gulf of Mexico waters deeper than 180 m. These sources indicate about 26 species or types of cetaceans have occurred in the Gulf.

Fritts et al. (1983) used aerial surveys to survey areas offshore of southern Florida, western Louisiana and southern Texas. While portions of their study areas included deep water, their primary objective was not to survey deep water and only one-fourth of the survey effort was over water greater than 180 m deep. They identified eight species or types of deep-water cetaceans.

It has been speculated that areas of high sea floor relief may concentrate cetaceans (Collum and Fritts 1985, Payne et al. 1986, Kenny and Winn 1986, Selzer and Payne 1988). From July through November 1989, the National Marine Fisheries Service (Mississippi Laboratories), Minerals Management Service and NOAA's Aircraft Operations Center cooperated in conducting a pilot study of four areas of high sea floor relief in the north-central Gulf (Lohoefener et al. in press). The pilot study was successful. Aerial survey was found to be an efficient method of studying deep-water cetaceans. Cetaceans were found in all study areas and 12 species or types of cetaceans were identified. The objective of our continued research was to expand the area studied to the include the areas between (and including) the 1989 study areas in order to better define the distribution, abundance and seasonality of deep-water cetaceans in the north-central Gulf.

METHODS

Beginning in January 1990, the study area extended from 87° 30' to 91° 00' west longitude. We divided this area into seven study blocks (Figure 3). Study blocks 1, 3, and 7 overlapped large portions of the 1989 study areas. Block 5 covered only the southern portion of the 1989 Mississippi Canyon area (Lohoefener et al. in press). The results of the 1989 portion of the study and those of Fritts et al. (1983) indicated that deep-water cetacean sightings were usually in water 200 m or greater in depth. The northern border of the study area was the surface projection of the 180 m isobath. The southern boundary was, for logistical reasons, 46 km south of the northern boundary. Water depths ranged up to 1900 m.

We used NOAA's Twin-Otter aircraft to study each block 2 times each month. Poor weather in January and February, 1990 prevented us from completely meeting this goal. During each survey, a series of systematically located transects, from a single randomly chosen starting point were surveyed. The surveys were conducted at 229 m altitude and at about 204 km/h ground speed. Two observers, one on each side of the aircraft, observed the trackline and adjacent water through large plexiglass bubbles. The observers relayed observations to the computer operator. The computer was interfaced with a LORAN-C receiver and automatically recorded the study block, date, time and location of each data record. Cetacean sightings were circled in order to make species identifications, to estimate herd size and to document sightings with 35 mm cameras and SVHS video cameras.

RESULTS AND DISCUSSION

From July 1989 through March 1990, we identified 13 species or types of deep-water cetaceans in the north-central Gulf.

Bottlenose dolphin (*Tursiops truncatus*)

We sighted 28 herds that averaged about 16 dolphins per herd. Bottlenose dolphins were sighted in six of the seven study blocks and in each survey month except February. Most sightings were in the northern portion of each block. In the Gulf, Fritts et al. (1983) did not observe bottlenose dolphins in water deeper than 180 m.

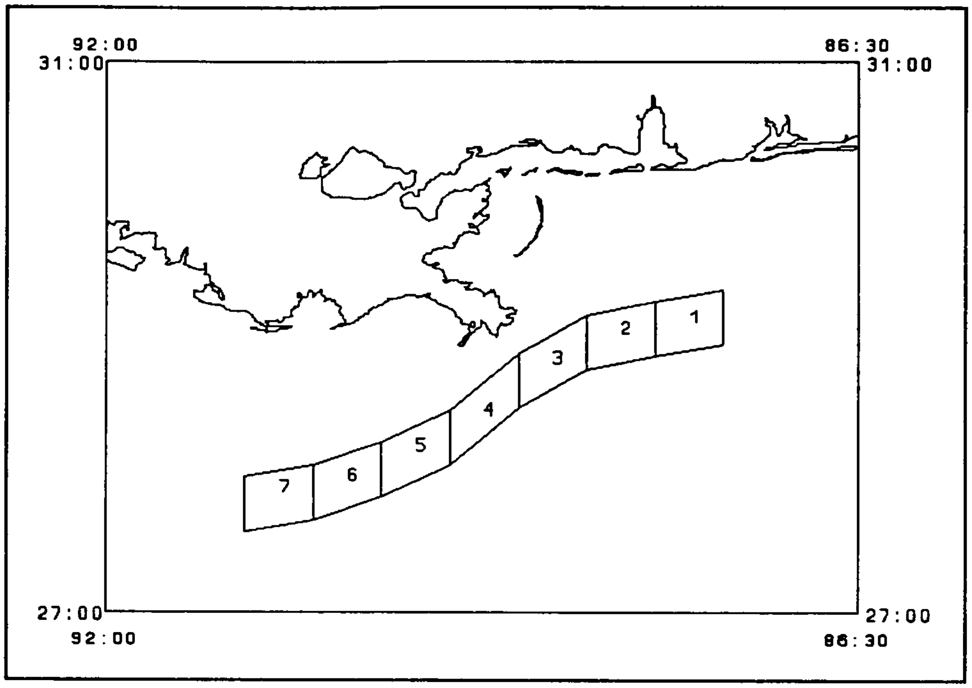

Figure 3. Location of the study area and the seven study blocks in the north-central Gulf of Mexico.

Atlantic spotted dolphin (*Stenella frontalis*)

Herd sizes averaged 41 dolphins in 35 herds sighted. Most herds were sighted in water less than 540 m deep (Figure 4). Atlantic spotted dolphins were sighted in six study blocks in every study month except January. Fritts et al. (1983) thought spotted dolphins were the most common deep water cetacean in the Gulf. At least in water from 180 to 720 m deep, our data suggest this statement may be correct.

Pantropical spotted dolphin (*S. attenuata*)

We sighted two herds that averaged 86 dolphins, during the March surveys. These spotted dolphins were sighted in blocks 4 and 6.

"Spinner" dolphin types (*S. longirostris, S. clymene*, and/or *S. coeruleoalba*)

During six study months and in five study blocks, we observed nine herds of spinner type dolphins. The mean herd size was 127 animals. Herds occurred in water depths from less than 360 m to greater than 1080 m. Fritts et al. (1983) identified one herd of spinner dolphins in their south Texas study area and striped dolphins in each of their Gulf study areas.

Common dolphins (*Delphinus delphis*)

Fritts et al. (1983) did not identify any common dolphins during their surveys. In water from 180 to over 1620 m deep, we sighted ten herds that averaged 76 dolphins during five months and in three study blocks.

Risso's dolphin (*Grampus griseus*)

Twenty-seven herds of Risso's dolphins sighted averaged 11 animals each. Herds were sighted in water from 180 to 720 m deep during six months and in six study blocks (Figure 5). Jennings (1982) reported five Risso's dolphin herds that were sighted in Gulf waters from 200 to 1800 m deep.

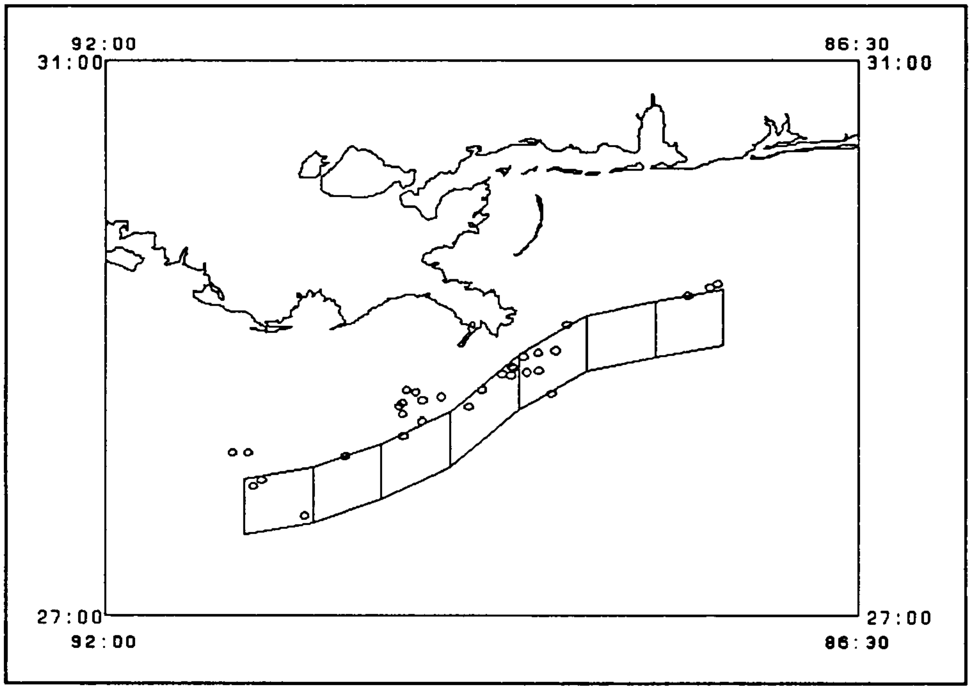

Figure 4. Locations (circles) of Atlantic spotted dolphin herds sighted from July 1989 through March 1990.

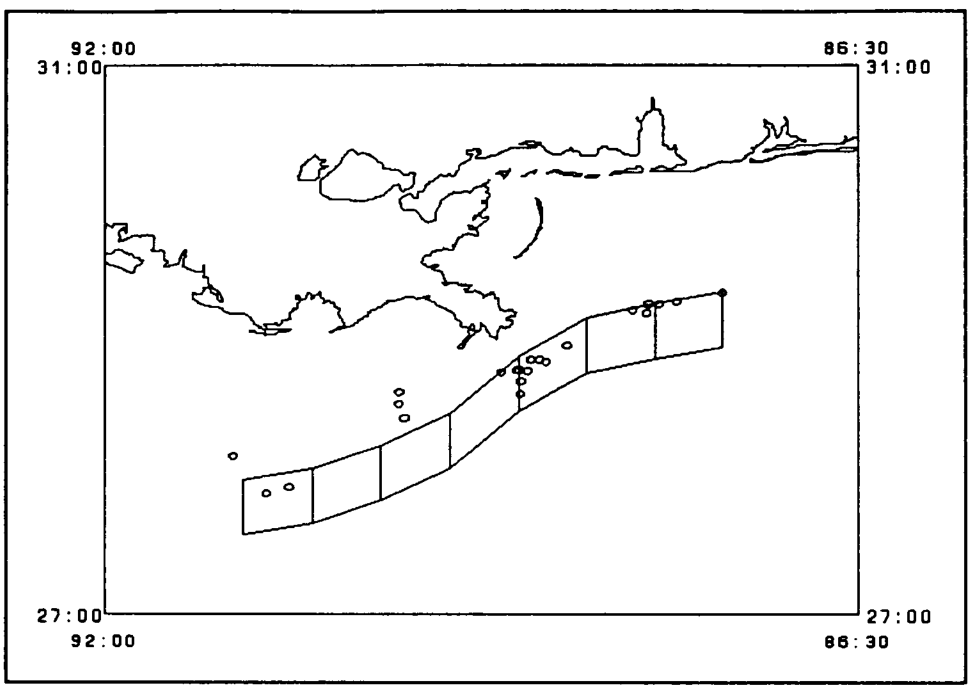

Figure 5. Locations (circles) of Risso's dolphin herds sighted from July 1989 through March 1990.

Short-finned pilot whale (*Globicephala macrorhynchus*)

We sighted five herds of pilot whales that averaged about 18 animals each. One herd was sighted with Risso's dolphins in August near block 7. The other four herds were sighted in block 3 in November. Each herd was sighted in water greater than 450 m deep. Fritts et al. (1983) identified pilot whales in their Texas and Louisiana study areas.

False killer whales (*Pseudorca crassidens*)

During August, we sighted one herd of three whales in block 3 in water about 1000 m deep. Fritts et al. (1983) did not recognize any false killer whales in the Gulf.

Pygmy killer whales (*Feresa attenuata*)

During August, we sighted one herd of about 25 whales in block 5 near a group of Risso's dolphins. This herd was located over the west wall of Mississippi Canyon in water about 300 m deep. Fritts et al. (1983) sighted one herd of these whales in their southern Texas area.

Pygmy and dwarf sperm whales (*Kogia simus* and *K. breviceps*)

Nineteen herds of these small whales were distributed throughout five study blocks. They were sighted during six survey months. Most herds were sighted over the west wall of Mississippi Canyon in and near block 5. Two whales were typically in each herd. Fritts et al. (1983) did not report any Kogia sightings from their Gulf surveys.

Sperm whales (*Physeter macrocephalus*)

Sperm whales were sighted 37 times. Herd sizes ranged from one to 11 whales and averaged about two whales. Three cow and calf pairs were sighted. Twenty-eight of the sightings were in block 3 near the mouth of the Mississippi River (Figure 6). Almost all of the sightings were in water from 700 to 920 m deep. Sperm whales were sighted in all study months but most were sighted in September and October. Collum and Fritts (1985) reported 17 sightings consisting of a total of 59 sperm whales in the Gulf. Most sightings were in water over 200 m deep. Gulland (1974) thought sperm whales were most common near areas of upwellings and high productivity. Perhaps the area near the mouth of the Mississippi River, where water depths ranged up to 920 m deep, was an area of high productivity.

Beaked whales (*Mesoplodon* spp. and *Ziphius cavirostris*)

Three species of Mesoplodon (*M. bidens, M. densirostris* and *M. europaeus*) have been documented from the Gulf. We sighted eight unidentified beaked whales in six herds. Based on their shape and white head, four other beaked whales were identified as *Ziphius cavirostris*. Beaked whales were observed during six months and in four study blocks. Fritts et al. (1983) sighted beaked whales three times during their southern Texas study.

Fin whale (*Balaenoptera physalus*)

Only one baleen whale was sighted during the study. During November over DeSoto Canyon (block 1) in water about 180 m deep, a large baleen whale was photographed and identified as a fin whale. Fritts et al. (1983) did not sight any baleen whales in the Gulf of Mexico.

SUMMARY

We used aerial survey to study the distribution, relative abundance and seasonality of cetaceans in the north-central Gulf of Mexico from July 1989 through March 1990. Not counting unidentified cetaceans, we made 167 sightings of over 4300 whales and dolphins. We identified 13 species or types of cetaceans. Results to date indicated that six species or types were distributed throughout the study area, occurring

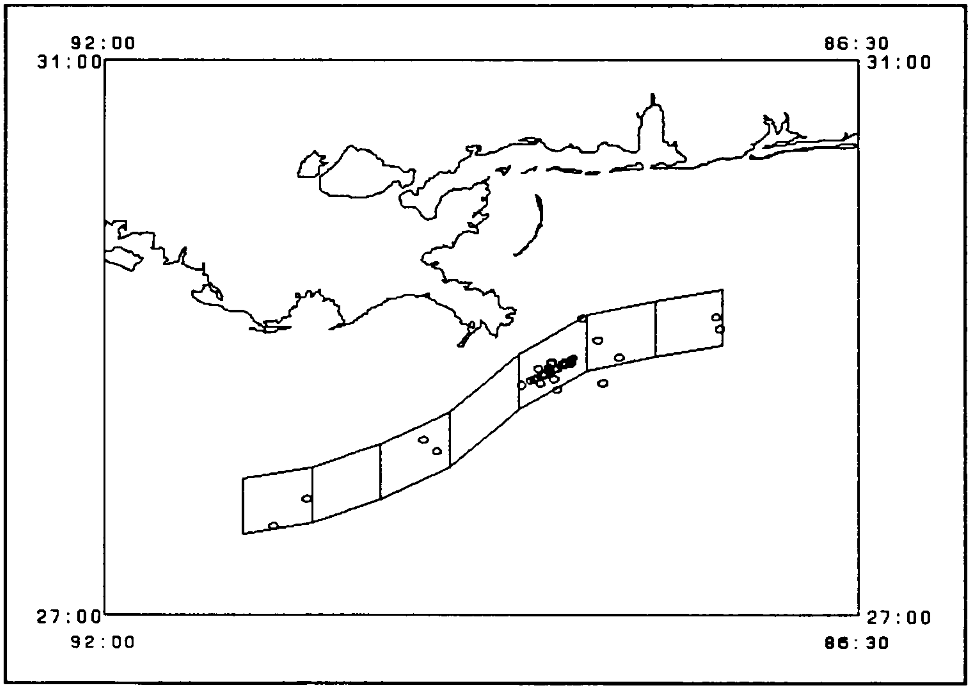

Figure 6. Locations (circles) of sperm herds sighted from July 1989 through March 1990.

in five or more study blocks. These include bottlenose dolphins, Atlantic spotted dolphins, "spinner" dolphins, *Kogia* spp., Risso's dolphins and sperm whales. These species plus common dolphins and beaked whales also had a wide temporal distribution in the study area; all were sighted in six or more of the eight study months.

REFERENCES

Collum, L.A. and T.H. Fritts. 1985. Sperm whales (*Physeter catodon*) in the Gulf of Mexico. Southwest. Nat. 30:101-104.

Fritts, T.H., A.B. Irvine, R.D. Jennings, L.A. Collum, W. Hoffman, and M.A. McGehee. 1983. Turtles, birds and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U.S. Fish and Wildlife Service, Div. of Biol. Services, Washington, D.C. FWS/OBS-82/65. 455 pp.

Gulland, J.A. 1974. Distribution and abundance of whales in relation to basic productivity, pp. 27-52. *In* W.E. Schevill. The whale problem, a status report. Harvard Univ. Press, Cambridge, MA.

Jennings, R. 1982. Pelagic sightings of Risso's dolphin, *Grampus griseus*, in the Gulf of Mexico and Atlantic Ocean adjacent to Florida. J. Mamm. 63:522-523.

Kenny, R.D. and H.E. Winn. 1986. Cetacean high-use habitats of the northeast United States continental shelf. Fish. Bull. (U.S.) 84:345-357.

Lohoefener, R., K. Mullin, W. Hoggard, C. Roden, C. Rogers, and B. Taggart. In press. Distribution, relative abundance and seasonality of outer continental shelf cetaceans in the north-central Gulf of Mexico: A pilot study. *In* Proceedings: Tenth Annual Gulf of Mexico Information Transfer Meeting, December 1989. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Regional Office, New Orleans, LA.

Odell, D.K. 1989. A review of the southeastern United States marine mammal stranding network: 1978-1987. Proc. 2nd marine mammal stranding workshop. NMFS Tech. Rep. (in press).

Payne, P.M., J.R. Nicolas, L. O'Brien, and K.D. Powers. 1986. The distribution of the humpback whale, *Megaptera novaeangliae*, in George's Bank and in the Gulf of Maine in relation to densities of the sand eel, *Ammodytes americanus*. Fish. Bull. (U.S.) 84:271-277.

Selzer, L. and P.M. Payne. 1988. The distribution and white-sided dolphins (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. Mar. Mamm. Sci. 4:141-153.

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

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ECOLOGICAL MONITORING ON REEFS OF THE EAST AND WEST FLOWER GARDEN BANKS

presented at the

Environmental Studies Meeting

Minerals Management Service
Gulf of Mexico OCS Region

by

Dr. Steve Gittings,
Mr. Ken Deslarzes,
Mr. Brenden Holland,
and
Mr. Greg Boland
Texas A&M University

INTRODUCTION

Deterioration of coral reef communities can be a rapid process, especially during episodes of catastrophic natural or man-induced mechanical disturbance (e.g., hurricanes, blasting, dredging, mining, and shipwrecks). Thermal, oil, chemical, or nutrient pollution may cause gradual deterioration of a coral reef (e.g., Marszalek 1987). Similarly, chronic low level mechanical impacts imposed by coral collection, destructive fishing techniques, high levels of diver use, or boat and ship activities may also cause the gradual decline of coral populations or coral viability (Tilmant and Schmahl 1983).

Coastal emergent reefs receive the majority of man-induced impact, but submerged reefs far offshore are not immune. In 1985 for example, a portion of Bright Bank, a reef at 37 m depth on the outer continental shelf of the northwestern Gulf of Mexico, was blown apart by treasure hunters (Bright 1986). The nearby Flower Garden reefs, which peak at approximately 18 m depth, are adjacent to commercial shipping lanes. They have been used as offshore anchoring sites by large vessels for decades. Concern over the fate of the Flower Garden reefs has been an important factor leading to their nomination for National Marine Sanctuary status.

The summits of the East and West Flower Garden Banks consist of actively growing coral reefs. Eighteen species of tropical Atlantic reef-building corals exist at the Flower Gardens, or approximately one-third of the reef-building coral species of the Caribbean. Cover of reef substrates by living coral approximates 50% on the top of each bank. Over 250 species of associated reef invertebrates and over 130 species of fish also exist. Coral cover and growth rates are considered to be comparable to other western Atlantic coral reefs (Bright et al. 1984).

Environmental concerns on these reefs include primarily the long-term effect of oil and gas production activities, and discrete and cumulative effects of mechanical impacts caused by ship anchors and ground tackle. A long-term monitoring program at the East and West Flower Garden Banks is currently being conducted by Texas A&M University. The goal of the program is to addresses concerns related to both gradual and punctuated degradation of these unique offshore ecosystems. The program will also augment a data base relating to coral community viability dating from the early 1970s. Such data are useful not only from the standpoint of assessing the impacts of industrial activities, but also since (1) the Flower Gardens are scheduled to become a National Marine Sanctuary in the summer of 1990, and (2) recreational use of underwater areas tends to increase following establishment as a marine park, preserve, sanctuary, or reef authority (Tilmant 1987). A long-term data base may allow the identification of impacts caused by this expected increase in recreational use. Furthermore, due to differences in the nature of recreational and industrial activities, and the nature of the damage potentially wrought through such activities, it may be possible to determine the principal factors leading to any community changes observed in future years at the Flower Gardens.

METHODS

During the early winter and spring of 1989, a monitoring site was established at the East Flower Garden Bank comparable to that established at the West Flower Gardens by Continental Shelf Associates in the summer of 1988 (during field work for Union Oil Co.). This involved implanting eyebolts and marker floats around a 100 m by 100 m study site, establishing and mapping 120 permanent stations for monitoring lateral encrusting growth of the corals *Montastraea annularis* and *Diploria strigosa* (60 stations for each species), implanting and mapping 40 permanent posts to mark repetitive sampling stations for studying individual coral colonies, and implanting and mapping 30 permanent accretionary growth spikes in M. annularis coral colonies. All stations at both banks were tagged using numbered, plastic, goat ear tags. Following this, and in October 1989, we carried out photographic and video field work at both banks, and will continue to do so at six month intervals over a three-year study period.

The monitoring study calls for two sampling trips each year. During each sampling trip, twenty 10-meter stratified random transects are photographed at each of the two study sites. Seventeen immediately adjacent photographs are taken along each transect using a camera framer which describes a 60 by 85 cm area of seafloor.

Each station for monitoring lateral growth of *M. annularis* or *D. strigosa* was established using two 10 cm long stainless steel nails. They are spaced 23 cm apart so that a plus/5 diopter framer attached to a 28 mm lens and Nikonos underwater camera can be placed directly over the nails and encompass a repeatable 13.3 by 19.7 cm photographic area. The border of living coral tissue traverses the approximate center of each photograph, allowing measurement of either tissue advance over adjacent coralla or tissue retreat.

Permanent posts for monitoring changes in individual colonies using repetitive photography were planted in 1 cm diameter holes drilled approximately 15 cm into the reef substrate. Single photographs of each station are taken from a height of 2.00 m using a 15 mm wide angle lens. The framer has a bubble level and compass to accurately position the camera above the station center before each photograph is taken. The sample area approximates eight square meters, which effectively samples the community and allows identification of most species on the reef.

The spikes used to monitor accretionary growth of corals are implanted in living coral tissue on the tops of coral heads. Growth spikes were driven into heads of the star coral, Montastraea annularis. The 20 cm spikes were driven to a depth of 10 cm, leaving approximately 10 cm exposed. The spikes are measured to the nearest millimeter during each sampling effort.

At each reef, a minimum of two videotaped transects of 100 m length are flown during each visit to show the general conditions of the coral community at each study site. We use 8 mm video format in order to obtain relatively high resolution images. The video transects are taken by diver from approximately 2 m above the bottom along 100 m lines tautly strung along the sides of each survey area. They will serve to establish semi-repeatable survey transects that can later be mapped to show distinctive features such as areas of sand, high coral density, diseased or damaged corals, etc., and document gross changes over time.

Light penetration is measured when on station near 1200 hours each day using a Biospherical Instruments QSP 200L Submersible Quantum Scaler Irradiance Meter. Measurements are taken on the surface, at 1 m depth, and near the bottom. Discrete measurements of temperature, salinity and dissolved oxygen are also obtained daily (near 1200 hours) at 1 m depth and 1 m above the bottom.

DATA ANALYSIS

Random Transects

Areal coverage of coral and leafy algae is considered the vertical projection of a colony onto the substrate (like canopy cover in terrestrial ecosystems). Objects on photographs taken along the random transects are outlined using a calibrated planimeter, and area (in cm^2) is automatically calculated. Percent cover data are acquired for all coral species and other appropriate organisms (e.g., leafy algae) on the photographs. Also calculated is the number of colonies of each species, the amount of bare coral substrate (most is actually covered by calcareous or filamentous algae), relative dominance of each coral species (% cover relative to total cover), the frequency of occurrence of each species, species diversity, and evenness.

Encrusting Growth Stations

From developed prints of growth stations, colony borders, distinctive features, and polyp mouth positions are traced onto sheets of mylar drafting material. Minor differences in scale between two sequential mylar traces at a station can be compensated for by projecting one trace onto the other using an image enlarging/reducing map projector. Individual polyp mouth positions can then be matched exactly on the superimposed traces and both colony borders are traced onto the same sheet.

Border lengths, areas of tissue advance and areas of tissue retreat can then be measured using a planimeter. Standardized statistics generated for each station will be the amount of tissue growth and/or retreat (in cm^2) and the border length over which this growth or retreat occurred. Growth and retreat can be analyzed separately, and data can be combined for analysis of net changes in tissue over time.

Also calculated are the proportions of the total border lengths exhibiting growth, the proportions exhibiting retreat, and proportions exhibiting no change. These will be plotted on ternary diagrams (three-coordinate plots). This technique was first used by our group to study coral growth on coral heads impacted by a freighter grounding in Florida (Gittings et al. 1988). The method was useful in determining the deleterious effects of the displacement of coral heads into sand flats by the ship.

Repetitively Photographed Stations

Developed color transparencies will be projected onto a digitizing pad. Coral colony sizes will be calculated at each station using a planimeter. Individual colony changes between time periods can then be determined directly. Other parameters to be compared will be total cover, relative dominance, species frequencies, species diversity, and evenness.

Accretionary Growth Stations

Coral growth will be determined for each coral head on which growth spikes are located by comparing sequential measurements taken from individual coral colonies. Differences between periods will be evaluated, as will trends through time.

Video Transects

Transcriptions from the videotape records will include observations on the general health of the hermatypic coral community and counts of invertebrates and fishes. By estimating elapsed time and physical dimensions along the transects, counts and other observations can then be converted to densities (number/m2). These densities will provide a means for quantitative comparisons between sites, seasons and years. Other information that may be useful to community characterization may include habitat characteristics (% sand flats, nature of live coral cover, general health of coral, etc.), patterns of abundance (numbers of individuals, spatial distribution, recruitment or loss of conspicuous reef fish or invertebrates), and relationships (correlation) between specific taxa and habitats or other biota.

DATA INTERPRETATION AND SYNTHESIS

A critical component of this study will be the comparison of the considerable existing knowledge on the Flower Gardens with the data that will result from this study. Some objectives are to:

- Compare data on coral populations and coral growth resulting from this study to existing published and unpublished Flower Gardens data;

- Assess time-dependent change in coral cover, relative abundance, relative dominance, diversity and evenness over the course of this study and in light of previous estimates of these parameters;

- Evaluate the nature and extent of bleaching caused by expulsion of zooxanthellae (as a periodic natural phenomenon or under stressful conditions) and compare these results to the findings of investigators working on other Western Atlantic coral reefs;

- Ascertain the apparent extent of human impact on the reefs, especially with respect to mechanical disturbance caused by divers, boat and ship anchors, debris, etc. and compare this with past and currently emerging information on human impacts in other coral reef ecosystems;

- Discuss the relationship between OCS hydrocarbon development activities and environmental sensitivity at the Flower Garden banks, integrating existing data on mechanical disturbance and chemical contamination of coral reefs.

REFERENCES

Bright, T.J. 1986. A survey of the topography and biological communities of Bright Bank, northwestern Gulf of Mexico. Rep. to Amarada Hess Corp., Houston, TX. 22 pp.

Bright, T.J., G.P. Kraemer, G.A. Minnery, and S.T. Viada. 1984. Hermatypes of the Flower Garden Banks, northwestern Gulf of Mexico: a comparison to other western Atlantic reefs. Bull. Mar. Sci. 34(3):461-476.

Gittings, S.R., T.J. Bright, A. Choi, and R.R. Barnett. 1988. The recovery process in a mechanically damaged coral reef community: recruitment and growth. Proc. 6th Int. Coral Reef Symp. 2:225-230.

Marszalek, D.S. 1987. Sewage and eutrophication, pp. 77-90. *In* B. Salvat, ed. Human Impacts on Coral Reefs: Facts and Recommendations. Antenne Museum E.P.H.E., French Polynesia.

Tilmant, J.T. 1987. Impacts of recreational activities on coral reefs, pp. 195-214. *In* B. Salvat, ed. Human Impacts on Coral Reefs: Facts and Recommendations. Antenne Museum E.P.H.E., French Polynesia.

Tilmant, J.T. and G.P. Schmahl. 1983. A comparative analysis of coral damage on recreationally used reefs within Biscayne National Park, Florida, U.S.A. Proc. 4th Int. Coral Reef Symp. 1:187-192.

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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. The includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, 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 assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.