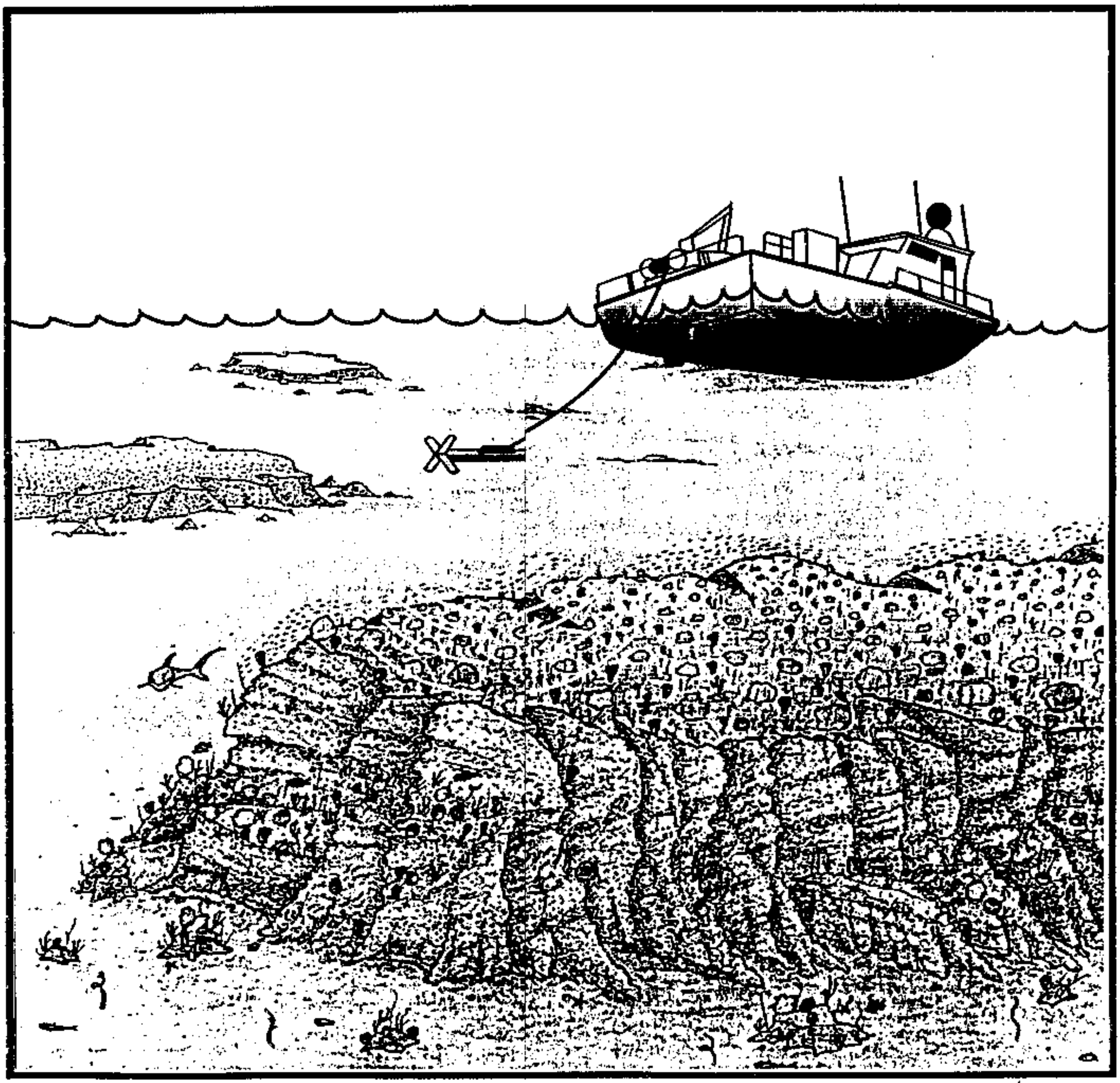
OCS Report
MMS 99-0014

MMS Seafloor Monitoring Project: First Annual Technical Report, 1997 Field Season



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

OCS Report
MMS 99-0014

MMS Seafloor Monitoring Project: First Annual Technical Report, 1997 Field Season

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TABLE OF CONTENTS

Page

LIST OF FIGURES

I. INTRODUCTION

Necessity and Regulatory Basis for Seafloor Monitoring

The National Environmental Policy Act (40 CFR 1505.2) states that "a monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation." The Minerals Management Service (MMS), to ensure safety and environmental protection, also has the authority under 30 CFR 250.33(o) for Exploration Plans and 30 CFR 250.34(s) for Development Plans to require operators to conduct various monitoring programs. More specific guidance to operators has been and can be provided through Notices to Lessees (NTL's), Letters to Lessees (LTL's), and Lease Sale Environmental Impact Statements (EIS's). At present, monitoring programs can be initiated through NTL 98-11 for chemosynthetic communities, NTL 98-26 for site clearance, the Live Bottom (Low Relief) Stipulation, and the Live Bottom (Pinnacle Trend) Stipulation.

The MMS develops and includes mitigative measures or reminders of lease stipulations in the environmental documents that are prepared to assess the effects of proposed activities in the Gulf of Mexico Outer Continental Shelf (OCS) Region. Examples include mineral exploration and extraction operations, decommissioning of offshore structures, disposal of naturally occurring radioactive materials (NORM), pipelining activities, and geological and geophysical activities. Areas of biological and archaeological concern require protection from the potential effects of the proposed activities. These areas may include:

- topographic features (e.g., Flower Garden Banks National Marine Sanctuary)
- chemosynthetic communities
- pinnacles or other live-bottom areas
- endangered, threatened, and protected species and their habitats
- refuges and wilderness areas
- national seashores
- prehistoric and historic archaeological resources
- artificial reef designated areas and sites

At present, the MMS imposes certain mitigative measures in environmental documents, primarily Categorical Exclusion Reviews (CER's) and Environmental Assessments (EA's), to minimize or preclude impacts from proposed operations. Mitigation typically requires avoidance or use of a remotely operated vehicle (ROV) camera to assess bottom features. On rare occasions, diver testing is employed when there is the potential for direct impact to biological or archaeological features.

Other mitigative measures provide specific guidance for controlling emissions where air quality exemption levels are an issue or when the development or modification of a Site-Specific or Regional Oil Spill Contingency Plan occurs.

More recently, the Government Performance and Results Act of 1993, as amended in 1997, requires Federal agencies to report on their performance in terms of measuring "outcomes" that result from their activities, rather than outputs. More specifically, the Act requires MMS to ask of itself how effective it is in ensuring environmentally sound OCS operations.

Although many environmental effects are difficult to measure, it is the responsibility of MMS to ensure OCS operations are carried out in an environmentally sound manner. Many aspects of the offshore environment at present are monitored by MMS and other agencies such as the Environmental Protection Agency (EPA) and the National Marine Fisheries Service (NMFS). However, until recently, MMS lacked the ability to verify the effectiveness of its mitigative measures with respect to protection of important seafloor features. This issue gained in importance as certain economically driven industry practices came to light that entailed more damage to the seafloor than had been assumed during the environmental analysis of the plan. For example, it had been assumed that the impact to the seafloor from a typical jack-up rig was limited to a relatively small "footprint" about 30 m in diameter. In practice, however, it was observed that under-powered tugboats were sometimes employed in towing the rigs into position and that one or more legs were dropped to the seafloor to slow the approach. This procedure could result in the incision of a massive trench 3 to 5 m wide and hundreds of meters long on the seafloor. Other unanticipated damage to the seafloor occurred from lay barge anchors because the frequency of anchor placement was far higher than supposed and the drag of the anchor chains across the bottom disturbed virtually the entire corridor.

In 1997, MMS instituted a Seafloor Monitoring Program to verify industry compliance with environmental mitigative measures and to ensure protection of significant seafloor habitats and archaeological properties. The Monitoring Program is twofold. First, it requires operators to demonstrate compliance with avoidance requirements by providing "as-built" maps showing anchor locations with their construction reports. Secondly, field monitoring by MMS personnel using high-resolution sidescan sonar and/or MMS divers verifies that protected features were avoided.

Methods and Equipment

The Leasing and Environment (LE) Section of MMS began planning to develop a pilot study to test the effectiveness of avoidance mitigation measures in 1996. Early in the process, LE management challenged their staff to propose a means for evaluating the condition of the seafloor in the vicinity of construction projects where an avoidance mitigation had been invoked. Both the use of ROV cameras and remote-sensing survey by outside vendors were discussed. However, the Environmental Operations Section (EOS) of LE argued that the project could most efficiently and cost-effectively be accomplished using high-resolution sidescan sonar operated by MMS personnel from chartered vessels. Although a certain amount of staff time would have to be re-directed toward this effort, it was argued that an equivalent amount would be lost to proceeding through the procurement process and that an in-house operation afforded better quality control, greater flexibility in selecting targets of opportunity, and could acquire a great deal more data for an equivalent budget. A proposal was subsequently approved by the Regional Director.

The principal data-gathering tool used by the pilot study was a high-resolution Marine Sonics SeaScan sidescan sonar with a 600-kiloHertz (kHz) towfish. The sonar images the seafloor in swaths up to 150 m wide (75 m to a side) along tracklines as the sensor is towed behind a boat. Sonar images are made by bouncing sound waves off the seafloor and measuring the level at which they are returned in much the same way as the brain interprets light reflected into the eyes to produce visual images. The higher the frequency of the sound waves (in this case 600,000 waves per second, expressed as 600 kHz), the greater the resolution of the produced image. By contrast, the sidescan sonars typically used for hazards surveys in the Gulf of Mexico are only 100-kHz instruments, which afford a greater range of about 600 m, but sacrifice resolution. The 600-kHz system was acquired in order to image objects on the seafloor with the greatest resolution possible.

The Marine Sonics SeaScan sidescan sonar is a PC-based instrument with all the processing electronics located on a proprietary computer board mounted in a ruggedized and splash-proofed IBM-compatible 486 computer. The control and recording software runs under Microsoft Windows. Acoustic images are stored as files 1,000 scan lines long (requiring about 1.1 kilobytes storage each) to the computer's hard drive. The MMS SeaScan is outfitted with a writable CD-ROM for long-term storage of the survey data. The sonagram files are linked to positioning control by receiving NMEA-0183 data through the RS-232 port from an external differential Global Positioning System (GPS). In this way, positioning data are integrated into the image files and the latitude and longitude of any observed feature can be retrieved by positioning the computer cursor over it and double-clicking the mouse button.

Positioning control is maintained using a Trimble NT200D GPS with and internal differential receiver. The unit receives position correction information broadcast by the U.S. Coast Guard to correct the effect of induced error, or Selective Availability (SA), transmitted from the U.S. Department of Defense Navstar satellite system. The published accuracy of the Trimble DGPS system is ±10 m. The Trimble unit also features several navigation screens, allowing the user to set up parallel search lines and providing helmsman guidance.

Goals and Criteria for Project Selection

The 1997 field season was a "pilot project" to acquire seafloor imagery of a random selection of oil and gas construction projects where operators had been instructed to avoid features protected by MMS stipulation or regulation. Seafloor features to be sampled included pinnacles, topographic features, and potential archaeological sites. In addition, several kinds of seafloor impacts were to be assessed, including both pipeline and platform installation and removal. A second goal was to assess the effectiveness of the instrument for a variety of operational uses, including verification of site clearance and the assessment of the condition of domes over wellheads (intended to prevent damage to shrimp nets). We also used the instrument to inspect reported shipwreck locations to assess them for their potential historical significance and to acquire imagery of two significant historic shipwrecks.

We undertook five separate research investigations during the course of the 1997 Pilot Project between June and October (Figure 1). The initial expedition went to the Pinnacle Trend area at the continental shelf break in the Main Pass Area. We examined two pipelines and a platform installation for potential adverse effects to protected pinnacle features and two shipwrecks. The second project, in the High Island Area, looked for seafloor disturbance from lay barge anchors around magnetic anomalies that had been identified as potential indicators of an historic shipwreck. Additionally, we used the instrument in conjunction with a diving investigation and magnetometer survey of the reported site of the 1846 wreck of the steamship *New York*, a site potentially eligible for inclusion on the National Register of Historic Places. We acquired sidescan imagery of the Flower Gardens National Marine Sanctuary during a joint MMS/NOAA-sponsored environmental monitoring survey conducted by Texas A&M University. Although not one of the originally proposed Pilot Project investigations, this effort afforded an opportunity to evaluate the instrument's performance in a very special seafloor environment. Another unproposed opportunity arose to use the sonar at the request of the MMS Field Operations Section to investigate the condition of several structures, subsea "trees," structure removals, and submerged wellheads in the West Delta and Grand Isle Areas. This investigation effectively combined the MMS Scientific Dive Team and MMS sonar survey capabilities to acquire important data on the condition and safety of these features quickly. The final project of the 1997 pilot study was another combined diving and sonar survey investigation of two significant topographic features, the Stetson Bank National Marine Sanctuary and Sonnier Bank. This project was jointly sponsored by LE and the Resource Evaluation Section and included participation by scientists from NOAA, Texas A&M University at Galveston, and the New Orleans Aquarium of the Americas.

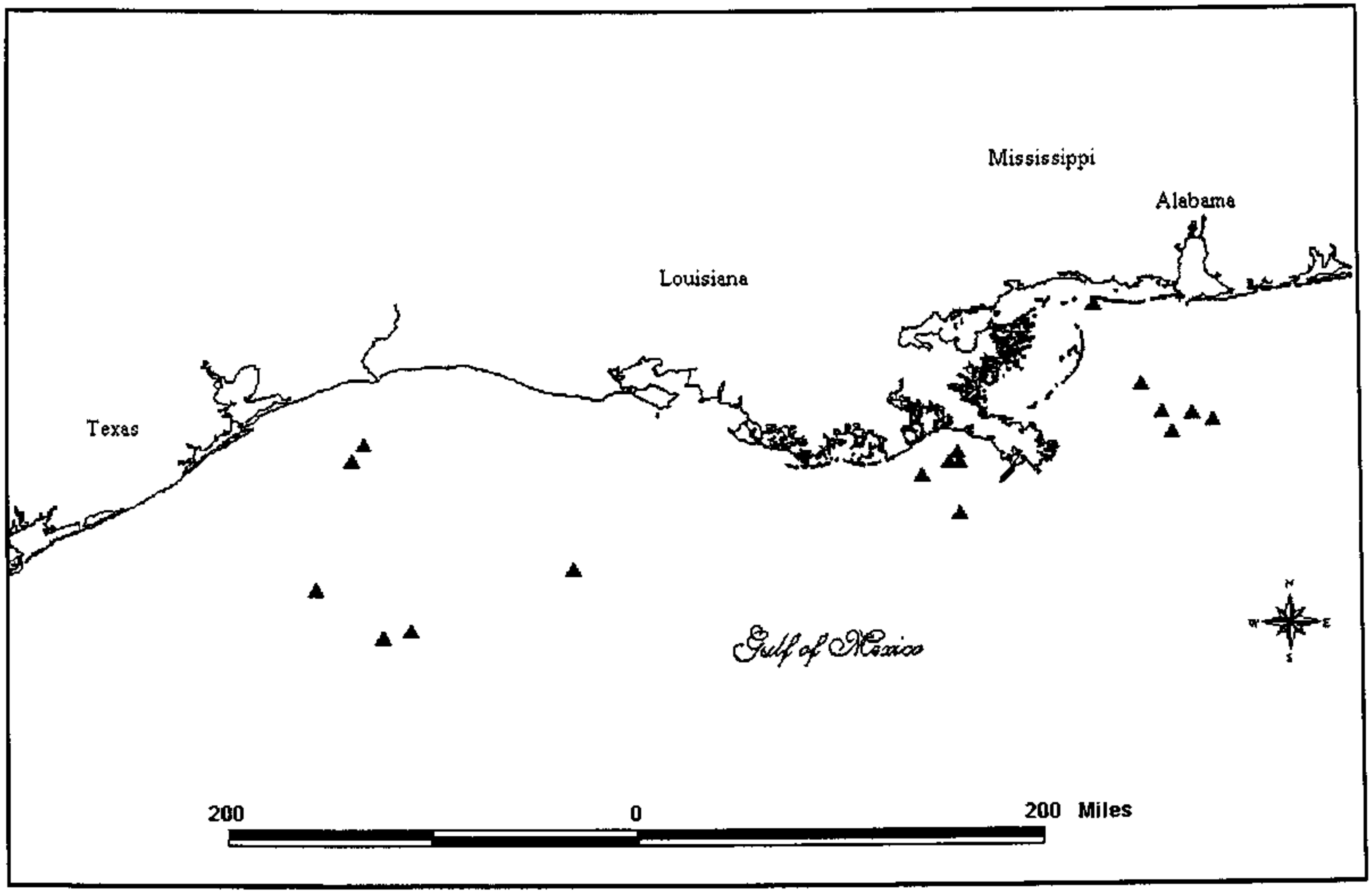

Figure 1. Location of seafloor monitoring investigations.

II. MAIN PASS AREA SURVEY

Project Area Description

The Main Pass (MP) Area, including the South and East Additions, is a large group of lease blocks east of the Mississippi River delta and south of the Mississippi/Alabama coast on the eastern side of the Central Gulf Planning Area (Figure 2). It bridges the edge of the continental shelf break near its southern boundary. Biologically significant seafloor features protected by MMS lease stipulation within the Main Pass Area include portions of the Pinnacle Trend.

The Pinnacle Trend is a region of topographic relief along the outer edge of the Mississippi/Alabama shelf between the Mississippi River and DeSoto Canyon. The pinnacles appear to be carbonate reefal structures in an intermediate stage between growth and fossilization. The region contains a variety of features from low-relief rocky areas to major pinnacles rising more than 20 m off the seafloor. Ridges, scarps, and relict patch reefs also are associated with the Pinnacle Trend. The features of the Pinnacle Trend offer a combination of relief and hard substrate for the attachment of sessile organisms and, therefore, have a greater potential to support significant live-bottom communities than the surrounding areas on the Mississippi/Alabama shelf. This potential to support significant biological assemblages has made these features a topic of concern.

Three types of hard-bottom features have been identified for biological characterization: (1) pinnacle features in 80 to 90 m water depths, (2) deepwater pinnacles and associated hard-bottom in water depths between 110 and 130 m, and (3) low-relief, hard-bottom features in water depths less than 75 m. The 120-m isobath appears to be the lower limit of any exposed carbonate material. The deepest features investigated during the 1997 Pilot Study bottomed in 90 m of water.

Investigated sites in the Pinnacle Trend included three parallel pipelines in MP 224 and MP 249, work barge anchors at a structure in MP 252, and an 8-inch gas pipeline in MP 262 and MP 281. Other inspected features include a structure removal in MP 160, an artificial reef in MP 166 (erroneously reported to MMS as a potential historic shipwreck), and an historic steamship.

Main Pass Area Blocks 224 and 249

Three pipelines converging on Platform A in MP 225, a CNG 6-inch pipeline, a Centana Gathering Company 8-inch pipeline, and an Amoco pipeline, all thread through a cluster of low-relief pinnacles in MP 224 and pass east of a second outcrop in MP 248, all in about 78 m of water (Figure 3). In each case, LE biologists performed a Pinnacle Trend Analysis of the proposed route during the permit application process and the operators were directed to avoid impacting the features.

The survey was run along the route of the center (Amoco) of the three parallel pipelines passing between stipulated hard-bottom features. A second survey line was run approximately 300 m east of the route across an outcrop area to inspect for anchor damage. Along the main pipeline route, a significant trench, measuring 3.35 m wide and more than 150 m long, was detected between and somewhat parallel to the western and central pipelines (Figure 4). This trench cut within 39.6 m of

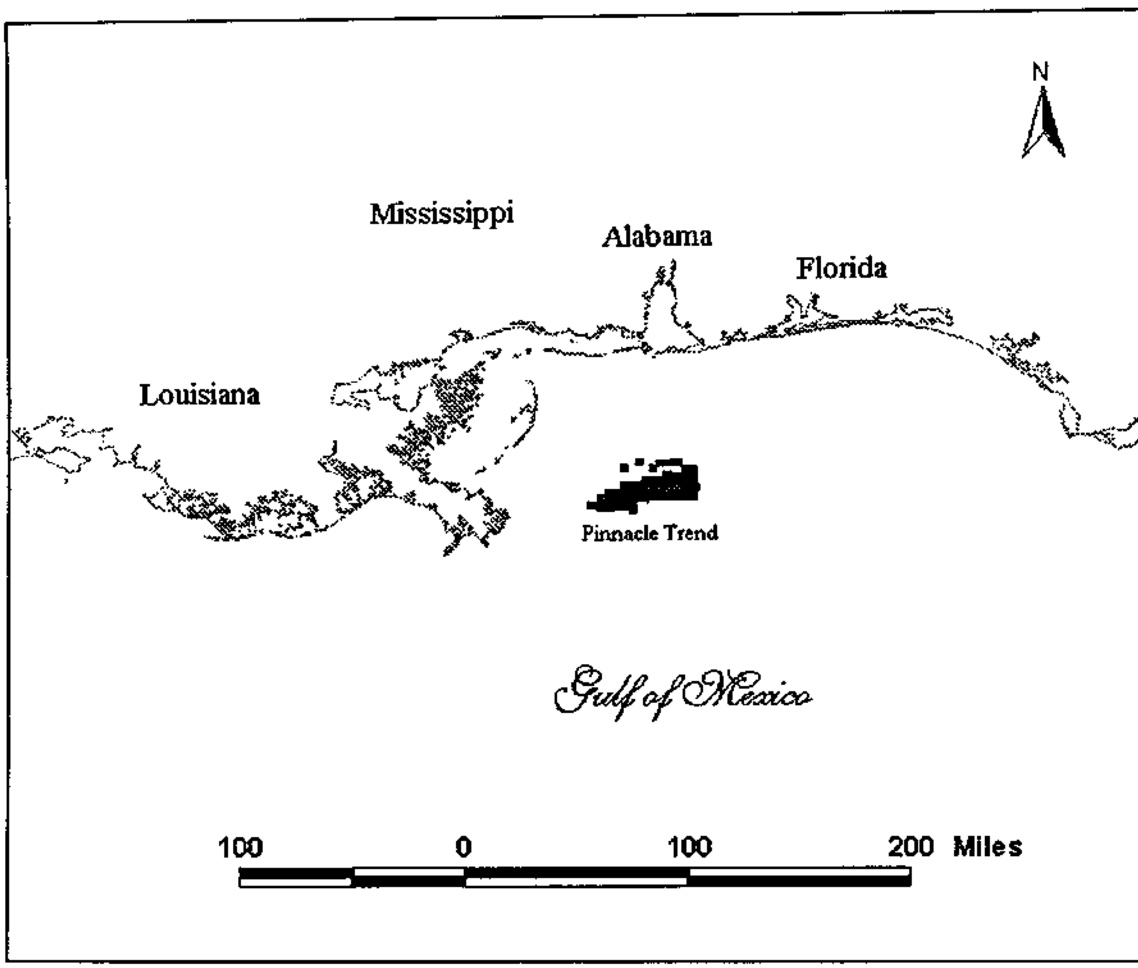

Figure 2. The Pinnacle Trend, Main Pass and Viosca Knoll Areas.

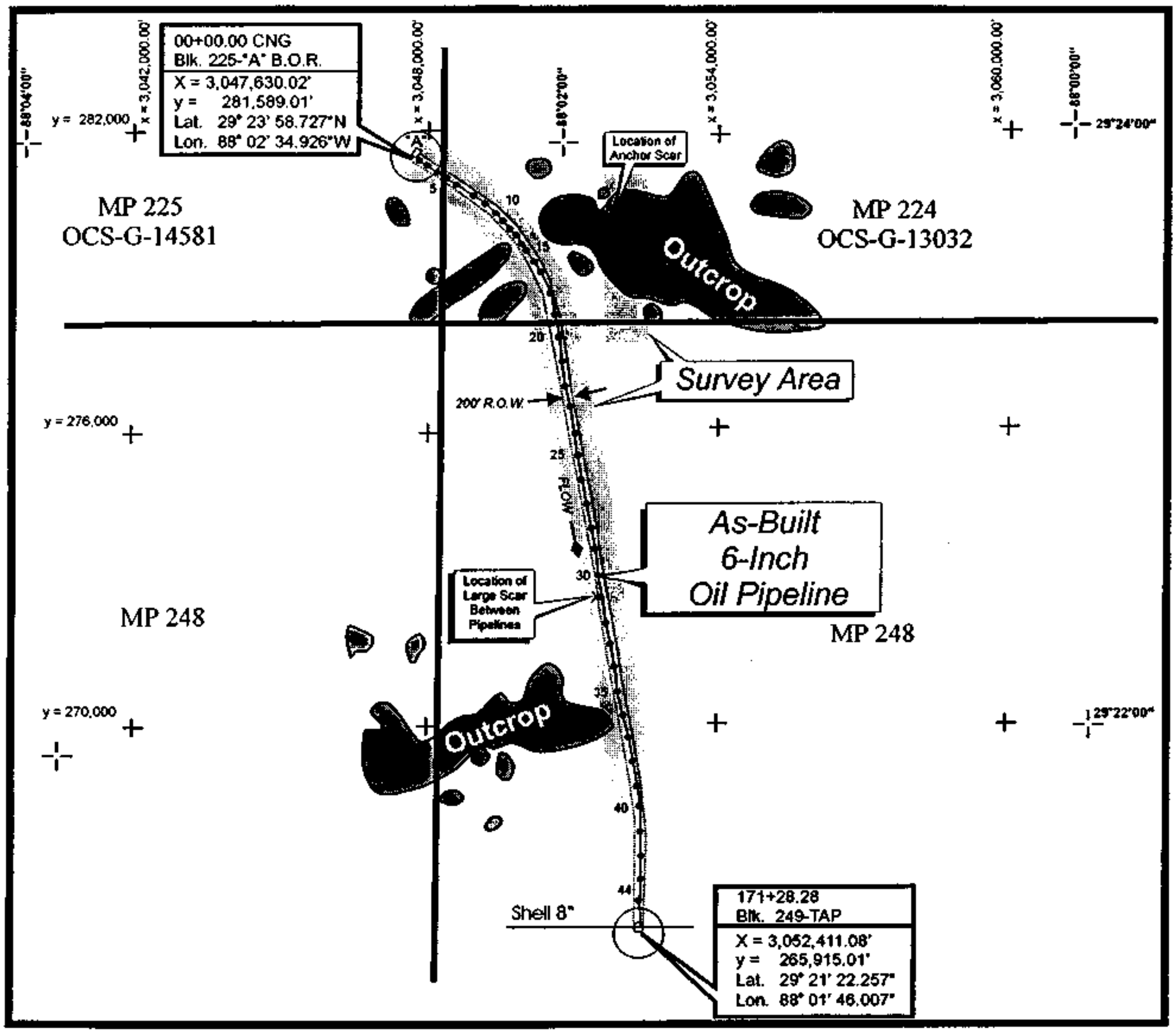

Figure 3. Area of sidescan sonar survey to investigate industry compliance with avoidance mitigation during pipeline construction in Main Pass Area Blocks 224 and 249.

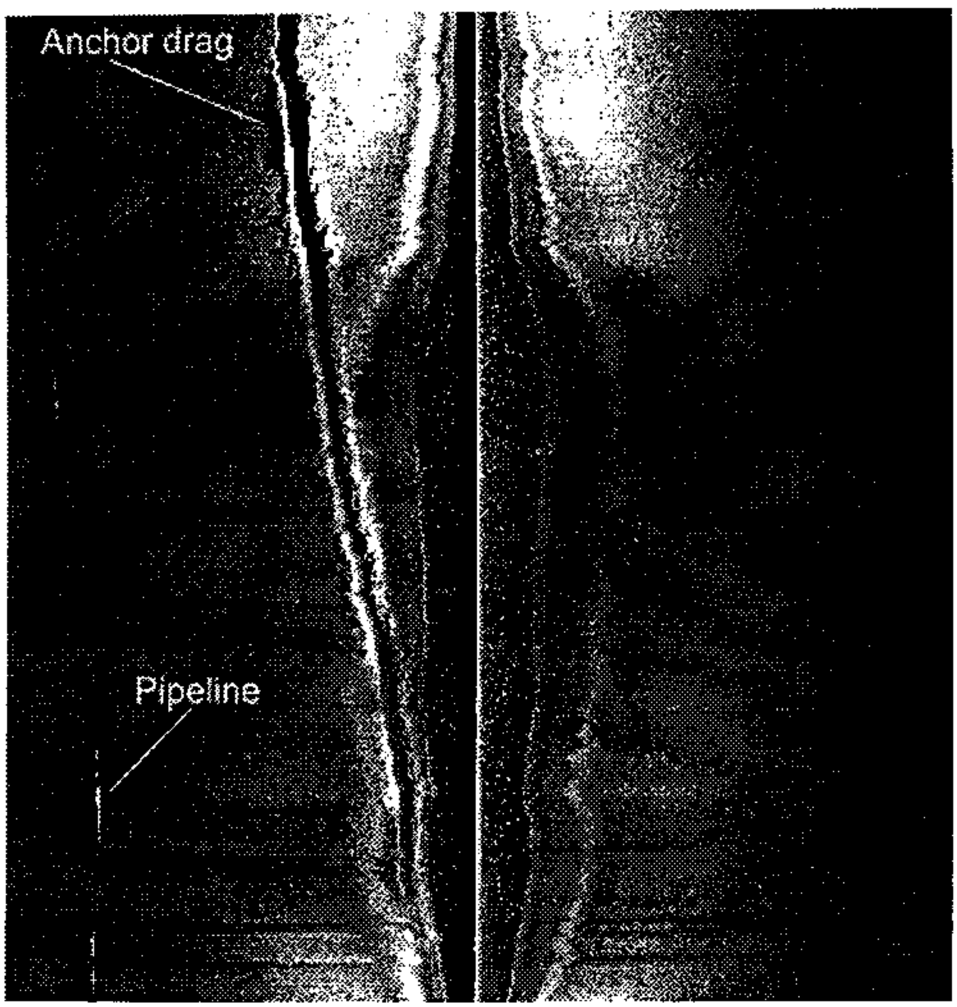

Figure 4. Large anchor scar near pipelines in Main Pass Area Block 249.

the western (CNG 6") line and terminated just short of the central line. The second survey track to the east detected significant outcrops with reliefs of more than 3 m. A large anchor scar was observed in an outcrop area that had been specifically identified for avoidance in an MMS Live-Bottom Review (Figure 5).

Since pre-lay survey data were not available to the Pilot Study, it is impossible to state with certainty which phase of construction was responsible for causing the damage to the seafloor in MP 224. It is also possible that the damage occurred from a large ship anchor. Two things became evident: first, that a true monitoring study would need access to both pre-lay and post-construction survey data for comparative purposes, and, second, that despite the amount of activity around these features, the impact to them was relatively light.

Shell Oil Platform, Main Pass Area Block 252

A Pinnacle Trend Review dated February 4, 1996, directed the operator to avoid reef-like features while installing platform "B" using an anchored work barge in 81 m of water (Figure 6). Six anchors were arrayed in a star pattern radiating from the work barge. Each anchor line was approximately 900 m long. The northernmost anchor line passed between two "reef-like features" identified in the permit application.

A survey was conducted along two legs of the anchor spread as indicated on the operator's as-built maps. The survey covered the corridor between the two pinnacle features identified during the permit review. We detected no damage to reef-like features during the survey. A second survey line passed along a Shell 8-inch gas pipeline feeding into adjacent Platform "A," which the operator's as-built showed as passing over a second hard-bottom area. No pinnacles or hard bottom was observed in the area.

CYX Energy 8-inch Pipeline, Main Pass Area Block 281

A Live-Bottom Review conducted by MMS on November 8, 1995, identified two fossil reef pinnacles 91 and 274 m north and southeast of the proposed pipeline in MP 281. Three parallel lines were surveyed across the pinnacles to inspect for possible anchor damage (Figure 7). Although several clusters of pinnacles were observed, and evidence of anchoring was observed elsewhere on the seafloor, no damage to pinnacle features was observed.

Sunken Ship, Main Pass Area Block 166

A routine archaeological survey conducted for this block (OCS-G 13012) reported a potentially historic shipwreck. The survey concluded that this vessel was, in fact, part of an approved artificial reef consisting of intentionally scuttled modern workboats (Figure 8). During the course of the survey, a nearby pipeline was identified that was exposed above the seafloor in less than 61 m of water. An analysis of MMS records concluded this to be a 20-inch gas pipeline (ROW G-15975) operated by Dauphin Island Gathering Partners.

Figure 5. Anchor scar impacting a protected hard bottom in Main Pass Area Block 224.

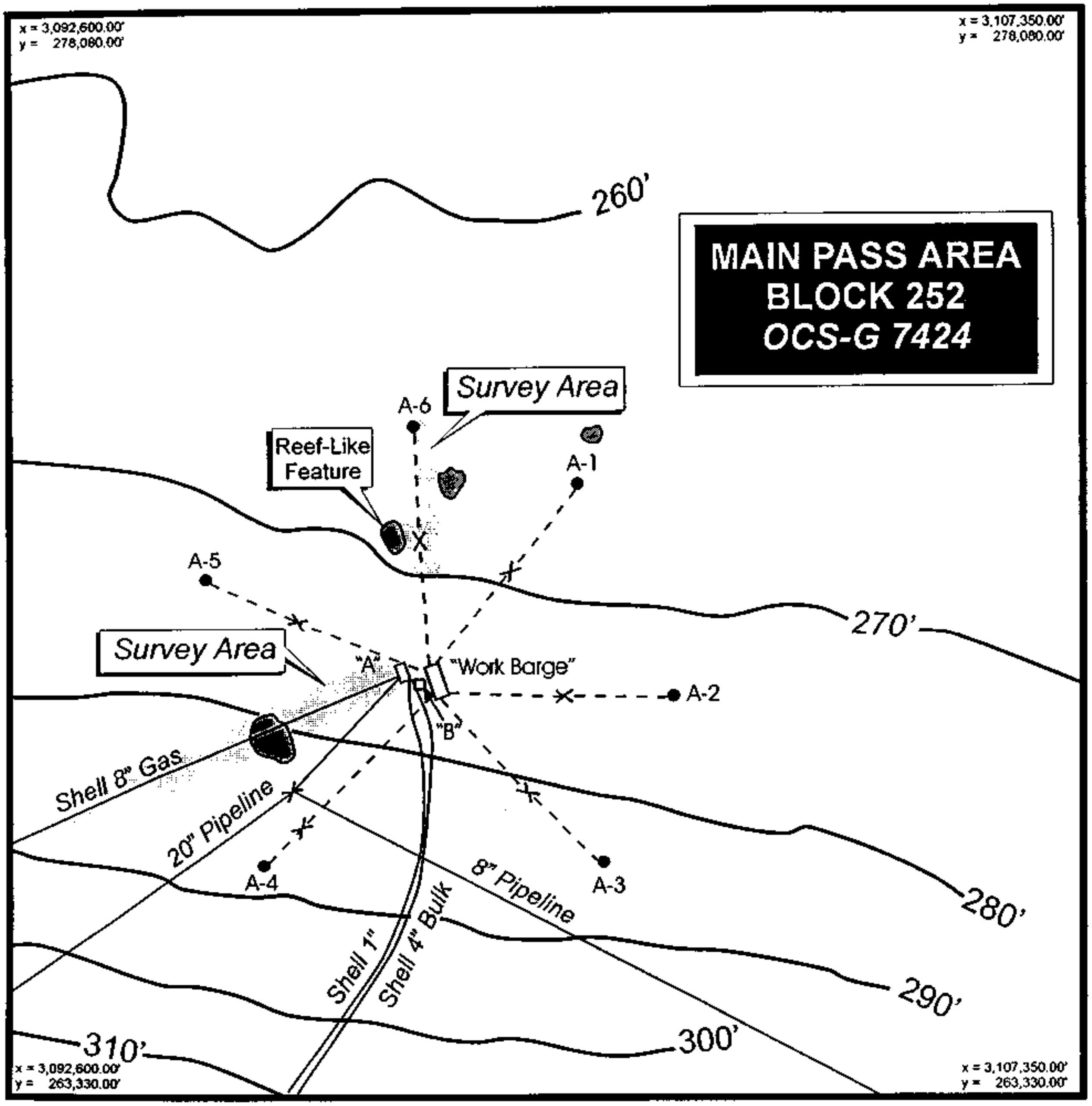

Figure 6. As-built plat of Shell Oil platform, Main Pass Area Block 252.

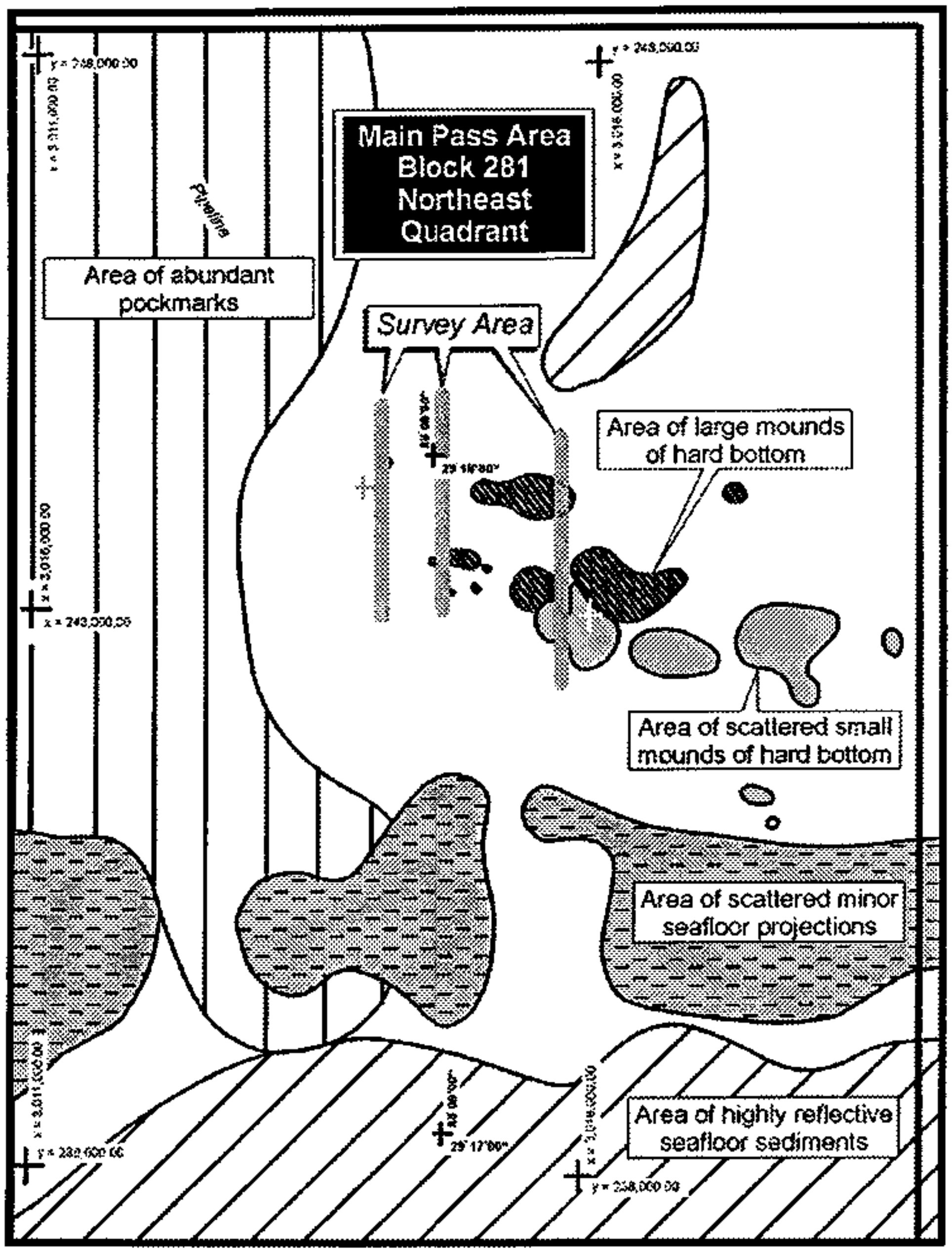

Figure 7. CYX Energy 8-inch pipeline, Main Pass Area Block 281, showing survey areas.

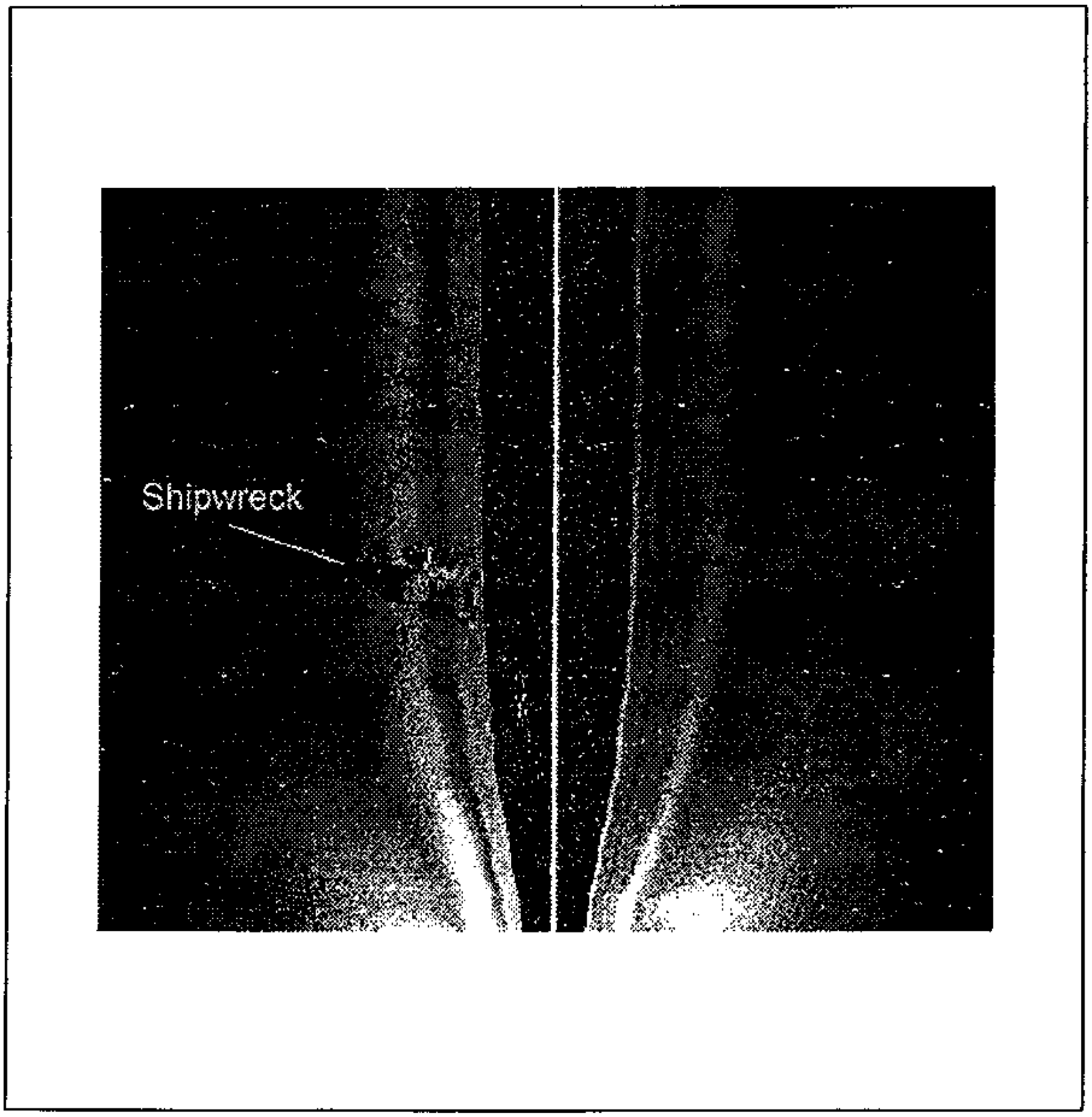

Figure 8. Sonar image of a sunken ship, Main Pass Area Block 166.

Horn Island Shipwreck

Loran C coordinates of an historic side-wheel steamship off Horn Island, Mississippi, were provided to MMS by an informant. Because of the inherent inaccuracy of Loran C, there was a possibility that this site could lie in Federal waters. Sidescan survey and DGPS positioning confirmed that the vessel lies in Mississippi waters. Information about the site was relayed to the Mississippi State Historic Preservation Office, which had no information about the vessel in their archaeological site records. The site has been assigned a trinomial designation of 22HR843.

The Horn Island shipwreck is a side-wheel steamship with an apparently intact walking beam engine and two large boilers visible above the seafloor (Figures 9 and 10). From the sidescan image, the vessel measures 53.6 m long by 10 m wide. Local informants report that it has an iron hull, although this has not been confirmed. Research is being conducted to identify the wreck, which most likely dates to the last half of the nineteenth century. Preliminary research suggests that the vessel may be the *Heroine*, built in Glasgow in 1862 as a blockade runner (Way 1983: 213). After the Civil War, the vessel was used as a towboat in New Orleans and after 1880 was converted into a passenger boat on the New Orleans-Bay St. Louis-Biloxi run. Because of its apparently intact condition, the vessel should be considered to be potentially eligible to the National Register of Historic Places.

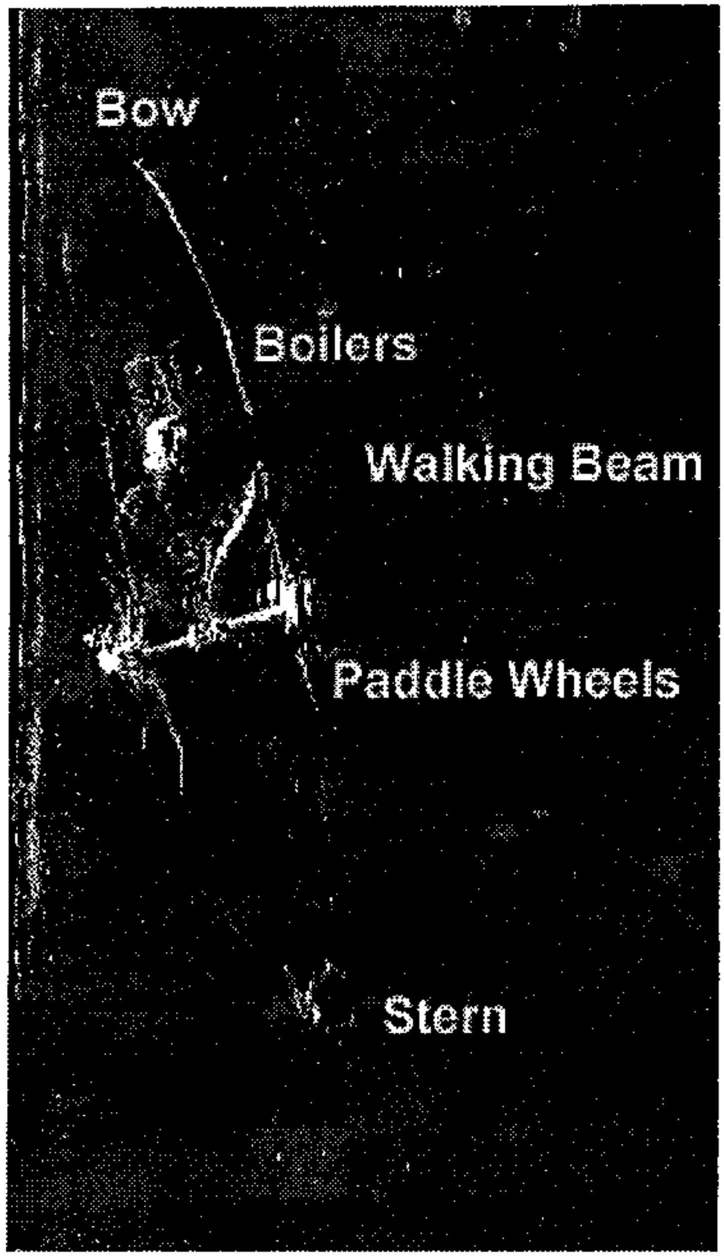

Figure 9. Horn Island shipwreck (22HR843).

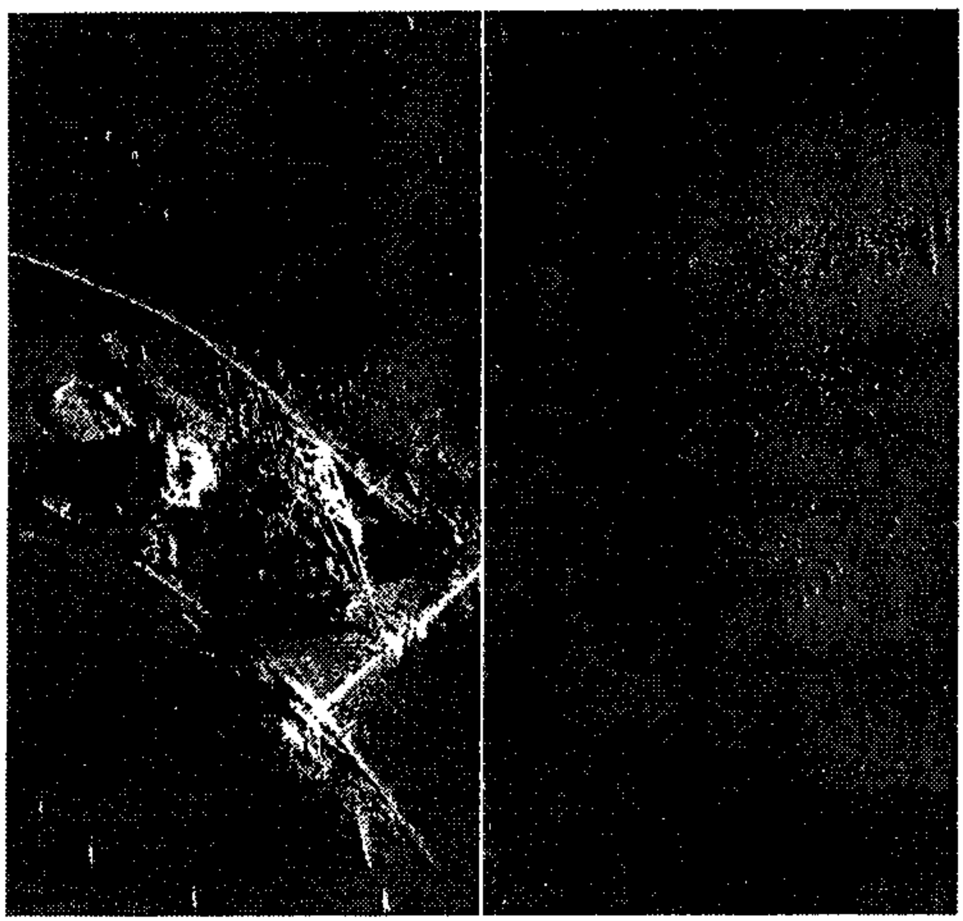

Figure 10. Detail view of engineering space, Horn Island shipwreck.

III. HIGH ISLAND AREA SURVEY

Introduction

The purpose of the High Island Survey was threefold: (1) to assess the effectiveness of avoidance mitigations placed on the oil and gas industry for a group of features identified as potential archaeological resources; (2) to confirm the identification of an historic side-wheel steamship as the *New York* and determine the size of the buffer needed to protect it from future development; and, (3) to determine if a recently reported shipwreck in HI 164 could be determined modern or historic from high-resolution sidescan imagery.

Monitoring the Construction Corridor of a 10.75-inch Natural Gas Pipeline

Project Description

IP Petroleum Company, Inc. (IP) submitted an application to the MMS to construct a 10.75-inch natural gas and condensate lease-term pipeline in High Island Area Block 108. This lease block is located within the MMS high-probability area for both prehistoric and historic archaeological resources, which location requires the operator to perform a remote-sensing survey of its lease block at a 50-m survey lane interval. The lease block analysis performed by the operator's contract archaeologist recommended avoidance of preserved Pleistocene/early Holocene channel margins, as well as nine unidentified magnetic anomalies and one sidescan sonar target. Based on this analysis and a review of the geophysical report, the MMS archaeologist conducted a site-specific archaeological review for the proposed pipeline application and concurred with the findings of the survey report. The operator was informed of the minimum distance by which these features were to be avoided as a part of the pipeline permit-to-construct. Operators typically are directed to avoid channel margins, magnetic anomalies or sidescan sonar targets that could be potentially significant archaeological sites during construction in order to eliminate the possibility of their action having any effect on archaeological resources. Also, as a part of the permit, MMS directed IP to provide an "as-built" map of the project area locating precisely each lay-barge anchor deployed during the pipeline construction. After construction of the pipeline, IP provided MMS with an anchor plat of the construction corridor.

Results of the Survey

The anchor plat provided by IP displayed 124 separate anchor placements for the 5,903-ft long pipeline. Based on the operator's plat, it appears that IP's pipeline did not affect the magnetic anomalies or sidescan sonar target. However, their anchors could have affected the margins of the buried Pleistocene/early Holocene identified in the permit to be avoided. The MMS sidescan sonar survey confirmed that no damage occurred to the manmade seafloor features identified in the operator's lease block survey. However, numerous large anchor scars were observed in the vicinity of channel margins. When IP was informed that, in fact, they had impacted the channel margins in violation of their permit requirements, they indicated that only the magnetic anomaly and sidescan sonar data, which were supplied to the operator in a table with precise State Plane X/Y coordinates, were provided to the pipeline construction firm. We concluded that the mitigation language used in the MMS permit with respect to buried channels was too vague. The MMS has since amended permits to include a copy of the contractor's shallow-hazard survey map to show operators the precise avoidance zones being required by MMS. Because of the lesson learned as a result of the Seafloor Monitoring program, the MMS is now following the same procedures for avoidance of other seafloor features, such as pinnacles.

Wreck of the *New York*

History of the Vessel

The *New York* was constructed in New York City in 1837 for the Southern Steam Packet Company, a partnership formed between J. P. Allaire, Charles Morgan, and John Haggerty. Vessel Registration No. 340 (National Archives), dated October 13, 1843, identifies the vessel as a steamboat "165 feet long with a beam of 22 feet and a depth of 10 feet." It was described as having one deck and two masts. A drawing of the ship on file in the Mariner's Museum in Newport News, Virginia, shows a cross-head type steam engine (Figure 11).

During 1837 and 1838, the *New York* made regular trips between New York and Charleston, South Carolina (Heyl 1969:225). After the Southern Steam Packet Company was dissolved, Morgan took over the vessel and transferred it to New Orleans, where he engaged it in trade between that city and Galveston, in the newly independent Republic of Texas. She undertook her first voyage under Morgan in November 1838, consigned to McKinney & Williams, agents (Hayes 1971:323). Fierce competition soon broke up Morgan's monopoly on the Galveston-New Orleans trade, and he responded by extending the *New York*'s route to include New York City. In May 1839, the *New York* undertook the first regular steamship service between Galveston and the Port of New York, with stops at Key West and Charleston. The ship was advertised to make the voyage in eight days and had accommodations for 200 passengers. The cabin rate between Galveston and New Orleans was $110.00 (Hayes 1971:326).

The *New York* departed Galveston for what was to be her final voyage on September 5, 1846. By 10:00 p.m. that evening, she came to anchor in heavy seas some 80.4 km eastward of Galveston, having unknowingly sailed into the path of a hurricane. After a fearsome pounding by seas and wind, which lifted the promenade deck, stove in the starboard guard and wheel house, carried away the smoke stack, and sprang the hull, the *New York* foundered in 10 fathoms of water at 6:00 a.m. on the morning of September 7 (*Daily Picayune*, September 10, 1846). Seventeen passengers and crewmen, including five children, were lost when the ship went down. The remaining survivors clung to rafts fashioned from a portion of the promenade deck and other wreckage for more than 12 hours until they were rescued by another steamer, the *Galveston* (New Orleans *Gazette*, September 10, 1846).

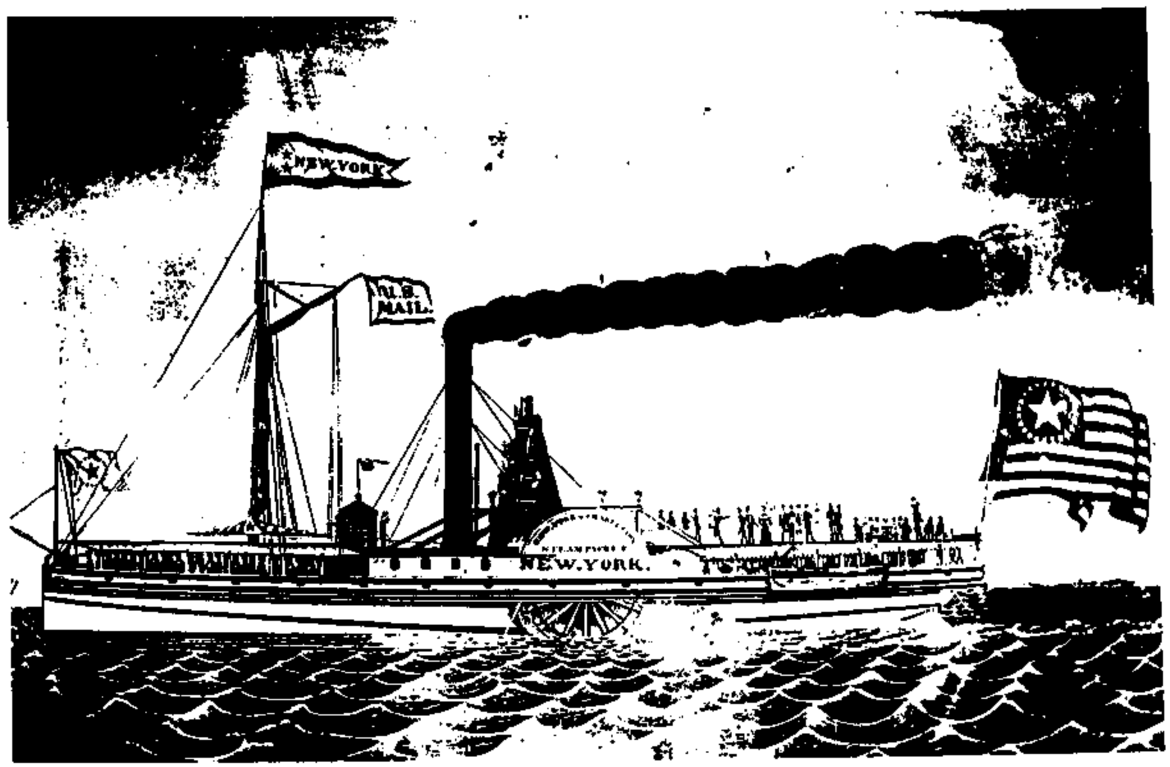

Figure 11. Drawing of the steamship *New York (Courtesy of Mariners' Museum, Newport News, Virginia).*

Discovery of the Wreck

A group of amateur divers from New Iberia, Louisiana, began searching for the wreck of the *New York* in 1985. Working only from the sparse clues contained within the survivors' accounts published in the New Orleans newspapers in 1846, the divers deduced the general location of the wreck site. They subsequently interviewed shrimpers who worked in the area to obtain information on the location of net hangs.[1] Over the course of the next five years, the team systematically tested each hang site in a 26-km^2 area using a fish finder to locate targets above the seafloor. After a supreme amount of effort and patience, using equipment primitive by hydrographic surveying standards, the team discovered in 1990 a wreck believed by the divers to be that of the *New York*. Materials recovered from the site, including coins and a mortising machine patented in 1836, were consistent with the 1846 sinking of the steamer. Subsequent examination of the site by MMS confirmed the presence of a low-pressure steam engine at the site, which also is consistent with the cross-head engine mounted in the *New York*.

MMS Involvement with the *New York*

An oil and gas company had surveyed the High Island Area lease block in which the *New York* lies for shallow hazards in 1988 at a line spacing of 150 m, the survey interval required by MMS at the time for all blocks in the archaeological high-probability area. The survey recorded a magnetic anomaly with a perturbation of 100 gammas over the wreck site, but the consulting archaeologist at the time did not associate it with the location of a significant historic shipwreck. Subsequently, a study conducted for the MMS to determine high-probability areas for the location of historic wrecks in order to reduce the survey interval for those blocks from 150 m to 50 m placed the wreck of the *New York* in Vermilion Area, more than 160 km away from its actual location. As a result, MMS reduced survey requirements for the block containing the wreck site to 300 m, further diminishing the chances that MMS would have ever identified the site. Fortunately, the leader of the team that discovered the wreck shared the location of the site with MMS in the interest of preserving it from inadvertent destruction by oil and gas development in the block.

The MMS first visited the site of the wreck in July 1997 to identify the wreckage and conduct an intensive remote-sensing survey to assess the site's size and extent. There was a particular concern to investigate the possible relationship between other magnetic anomalies discovered during the 1988 survey and the shipwreck.

A survey was conducted along north/south tracklines spaced 30 m apart over an area 457 m wide (east-west) by 1.2 km long (north-south). Survey instrumentation included a Geometrics G-866 proton precession magnetometer and a Marine Sonics Seascan 600 kHz sidescan sonar. A Trimble NT200D differential GPS receiving the U.S. Coast Guard differential beacons with an accuracy of

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[1] Many shrimpers maintain personal logs of obstructions within the areas in which they operate. These hangs often go unreported since this knowledge provides them a distinct economic advantage over competitors.

±10 m controlled positioning. The sidescan sonar receives positioning input from the DGPS and links the image files with the positioning files. We synchronized the magnetometer to the DGPS and we outputed magnetic data to a computer for storage. We later merged the time-synchronized magnetic and positioning files in post-processing to produce a single X, Y, Z coordinate file. The resulting file was contoured using *Surfer* software (Figure 12). Magnetic contouring revealed that wreck debris was scattered over the seafloor for a distance of about 450 m. The principal areas of magnetic perturbation centered over the hull (containing the steam engine) and a paddle wheel to the east. Several small, concentrated anomalies were observed curving to the southeast from the main wreck site. At present, none of these anomalies has been tested archaeologically.

Conclusions

The wreck of the *New York* serves as an important lesson for the MMS/GOMR archaeological program. The fact that the wreck site lies outside the currently designated high-probability area for historic shipwrecks suggests that the model on which this designation is based needs to be reevaluated. Secondly, it highlights the importance of developing better public outreach to the sport diving community and other maritime interests to enlist their trust and cooperation in locating historic wrecks in the Gulf of Mexico. It is unlikely that MMS would have discovered this nationally significant site without their assistance and cooperation. Finally, the analysis of the wreck by MMS demonstrates that the potential site size for a shipwreck on the OCS can exceed 24 ha (61 ac) of bottom land and be characterized by multiple, individual magnetic anomalies scattered over a wide distance. Since the majority of vessels that wrecked on the OCS did so as a result of foundering and being literally torn apart during a violent storm, this pattern may be expected to be repeated at other sites and should be considered as a general rule to guide decisions relating to activity avoidance zones.

Shipwreck in High Island Area Block 164

An operator reported a shipwreck to MMS in an archaeological and hazards survey report. The operator's survey, using a 100-kHz sonar, identified a hull-like shape partially buried in the sediment. The operator's contract archaeologist recommended the wreck for avoidance as a potential archaeological site. The MMS 600-kHz system, however, recorded what is interpreted as a 65-ft steel-hull vessel with a high bow, square transom, and internal transverse bulkheads typical of shrimp boat construction (Figure 13). Based on this evidence, protection of the wreck as an archaeological site is not warranted.

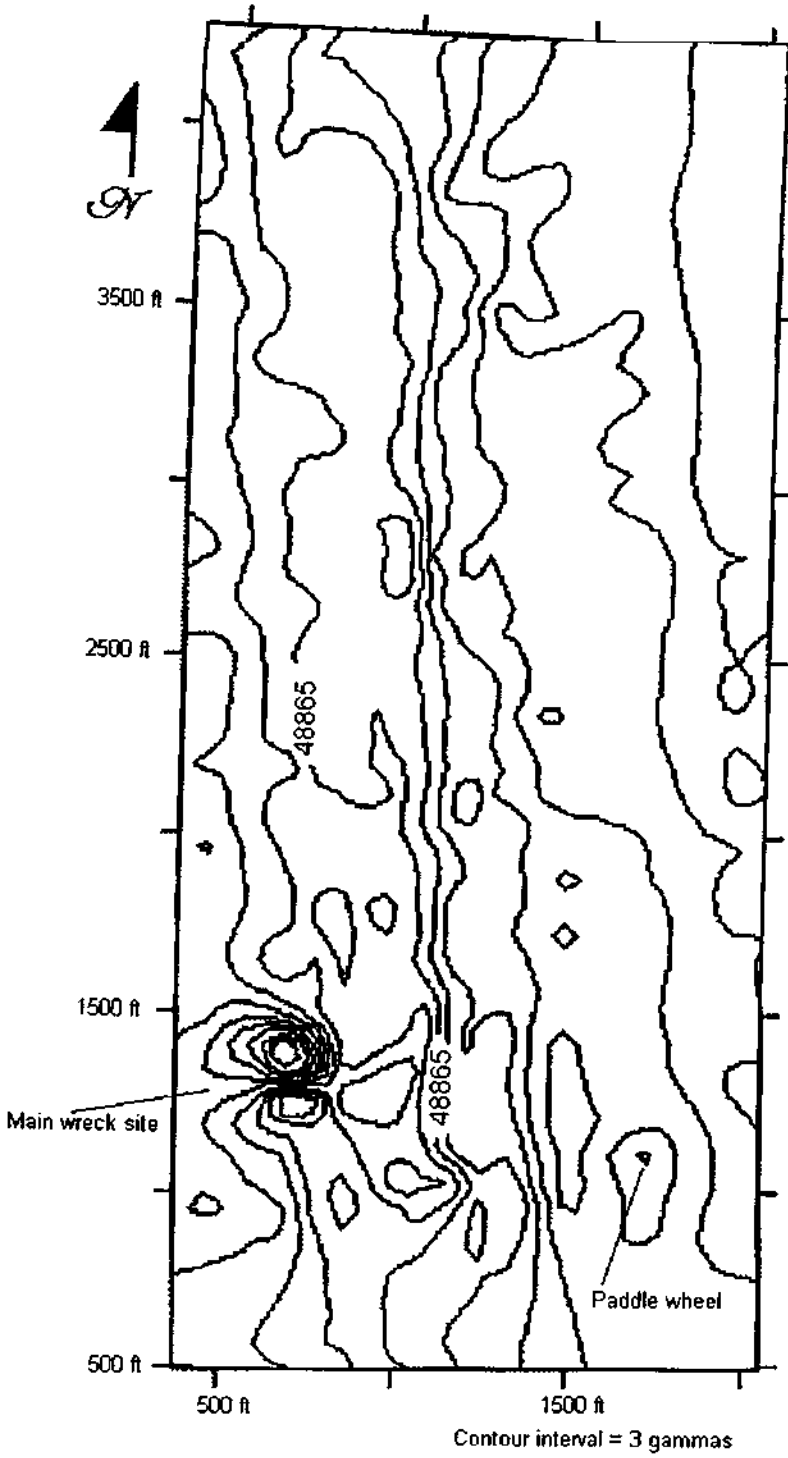

Figure 12. Magnetic contour map of the *New York* wreck site.

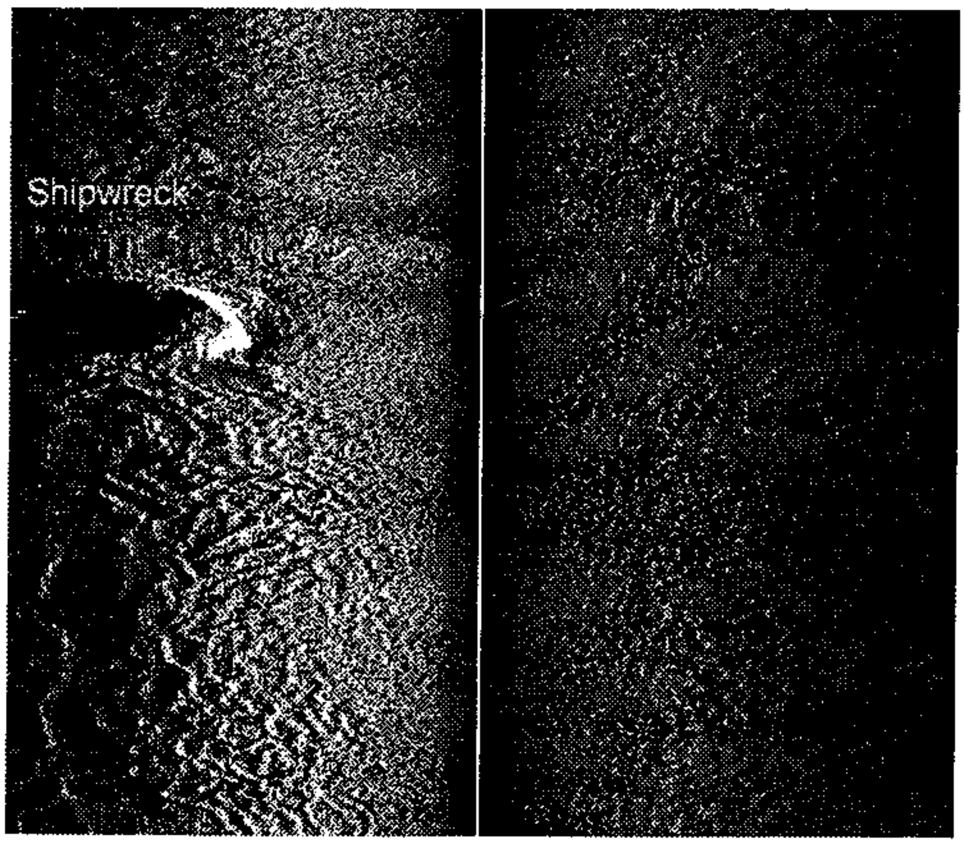

Figure 13. High Island Area Block 164 shipwerck.

IV. FLOWER GARDENS SURVEY

Introduction

Drs. Rik Anuskiewicz and Jack Irion participated in the 1997 season of the Flower Garden Bank Long-Term Monitoring Study conducted by Texas A&M University (Corpus Christi) to collect high-resolution sidescan sonar imagery of the West and East Banks. The monitoring study was jointly sponsored by MMS and NOAA.

Purpose

This trip collected for the first time high-resolution sidescan sonar imagery of the West and East Flower Garden Bank National Marine Sanctuary, and made this imagery available to marine biologists and coral reef ecologists for review. The objective of the operation was to obtain sonogram coverage of as much of the 30-m isobath at both banks as was possible without interfering with the planned work of the contractor. Operations were originally planned for early evenings, but this proved unfeasible since favorable conditions permitted night dives by the contractor and numerous mooring buoys made towing the sonar sensor hazardous after dark. As a result, we could conduct operations only during the divers' required surface intervals between moves from one bank to the next.

Findings

Sidescan sonar images were collected over approximately one-half of the 30-m isobath at both the West and East Banks. The sonar showed detailed pictures of the rugged surface of the banks, including locations of sand patches and concentrations of schools of fish. Figure 14 illustrates the typical topography of the East Bank.

Conclusions

A high-resolution sonar survey is a useful tool for collecting information about the physical characteristics of the Flower Gardens National Marine Sanctuary. It is likely to prove particularly useful for mapping the breaks in the reef characterized by large sand patches and for answering questions concerning fisheries concentrations and the formation and development of the reef.

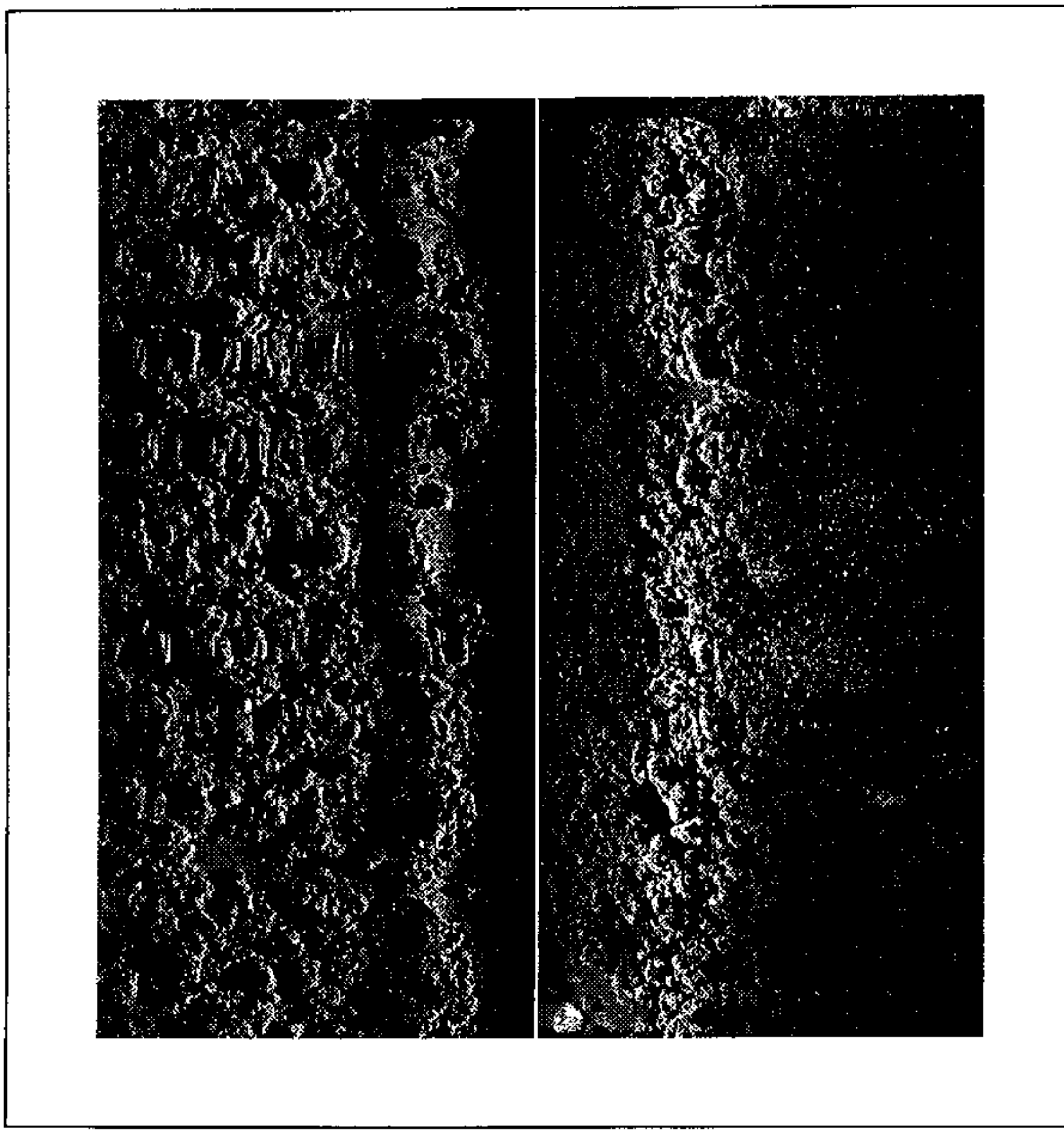

Figure 14. Sidescan image of the East Flower Garden Bank.

V. GRAND ISLE AND WEST DELTA STRUCTURE SURVEYS

Purpose

The Office of Structural and Technical Support (OSTS) of the Field Operations Section (FO) of the GOMR requested the Region's scientific dive team to assess and document the extent of structural damage at West Delta Area Block 133 Platforms "E" and "B," to conduct sidescan sonar survey and diver-groundtruthing at seafloor well stub sites to identify potential trawl hangs, and to inspect site clearance locations to verify that the seafloor was free of debris.

West Delta Area Block 133, Platforms "E" and "B"

The dive team performed four dives to investigate and record obvious structural damage to these two platforms. Underwater observations on Platform "E" revealed substantial damage (e.g., missing well collars, missing braces, and broken well conductors) at the -27.7-m conductor bay level. Several of the platform anodes at and below this level were completely missing or severely diminished. Platform "B," on the other hand, showed no visible structural damage. The well conductors on this platform were reinforced with doubler plates (patches) at the contact point with the well conductor collars. Platform "E" is an unmanned platform and may be scheduled for removal in the near future, thus the lack of attention to damage repair. Platform "B" is a manned platform.

Well Stub at West Delta Area Block 40, Well No. 8

The dive team investigated an area of approximately 5 ac around the reported position of this structure without result. We concluded that the position reported by FO was in error since the description of the location measured from a nearby structure did not match the recorded geographical coordinates by several thousand meters. This conclusion suggests the possibility that other positioning errors exist in the well stub database.

Subsea Completion at Grand Isle Area Block 41, Well No. 4

The dive team investigated a subsea "tree" completion in Grand Isle Area Block 41 using sidescan sonar. The tree was marked with a surface buoy, but the scope of the buoy anchor chain placed it some 48.7 m from the actual structure (Figure 15). An attempt made by the dive team to follow the anchor chain down to the subsea tree failed after the divers lost contact with the chain in the soft ooze and zero visibility at the bottom. However, the sidescan proved to be an efficient means of examining this type of structure.

Site Clearance at West Delta Area Block 33, Platform "E" and West Delta Area Block 42, Platform "X"

Two site clearance locations were examined by sidescan sonar survey. The first was the former location of Platform "E" in West Delta Area Block 33. A large "can hole" was observed on the

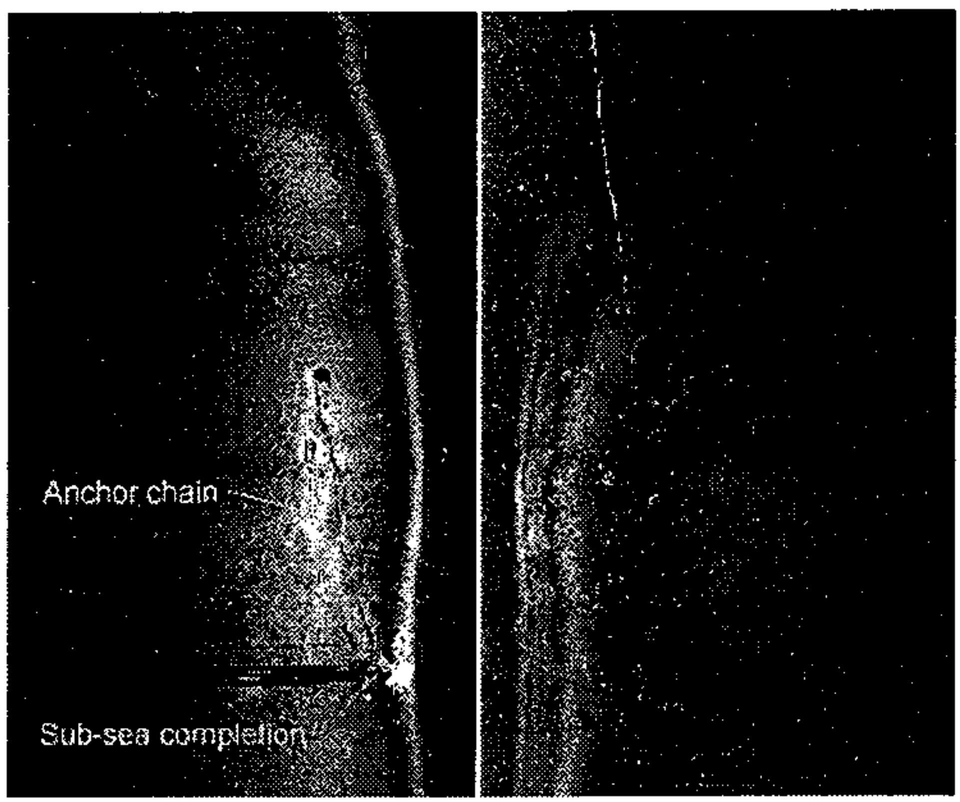

Figure 15. Sidescan image of a subsea completion in Grand Isle Area Block 41.

bottom, and some small, hard returns in the acoustic record may indicate minor debris (Figure 16). The second platform surveyed was the former location of Platform "X" in West Delta Area Block 42. A drill cuttings plume showed clearly as a bright spot in the acoustic record because of the difference in reflectivity between that and the surrounding sediment. One small piece of debris was observed near the drill site (Figure 17).

Utility of Sidescan Sonar and Diver Surveys in Assessing Operational Compliance

Monitoring investigations made by MMS in the West Delta and Grand Isle Areas in 1997 proved to be an effective means of acquiring firsthand information regarding MMS's stewardship of the marine environment as well as information relating to issues of structural integrity and safety. The high-resolution sidescan provided a high level of detail on bottom structures unrestricted by water turbidity. This instrument is extremely useful in the assessment of site clearances, the integrity of well stub protectors, and the condition of pipelines. Other tasks are best performed by the Region's scientific divers when detailed analysis of structural integrity is required.

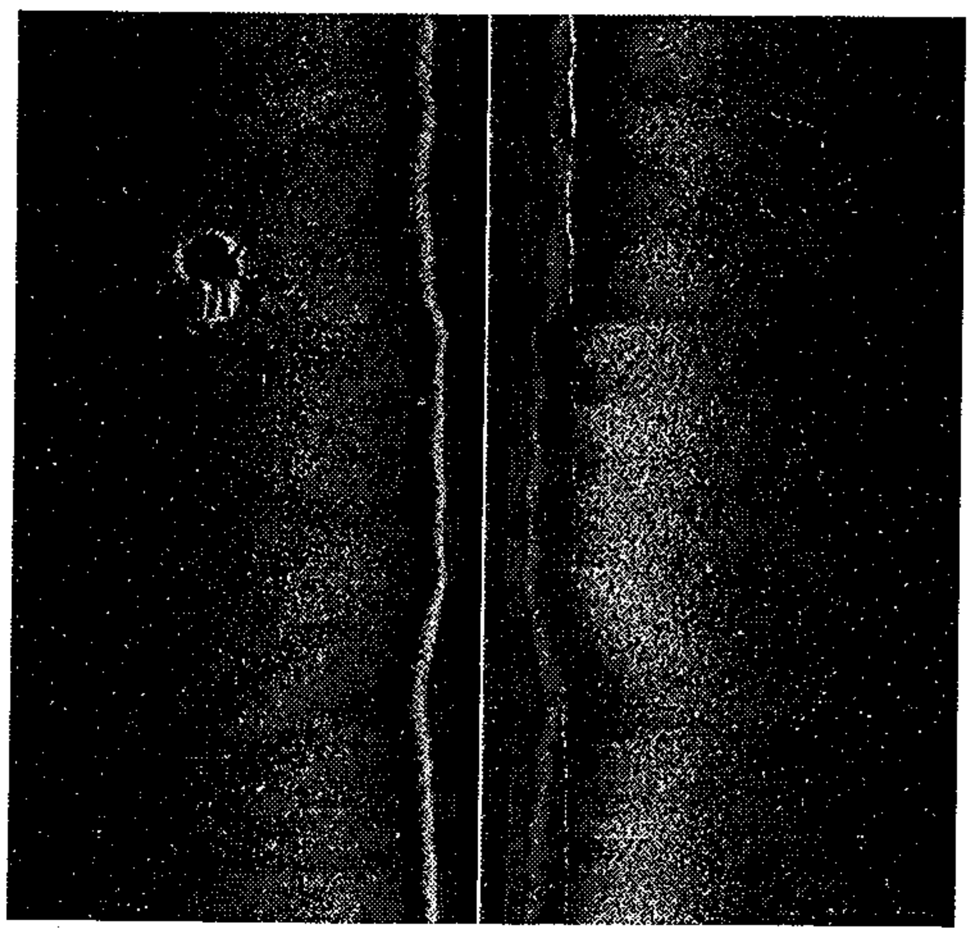

Figure 16. Site clearance at the location of Platform "E," West Delta Area Block 33.

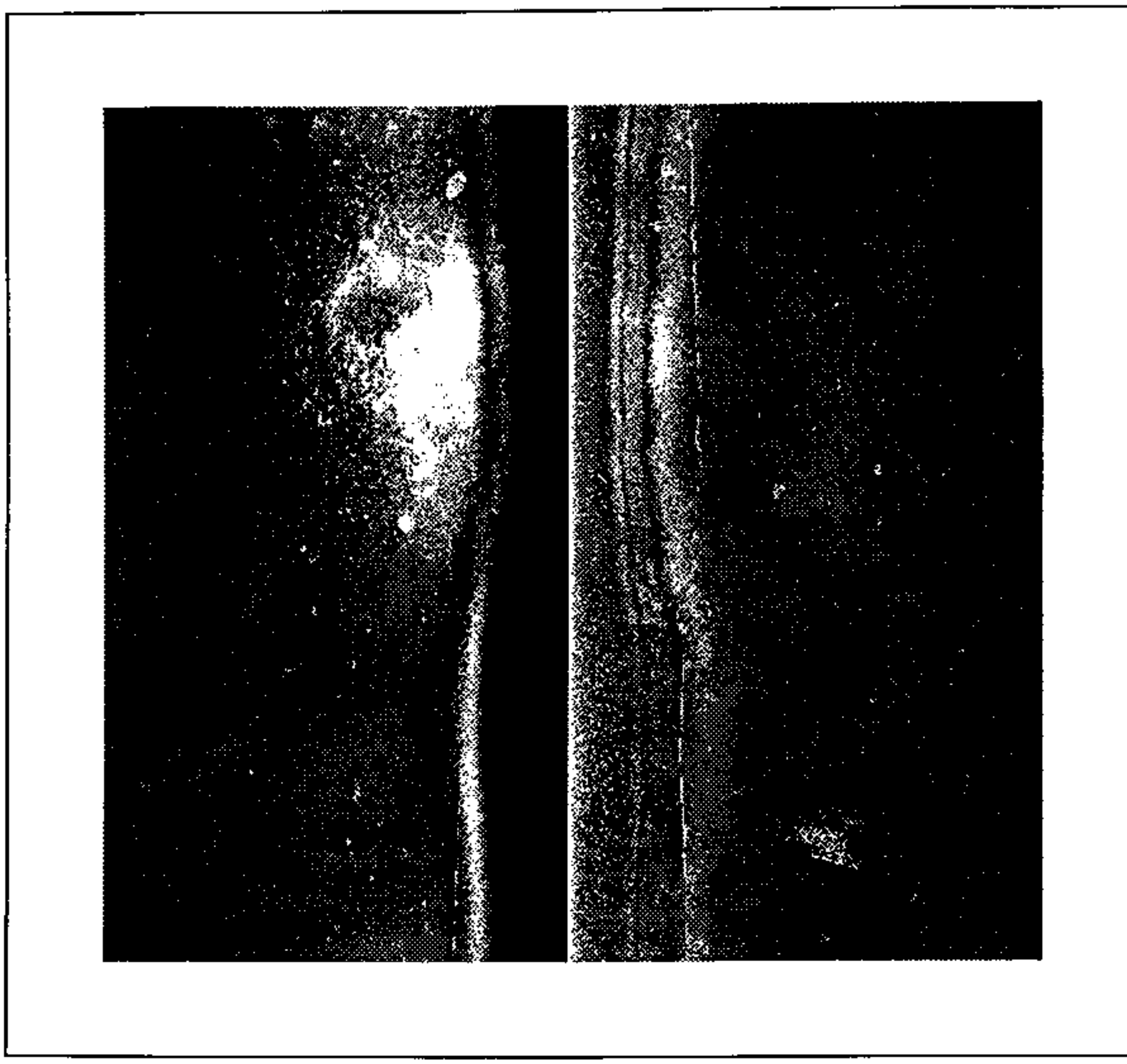

Figure 17. Site clearance at the location of Platform "X," West Delta Area Block 42.

VI. STETSON AND SONNIER BANKS

Introduction

The sidescan sonar survey and diving investigation of Stetson and Sonnier Banks, Gulf of Mexico, was a joint project of Leasing and Environment (LE) and Resource Evaluation (RE). Invited researchers from the National Oceanographic and Atmospheric Administration (NOAA), Texas A&M University (College Station and Galveston campuses), and the New Orleans Aquarium of the Americas assisted in the investigation.

Stetson and Sonnier are mid-shelf banks, which are defined by Rezak et al. (1985:169) as diapiric structures rising from depths of 80 m or less and having a relief of about 4 to 50 m. Both banks are associated with salt domes and are outcrops of relatively bare, bedded Tertiary limestones, sandstones, claystones, and siltstones. Stetson Bank, located in High Island Area Blocks A-502 and A-513, was accorded status as a National Marine Sanctuary in 1996. Stetson Bank is unlike most of the other mid-shelf banks that largely are covered with coral and carbonate formations; Tertiary bedrock is exposed at the surface, making the bank a suitable candidate for geological prospecting. Sonnier Bank, located in Vermilion Area, South Addition Block 305 consists of several peaks forming an arcuate pattern created by the collapse of the crest of the diapir after the salt dome pierced the seafloor and the salt washed into solution. The peaks rise from a depth of about 60 m to crest between 17 and 58 m. The 1997 field project investigated two of these peaks, one cresting at a depth of 22 m (Sonnier Bank [SB] Peak 1) and one cresting at 17 m (SB Peak 2).

Sonnier Bank, located in Vermilion Area Block 305, resulted from reef development on outcropping rocks related to a piercement salt diapir. During the Jurassic period, thick salt deposits formed from the evaporation of shallow seas across what is now the Gulf of Mexico. In subsequent times, large amounts of river-transported sediments were deposited over this salt layer. The pressure of this overburden, along with the buoyancy of the relatively less dense salt, forced movement of salt bodies up towards the earth's surface and, in some cases, through it. Such is the case at Sonnier Bank, where a salt dome and related faulting have deformed and moved Pleistocene Age rock beds to an exposed position at the earth's surface (Figure 18).

Climate changes during Pleistocene glacial periods led to a 90-m or more drop in sea level, resulting in the exposure of the rock beds at Sonnier Bank to erosion by wind and running water. The exposed central portion of the salt dome collapsed and the less resistant rock beds eroded away, leaving the present configuration of hard rock pinnacles rising from the 60-m water depth of the seafloor to 22.8 m below the water surface. These pinnacles originate from the upthrown sides of faults associated with the salt dome and vary in size and depth; several are within depth limits accessible to divers (Figure 19). In September 1997, MMS led an expedition to investigate two of these structures. Scientific Dive Team members made 14 dives to photograph and video the geologic features extensively. The outcropping beds exhibit dips of 45 degrees to 90 degrees and are composed of consolidated silts, clays, and sands. Thickness ranges from <2.5 cm to 30 cm. Representative rock samples were collected and will be analyzed for mineral content and fossil age dating. A detailed

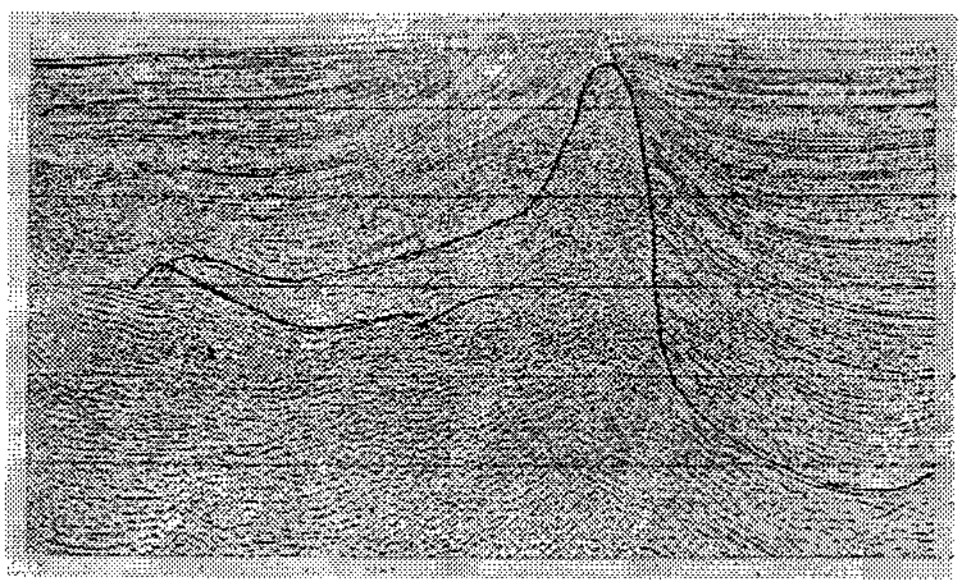

Figure 18. Seismic image of the salt dome underlying Sonnier Bank.

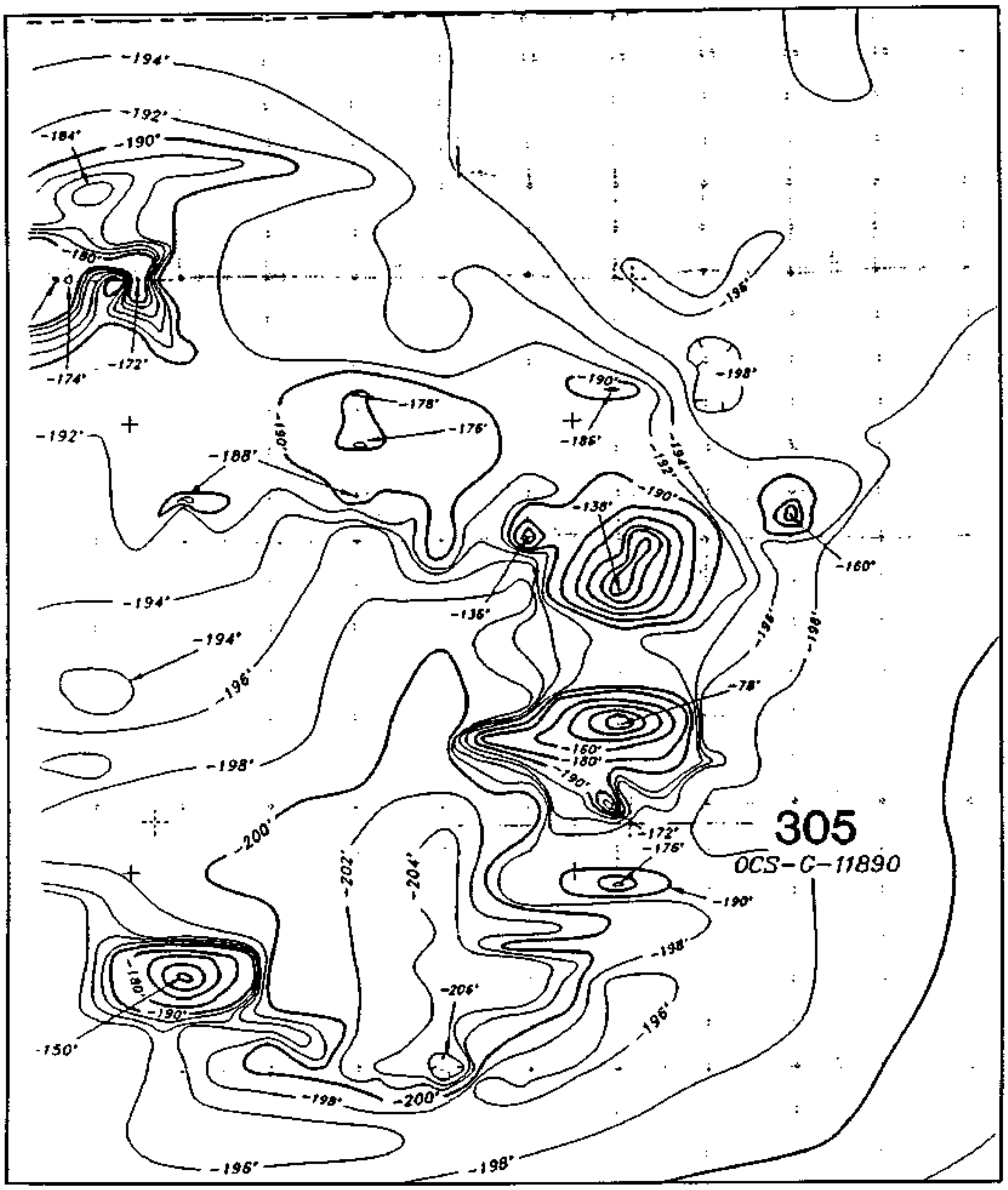

Figure 19. Bathymetric contour map of Sonnier Bank.

sidescan sonar survey was conducted over the area to aid interpretation of the complex structural relationships among the outcrops.

Objectives

The objective of the geological field work at Sonnier Bank was to study how salt diapir movement on the Outer Continental Shelf acts as a method of sediment transport. Salt domes are hydrocarbon production rich structures. The Vermilion Area Block 318 Field, on the south flank of the Sonnier dome, has several wells producing gas from Pleistocene age sands. Rock samples from Sonnier Bank will be correlated with the same age rock found in these wells.

The objective of the biological field work at Sonnier Bank was to continue the characterization of the benthic community by direct observation. A major goal of this portion of the project was to locate and evaluate SB Peak 2, which had not been previously investigated. Both studies were to be assisted by the collection of high-resolution sidescan sonar imagery of the bottom, from which we hoped to distinguish both structural characteristics of the banks and concentrations of benthic communities.

Field Methods

Geological Sampling

The MMS will analyze collected rock samples from both Stetson and Sonnier Banks using several methods. Paleo-age dating and ecologic zonation will help correlate the outcropping rocks with the electric well logging signature of the same age rock found at depths beneath the seafloor in nearby hydrocarbon wells. Electron and optical microscope examination of the samples will reveal composition and evidence for the type of depositional environment.

Biological Studies

Invited scholars from NOAA, Texas A&M University at College Station (TAMU), and Texas A&M University at Galveston (TAMUG) undertook the collection of biological data. Four dives were made per day by each scientist and his or her assistants with one day each spent at Stetson, Sonnier Peak 1, and Sonnier Peak 2. The team compiled observations following each dive and identified collected specimens to the lowest possible taxon using relevant field guides. Mr. Jeff Childs (Appendix I) and Drs. Stephen Gittings and Donald Harper (Appendix II) compiled the findings.

The scientists surveyed the fish community at Sonnier Bank using the "Roving Diver Technique" used in similar surveys at the Flower Garden Banks and Stetson Bank in the region. The survey method employs teams of trained observers on SCUBA for identifying and recording fish species and their abundance onto data forms (bubble sheets) provided by the Reef Environmental Education Foundation. Species not identified on the dive were sketched and later identified using available field guides. Survey teams compared observations and familiarized themselves with unfamiliar species reported from the previous dive. The team conducted surveys throughout the day, beginning shortly after sunrise, and ending at dusk. Additionally, the team instructed observers to note on survey forms any new species seen during night dives conducted at each pinnacle. Observers completed a total of 21 surveys, representing approximately 16 person-hours of bottom time.

Remote Sensing

We conducted remote-sensing operations using a 600 kHz Marine Sonic Technology SeaScan sonar using both a 50-m and 75-m per channel range setting. We controlled positioning with a Trimble NT200D differential Global Positioning System with an accuracy of ± 10 m. We surveyed only the upper reaches of the banks owing to the steepness of the topographical variability over the banks and the need to tow the sonar sensor at a consistent elevation of approximately 5 m off the seafloor. The best coverage was obtained by expanding the record across the full breadth of either the starboard or port channel and towing the sonar fish along the edge of the crest.

Conclusions

The preliminary geological analysis of both Stetson and Sonnier Banks indicates that both banks are formed predominately of soft siltstone. We observed no evidence of more consolidated sandstones. The ongoing study of Sonnier Bank provides an opportunity to collect and analyze outcropping rocks on the floor of the Gulf of Mexico, thus contributing to a better understanding of salt movement and resulting effects on surrounding rock beds. These rocks also constitute the preserved sedimentary record of events resulting from changing sea levels. Geologists can use this information to reconstruct the environment in which the sediments were deposited, helping in the prediction of the distribution of potential reservoir sands throughout the area. This is a vital step in the process of determining fair market value for lease tracts.

The sidescan sonar investigation over both banks also demonstrated the effectiveness of the instrument in imaging structural details of geological features that will aid in the analysis of their formation and development. Since the high-resolution instrument also detects fish in the water column, it will aid the biologists in developing calculations relating to biomass present on these features. The sonar also proved a useful tool for demonstrating that neither bank has suffered significant damage from anchor scarring.

Finally, the description provided by Drs. Thomas Bright and Richard Rezak for the features they surveyed by submersible on Sonnier Bank in 1977 (Bright and Rezak 1979) could easily be the description provided in 1997. Bright and Rezak described the features as being "almost entirely encrusted with fire coral (*Millepora* sp.) and sponges (*Neofibularia nolitangere* and *Ircinia* sp.)," a community they referred to as a Millepora-Sponge Zone. They also noted that fire coral "contributes significantly to the sediment which is produced on the bank," and that "populations of fishes and conspicuous, mobile invertebrates are diverse and abundant above 45 m and are very comparable to populations on Stetson Bank." Like Bright and Rezak, we observed "moderate" abundances of coralline algae above 40 m (Rezak et al. 1985), and that "the abundance of Millepora, sponges, coralline algae, and most of the other encrusting epifauna is greatly reduced below 40 m depth."

Divers encountered nearly all species shown on Bright and Rezak's cross section of Sonnier Bank on the two features surveyed in 1997. In addition, they found numerous coral and other species not encountered by Bright and Rezak. This may be attributable to recruitment over the last 20 years or a difference in survey techniques (i.e., submersible vs. divers).

Bright and Rezak suggested that "Sonnier Bank appears to be very healthy at present, and there is no evidence of past mass mortalities or large scale deleterious environmental effects attributable to any cause," even though numerous exploratory wells had been drilled within several kilometers of the bank. With the possible exception of the mass mortality of the long-spined sea urchin *Diadema antillarum* in the mid-1980's, an event experienced by nearly all reefs and banks in the western Atlantic, the present survey leads us to conclude that the banks are in virtually the same condition. Detailed biological reports on findings resulting from the 1997 field season may be found in Appendices I and II.

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Appendix I

Summary Report for Minerals Management Service on the Ichthyofaunal Surveys Conducted at Sonnier Bank in the Northwestern Gulf of Mexico, September 1997

SUMMARY REPORT FOR MINERALS MANAGEMENT SERVICE ON THE ICHTHYOFAUNAL SURVEYS CONDUCTED AT SONNIER BANK IN THE NORTHWESTERN GULF OF MEXICO, SEPTEMBER 1997

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Introduction

The Minerals Management Service (MMS) sponsored a cruise aboard the M/V *Fling* to Sonnier Bank in the northwestern Gulf of Mexico, in part to continue developing a baseline survey of the fauna there. This report addresses the ichthyofauna (and one avifaunal record) observed over a two-day period (September 30 to October 1, 1997) at Sonnier Bank, located at latitude 28°20.6′ N. and longitude 92°27.0′ W. It consists of several pinnacles that rise from the continental shelf to within approximately 20 m of the surface. Two pinnacles were surveyed, one designated as "24-m pinnacle," the other as "18-m pinnacle." The distance between these two pinnacles is estimated to be from 100 to 150 m.

Methodology

The fish community at Sonnier Bank was surveyed using the "Roving Diver Technique," also employed in similar surveys at the Flower Garden Banks and Stetson Bank in the region. This survey method employs teams of trained observers on SCUBA for identifying and recording fish species and their abundances throughout their dive. Upon returning to the surface, divers record data onto forms (bubble sheets) provided by the Reef Environmental Education Foundation (REEF). Species not identified on the dive were sketched and later identified aboard ship using available field guides. Survey teams compared observations and familiarized themselves with unfamiliar species reported from the previous dive. Surveys were conducted throughout the day, beginning shortly after sunrise and ending at dusk. Additionally, observers were instructed to note on survey forms any new species observed during night dives conducted at each pinnacle.

Surveys were conducted only in the vicinity of each pinnacle, from a depth of approximately 37 m to the surface. The area of each pinnacle was sufficiently small, so that survey teams could easily cover the entire pinnacle in one 40-minute dive. The 18-m pinnacle was roughly one-half the area of the 24-m pinnacle at 30 m in depth.

Five experienced ichthyofaunal surveyors participated in the cruise. A total of 21 surveys were completed, 9 at the 24-m pinnacle, and 12 at the 18-m pinnacle. Observers include Greg Bunch, Robin Harwell, and Tony Sebastian from the Aquarium of the Americas (AOA) in New Orleans; and Emma Hickerson and myself from the Flower Garden Banks National Marine Sanctuary (FGBNMS) in Bryan, Texas.

Surveys were compiled into a database upon returning from the cruise. In addition to examining diversity based upon taxonomic hierarchies, I also examined the ichthyofaunal diversity based upon their habitat associations. Four habitat guilds were identified from the species list generated from the surveys. These guilds comprise the following: reef, epipelagic, benthopelagic, and commensal species. Reef species are characterized as having a strong association with reef structures and may either crawl over or swim in close proximity of the reef. Epipelagic species are those that occur in the upper depths of the water column and do not necessarily demonstrate a close affinity to reef structures. The benthopelagic species, while inclusive of many reef species generally, is used in this report to characterize bottom-oriented species that may be wide ranging and capable of moving between bank communities, a trait not expected of most reef species. Commensal species are regarded here as those species having a close association with another mobile species, as opposed to a physical structure such as a coral colony.

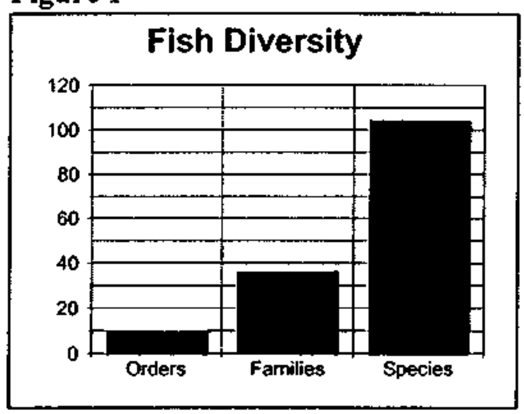
Results

Overall Fish Diversity for Sonnier Bank

Nine orders of ichthyofauna were observed at Sonnier Bank over a two-day period in late September - early October 1997 (Table 1). As expected for the region, the order Perciformes was the most evident, with 25 families represented and 82 species identified for the site.

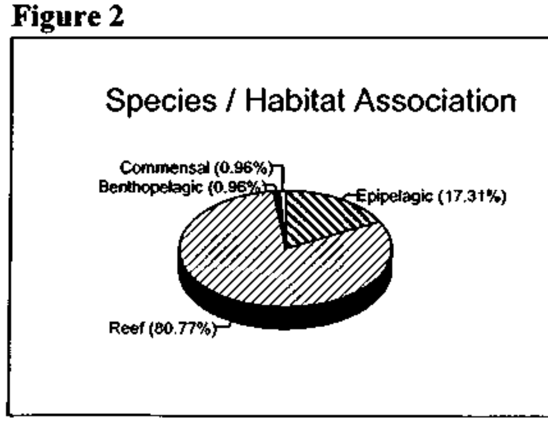
Observers recognized fish species from 36 families (Figure 1), most of which are generally associated with reef communities. Pomacentrids were the most diverse reef family observed with 26 species between the two pinnacles. Epipelagics were best represented by the family Carangidae, with 8 species identified.

Figure 1



A total of 104 species were recorded between the two pinnacles visited (Table 2), 84 of which were closely associated with reef habitats (Figure 2). One benthopelagic species (sandbar shark, *Carcharhinus plumbeus*) and one commensal species (sharksucker, *Echeneis naucrates*) were each observed. Eighteen species of epipelagics were identified, the most abundant of which was the little tunny (*Euthynnus alletteratus*). The creole-fish (*Paranthias furcifer*) and cocoa damselfish (*Stegastes variabilis*) were the most abundant reef species evident on the bank.

Figure 2

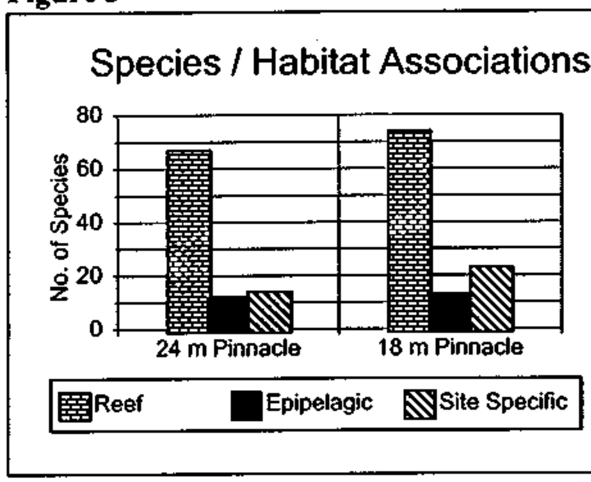


One species not clearly identified to species was a sailfish (family Xiphiidae, Nelson, 1994), which was observed leaping nine consecutive times from the water within 50 m of the dive platform. This speciesis not recorded in association with observations for a specific pinnacle, since it was observed in the waters around the bank.

Fish Diversity at the 24-m Pinnacle

Eighty species were identified at the 24-m pinnacle, representing 7 orders and 30 families. Nine species of Pomacentrids and 6 species of Carangids were recorded. One Aulopiform species, the red lizardfish (*Synodus synodus*), was observed at this site, an order neither reported at the 18-m pinnacle nor previously for Sonnier Bank. Reef ichthyofauna consisted of 67 species, while epipelagics included 12 species (Figure 3). Fourteen species identified at this pinnacle were absent in surveys conducted at the 18-m pinnacle.

Figure 3



Fish Diversity at the 18-m Pinnacle

Eight orders and 32 families of ichthyofauna were found at the 18-m pinnacle and, as with the 24-m pinnacle, Pomacentrids (12 species) and Carangids (6 species) were the most diverse reef and epipelagic groups represented, respectively. A total of 89 species were identified, 74 reef species and 13 epipelagic species, while 23 species were specific to this pinnacle. Unique orders observed at this site include two shark groups, an Orectolobiform, the nurse shark (*Ginglymostoma cirratum*) and a Carcharhiniform, the sandbar shark. One diver did report a putative bull shark (*C. leucas*); however, it was not recorded in the database due to the uncertainty of its identification.

Additional Vertebrate Fauna Observed at Sonnier Bank

A lone bird landed for a short time on the dive vessel and was identified as a member of the flycatcher species (genus *Empidonax*). The bird was the sole other vertebrate observed at Sonnier during the cruise, aside from its curious primate counterparts aboard ship and fish assemblages reported herein.

Conclusions

Sonnier Bank supports a diverse tropical and temperate assemblage of ichthyofauna characteristic of banks and reefs of the region. A total of 104 species were observed over two days between two pinnacles, reflecting 36 families and 9 orders of ichthyofauna. When these data are compared to a survey conducted at Sonnier Bank last summer, 5 fewer species were reported overall; however, 16 new species were identified for the bank. These new species contribute an additional 6 families represented at Sonnier Bank from the cruise last year. The strong representation of Pomacentrids

(26 species) and Carangids (8 species) at this site compares favorably with the Flower Garden Banks and Stetson Bank ichthyofaunal assemblage. Further, the presence of wide-ranging epipelagics and benthopelagics such as manta rays, sandbar sharks, and nurse sharks at Sonnier Bank, is expected.

When fish assemblages are evaluated by habitat guilds, 81 percent of the species are closely associated with reef structures, while 17 percent of the species are epipelagic in nature. The remaining 2 percent are benthopelagic or commensal species. This pattern may be characteristic of fish assemblages occurring at banks for this region. It might be useful for future analysis to examine the ichthyofaunal diversity indices for other banks and reefs such as the Flower Garden Banks and Stetson Bank, to determine if such assemblage structure (habitat guilds, for example) at Sonnier Bank is unique or not. Such indices would also prove useful when comparisons are drawn to other reef surveys in the western Atlantic, Gulf, and Caribbean large marine ecosystems.

Acknowledgments

I wish to thank the ichthyology survey team (Greg Bunch, Robin, Emma Hickerson, and Tony Sebastian) for their careful fish identification and enthusiastic dedication to ensuring this survey was a pleasant success. Further, I would like to thank the MMS staff (Les Dauterive, Jack Irion, Terry Dempre, and Rick Anuskiewicz), and the other members of the survey (Steve Gittings and Don Harper) for their support in carrying out surveys. Finally, I wish to thank Dr. Ann Bull for giving me the opportunity to participate in this enjoyable endeavor.

TABLE 1: Ichthyofaunal Diversity

	Sonnier	24-m Pinnacle	18-m Pinnacle
Orders	9	7	8
Families	36	30	32
Species	104	80	89
Commensal	1	1	1
Benthopelagic	1	0	1
Reef	84	67	74
Epipelagic	18	12	13
Site Specific	-	14	23

TABLE 2: Ichthyofaunal Species List - Sonnier Bank, Fall 1997

NOTE: Species names given here are common names used by the American Fisheries Society List of Common Names. Please refer to this source for scientific nomenclature. Families are those listed by Nelson, 1994. Family or common names in **bold** are newly reported taxon for Sonnier Bank.

Count	ORDER	FAMILY	SPECIES	HABITAT	24 m	18 m
1	Anguilliformes	Muraenidae	Goldentail Moray	reef	X	X
2	Anguilliformes	Muraenidae	Green Moray	reef		X
3	Anguilliformes	Muraenidae	Spotted Moray	reef	X	X
4	Aulopiformes	**Synodontidae**	**Red Lizardfish**	reef	X	
5	Beloniformes	**Exocoetidae**	**flyingfish (???)**	epipelagic	X	X
6	Beryciformes	Holocentridae	Blackbar Soldierfish	reef	X	X
7	Beryciformes	Holocentridae	Longspine Squirrelfish	reef	X	X
8	Beryciformes	Holocentridae	**Reef Squirrelfish**	reef		X
9	Beryciformes	Holocentridae	Squirrelfish	reef	X	X
10	Carcharhiniformes	Carcharhinidae	Sandbar Shark	benthopelagic		X
11	Orectolobiformes	Ginglymostomatidae	Nurse Shark	reef		X
12	Perciformes	Acanthuridae	Blue Tang	reef	X	X
13	Perciformes	Acanthuridae	Doctorfish	reef	X	X
14	Perciformes	Acanthuridae	Ocean Surgeonfish	reef	X	X
15	Perciformes	Apogonidae	Flamefish	reef	X	X
16	Perciformes	Apogonidae	Two spotted Cardinalfish	reef		X
17	Perciformes	Blenniidae	Barred Blenny	reef	X	
18	Perciformes	Blenniidae	Redlip Blenny	reef	X	X
19	Perciformes	Blenniidae	Seaweed Blenny	reef	X	X
20	Perciformes	Carangidae	**African Pompano**	epipelagic		X
21	Perciformes	Carangidae	Almaco Jack	epipelagic	X	X
22	Perciformes	Carangidae	Bar Jack	epipelagic		X
23	Perciformes	Carangidae	Blue Runner	epipelagic	X	X
24	Perciformes	Carangidae	Greater Amberjack	epipelagic		X
25	Perciformes	Carangidae	Horse-eye Jack	epipelagic	X	
26	Perciformes	Carangidae	Lookdown	epipelagic	X	
27	Perciformes	Carangidae	Rainbow Runner	epipelagic	X	X
28	Perciformes	Carangidae	Yellow Jack	epipelagic	X	
29	Perciformes	Chaetodontidae	Reef Butterflyfish	reef	X	X
30	Perciformes	Chaetodontidae	Spotfin Butterflyfish	reef	X	X
31	Perciformes	Cirrhitidae	Redspotted Hawkfish	reef	X	X
32	Perciformes	**Echeneidae**	**Sharksucker**	commensal	X	X
33	Perciformes	**Ephippidae**	**Atlantic Spadefish**	epipelagic	X	X

Count	ORDER	FAMILY	SPECIES	HABITAT	24 m	18 m
34	Perciformes	Gobiidae	Blue Goby	reef	X	
35	Perciformes	Gobiidae	Goldspot Goby	reef	X	X
36	Perciformes	Gobiidae	**Hovering Goby**	reef	X	
37	Perciformes	Gobiidae	Neon Goby	reef	X	X
38	Perciformes	Gobiidae	**Tusked Goby**	reef	X	
39	Perciformes	Gobiidae	Yellowprow Goby	reef	X	X
40	Perciformes	**Haemulidae**	**Tomtate**	reef		X
41	Perciformes	Kyphosidae	Chub	reef	X	X
42	Perciformes	Labridae	Bluehead Wrasse	reef	X	X
43	Perciformes	Labridae	Clown Wrasse	reef	X	X
44	Perciformes	Labridae	Creole Wrasse	reef		X
45	Perciformes	Labridae	Slippery Dick	reef	X	X
46	Perciformes	Labridae	Spanish Hogfish	reef	X	X
47	Perciformes	Labridae	Spotfin Hogfish	reef	X	X
48	Perciformes	Labridae	Yellowhead Wrasse	reef	X	X
49	Perciformes	Lutjanidae	Dog Snapper	reef		X
50	Perciformes	Lutjanidae	Gray Snapper	reef	X	X
51	Perciformes	Lutjanidae	Red Snapper	reef	X	X
52	Perciformes	Lutjanidae	Vermillion Snapper	reef	X	
53	Perciformes	Malacanthidae	Sand Tilefish	reef		X
54	Perciformes	Mullidae	Spotted Goatfish	reef	X	X
55	Perciformes	Mullidae	Yellow Goatfish	reef	X	X
56	Perciformes	Pomacanthidae	Blue Angelfish	reef	X	X
57	Perciformes	Pomacanthidae	Cherubfish	reef	X	X
58	Perciformes	Pomacanthidae	French Angelfish	reef	X	X
59	Perciformes	Pomacanthidae	Queen Angelfish	reef	X	X
60	Perciformes	Pomacanthidae	Rock Beauty	reef	X	X
61	Perciformes	Pomacanthidae	Townsend Angelfish	reef	X	X
62	Perciformes	Pomacentridae	Bicolor Damselfish	reef	X	X
63	Perciformes	Pomacentridae	Blue Chromis	reef	X	X
64	Perciformes	Pomacentridae	Brown Chromis	reef	X	X
65	Perciformes	Pomacentridae	Cocoa Damselfish	reef	X	X
66	Perciformes	Pomacentridae	**Dusky Damselfish**	reef		X
67	Perciformes	Pomacentridae	Longfin Damselfish	reef		X
68	Perciformes	Pomacentridae	Purple Reeffish	reef	X	X
69	Perciformes	Pomacentridae	Sergeant Major	reef	X	X
70	Perciformes	Pomacentridae	Sunshinefish	reef	X	X
71	Perciformes	Pomacentridae	Threespot Damselfish	reef	X	X
72	Perciformes	Pomacentridae	Yellowtail Damselfish	reef		X
73	Perciformes	Pomacentridae	Yellowtail Reeffish	reef	X	X

Count	ORDER	FAMILY	SPECIES	HABITAT	24 m	18 m
74	Perciformes	Rachycentridae	Cobia (Ling)	epipelagic	X	X
75	Perciformes	Scaridae	Greenblotch Parrotfish	reef	X	X
76	Perciformes	Scaridae	Queen Parrotfish	reef		X
77	Perciformes	Scaridae	Redband parrotfish	reef	X	X
78	Perciformes	Scaridae	Stoplight Parrotfish	reef	X	X
79	Perciformes	Sciaenidae	**Cubbyu**	reef		X
80	Perciformes	Sciaenidae	**Highhat**	reef		X
81	Perciformes	Sciaenidae	Spotted Drum	reef	X	X
82	Perciformes	Scombridae	Little Tunny	epipelagic	X	X
83	Perciformes	Scombridae	King Mackeral	epipelagic	X	X
84	Perciformes	Scombridae	**Wahoo**	epipelagic		X
85	Perciformes	Serranidae	Creole-fish	reef	X	X
86	Perciformes	Serranidae	Graysby	reef	X	X
87	Perciformes	Serranidae	**Peppermint Bass**	reef		X
88	Perciformes	Serranidae	Rock Hind	reef	X	X
89	Perciformes	Serranidae	Wrasse Bass	reef	X	
90	Perciformes	Serranidae	Yellowmouth Grouper	reef	X	X
91	Perciformes	Sparidae	Knobbed Porgy	reef	X	
92	Perciformes	Sphyraenidae	Greater Barracuda	epipelagic		X
93	Perciformes	**Xiphiidae**	**sailfish ???**	epipelagic		
94	Rajiformes	Dasyatidae	Southern Stingray	reef	X	X
95	Rajiformes	**Mobulidae**	**Manta ray**	epipelagic	X	
96	Tetraodontiformes	Balistidae	Black Durgon	reef	X	X
97	Tetraodontiformes	Balistidae	Gray Triggerfish	reef	X	X
98	Tetraodontiformes	Balistidae	Orangespotted Filefish	reef	X	X
99	Tetraodontiformes	Balistidae	Scrawled Filefish	reef	X	
100	Tetraodontiformes	Balistidae	Whitespotted Filefish	reef		X
101	Tetraodontiformes	Ostraciidae	Scrawled Cowfish	reef	X	
102	Tetraodontiformes	Ostraciidae	Smooth Trunkfish	reef	X	X
103	Tetraodontiformes	Ostraciidae	Spotted Trunkfish	reef		X
104	Tetraodontiformes	Tetraodontidae	Sharpnose Puffer	reef	X	X

Appendix II

Sonnier Bank - Biological Characterization
September/October 1997

SONNIER BANK BIOLOGICAL CHARACTERIZATION

September/October 1997

Steve Gittings and Don Harper

Overview

The following narrative describes invertebrate biological assemblages on two of the eight or so peaks present on Sonnier Bank. Four dives were made by both of us, as well as our dive buddies, on the first feature on September 30, 1997, and the second feature on October 1, 1997. Observations were compiled following each dive, and collected specimens were identified to the lowest possible taxon using relevant field guides. In this report we also compare our observations to those made in 1977 by Drs. Thomas Bright and Richard Rezak and speculate on the sensitivity of existing communities to activities related to oil and gas development in the northern Gulf of Mexico.

Terminology used in this report to represent relative abundances of organisms is:

Dominant - very abundant; singly the most abundant species or among a small number of very abundant species; or species with cover levels well above most other species; likely to exert control ecologically.

Abundant - a regularly encountered species observed in high numbers, representing a high percentage of observations.

Common - encountered regularly; seen in a large portion of their preferred habitat at a survey site.

Uncommon - Sporadic observations, usually at irregular intervals; generally several observations, or a higher number at survey sites with very high overall abundances.

Rare - seldom observed, or a very small percentage of observations at a site; usually only once or twice at any given survey site.

Sonnier Bank - Peak 1

Peak 1 was the larger of the two sites visited during the trip, the area within diving depths above approximately 30 m measuring perhaps 50 m across. The summit of the feature contained numerous, rugged claystone "pinnacles" comparable to those present on Stetson Bank, with up to approximately 4 m in relief. Minimum depth was 22 m and most observations were made above 32 m.

In depressions between some pinnacles were accumulations of sediment, most of which appeared to be composed of fragments of the hydrozoan *Millepora alcicornis* (fire coral), one of the species that dominated the pinnacles.

Cover on the pinnacles was variable, but extremely high, probably above 70 percent, and was dominated by fire coral, several species of sponges (dominated by *Neofibularia nolitangere*), the brown alga *Lobophora variegata* and, on some pinnacles, sabellid worms (parchment tube worms). Different species dominated different pinnacles, though most species were present on all pinnacles. Organisms that occupied less space included coralline algae and four scleractinian coral species, all of which have been found at either Stetson Bank or Peak 2 at Sonnier Bank.

The sponge fauna on Sonnier Bank was particularly well represented, with more varieties than divers could distinguish. The touch-me-not sponge, *Neofibularia nolitangere*, was the most abundant of the group. Ircinia sp. black ball sponges were conspicuous on this feature. Numerous other species of ball, vase, and encrusting sponges were considered either common or abundant. Tube sponges and upright finger sponges were not encountered.

Some small gastropods, such as the ceriths, were abundant or common, particularly at night, when hundreds per square meter were seen in some places. As a group, however, species diversity and abundances of the larger gastopods appeared to be rather low. It is possible that, like Stetson Bank, conspicuous species have been over-harvested by souvenir collectors. Bivalves had similarly low diversity and abundance, though numerous specimens of thorny oysters (*Spondylus americanus*) were present. This species is a common target of souvenir hunters, so its presence may suggest souvenir collecting is not occurring on a large scale and that mollusc diversity and abundance are limited by other factors.

Decapod crustaceans were probably somewhat better represented than suggested in Table 1. Hermit crabs occupied many small shells on the feature, but were not identified to species. Small shrimps, particularly snapping shrimp, occupied many of the bank's crevices and holes.

With the exception of a few sea urchins and sea cucumbers, echinoderms did not appear to be an important invertebrate group. But on night dives, Ophiocoma brittle stars were conspicuous, with abundances of several per square meter, and likely play a significant role in affecting benthic community structure.

Three gas seeps were observed in the vicinity of the feature, but none could be traced to the summit. One seep was traced to within a few meters of the edge of the feature (just below a 45° slope) where it emanated from several spots within gravelly sediment at 48 m depth. At one spot, a thin mat of bacteria, presumably Beggiatoa sp., was present around a gas seep, though no other organisms appeared to be present in unusual abundances.

Sonnier Bank - Peak 2

Though it has a significantly shallower summit depth than Peak 1 (17 m), Peak 2 was a very small feature, probably measuring less than 30 m across above 30-m depth. The east side of the feature is nearly vertical between 18- and 35-m depth. The north and west sides are fairly smooth and sloped at approximately 30° angle. The south side is somewhat more rugged and the slope averages perhaps 45°.

A significant difference between this peak and Peak 1 is the lack of pinnacles on Peak 2. The summit and slopes are nearly smooth, with only a couple of low relief pinnacles (less than a meter or so in height).

Cover on the bank's summit, between 17 and 25 m, was visually estimated to be dominated by *Lobophora variegata* (20%), *Neofibularia nolitangere* (15%), *Millepora alcicornis* (15%), an unidentified ridged sponge not seen on Peak 1 (5%), and Ircinia sp. (5%). Unlike Peak 1, sabellid worms were not dominant space competitors on this feature. Coralline algae crusts were more conspicuous on Peak 2, though cover was not estimated.

The sponge fauna was, in most respects, comparable to that on Peak 1. Neofibularia and Ircinia were the most conspicuous. One significant difference in the sponge fauna of the two peaks was the presence of an unidentified sponge with widely spaced low, flat-topped ridges that occupies a substantial amount of the bottom on the summit of Peak 2.

Though not important as space competitors, a surprising number of coral species were found on this small feature (Table 1). Ten species were encountered (equal to Stetson Bank), compared with four on Peak 1, though five were represented only as single colonies. The hydrozoan *Millepora alcicornis* is, by far, the dominant coral species. *M. alcicornis*, *Madracis decactis*, *Stephanocoenia intersepta,* and *Siderastrea radians* are the most commonly encountered scleractinians on all these features.

On Peak 2, thickets composed of *M. decactis*, *M. mirabilis*, *M. pharensis*, and associated sponges and other species occurred on the east-facing vertical wall. The thickets were not as well developed as those on two large pinnacles at Stetson Bank, but were of a similar nature. Observations of broken formations suggest that their development is likely limited by their tendency to break free as they grow and fall down the vertical wall.

The presence of single colonies of the antipatharians Cirrhipathes and Antipathes on Peak 2 at around 30 m was surprising. These are generally considered deepwater corals, usually found below 50 m on other banks in the northern Gulf of Mexico. Both were found on the vertical side of an east-facing wall, where the light levels may be comparable to that of deeper water habitats on this and other banks.

Bare substrate on Peak 2 was estimated at 20 percent. Some of the bare substrate had been evidently previously covered by fire coral and other encrusting species, but had recently been laid bare by slumping of the crusts. This was particularly evident on the vertical east wall of the feature, where slumping was clearly a factor in making space available for recruitment.

Mollusc diversity and abundance were not substantially different from Peak 1. The dominant gastropods were ceriths, many of which were inhabited by hermit crabs. A smaller number of cowries, thorny oysters, ark shells, and pen shells were also observed on both peaks.

Among the crustaceans, spiny lobsters seemed particulary abundant on Peak 2. During the night dive, one diver saw three individuals in less than 20 minutes; one lobster had a body length of over 50 cm.

Ophiocoma brittle stars were abundant during the night dive on Peak 2, though they retreated as soon as they sensed dive or video lights. Sea urchins, particularly *Diadema antillarum*, appeared to be more abundant on Peak 2, as did one unidentified species of sea cucumber. As many as five sea cucumbers were counted in a single square meter area on the feature.

Productivity - Benthic, Water Column, and Fish

These small features had surprisingly high benthic productivity as evidenced by high percent cover, well-developed communities of motile invertebrates and, based on previous observations, high turnover of ephemeral algae communities. Planktonic productivity also appeared to be high, with an abundance of pelagic tunicates and cnidarians.

The banks also had extremely dense and diverse fish communities. Numbering over 100 species, the fish fauna was represented by species from a variety of trophic guilds, including planktivores, invertivores, herbivores, carnivores, and omnivores. Numerically dominant species included creole fish (planktivores) and several jack species (carnivores). Like Stetson Bank, angelfish species appeared be unusually large. This is perhaps because of the abundance of sponges on the banks, a preferred food item of some of these fish.

Comparison to 1970's

The description provided by Drs. Thomas Bright and Richard Rezak for the features they surveyed by submersible on Sonnier Bank in 1977 (Bright and Rezak, 1979) could easily be the description provided in 1997. Bright and Rezak described the features as being "almost entirely encrusted with fire coral (Millepora sp.) and sponges (*Neofibularia nolitangere* and Ircinia sp.)," a community they referred to as a Millepora-Sponge Zone. They also noted that fire coral "contributes significantly to the sediment which is produced on the bank," and that "populations of fishes and conspicuous, mobile invertebrates are diverse and abundant above 45 m and are very comparable to populations on Stetson Bank." Like Bright and Rezak, we observed "moderate" abundances of coralline algae above 40 m (Rezak et al., 1985), and that "the abundance of Millepora, sponges, coralline algae, and most of the other encrusting epifauna is greatly reduced below 40 m depth."

Nearly all species shown on Bright and Rezak's cross section of Sonnier Bank were encountered by divers on the two features surveyed in 1997. In addition, numerous coral and other species not encountered by Bright and Rezak were found. This may be attributable to recruitment over the last 20 years or a difference in survey techniques (i.e., submersible vs. divers).

Bright and Rezak suggested that "Sonnier Banks appear to be very healthy at present, and there is no evidence of past mass mortalities or large scale deleterious environmental effects attributable to any cause," even though numerous exploratory wells had been drilled within several miles of the banks. With the possible exception of the mass mortality of the long spined sea urchin *Diadema antillarum* in the mid-1980's, an event experienced by nearly all reefs and banks in the western Atlantic, the present survey leads us to conclude that the banks are in virtually in the same condition.

Environmental Sensitivity

Bright and Rezak recommended that, because of the similarity in structure, environment and biota, Sonnier and Stetson Banks should be classed together in terms of measures to be taken to protect them from the possible effects of oil and gas activities. The recommendations for shunting discharges to a distance no greater than 10 m above the bottom outside a "No-Activity" Zone were based on the fact that the dominant fauna of Stetson and Sonnier Banks are invertebrates that either filter seawater or could be smothered by high sediment loads in the water column. Shunting was thought to reduce the potential for impact by transporting discharges to a depth within the already turbid nepheloid layer surrounding uplifted seabed features.

Existing populations and community structure on Sonnier Bank are similar to those found by Bright and Rezak in the 1970's. Furthermore, their present condition suggests that oil and gas operations since that time have had no impact on the banks, perhaps because of stipulations that control discharges near the banks. These findings, along with research conducted in the past 20 years on the effects of sedimentation on benthic filter feeders and suspension feeders, suggest that the recommendations regarding operational controls for oil and gas should remain in place for these banks.

Literature Cited

Bright, T.J. and R. Rezak. 1979. Northwestern Gulf of Mexico topographic features study. Executive Summary of Report to U.S. Dept. of the Interior, Bureau of Land Management, Outer Continental Shelf Office, New Orleans, LA. Contract No. AA550-CT7-15.

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, New York, 259 pp.

Table 1. Observations made by divers on at Stetson and Sonnier Banks in September and October 1997.

Relative abundance codes are: D=Dominant, A=Abundant, C=Common, U=Uncommon, R=Rare, X=Present, ?=Uncertain, -=No observations.				*Note: Observations for Stetson Bank were made by two divers on three dives and are not intended to provide a comprehensive biological community description.
	Stetson*	Sonnier	Sonnier	
	16m	22m (Peak 1)	17m (Peak 2)	
MONERA				
Beggiatoa sp		X	?	Diffuse mat at seep
PROTOZOA				
Foraminifera				"None seen, but prob. present"
Noctiluca scintillans?				Phosphorescence at night
PORIFERA				
Neofibularia nolitangere (Touch-me-not sponge)	D	D	D	
Agelas clathrodes (Elephant ear sponge)	C	C	C	
Grooved sponge (flat-topped ridges)	-	-	A	
Plakortis angulospiculatus? (Viscous sponge)	D	-	-	
Ircinia sp. (Black ball sponge)	?	A	A	
Spheciospongia vesparium? (Loggerhead sponge)	C	C	C	
"Blue sponge with large oscula, yellow interior"	C	C	C	
Xestospongia muta (Vase sponge)	U	C	C	
Gray fist sponge	?	C	C	
Large white sponge	-	-	U	
Purple encrusting finger sponge	C	C	C	

CNIDARIA				
Hydrozoa				
Millepora alcicornis (Fire coral)	D	D	D	Band at 32 m
Plumularia type hydroid	-	C	-	
Scyphozoa				
Aurelia aurita (Moon jelly)	C	C	C	
Unknown medusa	R	-	-	
Anthozoa				
Madracis decactis (Knobby finger coral)	C	U	C	
Madracis mirabilis (Yellow pencil coral)	-	-	U	
Madracis pharensis (Star coral)	R	-	U	
Madracis asperula	R	-	-	
Oculina diffusa (Ivory bush coral)	R	-	-	
Siderastrea radians (Lesser starlet coral)	C	U	C	
Stephanocoenia intersepta (Blushing star coral)	C	C	C	
Diploria strigosa (Brain coral)	U	R	-	
Montastraea cavernosa (Cavernous star coral)	R	-	R	
Meandrina meandrites? (Maze coral)	R	-	-	
Agaricia fragilis (Fragile saucer coral)	U	-	R	
Cladocora? sp. (Tube coral)	-	-	R	18 m
Cirrhipathes sp. (Bedspring seawhip) leutkeni	-	-	R	30 m
Antipathes sp. (Bushy black coral)	-	-	R	32 m
Ctenophora				
Euplakamis sp. (Sea gooseberry)	C	-	-	
Folia cf. parallela (Small Venus' girdle)	R	-	R	
Ocyropsis crystallina (Winged comb jelly)	U	U	U	
Beroe ovate (flattened helmet comb jelly)	?	R	-	

MOLLUSCA				
Gastropoda				
Astraea americana (American star shell)	C	C	C	
Cypraea spurca (Yellow cowry)	-	R	?	
Cypraea cervus (Atlantic deer cowry)	X	R	R	
Cymatium vespaceum (Hairy triton)	-	-	U	
Fucinus eucosmius (Ornamented spindle)	-	-	U	
Conus sp. (Cone)	-	-	R	
Cerithium litteratum (Stocky cerith)	A	A	A	Many shells inhab. by hermits
Cerithium algicola (Middle-spired cerith)	?	C	C	
Strombus gigas (Queen conch)	R	-	-	
Strombus pugilis (Fighting conch)	R	-	-	
Bivalvia				
Spondylus americanus (American thorny oyster)	C	C	C	
Barbatia candida (White-bearded ark)	?	R	-	
Lyropecten nodosus (Lion's paw)	R	R	-	
Anadara sp. (Ark)	U	U	U	
Papyridea soleniformes (Spiny paper cockle)	-	-	R	
Pinna sp. or *Atrina* sp. (Pen shell)	?	R	R	
Lima scabra (Rough Lima)	X	-	R	
Dendostrea frons (Frond oyster)	-	-	R	
Cephalopoda				
Octopus?	X	-	R	In plankton
ANNELIDA				
Polychaeta				
Spirobranchus giganteus (Christmas tree worm)	C	C	C	

Hermodice carunculata (Bearded fireworm)	C	U	A	Crepuscular
Sabellidae (Parchment tubes worms)	C	A	C	
Haplosyllis sp. (sponge worms)	?	-	A	
ARTHROPODA				
Decapoda				
Cleaning shrimp	R	R	R	
Stenopus hispidus (Banded coral shrimp)	?	-	R	
Hermit - striped leg	-	C	C	
Hermit - red w/white claw				
Stenorhynchus seticornis (Arrow crab)	U	U	U	
Dromid with sponge	U	U	U	
Majidae	X	R	-	
Calappa sp.	?	R	-	
Scyllaridae (Slipper lobster)	-	-	R	
Panulirus argus (Spiny lobster)	U	U	C	
ECHINODERMATA				
Ophiuroidea				
Ophiocoma sp. (brown spiny)	A	C	A	At night
Red brittle star	-	-	R	
Echinoidea				
Diadema antillarum (Black long-spined)	A	R	A	
Eucidaris tribuloides (pencil urchin)	A	R	U	
Echinometra lucunter (Rock boring urchin)	C	R	R	
Holothuroidea				
Isostichopus badionotus (Three rowed sea cucumber)	C	U	-	
Unknown holothurian	-	-	A	more seen at night

CHORDATA				
Urochordata				
Colonial pelagic tunicates	A	A	A	
Solitary pelagic tunicates	A	A	A	
PHAEOPHYTA				
Padina sp. (Leafy brown alga)	A	-	-	
Dictyota sp. (Leafy brown alga)	A	-	-	
Lophophora variegata	A	A	A	especially on east side
RHODOPHYTA				
Lithothamnion sp. (Pink coralline alga)	?	C	A	

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

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

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

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

Minerals Management Service
Gulf of Mexico OCS Region

U.S. Department of the Interior
1849•1999

Managing America's offshore energy resources

Protecting America's coastal and marine environments