SESSION 1C

DEEPWATER MARITIME SITES: A NEW CHALLENGE FOR ARCHAEOLOGY UNDERWATER

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INTRODUCTION

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This session focuses on two facets of archaeology underwater: the discovery and management of resources underwater. The discovery process can be either accidental or the result of exhaustive research and planning with hypotheses formulated and tested via rigorous application of the scientific method during survey and fieldwork. Once archeological resources are found, managing and protecting these underwater resources can be a significant challenge. Two papers in this session focus on the accidental discovery process. The authors address some of the management challenges and provide insight on the resource management strategies of these two deepwater shipwrecks sites. Other papers in this session look at remote-sensing instrumentation as a tool for both refining archaeological sites and for marine prehistoric and historic maritime model building.

Richard (Rik) J. Anuskiewicz was awarded his B.A. in 1972 and his M.A. in 1974 in anthropology, with specialization is archaeology from California State University at Hayward. Rik was employed with the U.S. Army Corps of Engineer Districts of San Francisco, Savannah, and New England Division from 1974 to 1984, as a terrestrial and underwater archaeologist. In 1980 he began work on his doctorate. In 1984 he accepted his present position with Department of the Interior, Minerals Management Service, Gulf of Mexico Region as a marine archaeologist. Rik received his Ph.D. in 1989 in anthropology, with specialization in marine remote-sensing and archaeology from the University of Tennessee at Knoxville. Rik's current research interest is focused on using remote-sensing instrumentation as a tool for middle-range theory building through the correlation of instrumental signatures to specific observable archaeological indices.

DISCOVERY AND MANAGEMENT OF A DEEPWATER HISTORIC SHIPWRECK IN THE GULF OF MEXICO

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INTRODUCTION

In February 2001, archaeologists with the Minerals Management Service, Gulf of Mexico Region, were notified of the accidental discovery of a wooden-hulled, copper-sheathed shipwreck lying in approximately 2,650 feet of water. The vessel, believed to be from the late eighteenth or early nineteenth century, had been discovered during a post-lay survey for a newly installed 8-inch pipeline by ExxonMobil. This was a groundbreaking discovery in many ways. It was the first opportunity we have had to study in detail a 200-year old wooden hulled shipwreck in over a half a mile of water in the Gulf. The discovery also afforded a chance to review the effectiveness of our program with respect to protecting archaeological resources (Anuskiewicz *et al.* 2001)

Although no archaeological assessment was required for this pipeline, a hazard survey was conducted. However, a review of the remote sensing data prior to construction did not identify any potential hazards in this area. One question that is continuously asked is “how could this happen?” That was exactly MMS’s question as well, and we believe we have a reasonable answer. Both the pipeline route and deep-tow side-scan used for the survey contributed to the problem. The pipeline route was predetermined taking into consideration engineering constraints, physical geography and geology, and the surrounding underwater environment to select a safe pipeline route. At this particular water depth the requirement for a magnetometer survey, one of the two standard remote sensing tools used for identifying shipwrecks, is typically waived. The side-scan sonar, then, became the primary instrument for possible shipwreck identification. Since the side-scan sonar instrument scans out at a slight angle when surveying and the survey line just happened to pass directly over the center of the wreck, the only image that appeared on the data was an anomalous smudge in the center of the sonar record, as indicated in the figure below (Figure 1C.1).

An even smaller image appeared at the extreme edge of the sonar record on an adjacent survey line. Again, this area of the Gulf did not require an archaeological assessment and no shipwrecks were known to have wrecked in the area. The main problem then, was that the survey lane spacing and the instrument setting were such that they allowed a blind spot directly below the acoustic sensor. The smudge that appeared was simply evaluated as not being a hazard to pipeline construction. Once the pipeline was in place, the survey company ran an ROV (Remotely Operated Vehicle) across the pipeline route to ensure proper installation. It was at this point that the historic shipwreck was discovered lying some 2,650 feet below the surface.

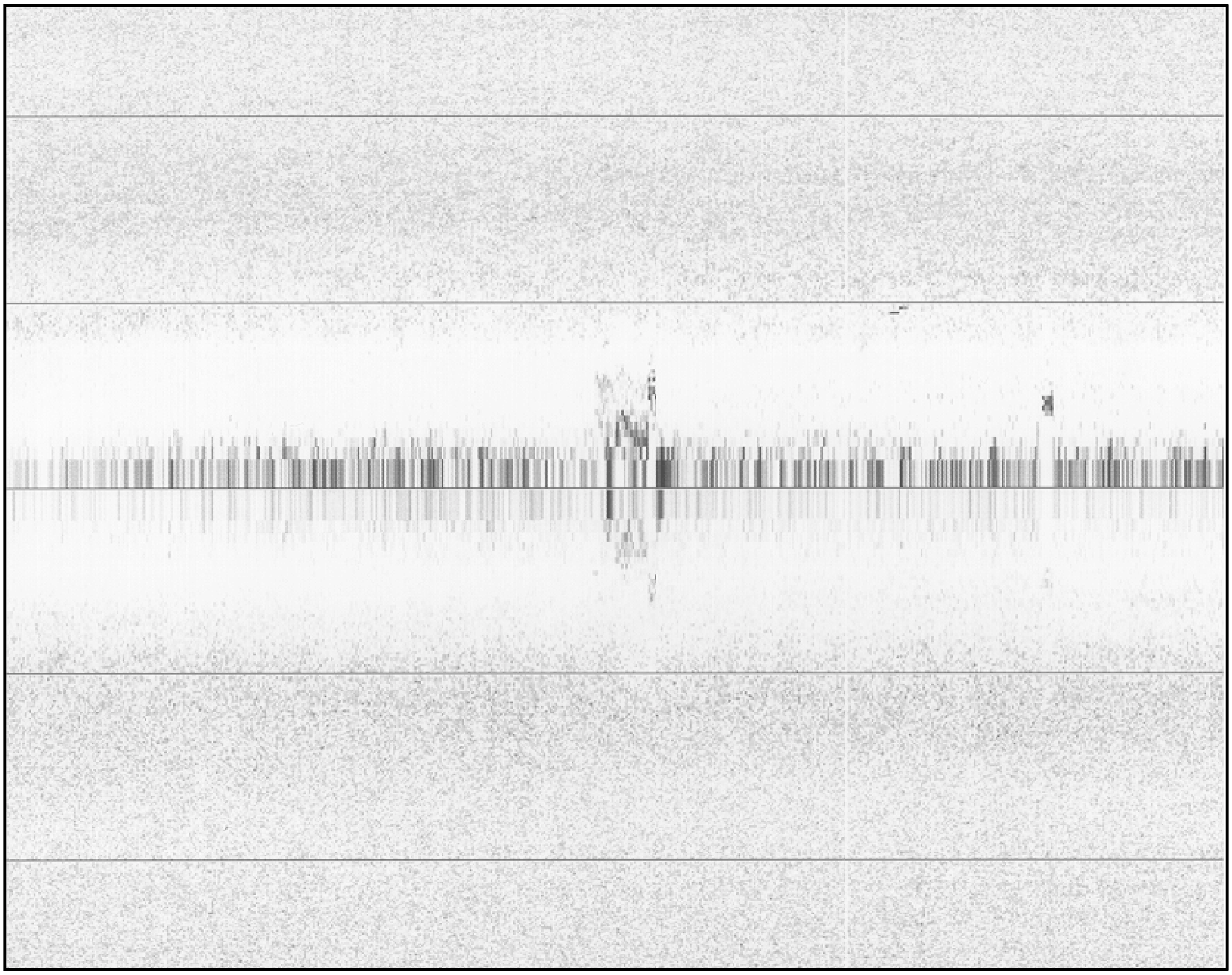

Figure 1C.1 Sonar image of shipwreck.

INITIAL INVESTIGATION

After notifying MMS archaeologists, ExxonMobil agreed to send the MMS GOMR Marine Archaeologists out to the site to direct a preliminary ROV investigation of the wreck in an attempt to determine what this vessel might have been. A total of about six hours of videotape was collected and reviewed by the archaeologists (Figure 1C.2).

The remains of the vessel are approximately 60-65 feet from bow to sternpost. It is approximately 20-25 feet wide. Most of the inner works of the ship are gone, but there is about six feet of relief at the bow and about nine feet at the stern. As it sits on the seafloor, all that remains appears to be a shell of the hull from the area below the waterline. The inside of the vessel is filled with sediment and may yet contain several diagnostic artifacts that can possibly help us determine its name, age, and perhaps even points of origin and destination. However, very few artifacts were visible in the video survey.

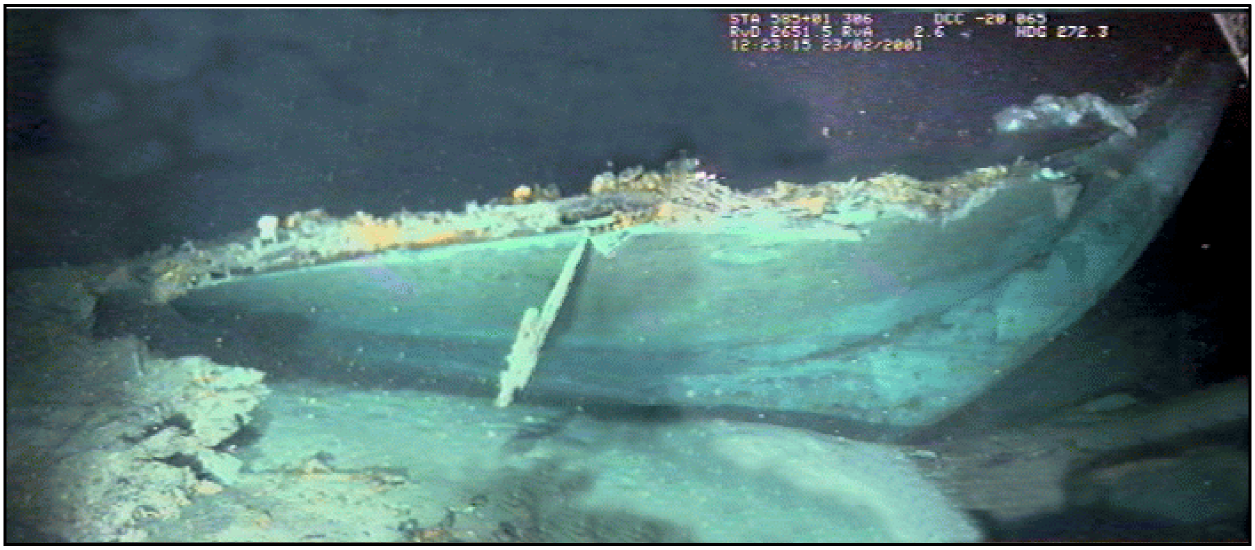

Figure 1C.2. Composite image of starboard bow section of the shipwreck.

During our preliminary investigation, two artifacts were removed from the vessel in an attempt to identify its age. The first artifact removed (Figure 1C.3) was recovered from the port side bow section of the vessel, prior to MMS notification. It was a lead tube approximately 45-cm long, 15-cm

Figure 1C.3. Hawsepipe, recovered from bow of vessel.

in diameter, 2-cm thick and weighed about 6.8 kilograms (15 lbs.). Initially we thought the lead artifact might have been part of the bilge pump system or perhaps one of the decking scuppers used to drain water from the decks. After further research, we now believe this artifact is a hawsepipe. A hawsepipe is an inclined tube which leads from the main deck to the outside of the vessel. An anchor cable or rope is passed through the hawsepipe holding the anchor. We believe the hawsepipe was subjected to the heat of a fire because of the folding of what would have been the interior end of the pipe (Anuskiewicz *et al.* 2002).

Trying to avoid as much disturbance to the shipwreck as possible, but also wanting to get an estimate as to the age of the vessel, we decided to recover one other artifact from the site: one of the loose pieces of sheathing that had fallen away from the vessel along its port side. Sheathing on historic vessels was an expensive undertaking, implemented as an anti-fouling method to keep marine growth and wood-boring organisms from weakening the wooden hull. It is known that pure copper was used from the mid 1700s through the mid 1800s. It is also known that a copper alloy, known as Muntz metal, replaced pure copper. Therefore, by obtaining a sample of the sheathing and having it assayed, we could narrow down the time period of this vessel. The sample that was collected turned out to be pure copper, which therefore gives us a date range of mid eighteenth to early nineteenth century. The sheathing also had a few pieces of wood planking fastened to it with small copper nails. The wood planking, which was approximately ½ inch thick, leads to an interesting hypothesis. Wood planking on vessels of this time period would typically have been oak, several inches thick. Therefore, we believe that the wood planking was most likely attached to the vessel as sacrificial planking (Stem to Stern 2002:5), prior to the copper sheathing. We sent the wood to two separate labs for sourcing and almost identical results came back to us. The wood was classified as white pine (*Pinus strobus*) which is native to the northeastern United States and Canada. The wood sample also showed evidence of charring, which leads us to believe that there was a fire on the vessel, which most likely led to its sinking.

MANAGEMENT OPTIONS

Since it was clear that we were dealing with an historic shipwreck, our next task was to determine an appropriate management strategy that best protected the resource. The four options we developed were as follows:

1. Lift and re-route the pipeline around the wreck
2. Construct a sandbag bridge over the wreck
3. Cut and re-route pipeline around the wreck
4. Leave in-place, conduct a limited data recovery program

After we collected available deepwater engineering data and cost figures for all four options it became obvious that, due to the extreme depth of this wreck, the most feasible option was a data recovery program, option 4. We therefore developed a research design incorporating a data recovery program that would contract for the use of a suitable ROV or submersible to excavate a representative portion of the interior of the wreck, recover a limited number of diagnostic artifacts, excavate up to 15 test units outside the wreck to determine if a scattering of artifacts exists outside the wreck, and obtain high quality video and digital images.

Funding for the project was supplied by the pipeline operator under the Moss-Bennett Act, which permits government agencies to accept private funds for the purpose of conducting archaeological salvage. The MMS subsequently entered into a cooperative agreement with Texas A&M University's Department of Oceanography and the Institute of Nautical Archaeology to perform this study, which is expected to be carried out sometime during summer 2002.

REFERENCES

Anuskiewicz, Richard J., Jack B. Irion and David A. Ball. 2001. Discovery and Management of a Deepwater Historic Shipwreck. Paper presented at the First Annual Underwater Archaeology Conference held in conjunction with The Florida Anthropological Society's Annual Meeting. St. Augustine, Florida.

Anuskiewicz, Richard J., Jack B. Irion, and David A. Ball. 2002. Discovery and Management of a Deepwater Shipwreck in the Gulf of Mexico. Paper presented the Society for Historical Archaeological Conference. Mobile, Alabama.

Stem to Stern Publication. 2002. Summer Field School Investigations Undocumented Ship Site in Edenton. Maritime Studies Program, East Carolina University. 17:5. Greenville, North Carolina.

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Dave Ball received his Bachelor of Arts degree in anthropology from Sonoma State University in 1992 and his Master of Arts degree, which focused on marine archaeology, from Florida State University in 1998. He has conducted fieldwork in archaeology for over 10 years and has directed field research on both land and underwater archaeological sites from Florida to Washington State. Some of the more notable sites that Dave has worked on include an inundated prehistoric site at Little Salt Spring, Florida, dating back about 10,000 years; a 1533 Spanish shipwreck in the Dry Tortugas; a Confederate Ironclad shipwreck in Mobile Bay, Alabama; and the 1686 French shipwreck *la Belle*, which wrecked in Matagorda Bay, Texas. Dave has been employed with the MMS as a Marine Archaeologist since October 1999.

Dr. Jack B. Irion received his doctorate in archaeology from The University of Texas in 1990. He has over 27 years' experience in underwater archaeology and has participated in or directed archaeological expeditions in England, Mexico, Belize, Turkey, Italy, Puerto Rico, and throughout the United States. Prior to joining the MMS in 1995, Dr. Irion served as a private consulting marine archaeologist working under contract to both private industry and state and federal agencies. His work has resulted in the discovery and documentation of numerous historic sites and shipwrecks, including the Confederate Harbor Obstructions in Mobile Bay and the wreck of the steamship *Columbus* in Chesapeake Bay. Since joining the MMS, Dr. Irion has directed the Seafloor Monitoring Team, composed of a group of diver/scientists with the MMS, in the documentation of several historic shipwrecks on the Outer Continental Shelf. These have included the Civil War gunboat U.S.S. *Hatteras* and the 19th century coastal steamers *New York* and *Josephine*, the latter of which was added to the National Register of Historic Places in 2000. In his free time, Dr. Irion also works as a volunteer diver with the Audubon Aquarium of the Americas.

REFINING AND REVISING THE GULF OF MEXICO OUTER CONTINENTAL SHELF REGION HIGH PROBABILITY MODEL FOR HISTORIC SHIPWRECKS

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Coastal Environments, Inc.

Mr. Stephen R. James, Jr.
Panamerican Consultants, Inc.

For over 25 years, the Minerals Management Service has required cultural resources assessments for federal oil and gas leases in the northern Gulf of Mexico Region or GOMR (Figure 1C.4). These assessments reflect the obligations of the MMS relative to the identification, protection and management of prehistoric and historic properties on federal lands in this area. Over this time, the MMS has funded several studies to collect data on the cultural resources of the northern Gulf of Mexico (GOM) to aid in their effective management. The results of these studies have been used to develop survey guidelines, equipment requirements, and analytical procedures deemed most appropriate for identifying submerged and/or buried cultural resources. Two of these studies have dealt specifically with historic shipwrecks in the GOM; they have resulted in lists of wrecks and statements about their distributions and preservation potential. In June of 2000, MMS awarded a contract to Panamerican Consultants to refine and revise the work of the previous studies on historic shipwrecks in order to enhance their management. Coastal Environments, Inc., of Baton Rouge, is participating with Panamerican in this study.

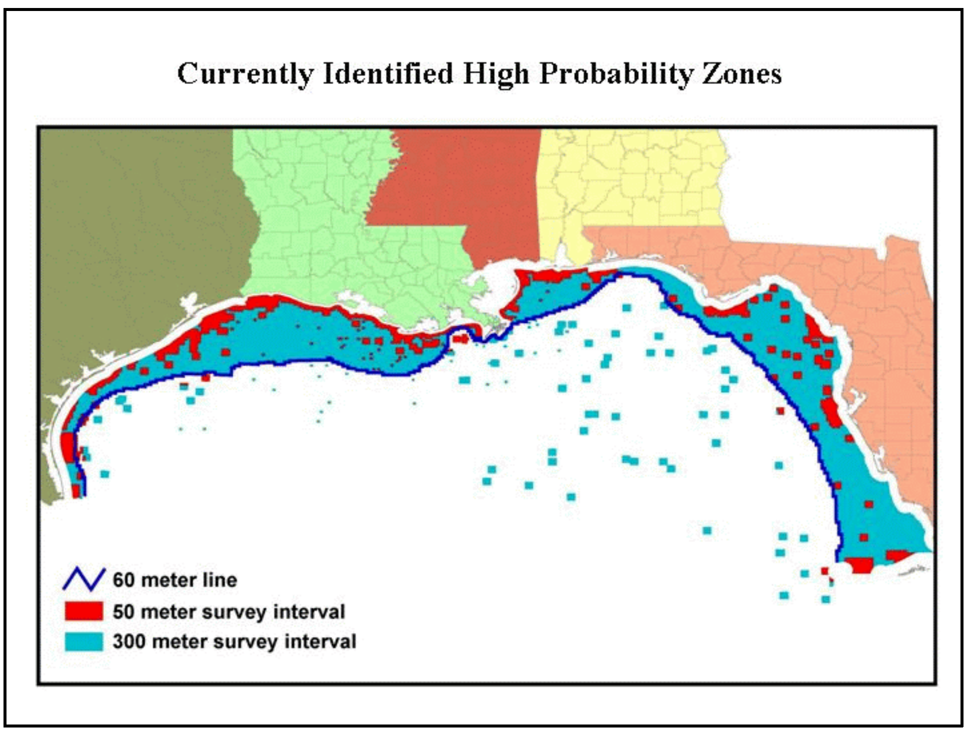

Figure 1C.4. Currently identified high probability zones.

This study has involved several tasks. (Figure 1C.5) One is the reevaluation and expansion of previously collected data on shipwrecks. Another is the correlation of these shipwreck data with other sorts of data on submerged objects from the GOM, such as reported snag and hang data. This second task involved diving on selected offshore targets to determine their identity. The third task focuses on using current offshore survey approaches via a magnetometer survey at selected target locations with differing equipment and survey strategies. The final task is the synthesis and consolidation of all of the collected information into a report for the MMS. Coastal Environments has been involved principally in Tasks 1 and 2, the reevaluation of shipwreck data and correlation with other data sets.

TASKS

1. **Archival Data Collection**
2. **Correlate Collected Data on Shipwreck Locations with Lease Block Survey Data, Reported Hang Locations, Etc.**
3. **Compare Marine Magnetometer Technologies and Survey Line Spacing**
4. **Synthesize Collected Data:**
    - **Develop Predictive Model from Shipwreck Data**
    - **Assess Results of Magnetometer Survey Tests**

Figure 1C.5. Tasks.

At the outset, we decided to gather all of the collected information on wrecks and other offshore objects into an electronic data base and to incorporate it into a Geographic Information System (Figure 1C.6) to make the information accessible to MMS personnel involved in cultural resources management. The database we are using is Access, and an example of a page of the 3-page entry form is shown here. The GIS system is ArcView.

The data on shipwrecks, objects, and hangs came from a variety of sources. We used MMS data, including wreck information from the two earlier studies, data from offshore lease block surveys, and snag data from the government's fisherman compensation fund. We also used data from the U.S. Coast Guard, NOAA, the National Imagery and Mapping Agency, U.S. Fish and Wildlife Service, and similar agencies from each of the Gulf states. We obtained hang and obstruction data from Texas A&M University and the Louisiana Department of Natural Resources. One of our advantages over previous studies is that many of these data sets are now in digital format. In addition, we examined the records at all of the state archaeologist's offices of the Gulf states to collect information on offshore remote-sensing surveys or shipwreck work previously done. Most of these studies dealt with state waters, but often they provide information on losses in federal waters. We also examined pertinent publications dealing with shipwrecks, including historical and

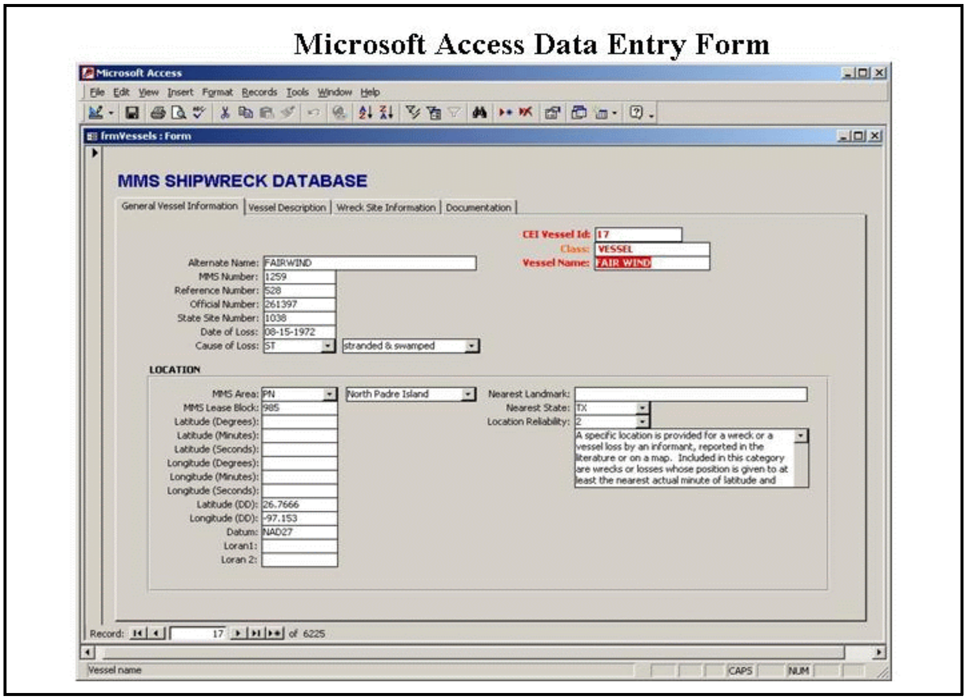

Figure 1C.6. Microsoft Access data entry form.

archaeological works. Some of the sports divers publications proved to be particularly useful for obtaining information on wrecks in offshore Florida, Alabama and Mississippi. Figure 1C.7 shows all of the reported and identified wrecks in the study area derived from these sources.

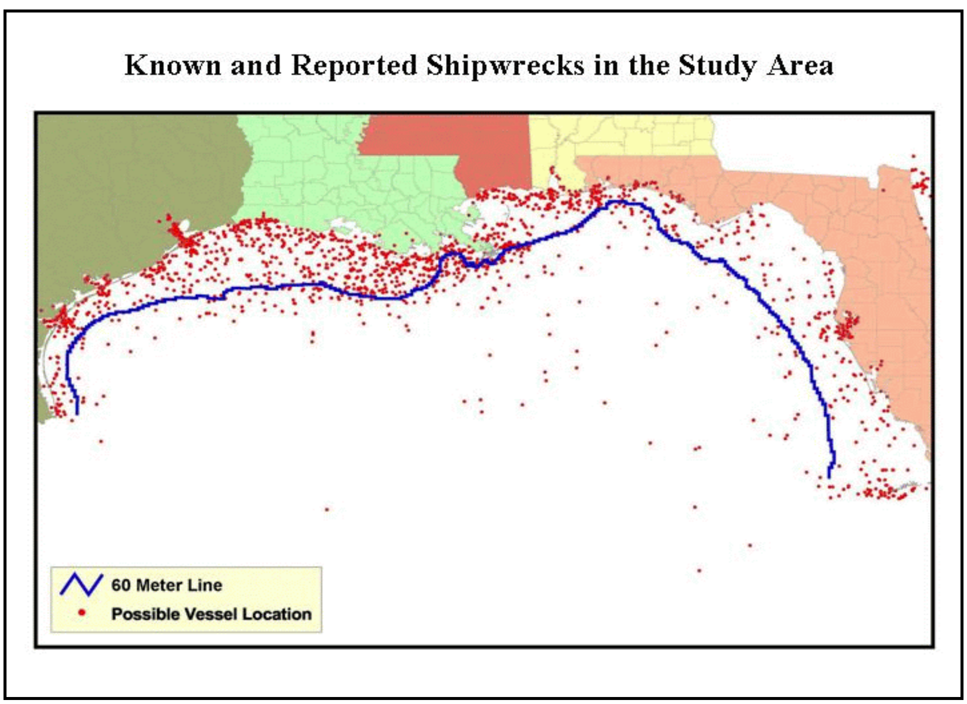

Figure 1C.7. Known and reported shipwrecks in the study area.

Many of the shipwreck data sets now available are in digital form. However, these data sets do have problems. There are numerous errors, duplications, and inaccuracies within these sets; some, but not all of which, can be resolved. One of the principal difficulties with these data sets relates to the reliability of the location of loss information provided. Some of the data sets do include evaluations of the reliability of the positions provided, but many do not. Additionally, reliability assessments vary across data sets and reliability assessments change over time. This forced us to go back to original wreck reports where they were available. Among the most useful of these proved to be the lists of Merchant Vessels of the United States, published by various agencies since the late nineteenth century. In referring to these lists we found numerous instances where the original wreck report contained imprecise information on the position of loss that had miraculously become very precise in recent data bases. Typical examples would be where a vessel might have originally been reported lost “about 50 miles east of Main Pass,” or even more vague “75 miles off Mobile,” with no direction at all given. These locations have been converted into geographic coordinates and, over time, incorporated into various wreck lists and databases where locations are often given to the nearest tenth of a second. It is obvious that developing statements about historic wreck occurrences and distributions using this type of information is fraught with difficulties. Of course, these problems are most prevalent with older wrecks, but even on recent losses, the reliability of the position of sinking can be poor. To address this problem, we have assigned locational reliability assessments to wrecks in the database, with reliabilities ranging from 1, very precise, to 4, very vague.

At present our data set of wrecks and objects includes 6,223 entries. This number does not include over 7,000 reported snag, well site locations, and the like, that we are including in the data sets we are examining. Of these entries, 3,260 are classified as vessels identified from the various sources used. This number is an increase of about 2,000 over the number of offshore wrecks given in the MMS list of wrecks developed in 1987. This increase is due to some losses since that date, but more so to the incorporation of many unidentified vessels from offshore survey work and various databases not used in the earlier study. Of these 3,260 wrecks, only 276 have been assigned a location reliability factor of 1 and 985 a factor of 2 (Figure 1C.8). These 1,261 wrecks constitute about 38% of the total and represent those that we feel are most useful in making statements about patterns of wreck distribution, except in the very broadest sense.

The distribution of known and reported wrecks in an area of offshore Louisiana and Texas is shown in Figure 1C.9 to give some idea of the type of information provided in ArcView. As can be seen, and as expected, the density of wrecks is highest in inshore Federal waters, generally corresponding to the high probability areas now identified by the MMS. Some wrecks in state waters are shown here, although our concern is only with those in federal waters. Moreover, some of the positions of the wrecks shown here in state waters are so unreliable that we are not sure whether they actually fall in state or in federal waters. These will be maintained in the final data set. Figure 1C.10 shows the same area that includes only those wrecks given location probabilities of 1 and 2. As mentioned, these are those that we feel can most reliably be used to make statements about vessel distributions and occurrences.

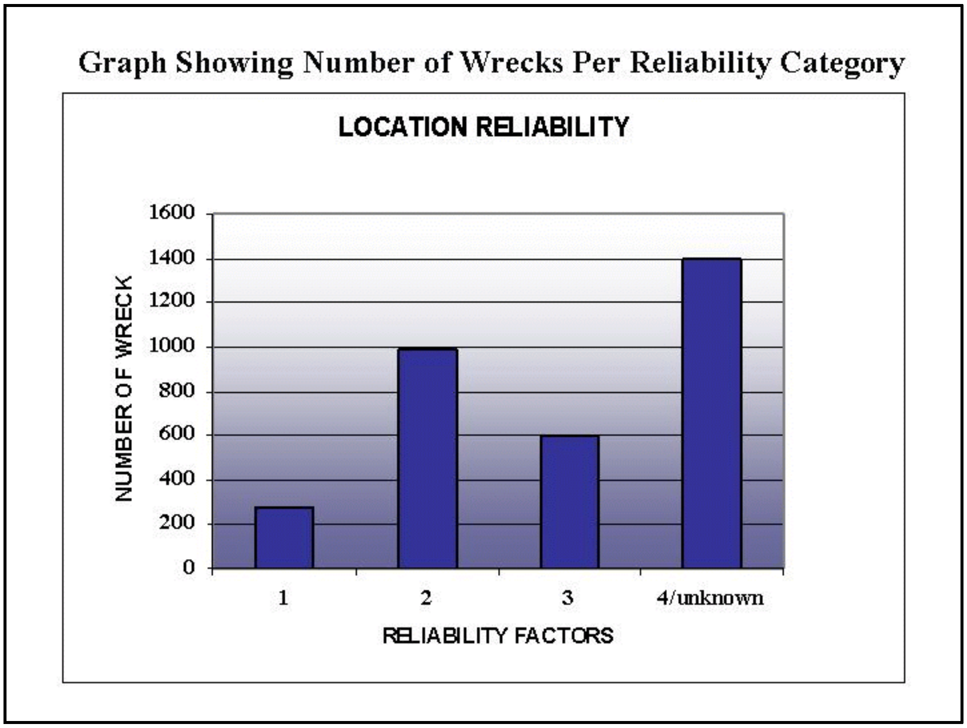

Figure 1C.8. Number of wrecks per reliability category.

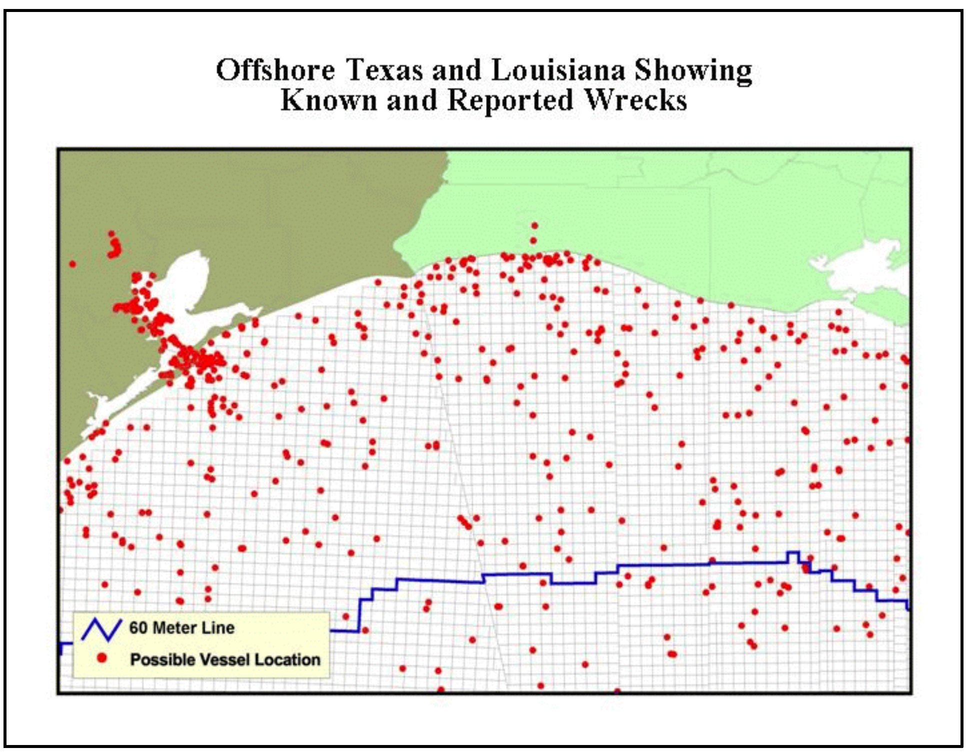

Figure 1C.9. Offshore Texas and Louisiana showing known and reported wrecks.

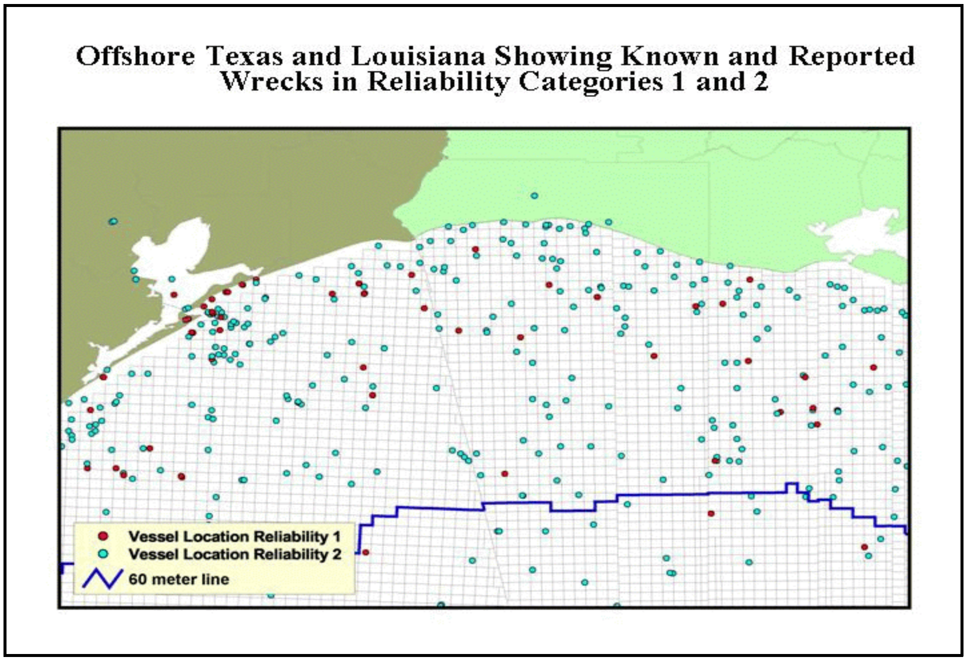

Figure 1C.10. Offshore Texas and Louisiana showing known and reported wrecks in reliability categories 1 and 2.

One of the objectives of this study was to assess reported hang locations with reported wreck locations to see if correlations exist, the assumption being that many of the reported net snaggings have caught exposed wreckage, based on findings at the small number of historic wrecks now known in the GOM. Figure 1C.11 shows a smaller area of offshore Louisiana with reported wrecks

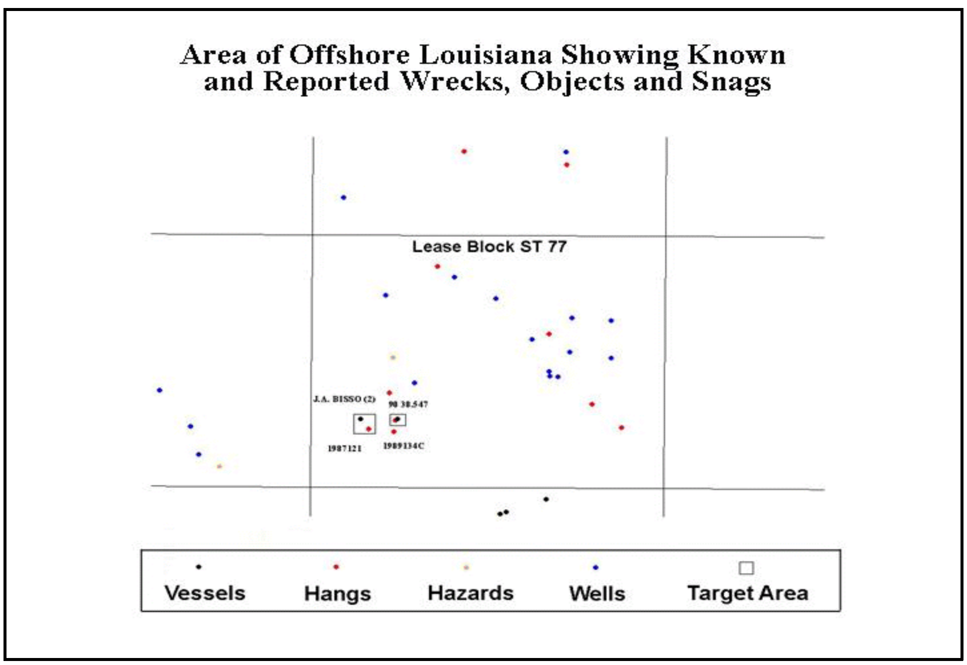

Figure 1C.11. Areas of offshore Louisiana showing known and reported wrecks, objects and snags.

and reported hangs shown. As can be seen, there are clusters of snags around some reported vessel loss locations and there are, also, clusters of hangs by themselves. The question is, do these clusters of hangs constitute undiscovered shipwrecks? One of the objectives of the diving operations was to examine this question.

We are still assessing the collected wreck data and have no final conclusions. The collected data add to our understanding of the occurrence, distribution, and preservation of shipwrecks in the GOM, but, also reveal a number of shortcomings that need to be considered and addressed. Of particular importance is the demonstration that GIS systems like ArcView can provide MMS personnel with a powerful and useful tool for managing these shipwreck resources.

The second phase of Task 2 was to conduct diving on approximately 20 targets identified in the hang and obstruction data to determine if hangs correlated with or represented shipwrecks. Twenty targets or target areas were chosen for selection for survey and subsequent diver investigation, this map showing their lease block locations (Figure 1C.12). All targets situated in less than 100 feet of water chosen for further investigation had the following characteristics:

- Group of hangs which correlated spatially with unidentified objects noted during previous hazard surveys.
- Group of hangs which correlated spatially with a reported wreck location.
- Group of hangs which correlated spatially with only themselves, the cluster suggesting the presence of an object. And/or

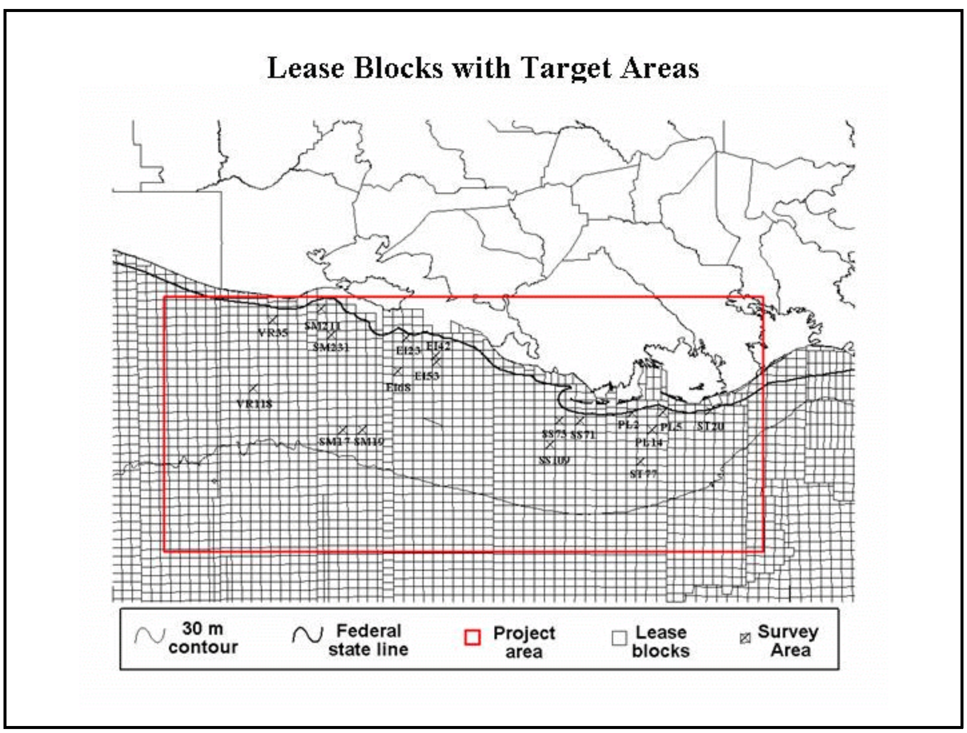

Figure 1C.12. Lease blocks with target areas.

- Precisely located unidentified objects located during previous hazard surveys, regardless of association with hangs.

As indicated by each target area's lease block map, the majority of target areas enclosed multiple targets composed of hangs, vessels, obstructions, etc. (Figures 1C.13 and 1C.14) With the exception of those targets precisely located during previous oil industry-related hazard surveys, we elected to

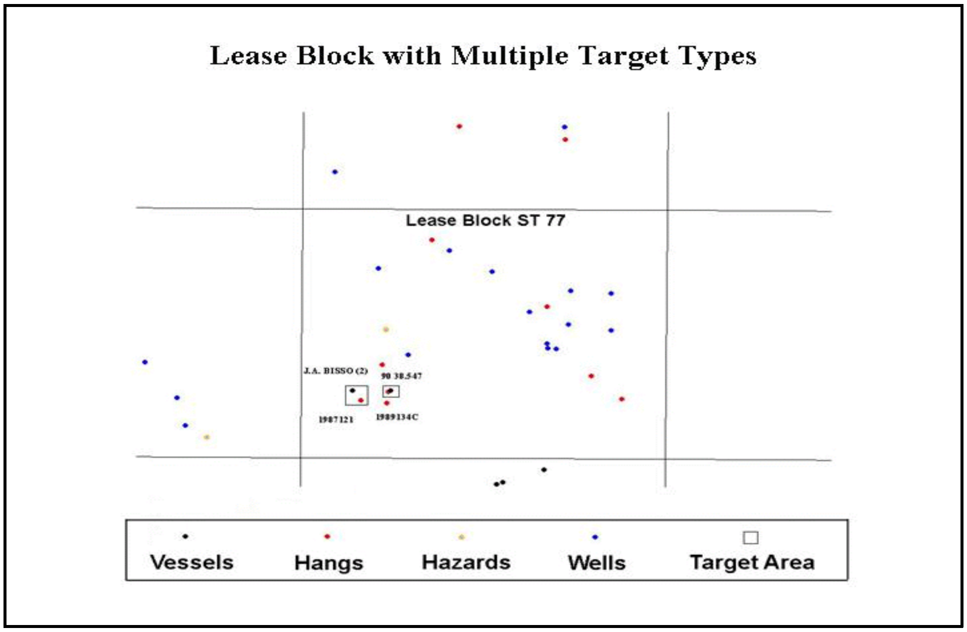

Figure 1C.13. Lease block with multiple target types.

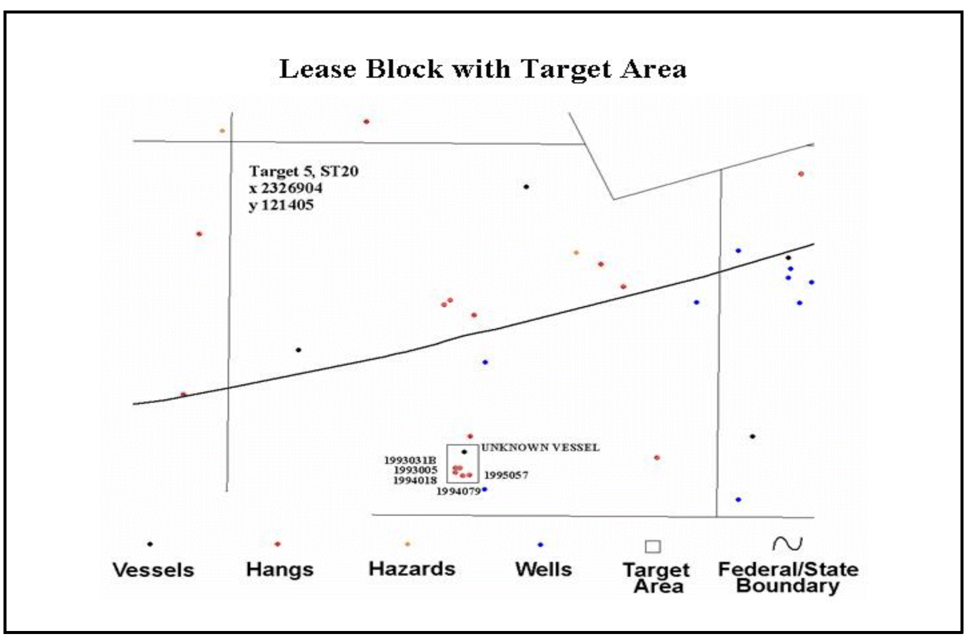

Figure 1C.14. Lease block with target area.

survey a large block around multiple hangs, objects, or unknown vessels in a cluster calling the survey block a single target, rather than investigating the specific coordinate of each hang or obstruction and calling that specific location a separate target (Figure 1C.14). This was implemented on the belief that closely clustered hangs or obstructions could represent the same object with slightly different coordinates because of the inaccuracy of the Loran system used to position most of them. Furthermore, we believed that calling each hang in a cluster a separate target would have offered the study only minimal correlation data. As opposed to 20 separate single targets our survey areas offered a much larger sample by investigating 51 recorded locations that included 29 hangs, 12 unknown vessels, 9 unknown objects, and 1 obstruction.

The initial examination of each of the 20 target areas involved a remote-sensing survey using a marine magnetometer, side-scan sonar, fathometer and DGPS for positioning. Of the 20 targets, only ten target areas contained bottom features indicative of submerged cultural resources (Figure 1C.15). Target inspection, which was conducted with surface supply diving techniques and completed in October 2001, indicated that of the ten potential targets, only one represented a shipwreck. Located in Lease Block VR118, (Figure 1C.16) Target 15 was a modern, steel-hulled shrimp trawler unassociated with any reported hangs. Of the remaining nine targets, two represented modern debris such as pipe or platform debris associated with the oil industry, and 7 represented natural bottom features or had negative findings. These results raise many questions, the least of which is reported coordinate accuracy of offshore objects. However, our analysis of these data is incomplete and positing implications at this time would be premature.

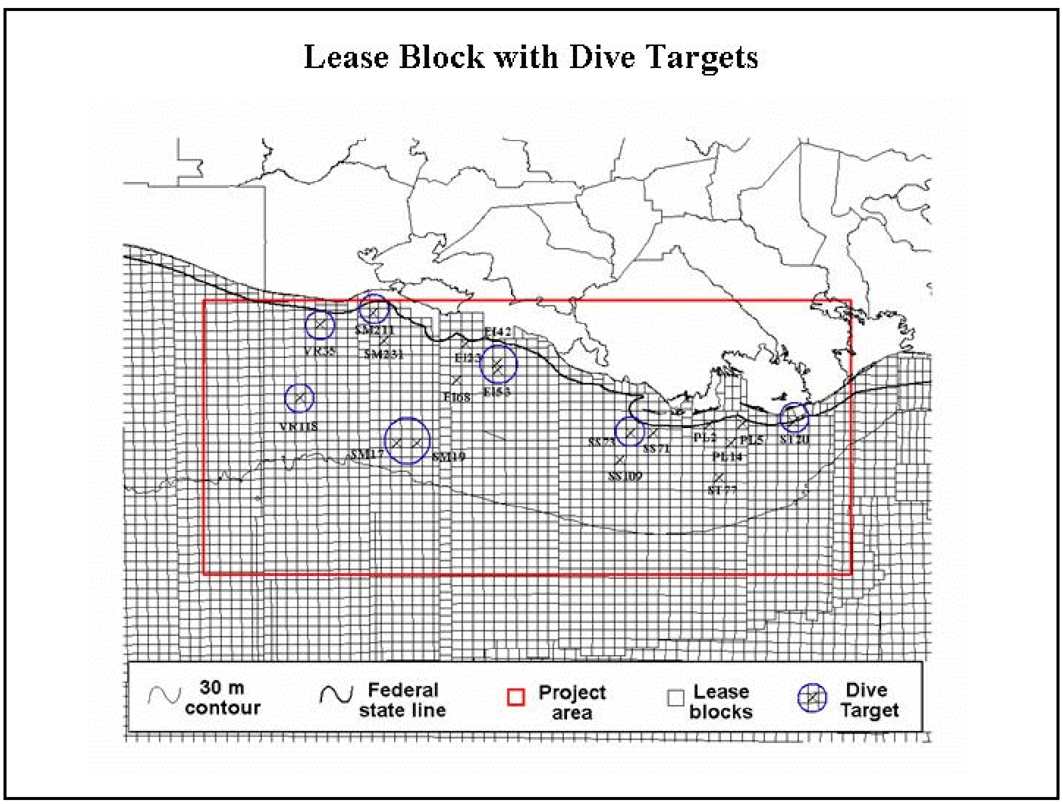

Figure 1C.15. Lease block with dive targets.

Figure 1C.16. Task 2: diving.

(Figure 1C.17) The third task of this project was and is a comparison of marine magnetometer technologies and survey line spacing. The goals of this task are: one, a comparison of different marine magnetometers to determine whether there is a significant difference in their performance in detecting shipwrecks; and two, to evaluate the magnetometers at various line spacings to

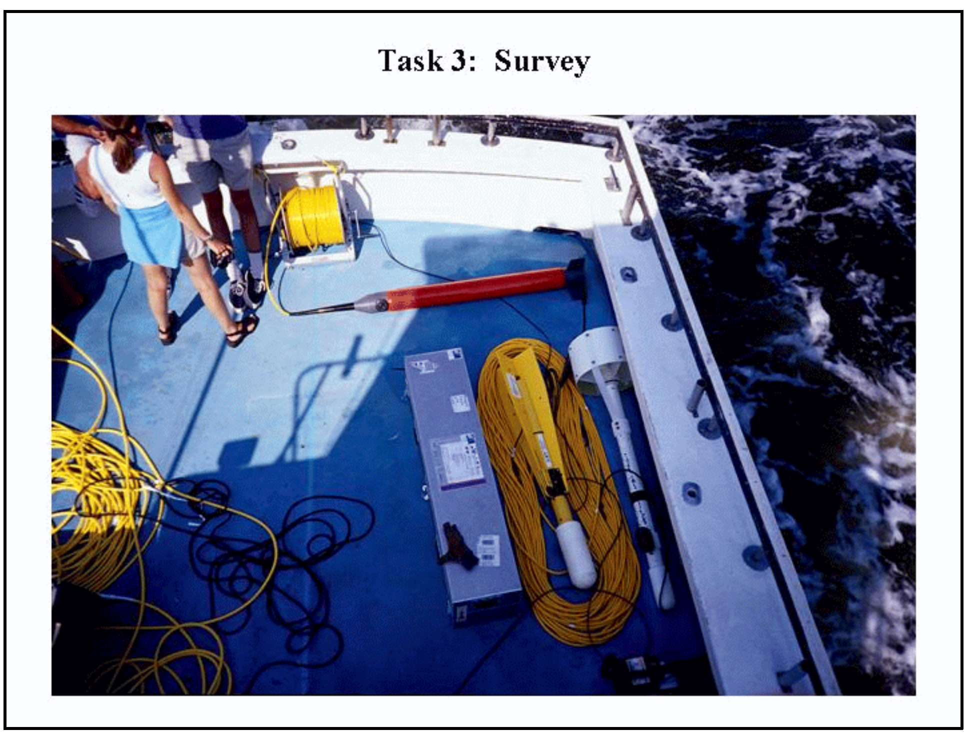

Figure 1C.17. Task 3: survey.

determine the minimally acceptable survey line spacing for detecting historic shipwrecks. Both study aspects are applicable to identifying warranted changes, if any, in the current MMS GOMR survey methodology.

To accomplish these tasks, surveys were conducted over two known shipwrecks, the *Josephine*, shown in Figure 1C.18, a nineteenth-century, iron-hulled sidewheeler located between Ship and Horn Islands south of Biloxi, Mississippi, and the wreck of the *Rhoda*, a nineteenth-century, wooden-hulled bark located in Pensacola Bay. Magnetometers employed and assessed during this investigation stage included the “industry-standard” Geometerics 866, (Figure 1C.19) its

***Josephine* Sidewheeler**

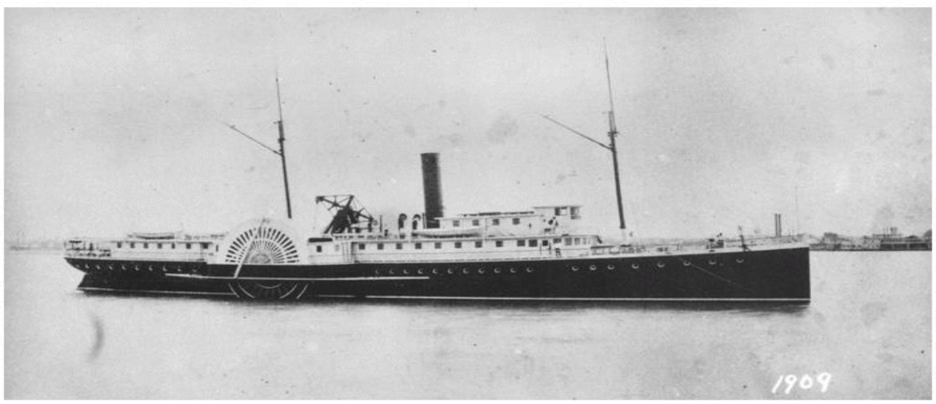

Figure 1C.18. *Josephine* sidewheeler.

866 Magnetometer

Figure 1C.19. 866 magnetometer.

submersible magnetometer base stations were employed to address questions of diurnal variation replacement the new Geometrics 877, (Figure 1C.20), and current state-of-the art magnetometers including the Geometrics cesium 881, (Figure 1C.21) and the Marine Magnetics Sea Spy, an Overhauser-type magnetometer (Figure 1C.22). In addition to the magnetometers, land-based and and its effect on data interpretation relative to the potential need for base stations (Figure 1C. 23).

877 Magnetometer

Figure 1C.20. 877 magnetometer.

881 Magnetometer

Figure 1C.21. 881 magnetometer.

Sea Spy Magnetometer

Figure 1C.22. Sea Spy magnetometer.

Land Magnetometer

Figure 1C.23. Land magnetometer.

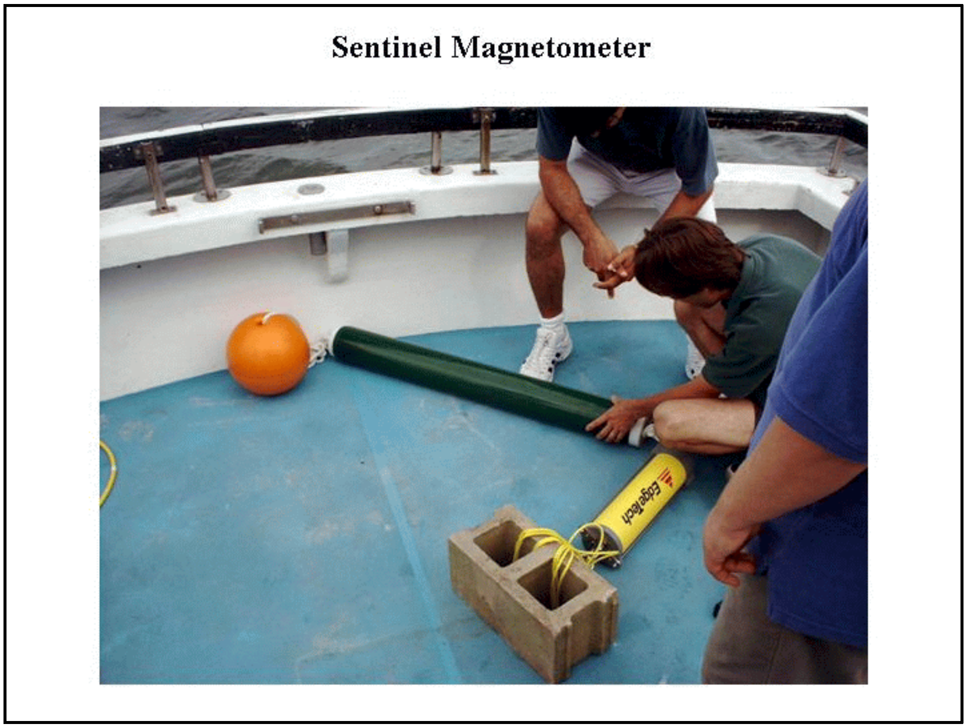

Figure 1C.24. Sentinel magnetometer.

Because land base stations have not been employed by the industry due to constraints of working offshore away from land, a location precluding their use, a Marine Magnetics Sentinel submersible base station was employed to address questions of its functionality as well as comparative results to land base stations (Figure 1C.24).

To address aspects of instrument sensitivity and the maximum or minimum line spacing that allows detection of various wreck types by each instrument, three transect grids were run with each instrument. The larger 600 meter grid was composed of transects spaced at 25 meters out to 150 meters from each wreck and then at intervals of 200 and 300 meters (Figure 1C.25). Two 30-meter grids were run, one at 4 knots and one at 6 knots in an effort to determine if increased speeds affect instrumentation sensitivity (Figure 1C.26).

Although data are currently being edited and assessed, preliminary indications are that differences do exist in magnetometer sensitivities. Figure 1C.27 illustrates the center line of the main grid atop the *Rhoda* for all magnetometers and indicates the difference in sensitivity as reflected in the larger gamma deviations for instruments. Interestingly, the 886 and 881 recorded strengths of 1,100 gamma, while the Sea Spy and 877 recorded strengths of 2,100 and 4,000 gammas respectively. These types of data will also be employed to determine maximum gamma deviation or sensitivity at 25-, 50- and 100-meter transect intervals, with 50 meters being the transect interval now required by the MMS for designated historic shipwreck high probability areas in the GOMR.

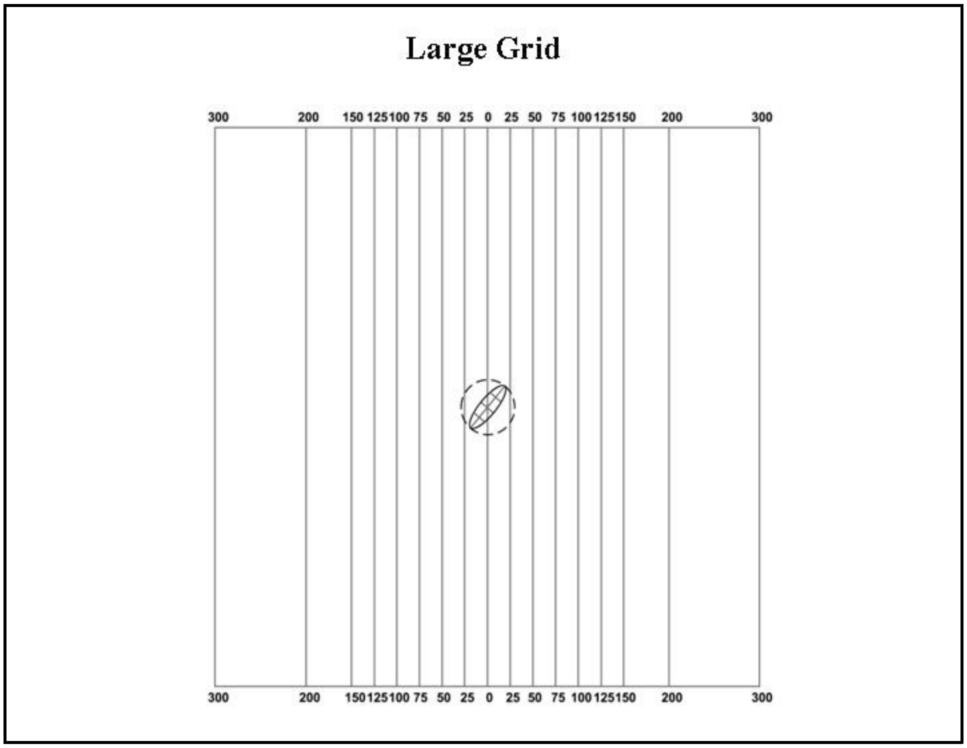

Figure 1C.25. Large grid.

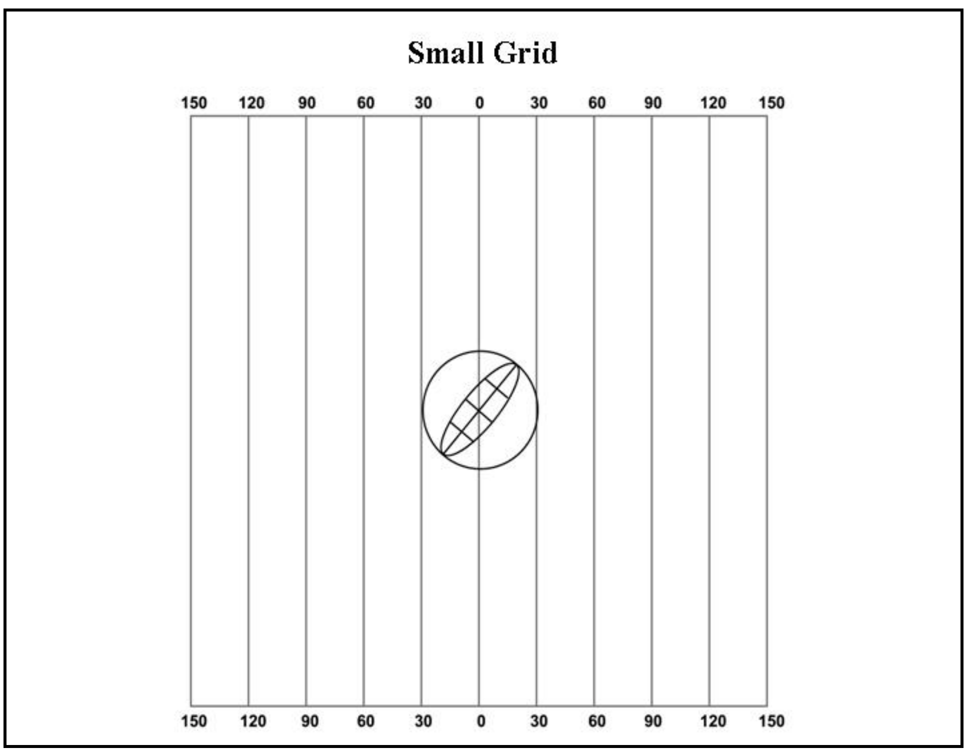

Figure 1C.26. Small grid.

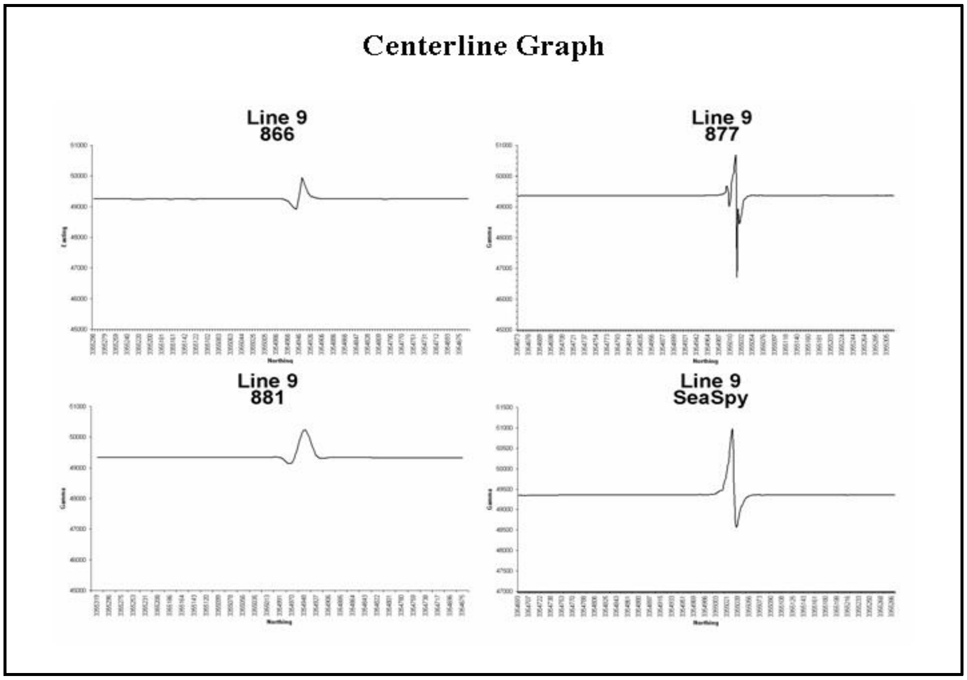

Figure 1C.27. Centerline graph.

Contour maps will also be generated from data for each magnetometer for each survey grid of varying line space (Figure 1C.28). Maps, such as these initial efforts, will be employed to address questions concerning magnetometer sensitivity, survey speed, transect interval, and diurnal variation, as well as issues concerning shipwreck signatures.

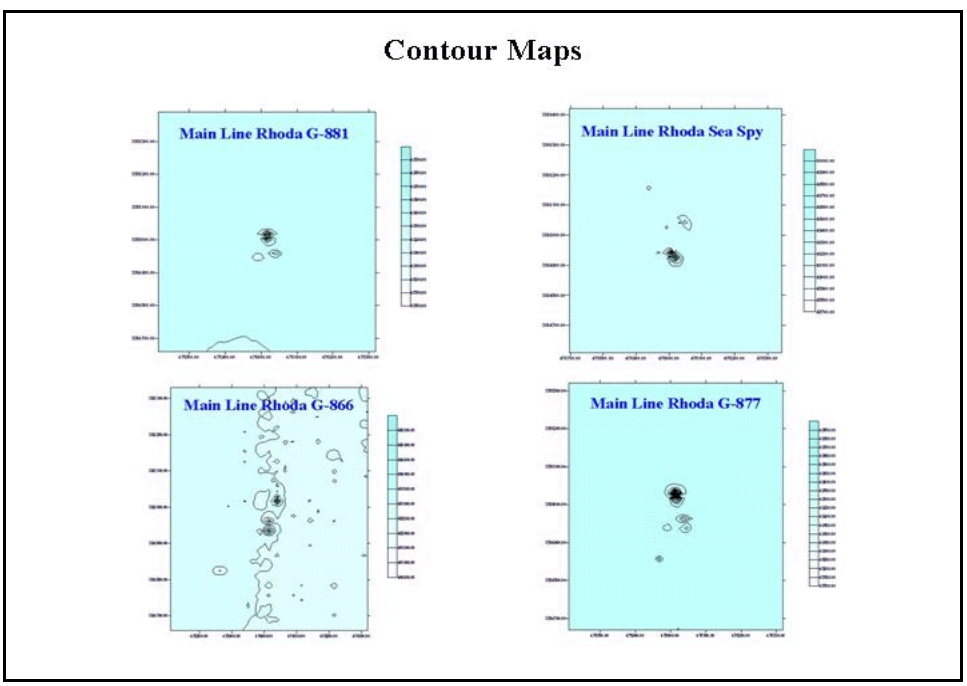

Figure 1C.28. Contour maps.

Currently we are reviewing, comparing, contrasting, and evaluating survey data and once this work is completed, we will make recommendations on survey instrumentation and minimal acceptable line spacing intervals to improve the detection and identification of historic shipwrecks in the Minerals Management Service's GOMR.

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NEW TECHNOLOGY, THE AUV AND THE POTENTIAL IN OILFIELD MARITIME ARCHAEOLOGY

Mr. Daniel J. Warren
Mr. Robert A. Church
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Recent years have seen rapid development in the technology for underwater exploration in the oil, gas, and cable industry. The industry requirement for faster, more detailed surveys and the move toward deepwater explorations has fostered development of various data acquisition systems. Although designed for natural resources and geophysical surveys, these new technologies have also greatly improved the ability of industry archaeologists to detect, document, and protect submerged cultural resources. These technologies will continue to have a significant influence on marine archaeology as they move into mainstream use in this field. Three of the systems that will have the greatest impact are high speed sonar systems, high resolution multibeam systems, and autonomous underwater vehicles.

Initially developed for the military, high speed side scan sonar has moved beyond the limitations of traditional sonar systems. Conventional side scan systems use a single beam per side to generate an image of the seafloor. This results in the decrease in resolution with range and requires speeds of five knots or less to obtain 10% coverage of the seafloor. These drawbacks were overcome in high speed sonar by designing systems that utilize several focused adjacent, parallel beams per side to produce an image of the seafloor. The result of using several beams is that the arrays can be towed at faster speeds and produce higher resolution data than conventional sonars.

The Klein Corporation was the first to introduce a commercial high speed sonar system. The Klein 5500 is a five-beam 455 kHz side scan sonar designed for hydrographic applications. The 5500 system can acquire high resolution imagery of the seafloor and bottom obstructions while operating at tow speeds up to 10 knots.

High speed sonars have two main benefits for both commercial and archaeological applications. The first is the ability to survey at higher speeds without loss of bottom coverage. Operation costs are often dependent on the time needed to conduct fieldwork. Using the new sonar systems, archaeologists can survey at more than twice the speed of conventional sonar allowing larger or more detailed surveys to be carried out. Secondly, the high resolution imagery from these systems can provide archaeologists with finely detailed imagery of underwater sites.

In 1999, while conducting a cable route survey along the Eastern Seaboard of the United States, C & C Technologies Inc. undertook a survey of the Civil War Ironclad, *Monitor,* utilizing the Klein 5500 system. The *Monitor* rests in roughly 200 feet of water off Cape Hatteras, North Carolina. Several passes were made over the site with the Klein system at speeds between six and eight knots. This was the first survey of the *Monitor* shipwreck with this type of high resolution system. The results were beyond expectations. The images clearly show minute details of the wreck including an anchor well, portions of the propeller shaft, damage to the hull, and the gun turret. Copies of these images were given to the National Oceanographic and Atmospheric Administration, which oversees the *Monitor* site, for analysis by their marine archaeologists.

High resolution multibeam systems use hundreds of beams of sound to take extremely accurate bathymetric measurements of the seafloor. Once collected, this data can be processed then combined with visualization software such as Fledermaus to provide a three-dimensional picture of the seafloor. Several high resolution systems already in use or under development have the potential to provide multibeam images nearly as detailed as side scan sonar.

One of the systems currently in use in the oil and gas industry in the Gulf of Mexico (GOM) is the Simrad EM 3000 high resolution multibeam system. The EM 3000 is a 300 kHz multibeam system. It is rated for depths from 0.5 meters to 150 meters below the transducer and has an accuracy of 5 to 10 centimeters throughout the swath width. The EM 3000 has been used to document shipwreck sites such as the S. S. *William Beaumont* off the coast of Texas. Additionally, in 2001 the EM 3000 was used during a pipeline survey in conjunction with side scan sonar to map the locations of several potential sinkholes off the coast of Florida.

The use of high resolution multibeam systems such as the EM 3000 in conjunction with other systems can provide archaeologists with an unique view of underwater sites. Using these systems together, it will be possible for archaeologists much more easily to study distribution and patterning on wreck sites in any depths or conditions of visibility. Also, by having detailed bathymetric maps of the site, it will be easier and less time consuming to develop a feasible site excavation plan.

High speed sonar and high resolution multibeam have had a enormous impact on how surveys are conducted in the oil, gas, and cable industry. But the most significant development has been the recent introduction of the Autonomous Underwater Vehicle or AUV for deepwater exploration. The use of these untethered systems is setting a new standard for underwater surveying in the oil, gas, and cable industry and will in the near future have a significant impact on how deepwater archaeological surveys are conducted.

Traditionally, deepwater geophysical surveys are conducted using a method known as a two-boat shoot. This technique involves having one vessel, usually with a hull mounted multibeam bathymetry system, tow a combined side scan sonar and subbottom system behind the boat while a second boat records the position of the towfish from the signal of and acoustic beacon on the unit. Depending on water depths, this technique can require that several miles of armored cable be let out behind the tow boat to get the array close enough to the seafloor to collect usable data. Utilizing this type of survey, the tow vessel is limited in speed to about two knots due to the amount of cable extended behind the boat and the need to keep the array at depth. Additionally, because of the length of the tow cable, line turns can take anywhere from 4 to 8 hours depending on water depth. Another drawback to this method of deepwater survey is positioning accuracy. Due to the influence of surface conditions on the tow vessel and undersea currents on the towed array along with horizontal USBL inaccuracy, the positioning accuracy of a deep tow system is usually only within thirty meters.

In January 2001 the first commercial AUV rated to a depth of 3,000 meters went into operation in the GOM. This system, the HUGIN 3000 AUV, was developed and built by C & C Technologies, Inc. Lafayette, Louisiana, in conjunction with Kongsberg Simrad of Norway. The HUGIN AUV or High Precision Untethered Geosurvey and Inspection System Autonomous Underwater Vehicle was designed to collect deepwater, high resolution geophysical data for site and route surveys in water depths down to 3,000 meters.

The HUGIN AUV contains a multi-instrument survey payload consisting of a Simrad EM 2000, a 200 kHz Swath Bathymetry system, dual frequency Edgetech Side Scan Sonar systems (120 kHz and 410 kHz), and an Edgetech Chirp Subbottom Profiler. Primary positioning of the AUV is accomplished using an inertial guidance system. This system uses precision gyros and accelerometers to maintain the AUV track of the mission plan. The AUV is also equipped with two acoustic modems, one providing a command link by which the systems of the AUV can be adjusted or the mission changed by commands from the mothership. The other modem is used to provide the mother ship with real time displays of the data being collected.

The AUV has several advantages over the traditional deep tow system. First, since the vehicle is untethered, there is no need for long expensive armored cable or a second boat for positioning. Secondly, because it is not tethered and has an internal positioning system, the AUV is able to survey at constant depth and stay online even in adverse sea conditions and currents. This allows a much higher accuracy for positioning during a survey. The accuracy of the AUV is within three to six meters at 1,400-meter water depth following post processing as compared to thirty meters with a deep tow. Finally, surveying with the AUV is much faster than with a deep tow system. The AUV can travel at up to four knots and takes only five minutes to make a line turn as compared to the deep tow that operates at two knots and takes several hours to make a line turn.

The applications of the AUV for archaeological surveys fall into two categories: area reconnaissance surveys and site specific surveys. The effectiveness of the AUV in these types of survey was shown in early 2001 during a route survey in Mississippi Canyon Area of the GOM for British Petroleum and Shell International. An initial survey had located a shipwreck of the passenger-freighter *Robert E. Lee* but did not locate another shipwreck known to be in the vicinity. An additional area survey was conducted to locate this second wreck site. The AUV surveyed a 1.5 by 2 mile area and was able to locate and collect imagery of the second wrecksite as well as additional data on the *Robert E. Lee*. This tasked was accomplished by the AUV in just under nine hours. The same task would have taken over three days of constant surveying with a deep tow system. An additional survey of the second wreck was undertaken following concerns that its attributes did not match those of the vessel that was suppose to be at this location. This survey carried out in approximately 2 hours consisted of the running of 33 tracklines spaced 10 meters apart. This type of site specific survey would be for all practical purposes impossible with a deep tow system since a single line turn would take up to four hours, and positioning would not be adequate to maintain 10-meter line spacing. Based on the data collected during the site-specific survey, the second area of wreckage was determined not to be that of a freighter *Alcoa Puritan* as was first thought, but the remains of the German U-boat, *U-166*. These findings were later confirmed by an ROV investigation of the site.

The development of new technologies in underwater exploration has led to new systems that have archaeological as well as commercial applications. The move toward the use of autonomous underwater vehicles will allow more deepwater sites to be explored and documented. Additionally, it is likely that eventually as AUV technology progresses and new systems developed, AUVs will become the standard in shallow water surveying as well, taking the place of towed systems all together. As these systems move beyond industry-specific uses and into the mainstream of use, archaeologists will develop new techniques and survey methods to utilize their full potential to locate and document submerged cultural resources.

REFERENCES

George, R.A. 1998. Simrad EM 3000 Multibeam System. C & C Technologies, Inc., Lafayette, Louisiana.

George, R.A. 1999. HUGIN 3000 AUV Technical Paper. C & C Technologies, Inc., Lafayette, Louisiana.

George, R.A. 2001. Klein 5500 Side Scan Sonar Technical Paper. C & C Technologies, Inc., Lafayette, Louisiana.

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UNRAVELING THE MYSTERY: THE DISCOVERY OF THE U-166

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HISTORIC BACKGROUND

In the spring of 1942 the war was going well for Nazi Germany as Hitler launched Operation Drumbeat. Using the might of Germany's *Unterseebootes* the new operation would take the war to the coasts of America as his predecessors had done in World War I. Unlike World War I, however, the U-boats would not be limited to the east coast of the United States, but would extend their destruction to America's soft underbelly, the Gulf of Mexico (GOM) (Miller 2000).

Hitler left the running of Operation Drumbeat to Karl Dönitz, the commander of the Krieggsmarine as the German Navy was known. In May 1942 with the sinking of the *Norlindo* by *U-507*, a wave of destruction began in the GOM that in just under 12 months would see 17 U-boats send 56 merchant vessels to the bottom and severely damage 14 others. Two of the vessels that fell victim to this onslaught were the cargo freighter *Alcoa Puritan* and the passenger freighter *Robert E. Lee* (Wiggins 1995), Figure 1C.29.

Figure 1C.29. SS *Robert E. Lee*, 20 January 1942. 5,184-ton, 375 ft. x 55 ft. Photo courtesy of the Mariners' Museum, Newport News, Virginia.

Korvettenkapitän Harro Schacht, commanding U-507, was the first U-boat commander to enter the GOM. On 6 May 1942, Schacht, sank his fourth ship in the Gulf. At 11:55, he attacked the *Alcoa Puritan* as she was in route from Port-of-Spain, Trinidad to Mobile, Alabama with a load of bauxite. The first torpedo missed and the alarm was sounded. The captain of the *Alcoa* immediately ordered full speed (about 16 knots) and turned his ship to present as small a target as possible to the U-boat. U-507 surfaced and began pursuit at about 18 knots, slowly overtaking the freighter. At a distance of about a mile the crew of U-507 opened fire with their deck gun. Over the next forty minutes, the U-boat expended nearly seventy-five rounds, scoring approximately fifteen hits, and disabling the *Alcoa Puritan*'s steerage. The captain brought the crippled freighter to a stop and gave orders to abandon ship. After all the crew made it off the freighter, U-507 moved in and finished the ship off with a torpedo. The *Alcoa Puritan* sank stern first in approximately eight minutes. The U-boat approached within 100 yards of the survivors and a German officer shouted through a megaphone, "Sorry we can't help you. Hope you get ashore." He then waved as U-507 sailed away. About 3 1/5 hours later the survivors were rescued by the U.S. Coast Guard cutter *Boutwell* (Browning 1996).

A few months later, in July, the passenger freighter *Robert E. Lee* left Trinidad with limited cargo and approximately 270 passengers, many of whom were American construction workers or survivors of other U-boat attacks in the Caribbean. She carried approximately 131 crewmembers and 6 armed guards, who manned a deck gun mounted on the stern of the vessel. She came up through the Caribbean with a convoy then continued into the GOM with a naval escort vessel, Patrol Craft 566. Lieutenant Commander H. C. Claudius was in command of PC-566. She was a newly commissioned vessel and her first mission was to escort the *Robert E. Lee* through the GOM (USS PS-566 1942; and Henderson 1942).

Late in the evening on July 29 they neared Tampa, Florida for a scheduled stop. The passengers asked Captain William C. Heath of the *Robert E. Lee* to allow them to disembark at Tampa to escape the miserable conditions on board the overcrowded freighter. Captain Heath agreed, but when a pilot was unavailable to guide the boat into the Tampa harbor he decided to continue on to their final destination of New Orleans, Louisiana. With the decision to continue to New Orleans the naval escort broke radio silence to notify the Gulf Sea Frontier command (The military command that oversaw wartime shipping activities in the GOM) that the *Robert E. Lee* was proceeding to New Orleans. The escort was ordered to continue with the *Robert E. Lee*. (Talbot-Booth 1942; Wiggins 1995; and Browning 1996).

In July 1942 there were at least ten U-boats operating in the GOM. One of these was the *U-166* commanded by Hans-Günther Kühlmann. The *U-166* had been laying mines off the mouth of the Mississippi for several days. On 27 July 1942 Kühlmann radioed the German Subcommand that he had finished his mine-laying operation. Although no further messages were received from Kühlmann after July 27 it is presumed that the *U-166* took up position to attack shipping coming into or out of the Mississippi River. On 30 July the *U-166* was prowling along the shipping lanes as the *Robert E. Lee* and PC-566 steamed toward New Orleans (War Diary 1942 and Garrison 1989).

The skies were clear and the sea calm on the evening of 30 July as the *Robert E. Lee* neared the Mississippi River. Around 4:30 p.m. and only 45 miles from Southwest Pass the passengers must have been anticipating their arrival in New Orleans when a few of them saw something in the water streaking towards their vessel. They questioned each other about whether it could be a shark or perhaps a dolphin, but it was a torpedo. The German “eel” slammed into the starboard side of the vessel, exploding just aft of the engine room. The ship began sinking quickly and many of the passenger and crew frantically donned life jackets then jumped overboard into the Gulf waters. Amidst the chaos, members of the crew managed to lower six lifeboats and sixteen life rafts that were quickly overloaded with survivors (Henderson 1942).

The crew of the escort vessel, traveling approximately a half-mile ahead of the *Robert E. Lee*, had been radioing New Orleans for a pilot when the attack occurred. Immediately PC-566 went into action. The Patrol Craft raced to the area where they had last spotted a periscope and the crew dropped a spread of five depth charges. After coming about they gained sonar contact on the U-boat and maneuvered to drop another spread of depth charges. Upon coming around for the second attack, Lieutenant Commander Claudius noted the *Robert E. Lee* had already disappeared beneath the water leaving only lifeboats and scattered debris to mark the location. It is estimated that the freighter sank within five to fifteen minutes of being hit. Following the escort’s attack on the U-boat an oil slick was reported and no further signs of the U-boat were observed. Feeling that the U-boat was no longer a threat, the crew of *PC-566* turned to the task of rescuing the survivors of the *Robert E. Lee*. (Henderson 1942; and Wiggins 1995).

Soon search planes appeared overhead to help watch for the U-boat and direct other rescue vessels to the site. Just after 8:30 p.m., two addition vessels, SC-519 and the tugboat *Underwriter*, joined the rescue operation. The *Underwriter* had just arrives at the pilot station to reopen South Pass when the request came to help. Bar pilot Captain Albro Michell recalled the events:

> South Pass was closed during the war and we had gone down to open it back up. We had just arrived at the pilot station when we were asked to go out and help in the rescue of a boat that had been torpedoed… . We took about 50 to 60 passengers off the naval ship onto the *Underwriter*. The seas were dead calm, otherwise we would not have been able to transfer the victims. Someone was watching out for them… .
>
> When we were asked to go out we only knew a ship had been torpedoed. We still had the provisions onboard for the pilot station; we didn’t have time to unload them. The survivors were hungry and ate all the provisions on the way into Venice (Michell 2001).

The survivors were transported to Venice, Louisiana then by bus and ambulance to the New Orleans hospital. As a result of the U-boat attack, 15 passengers and 10 crew were lost, including Winifred Grey of New Orleans, one of the few women merchant marine to be lost in wartime action in the GOM (www.usmm.org).

On 1 August two days after the *Robert E. Lee* was sunk, Coast Guard aviators, Henry White and George Boggs were on patrol in their Grumman J4F seaplane out of Houma, Louisiana. At about 1:30 PM they spotted a German U-boat on the surface. Immediately they radioed their position south of Isles Dernieres, Louisiana and began an attack run on the enemy vessel. The U-boat initiated a crash dive and was quickly slipping beneath the surface. When the plane neared 250 feet, White yelled “NOW!” and Boggs released the charge. He reported seeing the charge detonate near the vessel and a light to medium oil slick appeared on the surface of the water. After returning to base White and Boggs were instructed that the incident was classified and not to speak of it further. At the end of the war they were told that it was the *U-166* they had sunk that day (Wiggins 1995; “Baseball” 1943).

But was it? The entire premise that the *U-166* was sunk that day in August is based entirely on the fact that the *U-166* never returned from its war patrol and was never heard from again. No other evidence supports the claim. The last radio message from the *U-166* was on 27 July 1942 three days before sinking the *Robert E. Lee*.

The area in which the *U-166* is thought to have been sunk, is probably one of the most surveyed regions in the world. Oil and gas development in the area have led to numerous intensive surveys using various means or remote sensing instruments. For decades individuals, companies, and governments have extensively searched the area for the *U-166*. In 1997 a team from Germany came to search for the U-boat, but no trace of the *U-166* was identified (www.uboat.net; and McNamara 2000).

OIL AND GAS SURVEYS

In 1986, Shell Offshore, Inc. was conducting oil and gas exploration in the Mississippi Canyon Area of the GOM. They contracted John Chance and Associates to conduct the survey using a deep-tow side scan sonar. While performing the survey they detected two shipwrecks, which they identified as the *Robert E. Lee* and the *Alcoa Puritan*. The two sunken vessels would remain identified as such for the next sixteen years.

In January 2001, C & C Technologies, Inc. (C & C) conducted a deep-water pipeline survey for British Petroleum (BP) Amoco and Shell International in the vicinity of the reported location of the *Robert E. Lee* and *Alcoa Puritan*. This survey was conducted using C & C’s new HUGIN 3,000 AUV (<u>H</u>igh Precision <u>U</u>ntethered <u>G</u>eosurvey and <u>In</u>spection System, <u>A</u>utonomous <u>U</u>nderwater <u>V</u>ehicle). The HUGIN 3000 is the world’s first commercially operated AUV capable of surveying to 3000 meters water depth. It is untethered; therefore, it can operate even in rough seas at faster speeds with greater mobility and accuracy than conventional towed arrays. Operating in 5,000 feet of water C & C’s AUV is accurate to within 9 feet after post processing. Conventional towed systems are typically only accurate to 100 or more feet at the same water depth. The AUV utilizes a state-of-the-art multibeam bathymetry and imagery system, a dual frequency chirp side scan sonar, chirp sub-bottom profiler, a inertial navigation system coupled with the precision HiPAP (High Precision Acoustic Positioning) acoustic tracking system.

During the January survey, a large shipwreck was detected at the edge of the AUV’s survey corridor in 5000 feet of water. C & C Marine Archaeologists Robert A. Church and Daniel J. Warren contacted the United States Department of Interior, Minerals Management Service (MMS) to verify the identity of the vessel as the *Robert E. Lee*. C & C asked their clients if they could run a few investigation lines around the *Robert E. Lee* and the reported location of the *Alcoa Puritan*. BP and Shell not only responded favorably to the additional investigation they decided to have C & C conduct a 2 mile by 1.5 mile investigation survey in the area to precisely position any wreckage or out lying debris of both shipwrecks. This survey was conducted in March 2001 and addressed the archaeological and engineering concerns of the companies. The investigation survey consisted of 17 survey lines at 492-foot (150 meter) line spacing for a total of 31.7 nautical line mile. Using the AUV the entire investigation survey took less than 9 hours to complete, a fraction of the 72 hours a conventional deep-towed system would have required.

Upon completion of the offshore work the data from the archaeological survey was reviewed by the C & C's marine archaeologists. As they began analyzing the data the archaeologists realized that the debris scatter formerly identified as the *Alcoa Puritan* did not match the characteristics of a 6,759-ton freighter. The target consisted of two large sonar contacts with debris of various size scattered between them. The largest section of debris measured approximately 200 feet long and 20 feet wide. The other large section measured approximately 55 feet long and 20 feet wide. This made a combined length of approximately 255 feet, just over half the length of the *Alcoa Puritan,* which was 397 feet long by 60 feet at beam. Based on this data Church and Warren were doubtful the target was the *Alcoa Puritan*, but realizes it did match closely to the dimensions of a Type IX-C German U-boat (Figure 1C.30), as was the type of U-166.

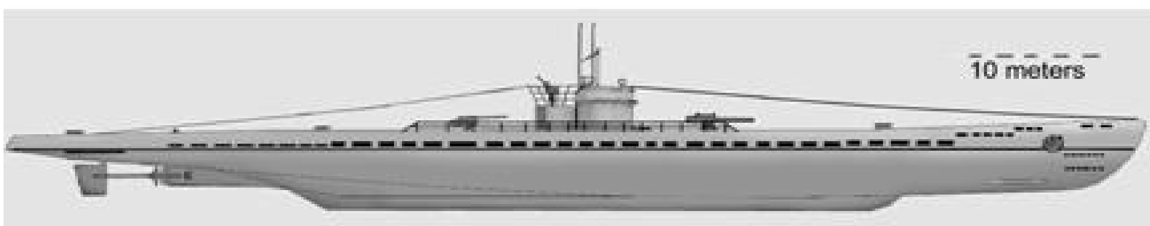

Figure 1C.30. Type IXC German U-boat. Length = 252 feet (76.76 meters), Beam = 22 feet (6.76 meters)

A NEW INTERPRETATION

The data from the AUV provided circumstantial evidence to support the *U-166* hypothesis. But, it did not seem reasonable to locate the *U-166* 140 miles away from where it was reportedly bombed and within less than a mile of the U-boats last victim. One possibility to explain the discrepancy was put forward by the archaeologists. What if the crew of the *PC-566* were far luckier on 30 July than anyone had given them credit and had actually sunk the *U-166* instead of just chasing it off as was presumed? If this was the case then what U-boat was bombed by White and Boggs on 1 August and what happened to that vessel?

Further research revealed there were three U-boats operating in the GOM on 1 August 1942 (*U-166, U-509*, and *U-171*). The *U-166* sank in the GOM with no survivors. Only infrequent radio transmissions provide clues to the *U-166*'s activities in the GOM, but if it was sunk by PC-566, then the Coast Guard could not have attacked it two days later. *U-509* did not venture very far into the

Gulf and did not sink any shipping during that patrol. It arrived safely back in Lorient, France on 12 September 1942 with no incident mentioned of a seaplane attacking them on 1 August. The only other boat known to remain in the Gulf at this time was the *U-171* commanded by Günther Pfeffer (War Diary 1942; and www.uboat.net).

The *U-171* arrived at its assigned area of operation between Galveston and New Orleans on 23 July 1942. Pfeffer's objective was to sink shipping coming into and out of the Port of Galveston. However, he found that the waters off Galveston were too shallow and radioed that he was moving toward the New Orleans area. Pfeffer found success off the Louisiana coast, sinking the *R. M. Parker, Jr.* on 13 August 1942. Curiously the attack on the *R. M. Parker, Jr.* took place within three miles of the location that White and Boggs made their attack on a U-boat (Wiggins 1995). On 9 October 1942, while returning from their patrol in the GOM, the *U-171* struck a mine and sank in the Bay of Biscay. Pfeffer along with twenty-nine crewmen survived, but twenty-two crewmen and the Captain's logs went down with the vessel. In reconstructed logs Pfeffer mentioned that between July 27 and 13 August 1942 a "flying boat" had dropped one depth charge on them and they escaped with no damage (NARA, *U-171*). From this research the archaeologist surmised that White and Boggs bombed the *U-171* on 1 August 1942. It also seemed probable that the debris to the east of the *Robert E. Lee* was the remains of the *U-166*, which *PC-566* sank following the attack on the *Robert E. Lee*. According to the Action Report of *PC-566*, Lieutenant Commander Claudius and his Executive Officer, D. Howard felt they had sunk or severely crippled the U-boat. Furthermore, Claudius stated that they "believed that the submarine was watching the sinking of the SS *Robert E. Lee* and had not been aware of our [PC-*566*] presence." It was not until the U-boat heard the ping of the sonar that they began to dive. If *U-166* was not expecting the naval escort, then it is doubtful the U-boat had overheard the radio transition sent by PC-*566* the previous day.

FURTHER INVESTIGATIONS

With the new hypothesis, C & C informed their clients, BP and Shell, that they might have found the long sought after U-boat. C & C, BP, and Shell then held a meeting with the MMS to fully disclosed the information. In light of the possibility of the new discovery, BP and Shell sponsored further site investigations of the *Robert E. Lee* and the suspected *U-166* site using the AUV (Figure 1C.31). The additional investigation provided sonar and bathymetry images and provided further evidence supporting the *U-166* hypothesis. The conning tower and deck guns of a U-boat could clearly be recognized from the 410 kHz sonar images. The bathymetry data showed that the U-boat was lying in what appeared to be a six-foot deep impact creator. Because the possibility that the site represented a significant historical wreck, ground truthing was warranted with a Remotely Operated Vehicle (ROV) for final verification of the remains.

On 31 May and 1 June 2001 a research team from C & C, BP, Shell, and the MMS conducted an ROV survey of the SS *Robert E. Lee* and the suspected site of the *U-166*. The archaeologist from C & C were joined by marine archaeologist Jack Irion and Richard Anuskiewicz of the MMS for the expedition. The research team left onboard the *Gary Chouest*, an anchor-handling vessel on contract to Shell, which was equipped with Oceaneering's Millennium VI ROV. After reaching the site, it took a hour to lower the ROV to the seafloor. The researchers setup about 200 feet south of

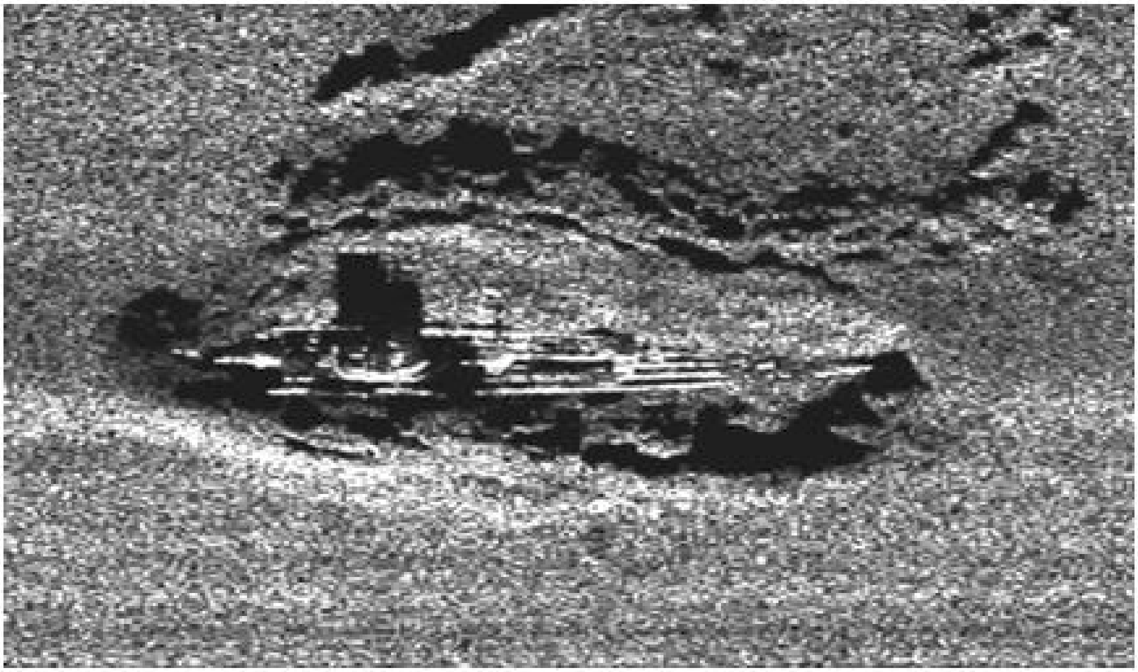

Figure 1C.31. AUV 410kHz side scan sonar image, ROV survey.

the U-boat and slowly moved the ROV across the seafloor toward the wreck site. The first image of the U-boat was the side of the conning tower looming out of the darkness.

The conning tower and stern appear to be in tacked and in good order. This section is deeply imbedded in the seafloor, only with the top of the deck, conning tower and deck guns visible. The conning tower is in excellent condition with the splashguard and railing of the wintergarden showing little or no damage. The 105mm deck gun, 37mm and 20mm antiaircraft guns are in place and clearly visible. The teak decking that once covered the deck frame is no longer present, having likely been eaten away by biological organisms.

After completing a thorough investigation of the stern section and conning tower, the research team relocated the ROV to the separated bow section, which lies 490 feet to the west-northwest. The bow section provided a reveling glimpse of what caused the U-boat to plummet to the seafloor. Just forward of where the forward torpedo-loading hatch would have been, a large indentation is visible in the deck. This damage appears to be the result of a depth charge explosion. The jagged metal where the bow tore away from the rest of the vessel is flared outward as if caused by an internal explosion. The evidence at the bow suggests a depth charge exploded almost right on top of the deck, rupturing the pressure hull. That event in turn caused an internal explosion, possibly from an armed torpedo or from salt water rushing into the battery room, both of which were present in that location of the U-boat. There is a large amount of scatted debris between the two sections of the U-boat, including what appear to possibly be two torpedoes partially protruding from the seafloor.

The ROV was then moved over to the site of the *Robert E. Lee*. As the stern of the vessel came into view, there was no doubt we were looking at the passenger freighter. The ROV maneuvered around the entanglements of the structure, collecting detailed video images of the final resting place of the *Robert E. Lee*. The deck gun on the stern was seen, which the eight man gun crew manned. Two lifeboats were videoed lying off to the port side of the ship. A large scatter of debris surrounds the freighter. During exploration of the debris field an unexpected discovery was made in the late hours of the survey. About 1:00 in the morning we moved the ROV toward a piece of debris lying over 200 feet off the port side of the *Robert E. Lee*. The first thing that came into view as we approached the unknown debris was a bit of metal framing lying on the seafloor. Then as the camera panned around, there stood the telegraph off the bridge of the *Robert E. Lee* (Figure 1C.32). It was an unbelievable find, just standing all alone on the seafloor just as if it were still on the bridge. Made of brass, it was in pristine condition and the words on the face of the telegraph could still be read. The indicator arrow from the engine room was locked in the “STOP” position, indicating that the “All Stop” command was sent and executed before the ship went down. The handle, however, was pulled back into the “FINISHED WITH ENGINES” position, a command that was never executed. This left the researchers to speculate that as the ship was sinking the bridge officer possibly pulled the handle back to that position out habit before leaving the bridge.

The new technology of the AUV, the historical research, and the combined efforts of the expedition team, positively identified the final resting-place of the *Robert E. Lee* and the *U-166*, solving one

Figure 1C.32. Bridge telegraph of the *SS Robert E. Lee* as found on the seafloor, 1 June 2001.

of the great historical mysteries of World War II in the GOM. On 30 July 1942, 25 lives were lost from the *Robert E Lee* and 52 German sailors from the U-boat. As the news of the discovery spread to the surviving family members it helped bring some closure to questions gone unanswered and some vindication for the crew of PC-*566* over credit never given. One of the unique elements of this archaeological site is that it tells the whole story of the U-boat war in the GOM. The hunter, U-166; its last victim, the *Robert E. Lee*; and the lifeboats representing the survivors are all found within a mile from each other on the seafloor. Now the history has been rewritten and story set straight with the discovery of the U-166.

REFERENCES

Anonymous. 1943. Baseball cap strikes out sub. The Key West Citizen, Gainsville, FL.

Browning, R.M., Jr. 1996. U.S. Merchant Vessel War Casualties of World War II. Naval Institute Press, Annapolis

Garrison, E.G., C.P. Giammona, F.J. Kelly, A. R. Tripp, and G. A. Wolff. 1989.Historic Shipwrecks and Magnetic Anomalies of the Northern Gulf of Mexico: Reevaluation of Archeological Resource Management Zone 1. Volume II: Technical Narrative. OCS Study 89-0024. U.S. Department of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Regional Office. New Orleans, Louisiana.

McNamara, D. 2000. Thunder in the Gulf: Nazi subs torpedoed ships off the Louisiana coast, and at least one paid the price. Louisiana Life.

Michell, A. 2001. Interview by Robert Church by phone and at Captain Michell's, New Orleans, Louisiana.

Miller, D. 2000. U-Boats: History, Development and Equipment, 1914-1945. Conway Maritime Press, London.

National Archives and Records Administration (NARA). 1985. Records of the German Navy, 1850-1954: Records Relating to the U-boat Warfare, 1939-1945. Compiled by Timothy Mulligan. Washington, D.C.: United States National Archives.

Henderson, E.D. 1942. Summary of Statements by Survivors of the SS Robert E. Lee, U.S. Cargo-passenger vessel, Navy Department, Office of the Chief of Naval Operations, Washington.

Talbot-Booth, E.C., ed. 1943. Merchant Ships, 1942. The MacMillan Company, New York.

Uboat.net. 2000. *<http://www.uboat.net>*

War action casualties involving merchant tank vessels. [n.d.] Prepared by Merchant Vessel Inspection Division, U.S. Coast Guard. Washington D.C.

War Diary. 1942. Oberkommando Kriegsmarine Kriegstagebuch, Akten betreffend U-166, 24 March 1942 through 3 August 1942. NARA, Washington DC. English translation in C.J. Christ's personal archives, Houma, LA.

Wiggins, M. 1995. Torpedoes in the Gulf, Galveston and the U-boats, 1942-1943. Texas A&M Press, College Station, TX.

Women Mariners in World War II. 2000. U.S. Merchant Marine. <*www.usmm.org/women.html*>

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GEOPHYSICAL REMOTE SENSING AND UNDERWATER CULTURAL RESOURCE MANAGEMENT OF SUBMERGED PREHISTORIC SITES IN APALACHEE BAY: A DEEPWATER EXAMPLE, SITE PREDICTIVE MODELS, AND SITE DISCOVERIES

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ABSTRACT

This paper briefly describes progress made in finding and investigating prehistoric sites in open ocean settings over the continental shelf of Northwestern Florida. It presents an example of "deep" water survey near the proposed "Clovis Shoreline" (40 meter isobath) conducted in 2000 and 2001, as well as submerged prehistoric site archaeology practiced in shallower water in Apalachee Bay since 1986. A significant number of sites and artifacts have been located on Florida's western continental shelf as part of this programmatic research. These sites represent Paleoindian and Archaic occupations of the shelf when it was exposed by lowered sea levels during the last glacial maximum.

INTRODUCTION

This paper briefly describes progress made in finding and investigating prehistoric sites in open ocean settings over the continental shelf of Northwestern Florida. It describes beginning archaeological research in "deep" water near the proposed "Clovis Shoreline" (at the 40 meter isobath), as well as abundant work conducted in shallower water since 1986. In other areas of the Gulf of Mexico (GOM), the sites reported here would be in federal waters, but in this area they are in submerged lands that belong to the state of Florida to a distance of 9 nautical miles. It is my opinion that this work can be a useful analog for resource managers in Alabama, Mississippi, and Louisiana, even though the sediment loads there are more substantial.

Professional cultural resource managers are more and more in need of examples of procedures, protocols, and practical experience with marine submerged prehistoric sites because of increased offshore mining of sand to replenish beaches, and other infrastructure and resource procurement projects. There are prehistoric sites threatened by this dredging. It is a fact that state and federal laws protect these resources like any other cultural resources. There is a robust interest in and practice of finding and managing historic shipwrecks in the cultural resource management community. The failure to consider submerged prehistoric sites is due in part to the historic lack of a formal academic discipline of this kind of study and the lack of experienced researchers and consultants.

Because of modern remote sensing and excavation equipment, increased research funding, and continued forays offshore, faculty and students at Florida State University are having good success at finding and managing marine submerged prehistoric sites and understanding the physiographic and stratigraphic character of the submerged landscape within which they occur. A set of procedures for finding and managing marine submerged prehistoric sites has been developed from research conducted since 1986.

This paper provides background on principles of finding submerged prehistoric sites, details of local sea level rise that are relevant to knowing where to find sites of different ages, and a very short description of the ages of cultures available in the local prehistory. Deepwater research seeking the Clovis Shoreline in federal waters is described next. The paper concludes with a summary of our findings in more near-shore state waters.

Experience has shown that offshore sites are predicted by local models of terrestrial geology and archaeology, combined with a knowledge of local sea level rise and local bottom morphology. This information can be collected for areas with early occupation expressed terrestrially, and in some cases it may be possible to follow specific occupation patches offshore in specific drainages (such as the PaleoAucilla example presented here). Another part of the procedure is to conduct remote sensing, coring, and induction dredge operations to find, characterize, and study the paleo-topography and sedimentary sequences locally.

This methodological sequence has been a fruitful approach in our work with the PaleoAucilla drainage system in the Apalachee Bay (Figure 1C.33). By modeling the kinds of environments, sites, time periods of exposure, and culture groups that might be represented and finding sites on the continental shelf, we contribute information to incorporate into local site file inventories and cultural historical and processual reconstructions.

Figure 1C.33 shows the distribution of late Pleistocene and early Holocene archaeological sites in Florida, and the extent of the Floridian continental shelf and the bathymetric contours that represent paleo-shorelines at various stages of the transgression process. While there may be some subsidence due to accumulated sediment and water weight since submergence (Stright 1995), and some movement due to karstic solution uplift (Opdyke *et al.* 1984), the Florida continental shelf platform is considered "stable."

Figure 1C.34 shows radiocarbon controlled sea level curves for the GOM, and Caribbean. Three curves come from the western GOM (Curray 1965; Frazier 1974; Nelson and Bray 1970) and one from Barbados (Fairbanks 1989). There is a short 8,000 to 6,000-rcybp sequence suggested by this research program for the northwestern continental shelf (Faught and Donoghue 1997). Some time between 5,000 and 4,000 rcybp sea levels were at today's levels in the Big Bend.

The continental shelf of the Big Bend of Florida is a drowned karst landscape submerged by a relatively low energy open ocean (CEI (Coastal Environments) 1977; Rupert and Spencer 1988). The seafloor bottom is somewhat like a basin and range landscape. Limestone outcrops of various relief and scale are interspersed by plains of coarse shelly sand and beds of sea grass growing in fine-grained organic sediments. The general trend of the bottom is flat but there is relief over long distances, particularly in the vicinity of paleochannels. Rock out crops can be from a few centimeters to 80 cm in height, sandy plains can cover karst voids of various relief.

Work by Ballard and Uchupi (Ballard and Uchupi 1970) indicates several paleocoastal features (shore-face erosion ledges and drowned barrier islands) at certain depths on the western Floridian continental shelf (that is at 160, 60, 40, 32, and 20 meters; Figure 1C.33 and Figure 1C.34). Full glacial lowering of

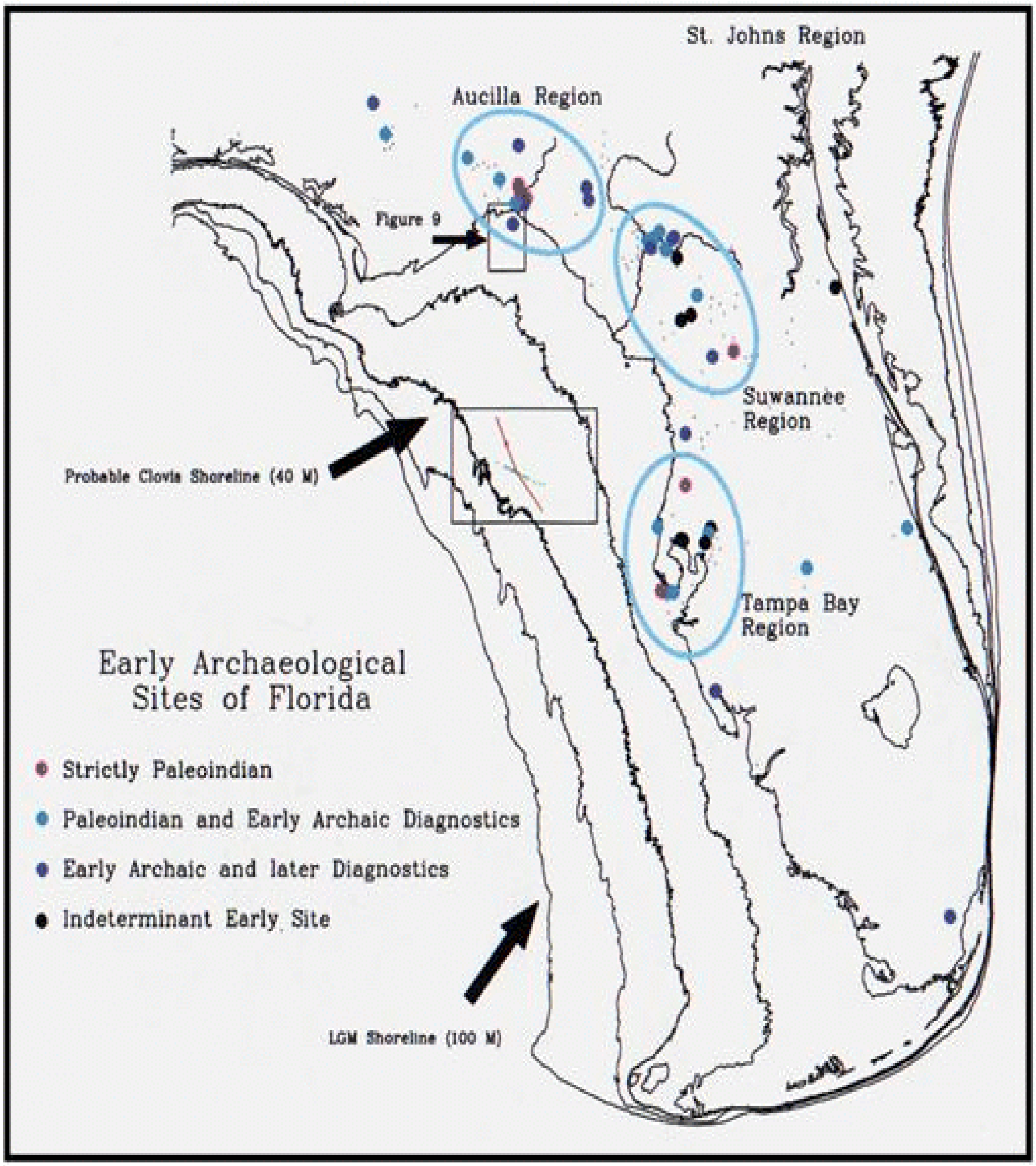

Figure 1C.33. Peninsular Florida, showing the distribution of find spots and excavated sites of Paleoindian and Early Archaic archaeological sites on land. Bathymetric contours at 20 meter intervals. The 40-meter contour is possibly the Clovis Shoreline (Dunbar *et al.* 1992; Faught and Donoghue 1997). Two research areas are shown: the southern area is that of Figure 1C.35, the northern of Figure 1C.36.

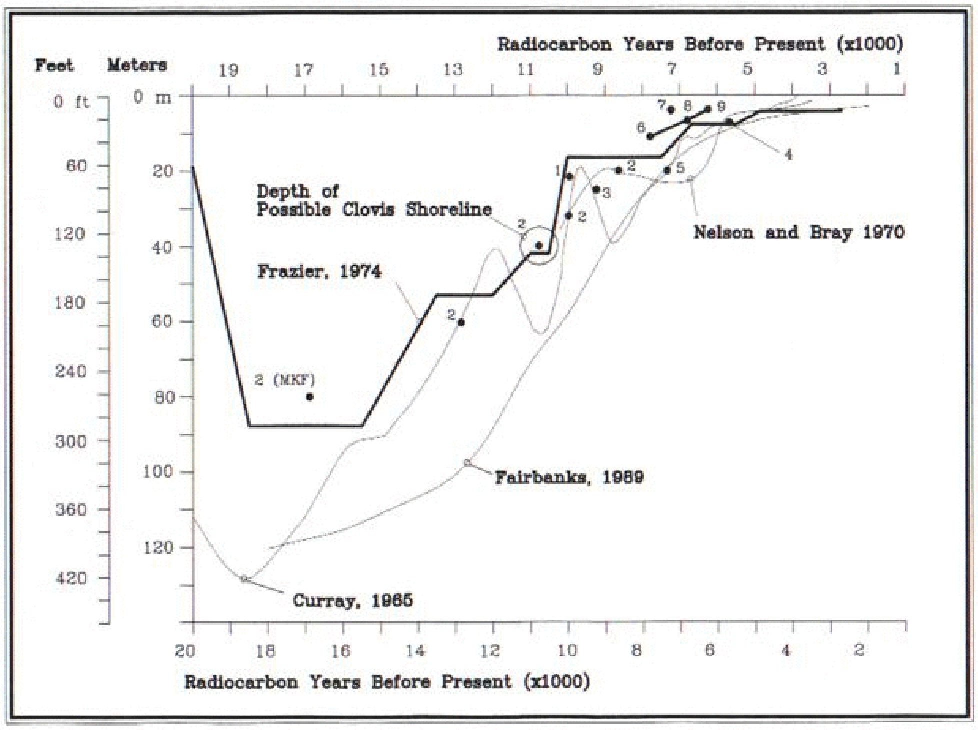

Figure 1C.34. Citations associated with curves are found in the references list. 1 = (Frazier 1974) 2 = (Ballard and Uchupi 1970) 3 – 9 = this research project.

this shelf was probably between 60 and 100-meter depths. The 160-meter isobath is anomalous, and may be a much earlier than the late Pleistocene. The Younger Dryas or Clovis Shoreline, may be at 40 m based on an overlap of western GOM data (Frazier 1974) and the paleocoastal features reported by Ballard and Uchupi at 40 meters (Faught and Donoghue 1997).

A simplified chronology of occupations in northwestern Florida is presented in Table 1C.1. The late Pleistocene-early Holocene cultural sequence in Florida is based on isolated artifacts and stratigraphic occurrences of diagnostic fluted Clovis points (or knives), lanceolate Suwannee points (or knives), and notched Bolen and Kirk projectile points (or knives) in that order. Sites are located on the karst landscape near sinkholes and river channels where there is much chert available. These represent adaptations showing social relationship with Clovis Paleoindians. Middle Archaic occupations are also represented in this portion of Florida, and they are marked by Archaic Stemmed Points. There may be a hiatus of occupation between the two cultural patches. The meaning of this is that sites found nearer to the modern shoreline have potential for occupation by both groups (Paleo / E. Archaic and Middle Archaic). Work farther offshore should restrict the discoveries to only the earlier group (Paleoindian and Early Archaic).

Table 1C.1. Sequence of culture history and sea level rise in northwestern Florida.

Projectile Point Type Name and Possible Depth Limit	
Lanceolate Clovis 11,000 rcybp	**Beginning Younger Dryas** 40 Meter Contour ??
Lanceolate Suwannee Greenbriar 10,500 rcybp estimate	**Younger Dryas** 40 Meter Contour
Side Notched Bolen Big Sandy Taylor 10,000 rcybp	**End of Younger Dryas** 40 Meter Contour
Corner Notched Palmer Bolen Kirk 9,500 rcybp	**Beginning Second Melt-water Pulse** 20 meters ??
Archaic Stemmed Several varieties 7,500 rcybp	**Last Phases of Submergence** 10 to 5 meters

DEEPWATER RESEARCH: SUSTAINABLE SEAS EXPEDITIONS 2000 AND 2001 TO THE FLORIDA MIDDLE GROUNDS

I was invited by Dr. Sylvia Earle of the National Geographic Society to accompany her on the Sustainable Seas Expedition (SSE) of 2000 to conduct work in and around Stu's Ridge at the 80-meter isobath, and the Florida Middle Grounds, between the 40-and 50-meter isobaths seeking paleohuman occupation sites. Stu's Ridge, a well-known grouper habitat, occurs around the 80-meter isobath and exhibits a wave cut notch, formed in a coquina. Wave cut notches are unequivocal evidence for sea level still stand, but we do not know the duration, or the age of the notch. It does have potential to mark the LGM (late glacial maximum) sea level stand.

The Florida Middle Grounds, on the other hand, is composed of high relief, flat topped, carbonate pinnacles with abundant algal growth, mollusks, and coral. The habitat of the Middle Grounds supports abundant marine life. This area is fished commercially and recreationally on a regular basis causing a depletion in marine fauna.

The Middle Grounds has been interpreted as a possible paleoreef feature, probably resulting from vertical reef growth with rising sea levels. An alternative interpretation, that it may be a pinnacle karst feature, is also possible. The tops of the Middle Grounds pinnacles are flat and occur at depths of approximately 30 meters. The eastern margins of the Middle Grounds are at the 40-meter contour, meaning that submerged prehistoric sites are more likely in shallower water, and east of this feature.

In the 2000 SSE cruise most of the research time was spent in the study of marine organisms by biological colleagues, and I spent time getting to know the DeepWorker submarines, studying the navigational maps, and making fathometer observations. One long transect (Figure 1C.35) was made with the fathometer aboard the NOAA Ship *Gordon Gunter,* while underway from Tampa Bay to the Middle Grounds (bearing 291 degrees) at about 10 knots on 12 August, 5:45 a.m. to 9:00 a.m. I observed and recorded positions of channels and rocky outcrops. Fathometers act as weak subbottom profilers, but there is no other record (digital or hard copy) other than bottom depth, latitude and longitude, and the perceptions of the observer.

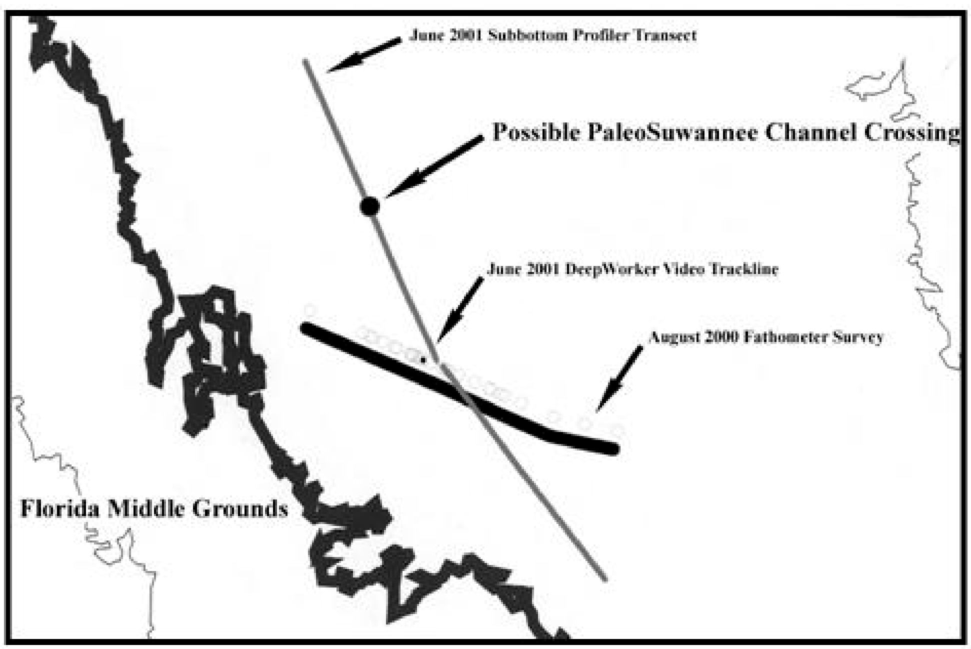

Figure 1C.35. Close-up of Middle Grounds research area and various tracklines outlined in Figure 1C.33. The heavy contour line is the 40-meter isobath. The 2000 fathometer survey and the 2001 subbottom tracklines are shown, as well as the 2001 DeepWorker video transect and the position of the subbottom profiler channel crossing.

Twelve anomalies were recorded as rocky rises, and eleven were channel or sediment filled depressions. Some of these latter features represent either side of a larger channel features. One location was targeted for further investigation. It is a rocky rise with nearby karst depression features analogous to features we are familiar with in our research nearer to the shoreline (summarized below). A topographic map was made from recorded fathometer data collected during nighttime tracklines shown in Figure 1C.36.

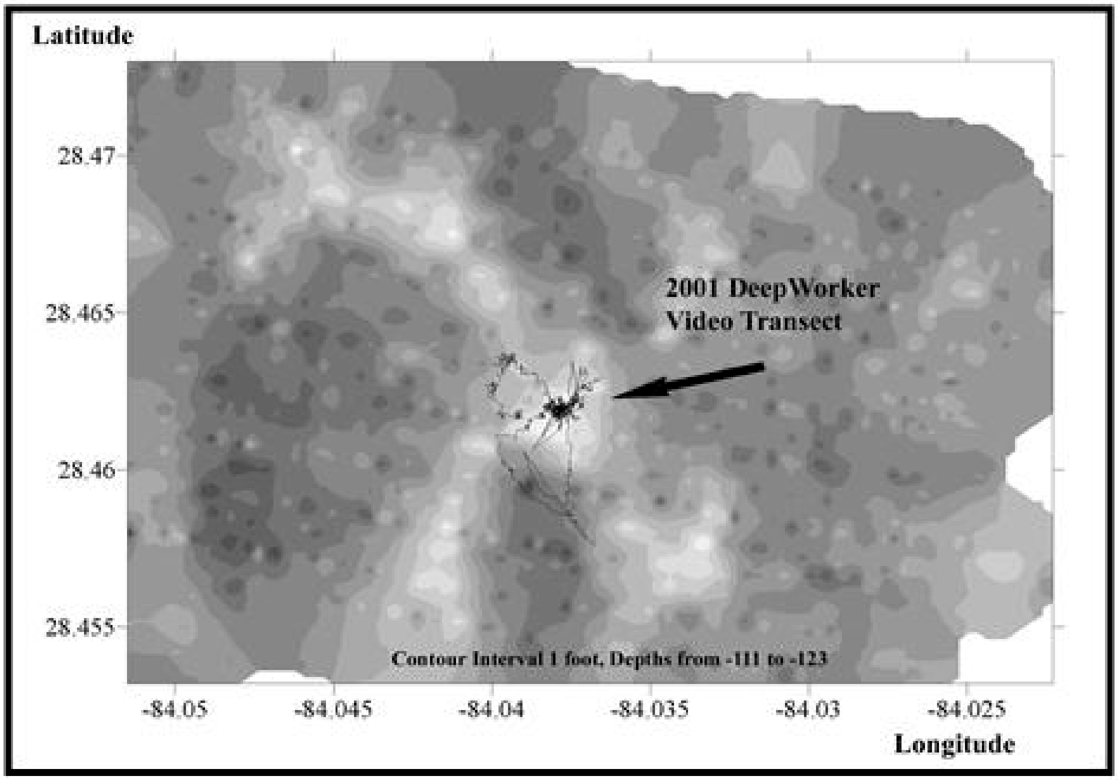

Figure 1C.36. Topographic map of the 2001 target area and submarine tracklines conducted there. Light areas are highs, darker colors lows. Range of topography is between -123 and -111. DeepWorker exploration of this location revealed bedrock exposures of limestone indicative of relict terrestrial conditions, but with significant sea floor life, and fish there now.

We developed an understanding of the needs of an archaeologist while at sea and agreed to try again in 2001. I proposed that we conduct subbottom profiler remote sensing research to identify the mouths of any channels that debouched at 40 meters and to search for artifacts around a potential rock outcrop features identified in 2000 by the study of fathometer returns. In June of 2001, and with the help of the able-bodied crew and scientists aboard the NOAA Ship *Gordon Gunter,* I organized two operations that were focused on the discovery of relict channel features and Paleoindian occupation sites (Figures 1C.33 and 1C.35).

One operation consisted of two nighttime sessions of subbottom profiler remote sensing to discover the position of what was thought to be multiple relict river channel mouths east of the Florida Middle

Grounds. A transect of 41 nautical miles (about 76 kilometers) was completed. Florida State's Program in Underwater Archaeology has a dual frequency BENTHOS Chirp subbottom profiler (2-7 kHz and 10-20 kHz) that was towed at speeds of between three and four knots in two sessions. The Chirp system digitizes the analog sound data to a computer hard drive for later processing. BENTHOS has developed a Windows based software for real time data processing, image display, and manipulation. Signal classification algorithms are included. The track line data is embedded with NMEA-183 formatted data as supplied by a GPS receiver with an accuracy of between 4 and 6 meters.

The subbottom profiler transects were designed to encounter the mouths of rivers that might have come out into what might have been a bay-like feature inside of the Florida Middle Grounds. At the time, I thought there might be several of these crossings in the subbottom profiler pathway. However, only one channel feature was crossed in almost 40 nautical miles of remote sensing (Figure 1C.35). This feature was at the approximate latitude of the Suwannee River along today's coast. Surely, more remote sensing will be needed to confirm this finding or to show it to be the result of sampling bias.

A second research operation was conducted around the topographically reconstructed target from 2000 (described above) with a video transect by a DeepWorker submarine piloted by George P. Schmal of NOAA's Flower Gardens. There are two or three hours of video recording the trackline observations conducted over rocky areas and sandy sea floor bottom. There was no manipulator arm available for this transect, so no samples could be taken of the potential objects. One note of interest is that the biologist piloting the submarine was involved in aiming the camera at larger scale scenes, and scenes that focused on fish and fish behavior. In several frames of the video there are objects that very easily could be artifacts, as we are used to seeing in more shallow water, but until we can get some divers down to the target to look and collect, we will not know for sure. The DeepWorker proved its potentials, moreover, with certain upgrades and a pilot with archaeological experience it could be a great remote sensing tool (this is in no way a critic of the pilot of the sub, rather an interesting note about research attention and focus).

RESEARCH IN SHALLOWER WATER: DEVELOPING THE METHODS NEEDED FOR DEEPER WATER DATA RECOVERY

Since 1986, nine multi-week forays to open ocean localities on the Floridian continental shelf have been organized. Four were organized for doctoral dissertation field research in 1988, 1989, 1991, and 1992 (Dunbar *et al.* 1992; Faught 1988, 1992, 1996; Faught and Donoghue 1997). Another four field sessions have been organized since 1998 as a programmatic approach to submerged prehistoric sites archaeology. These latter four projects have been included in FSU's Field School in Underwater Archaeology. The current incarnation of the research is known as the *PaleoAucilla Prehistory Project* (www.adp.fsu.edu/paleoaucilla).

The intellectual intent of the *PaleoAucilla Prehistory Project* has been to work out from the modern coastline Aucilla River (*known*), to the offshore-*unknown* environment in search of relict portions of that river and sites within its channels and along its margins. The intellectual logic has been to investigate progressively deeper and farther out locations as boats, gear, funding, and staff permit. Most research time has been spent within about 17 km (9 nautical miles) of the modern coastline at depths varying from

12 to 20 feet. We are searching in areas containing channel features, rock outcrops, sea grass beds, and sandy, desert-like plains.

Underwater research has resulted in the retrieval of more than 4,000 chipped stone artifacts from 33 localities (sites) offshore since 1986, samples shown in Figure 1C.37. Of the chipped stone specimens, 1,158 have been found on survey, 1,632 have been retrieved from J&J Hunt, the remainder were collected from two other sites exhibiting hundreds of artifacts each (i.e. Econfina Channel and the Fitch Site in Figure 1C.38). The types and amounts of artifacts that are encountered range from a few isolated chunks of worked chert-quarry debris, to significant numbers of stone tools, biface thinning flakes, and other tool-making and edge-maintenance debris. These latter sites exhibit diagnostic projectile points as well. Based on the presence of diagnostic projectile points and certain unifacial tool types, three locations are late Pleistocene Paleoindian and early Holocene Archaic occupations. Four sites have produced evidence of the middle Holocene Archaic of Florida. Two of the locations indicate both groups: one of these is the J&J Hunt site reported in more detail here, the other is a site found in 2001 called "Ontolo" (Figure 1C.38).

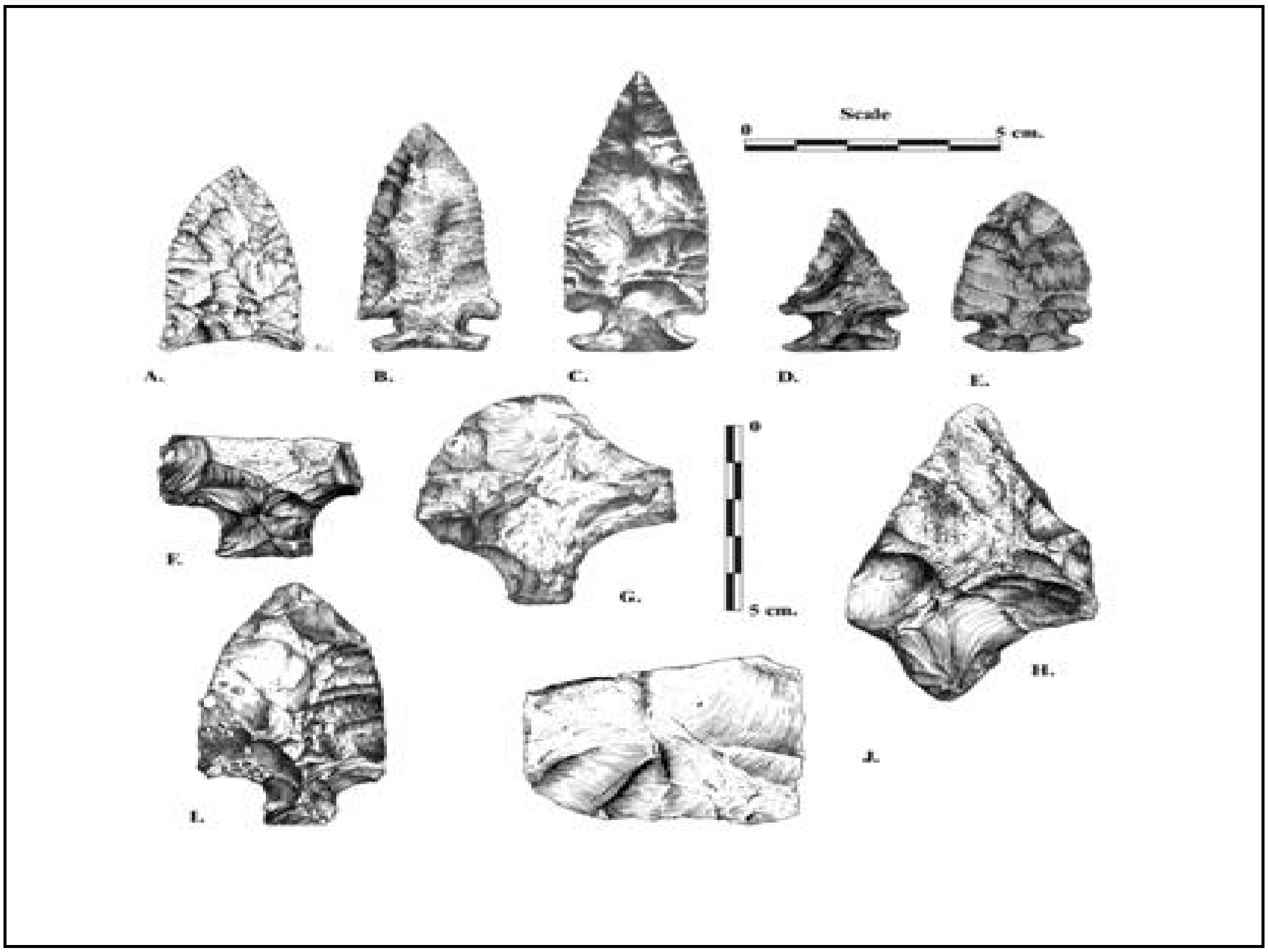

Figure 1C.37. A selection of projectile points found by offshore research. Paleoindian (A,J), Early Archaic(B-E), Middle Archaic(F-I) examples are shown (Drawings by Brian Worthington).

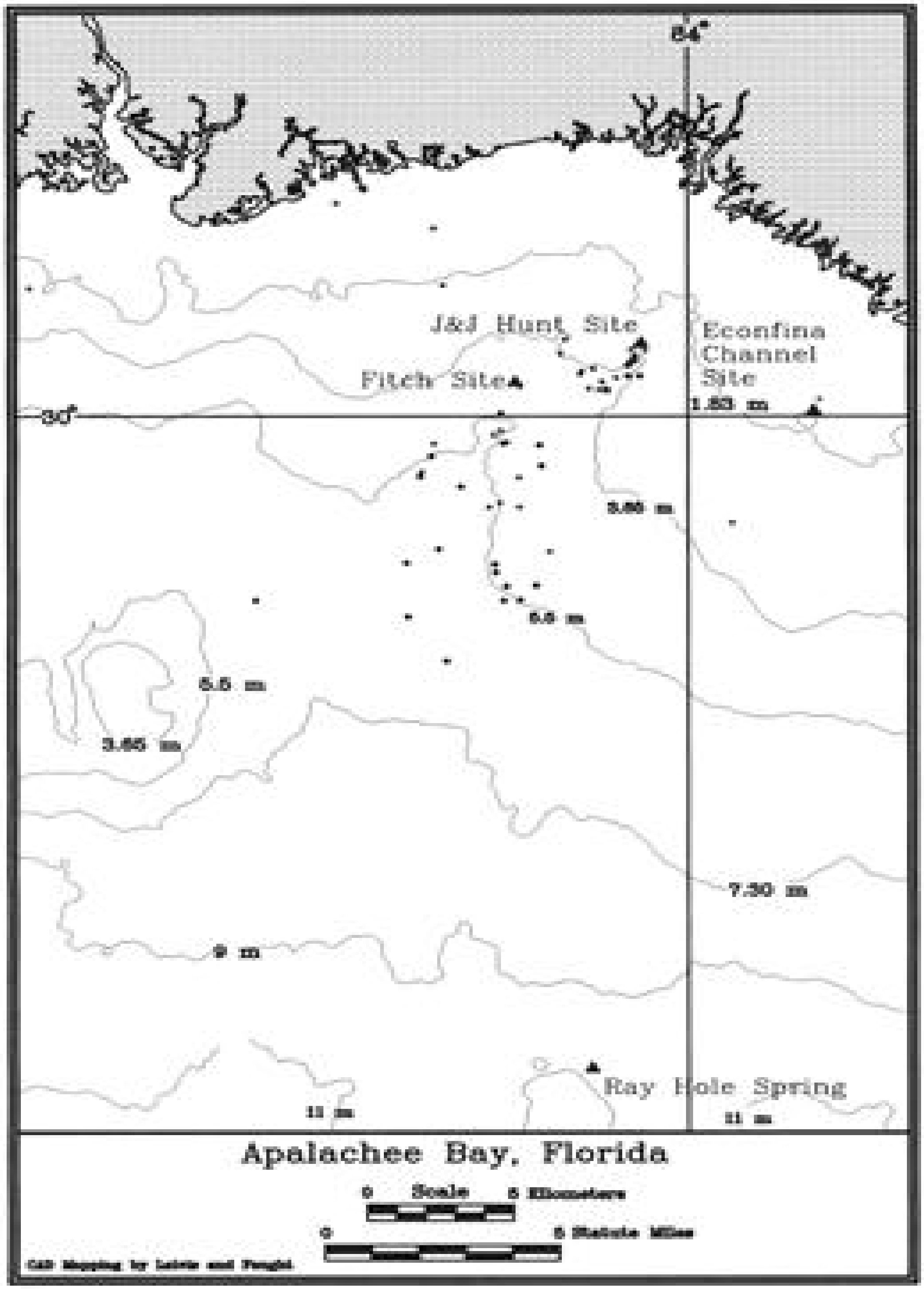

Figure 1C.38. Research area of the Paleo Aucilla Prehistory Project showing the locations of sites mentioned in the text, and sites located by survey operations.

Conducting open ocean operations is a logistical complexity controlled by the size and capabilities of the vessel, or platform to be used at sea. The difficulties with regard to boats (or other working platforms) revolve around adequacy of size, affordability, and availability. Boat sizes of 18 to 23 ft were used during the Ph.D dissertation research to work as far out as 3 nautical miles, but their capabilities in this environment were marginal. Crew sizes were restricted to three to five in each boat—including their dive gear and dredge equipment. There are only emergency overnight capabilities on vessels of these sizes, and no working in seas over about 2 feet.

Larger, more appropriately sized vessels, with galleys, heads, and comfortable sleeping quarters have been leased since 1998 because funds have permitted. We have chartered 50 ft (crew of five), 65 ft (crew of ten), and 72 ft (crew of ten) vessels from Florida State University, Panama City Marine Institute, and Florida Institute of Oceanography. We load the vessels at FSU's Marine Laboratory at Turkey Point, St. Teresa, Florida, and then run four to five hours to the survey areas reported here. The benefits of larger craft cannot be over-stated. Justifications for their procurement include the ability to stay at sea for as many as five days with adequate crew and equipment to run two or three operations simultaneously (remote sensing, diver survey, mapping, coring, or excavations). Crews are rested and better able to sustain safe and effective research activities on these larger vessels.

Just as a stratified random approach is desirable for terrestrial resource management inventory projects, increasing "site encountering success" rates are important factors in locating sites offshore. An initial study area was defined in 1986 that encompasses almost 1,500 square kilometers (585 square statute miles, shown in Figures 1C.33 and 1C.38).

One method of understanding the sea floor bottom with limited resources has been bathymetric enhancement conducted by digitizing the locations of known depth from the NOAA navigation map, recordation in spreadsheet format, gridding in Surfer, and study of depression trends, the likely paths of paleo channel features (Faught 1996). Figure 1C.39 is one such reconstruction of the topography of the seascape around J&J Hunt based on the depths recorded on the NOAA Navigational Map (Apalachee Bay), combined with subbottom profile fathometric data from 1991. The topography of the research area bottom has to be enhanced by a factor of 500 in Figure 1C.39 in order to bring out subtle differentiation.

Subbottom profiler remote sensing is another, better, but more expensive tool for accurately locating the paleo- drainage system offshore and understanding the character of the stratigraphic beds. All told, we have run 216 linear kilometers of subbottom profiler tracklines (111 in 1991 and 105 in 2001). This record crosses channels and other karstic depressions in several places. The equipment used in the 1991 field session included a GEOPULSE 3.5 kHz "Boomer" sounding device with an 2.4 meter hydrophone array, processed by a GEOPULSE 5210A receiver, and recorded on thermal paper. As described above, FSU's Program in Underwater Archaeology now has a dual frequency BENTHOS Chirp subbottom profiler.

Side scan sonar has proven to be another effective instrument for survey of large areas of the seafloor bottom for identifying features which might justify diving or other testing. At the time of this writing side scan sonar operations have accrued 250 kilometers of imagery (with swaths varying from 150 to 200 meters). The use of the side scan sonar for investigating the character of the seafloor bottom cannot be

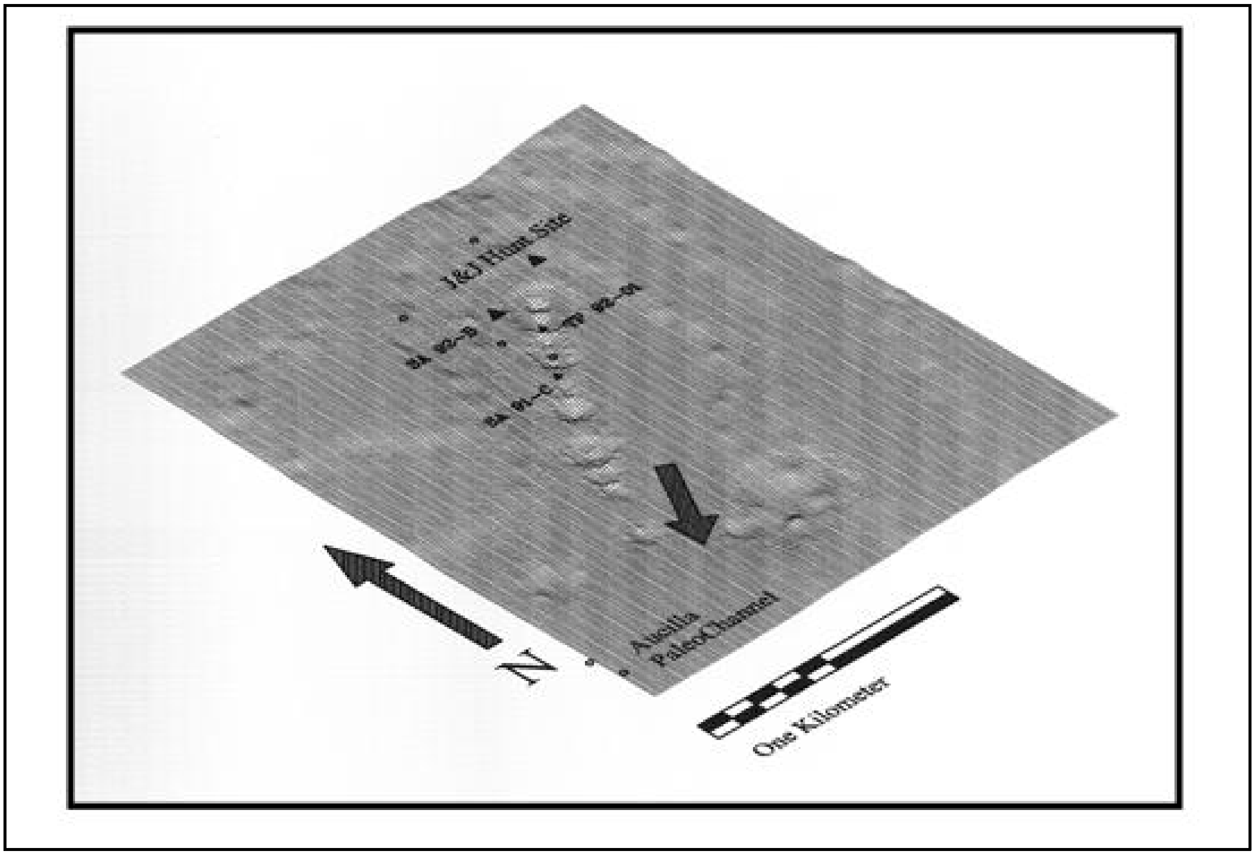

Figure 1C.39. Bathymetric reconstruction of a segment of the PaleoAucilla, showing the location of the J&J Hunt Site and other artifact locations discovered offshore.

understated. Especially when used in conjunction with the use of a third party mosaicking program. The side-scan sonar unit being used by FSU is a Marine Sonic Technology Sea Scan PC "Splash-proof" digital image sonar survey system with a 600 kHz tow fish, a two-gigabyte hard drive, and a Pentium splash-proof CPU. The track line GPS data is embedded in the digital record and is supplied by any GPS system with data output (NMEA-183 type) with an accuracy of between 4 and 6 meters. The swath of the side scan coverage can be set from 100 to 200 meters with the speed of the vessel running between three and four knots.

Before 1998 site locations and remote sensing tracklines were recorded with Loran-C navigational signals, manually plotted on the NOAA Apalachee Bay navigation map, and then digitized onto the CAD map using a State Plane (Florida North Zone) coordinate base (Figure 1C.38). Since 1998 our locations have been recorded in latitude and longitude using DGPS technology, plotted in both GIS and CAD formats by translating the global coordinates into either state plane and UTM coordinates. The differential signals that reach the Big Bend are weak, and therefore most of our GPS data has been without differential control since selective availability was turned off in May of 2000.

Since 1986 this research project has dived at 52 locations and encountered artifacts at 35, a discovery rate of about 67% overall (Faught 1996; Pendleton and Tobon 2002) (Figure 1C.38). In 2001 our rate was six encounters for seven targets dived for a success rate of 85%. Of these artifact encounters, 15 are registered with the Florida State Master Site File because those were encounters of ten or more artifacts (a protocol of the research program). The numbers of artifacts recovered has already been described above.

Initially, all sites are sampled randomly. Controlled hand fanned sampling is employed if artifacts are produced and if time and conditions allow. More intensive excavations, coring, and mapping have been conducted at J&J Hunt, and two other locations (Econfina Channel (Faught 1988), The Dorothy C. Fitch Site (Faught 1996)).

CONCLUSIONS

This paper has briefly described progress made in finding and investigating prehistoric sites in open ocean conditions over the continental shelf of Northwestern Florida. It described initial research in "deep" water near the proposed "Clovis Shoreline" (40 meter), and gave a short overview of abundant research conducted in shallower conditions. I believe that this work can be a useful analog for resource managers in Alabama, Mississippi, and Louisiana, even though the sediment loads there are more substantial. In other areas of the Gulf, many of these sites would be in federal waters, but in this example they are in state of Florida waters to a distance of nine nautical miles. More submerged cultural resource management projects need to consider these kinds of resources, more prehistoric archaeologists need to be able to manage them because of the specialized nature of site prediction, recognition, and analysis, and obviously more sites need to be discovered.

Sustained research in the Florida Big Bend has resulted in practice with several conceptual and methodological techniques found useful in the investigation of marine submerged prehistoric sites. In general, offshore site prediction is best conducted by developing local predictive models; models based on the local terrestrial record of prehistoric sites, local sea level rise history, and local bottom type and past drainage systems. One site prediction model in Florida postulates that artifacts and Pleistocene fauna can be found in river sinkhole features as at the Page Ladson Site, in the Aucilla River. Another site prediction model suggests that sites can be found by taking perpendicular (lateral) transects from the channel margins.

The amount of work that can be accomplished offshore is dependent on sufficient funding, procurement of appropriate boat (or boats), adequate levels of technical support, and the vagaries of inclement weather and crew availability. We have found that use of remote sensing (subbottom profiler and side scan sonar devices) and coring operations are helpful to find paleotopographic features, sediment packages and sites. Induction dredge testing operations have also been effective to investigate sites. One of the more successful approaches is simply having divers in the water seeking artifacts to define sites by hand fanning.

REFERENCES

Ballard, R.D. and E. Uchupi. 1970. Morphology and quaternary history of the continental shelf of the Gulf Coast of the United States. Bulletin of Marine Science. 20(3):547-559.

Coastal Environments, Inc. (CEI). 1977. Cultural Resorces Evaluation of the Northern Gulf of Mexico Continental Shelf. Office of Archeology and Historic Preservation, National Park Service.

Curray, J.R. 1965. Late quaternary history, continental shelves of the United States. Pp. 725-735. *In* Wright H.E., D.G. Frey, eds. The Quaternary of the United States. Princeton University Press.

Dunbar, J.S., S.D. Webb and M.K. Faught. 1992. Archaeological sites in the drowned tertiary karst region of the Eastern Gulf of Mexico. Pp. 117-146. *In* Johnson, L. and M. Stright, eds. Paleo-Shorelines and Prehistory: An Investigation in Method. CRC Press, Boca Raton.

Fairbanks, R.G. 1989A. 17,000-year glacio-eustatic sea level record: influence of glacial melting rates on the younger dryas event and the deep ocean circulation. Nature. 342:637-642.

Faught, M.K. 1988. Inundated sites in the Apalachee Bay Area of the Eastern Gulf of Mexico. Florida Anthropologist. 41(1):185-190.

Faught, M.K. 1992. New evidence for Paleoindians on the continental shelf of Northwestern Florida. Current Research in the Pleistocene. 9:11-12.

Faught, M.K. 1996. Clovis Origins and Underwater Prehistoric Archaeology in Northwestern Florida. Ph.D. dissertation, University of Arizona.

Faught, M.K. and J.F. Donoghue. 1997. Marine inundated archaeological sites and paleofluvial systems: examples from a karst-controlled continental shelf setting in Apalachee Bay. Geoarchaeology. 12(5):417-458.

Frazier, D.E. 1974. Depositional – Episodes: Their Relationship to the Quaternary Stratigraphic Framework in the Northwestern Portion of the Gulf Basin. University of Texas. Copies available from Geological Circular 74-1.

Nelson, H.F. and E.E. Bray. 1970. Stratigraphy and history of the holocene sediments in the Sabine High Island Area, Gulf of Mexico. P. 48-77. *In* Morgan, J. P., ed. Deltaic Sedimentation. Society of Economic Paleontologists.

Opdyke, N.D., D.P. Spangler, D.L. Smith, D.S. Jones and R.C. Lindquist. 1984. Origin of the epeirogenic uplift of Pliocene? Pleistocene beach ridges in Florida and development of the Florida Karst. Geology. 12:226-228.

Pendleton, R. and C. Tobon. 2002. PaleoAucilla Prehistory Project, Report of Investigations #XX. Florida State University.

Rupert, F. and S. Spencer. 1988. Geology of Wakulla County, Florida. Florida Geological Survey Bulletin No. 60.

Stright, M.J. 1995. Archaic period sites on the continental shelf of North America: the effects of relative sea-level changes on archaeological site locations and preservation. Pp. 131-147. *In* Bettis, E. A. I., ed. Archaeological Geology of the Archaic Period in North America,. Geological Society of America Special Paper 297.

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