Deep-water Archaeology in the Gulf of Mexico: A Multidisciplinary Approach

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Abstract
An interdisciplinary research team of archaeologists and biologists from multiple academic institutions, government agencies, and private firms recently completed a scientific study of several deep-water shipwrecks in the Gulf of Mexico (MMS Study 2007-015). The United States Department of the Interior, Minerals Management Service, and the NOAA Office of Ocean Exploration sponsored this multidisciplinary project under the auspices of the National Oceanographic Partnership Program (NOPP).

The shipwrecks were casualties of World War II in the Gulf of Mexico and their depths range from 87 to 1,964 meters. They all were found during oil and gas surveys using deep-tow systems or Autonomous Underwater Vehicles (AUV). Today, these wrecks serve as artificial reefs and their well-documented sinking dates offer biologists a unique opportunity to study the “artificial reef effect” of man-made structures in deep water. Historically, these sites represent an underwater battlefield and a vital historical resource documenting a little-studied area during a crucial period in world history. They preserve information vital to scholarly and popular understanding of the impact of World War II in the Gulf of Mexico, on the American home front, and throughout the world.

Several exciting discoveries and developments were made during the study, including the unexpected finding of well-developed deep-water coral (*Lophelia Pertusa*) thickets along with reef fishes on the *Gulfpenn* wreck site in 545 meters of water. This project also led to the development of a predictive model for establishing better avoidance and investigation criteria for these and other deep-water shipwreck sites. A four-year follow-up project, started in 2008, will examine additional deep-water shipwrecks, including several wooden sailing vessels from the nineteenth century and possibly earlier in waters as deep as 2,280 meters.
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In the summer of 2004 and the fall of 2008, a multidisciplinary team composed of archaeologists, biologists, filmmakers, oceanographers, professional surveyors, and ROV operators embarked on two separate expeditions to document and analyze biological and archaeological aspects of several deep-water shipwrecks in the Gulf of Mexico. The vessels included casualties of World War II, nineteenth century sailing vessels, and shipwrecks of unknown date and origin. Despite their differences in age and type, each of the shipwrecks has at least two things in common: they were discovered during oil and gas surveys and they were lost in deep-water regions of the Gulf of Mexico. Water depths at the wreck sites ranged from 87 to 2,280 meters. The partial objectives at each shipwreck are to determine site boundaries, evaluate National Register of Historic Places eligibility, examine the state of preservation and stability, and study the potential for such man-made structures to function as artificial reefs in deep water.

The Minerals Management Service (MMS) and the National Oceanic and Atmospheric Administration’s Office of Ocean Exploration (NOAA OER) sponsored both studies under the auspices of the National Oceanographic Partnership Program (NOPP). The MMS contracted C & C Technologies, Inc. (C & C), to manage the 2004 project, provide survey support, and conduct the archaeological analysis. The following organizations joined C & C on the 2004 study: microbiologists from Droycon Bioconcepts, Inc., an oceanographer with the University of Alabama/Dauphin Island Sea Lab; marine vertebrate zoologist from the University of West Florida; and marine invertebrate zoologist from the University of Alaska, Fairbanks. The PAST Foundation along with Montana State University’s film department conducted the project’s educational outreach component, which included documenting the study on film, managing a project web site, and developing secondary education curriculum. NOAA OER contracted Sonsub Inc. to provide vessel and Remote Operated Vehicle (ROV) support for the project. Several Masters and Ph.D. candidates from the University of Rhode Island, Texas A&M University, the University of Alaska Fairbanks, the University of West Florida, and Montana State University also participated in the study.
The MMS, NOAA OER, and NOPP also sponsored the 2008/current study with TDI Brooks International as the primary contractor for the project. The current project is a multi-year *Lophelia* and shipwreck study. C & C was contracted to conduct the archaeological component of the project. Other participants include: Pennsylvania State University, Texas A&M University-Corpus Christi, Temple University, Louisiana State University, University of Alabama/Dauphin Island Sea Lab, the US Geological Survey, Sea Vision, and Wood Hole Oceanographic Institute. This project will support Masters and Ph.D. candidates from Pennsylvania State University, Texas A&M University-Corpus Christi, and the University of West Florida.

The diverse team of researchers pooled their expertise to meet the goals of the project and systematically investigate each site using an acoustically positioned ROV. The ROV survey was designed to maximize the efforts and time for both the archaeological and biological studies. Detailed visual inspections provided needed data to document each wreck’s cultural and biological characteristics.

Of the six World War II wrecks designated for the 2004 study, three (*Alcoa Puritan*, *Robert E. Lee*, and *U-166*) were positively identified before the project. The remaining vessels (*Gulfpenn*, *Halo*, and *Virginia*) had only been tentatively identified based on geophysical surveys and limited video documentation. The six wrecks included in the 2008/current study include *Gulfpenn* from the 2004 expeditions and five additional wrecks that were not identified prior to the 2008 field investigations. The *Gulfpenn* is included in the current study because it is one of the top three best sites in the Gulf of Mexico known for the deep-water coral, *Lophelia Pertusa*. The remaining five sites include one other suspected World War II casualty, four historic nineteenth century sailing vessels, and one wreck site that is yet to be explored. This paper will focus on the four deepest wrecks sites from the 2004 expedition (*Gulfpenn*, *U-166*, *Robert E. Lee*, and *Alcoa Puritan*) and one site from the 2008 expedition (The Ewing Banks Wreck).
On May 13, 1942, the tanker *Gulfpenn* (Figure 1) was transiting from Port Arthur, Texas to Philadelphia, Pennsylvania when she crossed paths with *U-506*. The U-boat’s torpedo struck the engine room, destroying that section of the ship, immediately stopping the engines, and killing all personnel in the engine room. The tanker sank stern first, taking only five minutes to slip beneath the waves. Out of the 38 crewmen, only 25 survived the attack (Burch 1942).

In 1994, the wreck of *Gulfpenn* was discovered during a deepwater survey in the Mississippi Canyon Area of the Gulf of Mexico. The wreck was detected at the edge of the survey swath by side scan sonar. Marine archaeologist Laura Landry tentatively identified the shipwreck as *Gulfpenn* (Landry 1994).

In August 2004, the science team collected the first spectacular images of *Gulfpenn*. The wreck is oriented with the bow pointing north-northwest. Water depths range from approximately 553 meters at the bow to 555 meters at the stern. The vessel’s bow stands approximately 19 meters proud of the seafloor as opposed to the aft deckhouse, which rises only 5.5 meters above the ambient seafloor.

The bow and forward section are relatively intact, but the superstructure’s upper works show considerable deterioration. The pilothouse is gone and the bridge’s deck is disintegrating. The ship’s telegraph has fallen over and spans part of the metal framework of the bridge. The superstructure’s starboard side is almost entirely covered by coral colonies (Figure 2).
Extensive damage is present aft of the vessel’s main superstructure. Although the catwalk and piping from the main structure to the aft deckhouse are intact, the hull amidships has partially collapsed. *Gulfpenn*’s aft portion exhibits the most severe damage. The deck of the aft deckhouse is deteriorating and has partially collapsed inward exposing the interior. Almost 11 meters of the stern is missing and the hull ends abruptly in a contortion of mangled metal plating.

An extensive artifact scatter surrounds the wreck site. The main debris zone extends nearly 161 meters northwest from the vessel. The stern’s missing section lies within the main debris field 27 meters northwest of the bow. Other material within this dense debris field includes vent hoods and pipe, railing, twisted metal, and a lifeboat.

Figure 2. Looking down on the upper cluster of *Lophelia pertusa* colonies. These colonies are growing from the main deck to above the top of the pilothouse (about 20 feet vertically) on the forward starboard corner of the superstructure.

Biologically, *Gulfpenn* had higher species richness than any of the other project sites. This wreck was also the deepest site in this study where both corals and reef fishes were found. Microbial concretions were more abundant at this site than at the two shallower wrecks and
coated 30% of the ship’s observable surface. Abundant and diverse invertebrates were observed at the site. Many Spiny crabs (*Rochinia crassa*), Galatheoid crabs (*Eumunida picta*), and Venus flytrap anemones (*Actinoscyphia* sp.). The deepwater coral *Lophelia pertusa* has colonized 12-15 percent of the ship’s surface, including a vertical wall of coral seven meters long and 3.5 meters high along the starboard side of the ship. The fish community was dominated by slimeheads (*Hoplostethus occidentalis*) along with two species of scorpionfishes (blackbelly rosefish (*Helicolenus dactylopterus*) and Atlantic thornyhead (*Trachyscorpia cristulata*). Conger (*Bathycongrus dubius*), gulf hake (*Urophycis cirrata*), and gulf hagfish (*Eptatretus springeri*) were also collected at the site (Church et al. 2007). In September 2008, a research team returned to the wreck site. The team assessed a microbial experiment placed during the 2004 expedition and set a temperature logger near large coral colonies on the bow. The microbial experiment is part of the ongoing deterioration rate analysis study. The temperature readings will assist with the continuing *Lophelia* study at Gulfpenn.

**U-166**

*U-166* was one of 54 German Type IXC U-boats constructed during World War II for long-range fast-attacks (Miller 2000) (Figure 3). The U-boat entered the Gulf of Mexico in mid July 1942 under the command of Oberleutnant zur See Hans-Günther Kühlmann. On July 27, 1942, Kühlmann radioed the Kreigsmarine Command to report completion of mine laying activities and that he was proceeding to hunt shipping (War Diary 1942: 36,53,92). It was the final message from *U-166*.

On July 30, 1942, *U-166* had the large passenger freighter *Robert E. Lee* in its sights. It is not known if *U-166* realized *Robert E. Lee* was being escorted by the naval patrol craft *PC-566*. The U-boat attacked and sank the freighter, then found itself under attack from the patrol craft while watching the freighter sink. *PC-566* destroyed the U-boat in minutes with depth charges.

An oil slick appeared after the attack, but the U.S. Naval Command dismissed it as possibly oil from the freighter. They decided *U-166* escaped the attack by the patrol craft after a U-boat was spotted to the west two days later. The mystery surrounding the U-boat’s location soon grew into legend during the years following the war. The mystery was finally solved 59 years later when *U-166* was discovered as the result of a pipeline survey.
In January 2001 and March 2001, C & C conducted a survey for BP and Shell in the Mississippi Canyon Area near Robert E. Lee’s reported location. C & C performed the survey utilizing C-Surveyor I, its new Autonomous Underwater Vehicle (AUV). In addition to Robert E. Lee, a second wreck was imaged. Several years prior to the 2001 surveys, the second wreck location was identified as another freighter, Alcoa Puritan. C & C’s archaeologists Church and Warren realized the second wreck matched the dimensions of U-166 and put forth the hypothesis that PC-566 sank the U-boat on July 30, 1942, and that it potentially now had been found.

Between May 31 and June 1, 2001, a research team comprised of representatives from BP, Shell, C & C, and the MMS traveled to the Mississippi Canyon Area to determine if the German U-boat U-166 had been located. The first glimpse of the vessel was the unmistakable conning tower of a German U-boat. The 105-millimeter deck gun, and 37-millimeter and 20-millimeter anti-aircraft guns were clearly visible (Figure 4). Post-field analysis and research revealed that each feature matched that of U-166, an early version of the Type IXC long-rang U-boat design.
In October 2003, C & C, in conjunction with the NOAA Office of Ocean Exploration, Droycon Bioconcepts, Inc., and the PAST Foundation, returned to U-166 to conduct a more thorough investigation of the wreck (Warren et al. 2004). Over five days in October 2003, the researchers successfully recorded U-166’s remains in one of the deepest archaeological mapping projects using long baseline positioning. The project’s success was a result of the partnership of academic, private, and government entities coming together as a multidisciplinary research team.

During the 2003 mapping project, 307 artifacts were documented at the U-166 site. In addition to the non-invasive archaeological investigations, the microbiological communities (rusticles) growing on U-166 were documented and the team placed long- and short-term experiments at different wreck sections. Short-term experiments, called BARTS and etch tests, were placed on the wreck site at various locations and left in place for approximately 48 hours. The experiments helped biologists determine the level of bacterial activity at the site. The long-term experiments will assist biologists in determining the wreck site’s biocorrosion rate. The experiments were left on the wreck and checked during the 2004 site visit.

The microbiological study form 2003 determined that microbial activity at the U-166 site was high, and white rusticles were documented, which had been seen previously only on the German battleship Bismarck. The 2004 archaeological investigations undertaken at U-166 continued the 2003 fieldwork. The 2004 research team mapped the southern extent of the site.
and located twenty-three additional artifacts associated with the wreck site. The 2004 team also produced a photo mosaic of the bow from video data collected during this survey (Figure 3).

In addition to the microbial analysis, biological findings revealed abundant invertebrates at the site consisting of red deep-sea crab (*Chaceon quinquedens*), squat lobsters (*Munidopsis* sp.), and Venus flytrap anemones (*Actinoscyphia* sp.). Fish species diversity was low at *U-166* and included cuskeels (Order: Ophidiiformes), Halosaurs (Family: Halosauridae), cutthroat eel (*Synaphobranchus brevidorsalis*), and grenadiers (Family: Macrouridae). A six-gill shark (*Hexanchus griseus*) also was observed away from the wreck at one of the fish traps (Church et al. 2007).

*Robert E. Lee*

![Robert E. Lee](image)

Figure 5. *Robert E. Lee* while in service to the Old Dominion Line (photograph courtesy of the Mariner's Museum, Newport News, Virginia).

In July 1942, the passenger freighter *Robert E. Lee* (Figure 5) was in Port-of-Spain, Trinidad, preparing to transit to New Orleans, Louisiana, with approximately 270 passengers. Six Merchant Marine officers and 131 general crewmembers were aboard *Robert E. Lee* when the vessel left port on July 20. *Robert E. Lee* crossed the Caribbean as part of a convoy, but on the
morning of July 29, broke from the group to rendezvous with the United States Navy Patrol Craft 566 near Key West, Florida. PC-566, commanded by Herbert C. Claudius, was designed for anti-submarine warfare. PC-566’s orders were to escort Robert E. Lee to Tampa, Florida, where the steamer would take on provisions (Charlton 2003, Henderson 1942, USS PC-566 1942).

Around 9:45 P.M. on July 29, Robert E. Lee and PC-566 arrived at Edgemont Key Light near Tampa Bay. When no pilot was available for Robert E. Lee to enter the harbor, Robert E. Lee’s captain decided to proceed to New Orleans. The Gulf Sea Frontier Command ordered PC-566 to continue with Robert E. Lee to New Orleans (Henderson 1942, USS PC-566 1942). Robert E. Lee and the patrol craft transited the Gulf of Mexico on July 30 without incident until the vessels were 72 kilometers southeast of the Mississippi River. Just after 4:40 P.M., passengers and crew on Robert E. Lee noticed an elongated shape about 200 meters off the starboard side of the ship. The passengers who noticed the object argued that it was either a shark or a dolphin. The object reportedly turned sharply towards Robert E. Lee, and the passengers, to their horror, realized the object was a torpedo. The torpedo struck Robert E. Lee’s starboard side aft of the engine room. Lookouts aboard PC-566, a half mile ahead of Robert E. Lee, observed a periscope off the steamer’s starboard side. The freighter settled fast by the stern while PC-566 moved to attack the U-boat. The passengers and crew frantically abandoned the ship. The more desperate passengers jumped into the water. Robert E. Lee’s bow rose out of the water until it reached a precariously steep angle, then the vessel plunged to the bottom of the Gulf (Henderson 1942, USS PC-566 1942, Winnier 2003 and 2004).

Robert E. Lee sank within ten minutes following the torpedo attack. The disaster resulted in the deaths of ten crewmembers and fifteen passengers. While the freighter was sinking, PC-566 crossed the submarine’s suspected location twice and dropped depth charges. The depth charges were close enough to Robert E. Lee’s lifeboats and rafts that the survivors felt shockwaves from the explosions. After attacking the submarine, PC-566 began rescuing Robert E. Lee's survivors. Naval vessel SC-519 and the tug Underwriter arrived to help with the rescue (Charlton 2003, Henderson 1942, and USS PC-566 1942).

In 1986, Shell Offshore, Inc., hired John E. Chance and Associates to conduct a geophysical survey in the Mississippi Canyon Area in the Gulf of Mexico. During the survey they found two shipwrecks in approximately 1,500 meters of water. The only shipwrecks the MMS listed in the vicinity were two World War II casualties, Robert E. Lee and Alcoa Puritan (Prior et al. 1988).
No further investigations of the shipwrecks were undertaken because the sites were not threatened and due to the considerable time and expense involved in conducting deep-tow surveys. Robert E. Lee was correctly identified, but the vessel believed to be Alcoa Puritan in 1986 was actually U-166. The U-boat’s true identity was not discovered until additional survey work in 2001 with improved survey technology and stricter MMS archaeological regulations (Church et al. 2003).

During the 2003 U-166 mapping project (Warren et al. 2004), limited archaeological inspection and microbiological collection was conducted at the Robert E. Lee site. Targets near the wreck as well as those away from Robert E. Lee were investigated, but the debris field to the north was not examined because of time constraints. Two unidentified targets documented by the 2001 AUV survey approximately 700 meters away from the Robert E. Lee wreck site were investigated and identified as two lifeboats. Their extreme distance from the wreck site suggests these boats were possibly abandoned after the survivors in them were rescued.

The Robert E. Lee wreck site was investigated again in August 2004. Robert E. Lee’s wreckage lies 1,481 meters below sea level and is oriented with the bow pointing west. Upon initial inspection, the vessel appears to lie evenly on the sea floor, but at the bow, the ship rises 10.9 meters above the ambient seafloor while the stern stands only 7.6 meters above the sediment. Considering the stern is buried deeper than the bow, it is likely that Robert E. Lee impacted the seafloor stern-first.

The ROV survey of the hull indicated the vessel is largely intact, but the upper superstructure is severely damaged. A light layer of sediment covers the wreck, likely from the initial impact plume paired with 62 years of sediment deposition. Robert E. Lee’s stern is relatively intact. The most prominent structure in this area is a 4-inch gun mounted on the top deck of the fantail. The gun and railing on the stern are covered with biological growth (Figure 6).
The survey of the debris field focused on the northern area because of the lack of data from previous investigations. The artifact scatter extends 150 meters north of the hull’s center. Artifacts within the northern debris field include various items from the ship as well as personal items from the crew and passengers. Shoes, along with other textile remains that appear to have been packed in a suitcase or bag, are located 52.7 meters north of the hull. Stacks of dishes are
located 8.2 meters north of the hull amidships. Bathroom stalls from the vessel’s interior were discovered 24.4 meters off the starboard bow. Lying 11 meters off the vessel’s starboard side is a tangled heap of metal, wire, and miscellaneous debris. A signal bell, rudder controls, and an engine-order telegraph indicate this is part of the ship’s bridge that fell to the starboard side of the wreck. The remainder of the bridge section was found on an earlier expedition 88 meters off the port side of the ship.

During investigations of the southern debris field, two of the ship’s engine-order telegraphs were located. One of the telegraphs, documented on earlier expeditions, is standing upright (Figure 7), but the other is lying face down. The upright telegraph’s face is visible and the controls are set to “Finished with Engines” (Figures 5). The telegraph lying down is 14 meters north of the upright telegraph, but was not documented on previous site visits.

Brown hanging rusticles were numerous on the wreck, occupying 20% of the visible areas. Brown rusticles ranged in length up to 2 meters with widths ranging up to 250 millimeters. A few white rusticles were also documented. Invertebrates observed at the site consisted of deep-sea red crab (*Chaceon quinquedens*), squat lobster (*Munidopsis* sp.), and Venus flytrap anemones (*Actinoscyphia* sp.) attached to the substrate provided by the shipwreck. Several species of shrimp were observed away from the main hull. Fish species diversity was low at *Robert E. Lee*, consisting mostly of the same species observed at *U-166* (Church et al. 2007).
**Alcoa Puritan**

On her last voyage, *Alcoa Puritan* (Figure 8) carried 41 officers and crew and seven passengers. At least six passengers were survivors of the tanker *T.C. McCobb*, which had been torpedoed off Brazil (Conwell 1986, and Browning 1996). In May 1942, *Alcoa Puritan* was en route from Port of Spain, Trinidad, to Mobile, Alabama, with a cargo of 10,000 tons of bauxite. The vessel, under Captain Yngvar Axelstien Krantz’s command, plied the Gulf of Mexico’s relatively unprotected waters when she crossed paths with the German U-boat *U-507* (Moore 1993).

![Alcoa Puritan](image)

Figure 8. *Alcoa Puritan*, United States Coast Guard Photograph, November 11, 1941 (Courtesy of the Steamship Historical Society of America, University of Baltimore).

*U-507’s* first torpedo just missed *Alcoa Puritan’s* stern. The captain ordered full ahead in an attempt to out-run the U-boat, but *U-507* surfaced and began pursuit. Firing with its deck guns, the U-boat slowly overtook the freighter and managed to cripple *Alcoa Puritan’s* steering. The freighter’s crew abandoned ship as the U-boat approached. After the crew was away, *U-507* put a torpedo in *Alcoa Puritan’s* port side, sending her down to the depths (Conwell 1986, and Powers 1942).

Between March and June 2001, about the same time as *U-166’s* discovery, Shell International Exploration and Production contracted Fugro GeoServices, Inc. (FGSI) to conduct a deep-tow survey for a pipeline project. A large shipwreck was discovered on that survey in 1,965 meters of water, 23 kilometers southeast of the *Robert E. Lee* and *U-166* sites (Church et
al. 2003). Marine archaeologist Laura Landry conducted the archaeological assessment for the survey. Based on survey data and historical information, Landry identified the wreck as *Alcoa Puritan* (USDI MMS 2002).

Shell International and Production, Inc. conducted the first ROV investigation of the wreck site on July 3, 2002. The ship’s name “*ALCOA PURITAN*” and homeport “NEW YORK” were observed across the stern. The ROV investigation confirmed the site’s identity and provided valuable data for researchers (Church et al. 2003).

A research team investigated *Alcoa Puritan* in August 2004. The vessel lies in 1,964 meters of water with the bow pointing southeast and stern northwest. The bow stands 4.3 meters proud of the ambient seafloor and is elevated higher than the stern. A seafloor depression around the stern measures approximately 50 meters across and 4 meters deep. The stern is approximately 1.2 meters lower than the ambient seafloor outside the depression.

ROV reconnaissance of the main structure discovered that the hull is mostly intact with moderate superstructure damage. Numerous shell holes are visible along the hull. Moderate damage was observed on the vessel’s starboard side, but the most extensive damage is to the port side. A large hull breach caused by a torpedo is visible near the mud line, below the superstructure’s aft portion. The tear measures 11.4 meters across and extends 2.5 meters above the mud line. Physical deterioration is substantial in this area. Part of the aft bridge roof has collapsed, exposing the interior of the bridge; one of the ship’s bridge telegraphs, lying on its side, is visible through the opening.

The geophysical survey data was centered on the main hull and did not indicate an extensive debris field surrounding the wreck site. The debris observed during the ROV investigation was limited to only four scattered artifacts near the hull. The most notable of these was one of *U-507*’s 105-millimeter shell casings located approximately 112 meters east of *Alcoa Puritan*’s bow. A large debris field, however, was surprisingly discovered near the edge of the survey area, approximately 300 meters north of the vessels location. Investigations indicated the debris field covered a 213-meter by 213-meter area and contained large sections of wreckage, including a ship’s mast and telegraph (Figure 9). The discovery of this large artifact scatter, nearly missed during the investigation, illustrated the need to redefine the estimated range of scattered debris for deepwater shipwrecks.
The site had the greatest density of brown rusticles in the 2004 study with 35% of the observable area covered. The rusticle formations are similar to those observed at RMS Titanic. Multiple microbial test platforms have been deployed since 1998 at Titanic and later analyzed (Cullimore and Johnston 2000). Based on available data, microbiologists developed a model projecting the Titanic’s rate of the deterioration (Ballard 2004). From these parallel rusticle investigations, an estimate of rusticle growth can be made for Alcoa Puritan. Current rusticle development at Alcoa Puritan may be similar to that of Titanic during the mid-1970s when it had been submerged for a similar length of time (Cullimore and Johnston 2005, and Cullimore et al. 2001).

Vertebrates and invertebrates observed at the site were similar to those observed at U-166 and Robert E. Lee. Red deep-sea crabs (Chaceon quinquedens) were the predominant invertebrate collected, but a hermit crab (Paragiopagurus sp.) also was collected. Numerous squat lobsters (Munidopsis sp.), Elaspodid sea cucumbers, and a bright red carid shrimp (Notostomus sp.) were also observed (Church et al. 2007).
Ewing Banks Wreck

The Ewing Banks Wreck is an unidentified wooden sailing vessel, which likely dates to the late nineteenth century. The wreck was discovered during an AUV survey with the C-Surveyor I in 2006 and soon after a second AUV site-specific survey was conducted (Figure 10). The vessel measures roughly 43 meters in length, 11 meters at beam, and has approximately 2.4 meters of relief at one end. Multibeam bathymetry data indicates the wreck site is resting on a south trending slope with an average gradient of 1° (Warren 2006).

This site had not been visually investigated prior to the 2008 expedition. The shape of the hull indicated it was likely a late eighteenth or nineteenth century sailing vessel. The substantial amount of outer hull remains apparent from the geophysical data suggested the vessel was possibly sheathed with copper or similar metal. In September 2008 the research team deployed a Falcon Sea Eye ROV from the deck of the NOAA R/V Nancy Foster and became the first to see the wreck in possibly over 100 years.

Figure 10. Side scan sonar image (410 kHz) of the Ewing Banks Wreck from C-Surveyor II AUV.

Although the identity and history of the wreck is not known, the 2008 field investigation confirmed many of the researchers suspicions as well as offering several surprises. The
shipwreck is sheathed with a cupreous metal, but no samples of the sheathing were collected during the reconnaissance visit to confirm whether the sheathing was pure copper or an alloy like Muntz Metal. The gudgeon and pintle, which is a hinge that holds the rudder to the stem post, is visible, but the pentle is broken at the first bolt and the rudder is missing. The hull appears surprisingly empty providing a rare glimpse at the remnants of the keelson. Heavy accumulated sediments obscure the sparse contents of the hull. No evidence was observed of deck structure, or possible cargo and the absence of these remains are currently a mystery. The visible elements of the hull at the stem and bow indicate a possibly late nineteenth century construction, but no wire rope, chain, windlass, or other machinery typically associated with vessels of that period were observed.

Figure 11. Port bow of the Ewing Backs Wreck.

The bow of the vessel appears to be heavily constructed. The stem post is broad and protrudes over 2 meters off the seafloor. The stem contains substantial iron content (likely iron fasteners), which is evident by the large rusticle formations. The bow is also covered with a surprising amount of *Lophelia* (Figure 11). The iron fasteners holding the bow together have likely diffused out through the wood creating a hard substrate for the coral to attach. The stem
post extending prominently into the water column has possibly aided colonization on that part of the wreck.

One small wood sample was collected from the seafloor along the aft starboard side. The sample was sent to Droycon’s lab for microbial analysis. That analysis revealed the intrusion of copper into the wood, possibly the result of microbial activity as bacteria slowly consume the wreckage. The preliminary findings offer intriguing questions regarding the metal content of the sheathing and the possibility of using the rate of microbial decay for dating shipwrecks.

**Site Distribution**

One archaeological goal of the project was to determine site boundaries for each wreck. When a ship sinks, debris falls from the vessel as it passes through the water column. The material disperses outward as it descends and generally continues to trail off from the main hull as it sinks. The greater the water depth, the further the material will disperse across the seafloor. Therefore, the deeper the water, the wider the debris field or longer the debris trail will be from the main hull. An examination of the debris distribution data from the 2004 Deep Wrecks Project (Church et al. 2007) revealed a trend for the site area to increase proportionately as water depth increases. The maximum distance from the core shipwreck remains to the site’s periphery forms a uniform curve with respect to water depth that closely follows the mean distribution average between distance and water depth (Figure 12).

Using data from the 2004 study (Church et al. 2007), a formula was developed to estimate a radius slightly larger than the suspected boundary size of a steel-hulled shipwreck site in deepwater. The formula states that 20 percent% of water depth plus vessel length is equal to or slightly greater than the distance from the center of the main hull to the edge of the debris field ($0.20wd + vl \geq site\ boundary\ radius$: $wd$=“water depth” and $vl$=“vessel length”).

This formula is based, however, on a small data set consisting of steel-hulled shipwrecks lost under catastrophic wartime conditions, and does not take into account wooden shipwrecks or smaller iron-hulled vessels that foundered at sea. This formula is intended as a working model for future research to build upon and additional shipwreck information from the 2008/current study will be used to refine this model. This model will allow government agencies to determine adequate avoidance criteria at similar wreck sites and will aid researchers in developing survey plans for the future investigations at of these sites.
Figure 11. Correlation between water depth and debris distribution.

Conclusions

The multidisciplinary approach allowed the research team to maximize expensive ship time and draw on a wide range of expertise for a holistic approach to studying the shipwreck sites. The current shipwreck study, which began in 2008, is building upon the groundwork laid during the 2004 project. The biological data collected during these studies is providing an unparalleled amount of information regarding the artificial reef effect of deepwater shipwrecks and deepwater coral colonization. Archaeologically, the studies provide a substantial amount of information on deepwater wreck-site formation processes as well as helping to broaden our understanding of our cultural maritime heritage. The microbial analyses provided a strong bridge between disciplines by helping the archaeologists to better understand the preservation issues concerning the sites and deterioration rates, while at the same time meeting microbiology objectives. Just as the biology studies are aiding the archaeologist in understanding the environment of the site and the
processes acting upon the wrecks, the archaeological and historical information gives biologists
insight about the structure of the artificial reef and the temporal context of its formation.
Through a multidisciplinary approach the knowledge of our maritime heritage, our understanding
of deepwater reefs, and how the two are intertwined has grown substantially. It is hoped that
future multidisciplinary work in this area will continue to further our understanding of deepwater
shipwrecks and the ecosystems formed around them.
References


