

**Deepwater Program: Exploration and Research of Northern Gulf of Mexico
Deepwater Natural and Artificial Hard Bottom Habitats with Emphasis on Coral
Communities: Reefs, Rigs and Wrecks**

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LONG-TERM GOALS

A primary goal of this study is to obtain a robust predictive capability for the occurrence of rich cnidarian (primarily scleractinian coral) hard ground communities in the deep Gulf of Mexico. To achieve this long-term goal, this study will accomplish three interrelated and interdependent objectives

OBJECTIVES

A primary goal of this study is to obtain a robust predictive capability for the occurrence of rich cnidarian (primarily scleractinian coral) hard ground communities in the deep Gulf of Mexico. To achieve this long-term goal, this study will accomplish three interrelated and interdependent objectives:

- 1) Discover and describe new locations at greater than 300m depth in the GoM with extensive coral community development, particularly including *Lophelia pertusa*.
- 2) Gain a more comprehensive understanding of the fundamental processes that control the occurrence and distribution of *Lophelia* and other extensive coral communities at depths greater than 300 m in the GoM through both laboratory experiments and field data collection.
- 3) Document and understand the relations between coral communities on artificial and natural substrates with respect to community composition and function, phylogeographic and population genetics, and growth rates of the key cnidarian foundation fauna.

Upon meeting these three interrelated objectives we will have obtained an understanding of the biology and biogeography of *Lophelia* in the GoM that will result in a quantum increase on our ability to predict the occurrence of *Lophelia* at additional sites based on data such as bathymetry, current models, 3D seismic profiles, and known occurrence of source populations.

APPROACH AND WORK PLAN

In order to meet the objectives outlined above, the following scientific and technical plan is being implemented.

Key individuals participating in this work and their roles are: Dr. James Brooks is the Project Manager and leads in administration of this project. Dr. Charles Fisher (Pennsylvania State University) coordinates the biological studies and interface with the USGS teams and the geological and oceanographic studies. His research group will take responsibility for quantitative physical and photographic collections, community composition and structure analyses, and trophic studies of the endemic and other closely associated seep and coral fauna. Dr. Harry Roberts (Louisiana State University) coordinates the geological/geophysical and oceanographic studies. He develops site selection for exploration of potential new natural deep coral communities and also coordinate the geological and oceanographic deployments and studies. His colleague, Dr. Susan Welsh develops and runs a very high resolution numerical circulation model of the Gulf of Mexico that is used to identify the likely geographic areas and depth ranges for recruitment of *L. pertusa* larvae on the northern slope and compute dispersal kernel trajectories and dispersion of coral larvae by oceanographic current. Dr.

Erik Cordes (Temple University) is responsible for the live *Lophelia pertusa* experiments, gorgonian genetics, and coordinate the phylogeography and taxonomy team. He also works with Fisher's team on studies of coral communities and be responsible for coordination with other outside taxonomic experts. Dr. Ian MacDonald directs the use of digital imagery in the initial site survey and recon cruise, contributes to the site selection process, oversees the use of transect imagery for site descriptions and contributions to faunal inventory, and the deployment and analyses of the time lapse cameras and imagery and the Fisheries review in Year 1 of the project. Dr. Chris German leads on deployments of the time series sediment traps and oversees the integrated analyses of the samples. Dr. William Schroeder assists in the analysis of coral communities on rigs and wrecks and also participates in the over-all study synthesis phase. Mr. Dan Warren and Mr. Rob Church from C&C Technology coordinate the wrecks studies. Dr. Chris German (WHOI) coordinates the time series sediment trap studies, and Ms. Liz Goehring (Penn State and NSF Ridge 2000 office) coordinates the education and outreach activities. Dr. Bernie Bernard, TDI-Brooks Director and Chief Technology Officer coordinates navigation and logistics. Dr. Gary Wolff is project Data Manager and Ms. Suzanne Cardwell is financial and project administrative support.

Dr. Tim Shank conducts studies on the population genetics of several coral associated taxa. Dr. Iliana Baums oversees development of molecular markers for studies of population connectivity in antipatharians and the construction of live *Lophelia* maintenance aquaria. Dr. Stephen Cairns identifies the hard coral samples collected. Peter Etnoyer oversees the classical taxonomy of octocorals and Dr. Dennis Opresko the classical taxonomy and phylogeography of antipatharians. Dr. Roy Cullimore, and Lori Johnston (Droycon Bioconcepts Inc. of Regina Canada) - deterioration rate, preservation and stability of the wreck sites. Dr. Sheli Smith (PAST Foundation) - eighteenth and nineteenth century marine architecture, Dr. Christina A. Kellogg, USGS, microbiology

In addition to this core team we have assembled an international team of collaborators that significantly expands our taxonomic expertise.

Anders Waren (Swedish Museum of Natural History) - Limpets and snails

Dr. Stéphane Hourdez (Station Biologique de Roscoff, France) - polychaete

Dr. Daphne Fautin (University of Kansas) - sea anemones

Dr. Sabine Stohr (Swedish Museum of Natural History)- ophiuroids

Maria Pia Miglietta (Penn State University) – hydroids

WORK COMPLETED

Three cruises have been completed on the *Lophelia* II project. Cruise 1 was conducted on the NOAA Ship research vessel *Nancy Foster* from September 2, 2008 to October 2, 2008.. The cruise mobilized and embarked from Galveston, Texas and returned to Gulfport, Mississippi for the second leg. The second leg concluded on 2 October 2008 and demobilized in Pascagoula, Mississippi. Cruise 2 was conducted on the TDI-BI Ship *RV Brooks McCall* from **17 June – 1 July**, 2009. The cruise mobilized and embarked from Freeport, Texas and demobilized in Gulfport, Mississippi. Cruise 3 was conducted on the NOAA Ship *Ronald H. Brown* from 19 August – 12 September 2009. The cruise mobilized in Key West, Florida. One mid-cruise personnel transfer took place on 5 September. The cruise demobilized in Pensacola, Florida on 12 September 2009.

RESULTS

Cruise1 Leg1 - The Ewing Banks Wreck site was confirmed to be a historic shipwreck site, which likely dates to the nineteenth century. More *Lophelia* was discovered growing on that site than any other nineteenth century wooden wreck known in the Gulf of Mexico. Many of the wreck's attributes, such as the lack of cargo, rigging, or machinery, make it an intriguing mystery. The identity of *Gulfoil* was confirmed on a brief dive at the site and substantial coral colonies were documented. The preliminary examination suggests the *Lophelia* coverage at *Gulfoil* may be more substantial than that documented at *Gulfpenn* in 2004. The dive on *Gulfpenn* allowed the identification of the stern section of the tanker, the microbial experiment placed on the site in 2004 was reexamined, and a temperature logger was placed on *Gulfpenn*'s bow.

Cruise1 Leg2 - During the 12 working days at sea, multibeam data was collected at 13 sites and 10 lowerings of the ROV were completed over 8 different sites. There were two ROV operations days lost to weather conditions, one dive never reached the bottom, and three other dives were ended with under two hours of bottom time due to technical problems with the ROV. During almost every dive the manipulator failed, and this severely limited the capacity to collect physical samples for future genetics work. On most of the latter dives, only one attempt was made to collect samples in areas of high coral diversity and density due to the anticipation of manipulator failure and the extremely long amount of time required to sample (1-5 samples obtained in 1-3 hours).

Cruise 2 –

Surveys were completed using WHOI's AUV *Sentry* at targeted features in the following MMS lease blocks: GB837, GB535, GC600, GC 246, MC885, MC657 and VK826.

Cruise 3 – UWHOI's ROV *Jason II* was used to: explore 4-6 new sites for the occurrence of deep water coral reefs; make collections of *Lophelia* and other corals for genetic and physiological studies, make collections of communities associated with *Lophelia* and other corals for ecological studies; collect quantitative digital imagery for characterization of sites and coral communities; collect spatially explicit physical near bottom oceanographic data; deploy cameras and microbial arrays; reposition larval traps and current meters; collect push cores; and conduct a series of linked archeological/biological investigations on deep water shipwrecks. In addition to launching and recovering *Jason II*, elevators were deployed and recovered approximately six times, four moorings (2 larval traps and 2 current meters) were deployed, and CTD casts were conducted.

Completed 17 dives at 13 natural sites, eight of which had never had visual surveys before. Even with this high degree of pure exploration, corals were found at every site, and new high-density *Lophelia pertusa* communities at three of the sites. These included Garden Banks 535, the western-most *Lophelia* site in the Gulf; Viosca Knoll 906, one of the largest continuous *Lophelia* reefs known in the Gulf and named Roberts' Reef; and a new area of Viosca Knoll 826, a 200 m long ridge hosting a large *Lophelia* reef. At Mississippi Canyon 751, the most active seep known to host live *Lophelia* colonies was investigated. Some high density black coral communities were found at a number of the sites investigated, and a new site with a high abundance of bamboo corals at the northern end of the Florida Escarpment. This site in DeSoto Canyon was a new depth record for six different genera of octocorals including three different species of bamboo corals. The first alkalinity data from the deep Gulf of Mexico was collected, which will guide research into the potential impact of ocean acidification on deep-water corals throughout the rest of the project.

A total of five historic shipwreck sites were investigated, one of which had never had been surveyed by ROV before. The wrecks included 4 metal-sheathed wooden sailing vessels (VK wreck, 7,000' wreck, EW Bank wreck, GC245 wreck) and 1 World War II U-boat casualty (*Gulfpenn*). One of these wrecks, the 7,000 ft wreck, represents the deepest known shipwreck site in the Gulf of Mexico. Investigations at the wooden wrecks detailed them with video and still imagery and placed long and short-term microbiological experiments for corrosion studies. The survey of the *Gulfpenn* was carried out primarily to further document the extensive growths of *Lophelia* corals at the site. Archaeological investigations were limited since this wreck was studied extensively during the 2004 Deep Wrecks I Project. The four metal-sheathed wooden sailing vessels represent not only a cross-section of 19th and early 20th century wooden shipbuilding technology, but their locations and various depths provide a unique opportunity to examine site formation and distribution processes in the Gulf of Mexico's deepwater areas. The study of these site formation and distribution processes will help refine the shipwreck avoidance criteria model developed during the 2004 Deep Wrecks I Project.

IMPACT AND APPLICATIONS

National Security

This program will provide critical information on the exploration, characterization and function of hardground communities to MMS. As manager of the nation's seafloor mineral resources, MMS will use this information to aid in the development of critical energy resources, which may affect domestic energy production.

Economic Development

Increased energy and mineral production will have a positive economic impact at numerous levels in industry.

Quality of Life

Information on the location and functioning of hardground communities gathered by this program will have a positive impact on other ocean users, the natural environment, and the human environment. It will aid in minimizing the environmental impact on sensitive habitat and mitigate any potential damage to these communities.

Science Education and Communication

As a NOAA Ocean Explorer "Signature Expedition," the *Lophelia II* cruise was featured on the NOAA Ocean Explorer website (<http://oceanexplorer.noaa.gov/welcome.html>) and promoted through NOAA OE channels (e.g., VIMS Scuttlebutt listserve). During the cruise, log entries, seafloor and shipboard imagery and seafloor video clips were posted to the NOAA OE site on almost a daily basis. Log entries were authored by various cruise participants as an opportunity to feature individual contributions to the overall research agenda. A Highlights "Best Of" Imagery and Video DVD was also created and provided to NOAA OE.

TRANSITIONS

Data is provided to the ChEss database, which is a component of the Census of Marine Life (CoML) Ocean Biogeographic Information System (OBIS) data base. This work will contribute significantly to the goals of the Atlantic Equatorial Belt studies of the ChEss program, particularly the components that will allow interpretation of our findings in the context of hardground habitats around the world.

RELATED PROJECTS

- Chemosynthetic Ecosystems Study (MMS Report 95-0021). <http://www.gomr.mms.gov/homepg/regulate/envIRON/studies/1995/95-0021%20Vol%20I.pdf>.
- Stability and Change in Gulf of Mexico Chemosynthetic Communities (MMS Report 2002-036). <http://www.gomr.mms.gov/homepg/regulate/envIRON/studies/2002-036.pdf>.
- The Deepwater Program: Northern Gulf of Mexico Continental Slope Habitat and Benthic Ecology (MMS contract 1435-01-99-CT-30991).
- Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico. (Award Number: 1435-01-05-39187) <http://tdi-bi.com/chemo3/chemo-main.htm>
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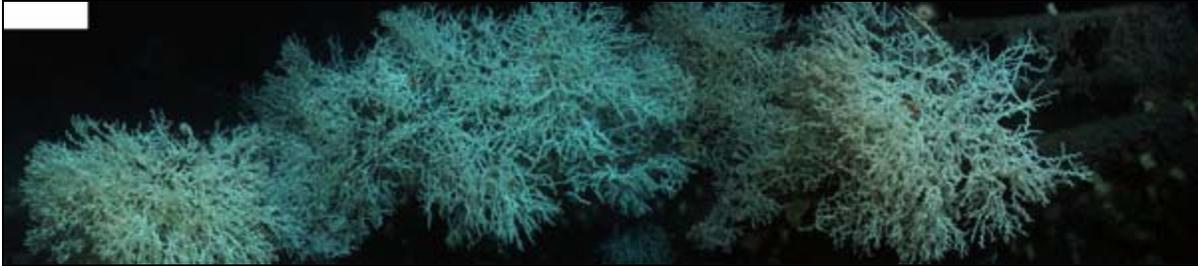


Figure 1. Mosaic of *Lophelia* colonies growing on the rails and superstructure of the *Gulfpen*.



Figure 2. A view of the copper sheathing on the VK Wreck's port side hull.

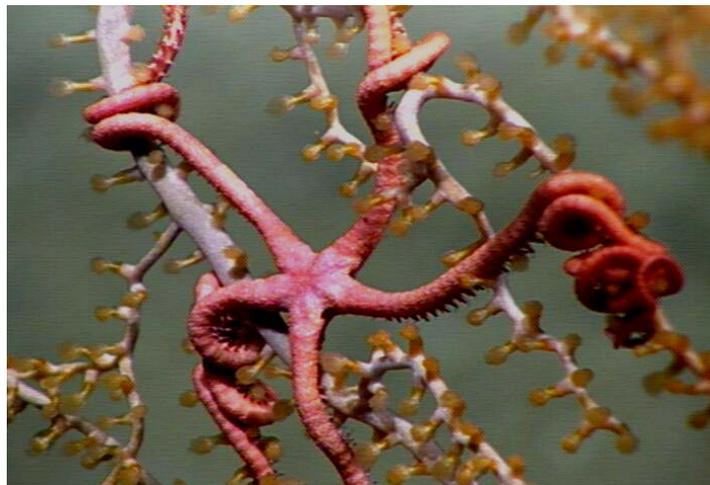


Figure 3. Paramuricid hosting a single *Asteroschema* ophiuroid.

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