

# Islands in the Stream 2002: Exploring Underwater Oases



NOAA Office of Ocean Exploration

## Mission Two: SUMMARY

### Exploration of Outer Shelf and Slope Habitats off the Coast of North Carolina

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This beautiful pale orange coral was collected at the Lophelia coral banks off North Carolina. Very different from the surrounding pale white Lophelia, the scientists had never seen this type of coral before.

## INTRODUCTION

The Islands in the Stream 2002 (IIS02) expedition was designed to explore and investigate the biota of deep-water reefs, rocky outcrops, and hard-bottom areas at the edge of the continental shelf, as well as on the continental slope. As with IIS 2001, the overarching theme of the expedition was to conduct geological, biological, and ecological observations of these habitats, and to collect samples for further analysis as a means to better characterize these little known and poorly understood areas. The expedition used a variety of methods to collect information from the ocean's surface to the bottom, in order to better understand how these habitats function. The information gathered will complement the data collected last year, and will be made available to other scientists and natural resource managers as they struggle to determine how to best manage human activities that may influence the health of the habitat and the species that depend upon it.

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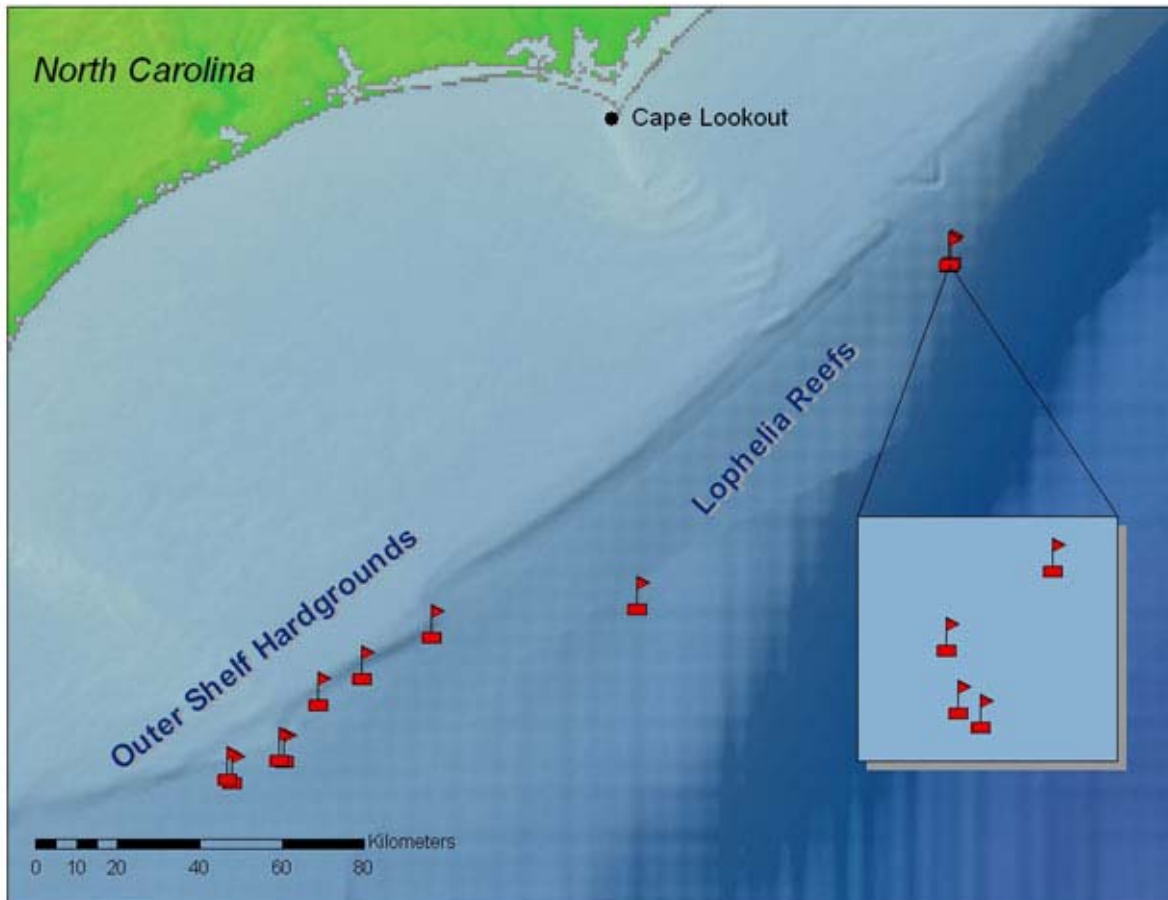
This mission explored two major types of unique and biologically productive habitats along the North Carolina coast, both of which have experienced an increase in commercial and recreational fishing activities, as well as increasing interest for hydrocarbon exploration and development. Given that human activities are expanding into these areas, as well as a general lack of knowledge concerning the habitats, species, and how they function, this research is critical. Furthermore, learning more about these deep water systems will help scientists and natural resource managers understand more about potential connections with shallower water systems.

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The two primary goals of this mission were to study two distinct and unique habitats: 1) the outer shelf hardgrounds in water depths of 80-200 m that are characterized by rocky outcrops, hard-bottom "pavement", pinnacles, and sand channels; and 2) reef banks of *Lophelia*-type corals found on the middle continental shelf in water depths of 400-500 m. The *Lophelia* reefs exhibit undulating hillocks that provide habitat for a diverse community of fishes and invertebrates.

Habitat	Substrate	Description
Outer Shelf Hardgrounds (80-200 m)	"Limestone" outcrops, pavement & rubble with many attached invertebrates	Extensive outcrops, undercut ledges, and rubble piles are interspersed with sand areas and channels. There is a very healthy and diverse community of fishes and invertebrates including hard and soft corals, sponges, tropical and temperate reef fish species (snappers and groupers), and pelagic fish species.
Lophelia Reefs (400-500 m)	Sand, corals and coral rubble overlying sediment mounds	Undulating hills of sand and coral rubble up to heights of 30m are covered with vast stands of living and dead <i>Lophelia pertusa</i> colonies, as well as lesser amounts of other corals. Diverse communities of deep-water reef fish species exist, some very rare and unique. Considerable differences in communities are found at separate reefs.

Description of the two major types of habitat investigated.



Mission 2 dive sites.

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Specific objectives of this mission include the following:

- Determine community structure (mostly fish/nekton) at all study sites
- Collect specimens of all biota as vouchers for photographic, video and visual observations
- Map and define habitats using accurate positioning and locate previously undocumented deep coral banks
- Examine extent to which hard bottom or adjacent habitats are used as juvenile fish nursery areas
- Compare/contrast the proposed marine protected area with neighboring hard bottom habitats
- Collect data to allow scientists to compare/contrast the outer shelf grounds of the South Atlantic with those at similar depths in the Gulf of Mexico
- Compare/contrast in situ observations of faunal structure with data collected from hook and line
- Investigate age distribution of deep water corals, particularly *Lophelia*
- Collect data (diet and stable isotopes) from which a trophic model can be constructed
- Provide education and outreach products

Over 10 days, the science party conducted 12 submersible dives using the *Johnson Sea-Link II (JSLII)* submersible: 7 at various locations along the shelf-edge reef system; 4 at the northern *Lophelia* banks; and 1 at the southern *Lophelia* banks. These dives resulted in over 30 hours of digital video tape of the habitats investigated, approximately 30 hours of audio files, and over 100 samples of sediment, invertebrates, and fishes. In addition, 29 separate sampling activities were conducted from onboard the ship resulting in thousands of individual specimens. By using different types of nets, the science party was able to collect these samples from the bottom, just off the bottom, and from the surface. Unlike last year, no mid-water samples were collected because the ship was unable to deploy the mid-water trawl. Also, both bottom trawls were lost early in the cruise, substantially reducing bottom-sampling efforts.

During this mission, the science party made much progress toward characterizing the northern *Lophelia* banks, as well as the shelf-edge hardgrounds, in terms of habitat, species, and ecology, and was able to collect enough visual information at the southern *Lophelia* bank to determine that the invertebrate and fish community was much different than the community found at the *Lophelia* banks only 80 km to the north. Overall, the habitat in these areas appeared to be healthy, with few exceptions, but there was evidence of fishing activity. Furthermore, observations made while transiting over extensive sand fields to target outcrops indicate that even small areas of outcrops or rubble provide habitat for numerous species. As with the first mission, scientists also observed numerous lionfish or turkeyfish (*Pterois*



The *Research Vessel Seward Johnson* carries the scientific parties for the Islands in the Stream 2002 Expedition. Owned and operated by the Harbor Branch Oceanographic Institute, the vessel served as the platform for the *Johnson-Sea-Link II* submersible.

*volitans*) on some of the shelf-edge hardgrounds. Interestingly, the fish observed were all of similar adult size with no sightings of juveniles. These were the deepest records yet for this invasive species.

The mission to investigate these areas was a success on most counts, with the exception of collecting mid-water data and the loss of all bottom trawl gear (with subsequent potential data). The data obtained – video tapes, audio tapes, specimens, water chemistry – will be assessed in conjunction with data collected from these areas over the past few years in an effort to develop a better understanding of their characteristics, status, and health. In addition, the data will be used in continuing efforts to engage students and teachers.

## KEY FINDINGS AND OUTCOMES

### Area 1: Outer Shelf Hardgrounds

**Reef Morphology:** The outer continental shelf hardgrounds were generally the most spectacular, with steep profiles often covering a vertical range of 10-20 m. These rocky systems offer very complex, bioeroded habitats with abundant coverings of attached plants (depending on depth) and invertebrates. Eroded, undercut ledges often present overhangs and caves that harbor many fishes. While not continuous along the shelf edge, these features are common along the southeast United States from Florida to almost Cape Hatteras, North Carolina.



This Bigeye (top) is a common reef fish at these depths. The submersible crew also encountered groupings of Almaco jacks (bottom) swimming near higher relief areas of the Outer Shelf Hardgrounds.



**Fish Community:** The fish community inhabiting the shelf-edge reef systems is very diverse and sub-tropical in nature. Because the deep, rugged habitat is difficult to sample, this community has been poorly documented. The scientists working to date in this area have “discovered” a number of species that had not yet been reported in this area, or even, in some cases, in United States waters. These reefs have been productive commercial fishing grounds because they are a major habitat for such species as groupers (yellowedge, gag, black, scamp, snowy, speckled hind), snappers (blackfin, red, yelloweye, vermilion), and porgies (knobbed, jolthead, littlehead). Other non-commercial reef fishes fill a variety of ecological niches and include such species as angelfishes (blue, queen, French, rock beauty), small basses (streamer bass, yellowfin bass, threadnose bass), cardinalfishes, squirrelfishes, damselfishes, butterfly fishes, wrasses, and jacks. More mobile, pelagic fishes are also attracted to these reef systems and include mackerels, rays, sharks, “bait” fishes, cobia, and jacks. Many of these fishes reach the northern extent of their ranges in North Carolina.

**Invertebrate Community:** Like the fishes, invertebrates on shelf-edge reefs off North Carolina are generally sub-tropical and have very diverse communities. They are even less well studied than the fish communities, and this mission targeted them for collection and documentation. Many species of sponges, soft and hard corals, bryozoans, and mollusks cover the rocky outcrops, providing food sources as well as making the habitats more complex. Small shrimps, crabs, amphipods, lobsters, echinoderms and numerous others move about and over the reef and occupy almost all possible areas.

**Ecology:** The overall shelf-edge hardground community depends on both outside recruitment of larvae from other reefs as well as larvae produced locally (depending on the taxa). Recruitment dynamics are poorly understood but probably



This deep-sea scallop shell was retrieved by the *JSLII* during a dive at an area off the South Carolina coast. Even though the scallop within the shell has died, the shell itself provides a home for bryozoans, tunicates, serpulids, and algae that grow upon it.

depend on large (e.g., Gulf Stream) and small (local eddies) scale currents. The food webs of these species-rich habitats are complicated, with many interacting steps. Some species feed away from the reefs, while others are totally dependent on the reef structure. Being located on the outer shelf allows these hardgrounds to be somewhat buffered from seasonal temperature extremes, facilitating a self-sustaining sub-tropical community. For many tropical species, North Carolina is the northernmost extent of spawning. The degree of movement or exchange of animals between reefs is unknown. Over the last decade, increased fishing exploitation has forced some changes in the age/size structure of some reef fish populations, driving some stocks to low levels. The overall impact of fishing to the entire community is unknown.

#### **Unique Features and Findings:**

- Non-native, introduced species are invading the area, as evidenced by several observations of turkeyfish (lionfish), a species native to the western Indo-Pacific. They were observed at depths below which they were previously known, and more individuals were observed in one area than had yet been reported in the Atlantic Ocean. This species appears to be numerous, widespread, and well established. Its impact is unknown.
- Low relief, scattered hardgrounds, such as in much of the proposed North Carolina Marine Protected Area, can harbor large numbers of commercially-important species.
- Many species new (unreported) to this area or the United States exist on these hardgrounds. An absence of previous recordings of them is probably due to a lack of sampling.
- Many species purported to be rare, are actually more common, probably also an artifact of poor sampling.
- Complex currents sweep these reefs, having an unknown influence on the biota.

## Area 2: Lophelia Reefs

**Morphology:** Unlike the familiar corals of warm tropical seas, deep-sea corals inhabit a cold, dark world. Lacking symbiotic algae, they are referred to as ahermatypic, which means that they are non-reef building. However, the deep-water ahermatypic coral *Lophelia pertusa* does indeed build extensive reefs (also termed banks, thickets or bioherms) at depths between 400 and 2000 m. Inhabiting the deep sea in many locations around the world, this coral forms one of the most extensive living biotopes. Lophelia reefs and their associated communities of fishes and invertebrates however, are poorly studied, especially off the US coast. Well beyond the depths of SCUBA, and difficult to sample remotely from an oceanographic vessel, Lophelia banks have eluded exploration until recently. Submersibles are required for this work, since direct photography, videography and direct sampling are needed to investigate the deep reef habitat and its resident fauna.

Lophelia reefs are impressive, extending for hundreds or thousands of meters in length, and rising abruptly from the ocean floor as high as 50 m. As dramatic topographic features on an otherwise uniform sea floor, Lophelia reefs are readily recognizable on echo-sounder records. They also return a distinctive reflected acoustic signal, which led to the re-discovery of several reefs off North Carolina, during the U.S. Geological Survey "Gloria" acoustic seafloor mapping program in 1988. Some of these reefs were initially discovered during a series of drop-camera deployments from the *R/V Eastward*



On top is a healthy branch of Lophelia coral sampled from the deep ocean reefs. Below is a close-up of the branch.

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in 1968. Subsequently, a 1993 mission on the U.S. Navy research submersible *NR-1*, in which two scientists aboard this IIS 2002 mission participated, located two large *Lophelia* reefs, paving the way for submersible exploration during the 2001 and 2002 Islands in the Stream expeditions.

Off North Carolina, *Lophelia* reefs occur along a series of narrow ridges along the 400-450 m depth zone. The reefs lie on the northern end of the Blake Plateau, an enormous layer of calcium carbonate sediment derived from the Caribbean. The initial larval coral colonist off the coast of Cape Lookout, NC probably settled on a patch of exposed hard substrate. Also important to early coral colonists were the existence of geological ridges along the continental slope. Such ridges generate local bottom current acceleration and local eddy fields, both important to filter-feeding coral colonies such as these. Once a colony was established, new bushes propagated from fragments that broke off and fell to the seafloor. Mature coral



This galatheid crab was brought aboard the *R/V Seward Johnson* from 430 meters. It was found sitting within a mass of *Lophelia* coral.

bushes grow to several meters in diameter and 1-3 meters high, with closely intertwining and anastomosing branches, but *Lophelia* is fragile and easily broken by strong bottom currents or contact with large fishes (a process observed from *JSLII*). Also, the coral bush is under constant attack from boring organisms, including a boring sponge. Such bio-eroders weaken the base of a colony over time until it finally tumbles over.

During the *JSLII* dives, it was found that the sediment surface for hundreds of meters around a *Lophelia* reef was carpeted with a dense layer of living and dead coral rubble, a distinctive habitat in its own right. Over thousands of years, a mosaic of coral banks and rubble field biotopes has taken shape, providing a 3-dimensional matrix that is home to many species of fishes and

invertebrates. The living corals were readily distinguished by their white branches. They are reported to be slow growing (1-2 mm per year) and able to reach very old ages, but the reported ages, ranging from hundreds to thousands of years, cannot be confirmed in the western Atlantic. Even the gray-to-black dead branches are important habitat. Several types of crabs, anemones, brittle stars, sponges and fishes make their home among or within the dead coral rubble. One tiny hermit crab was observed living inside a hollow calcareous cup once inhabited by a living coral polyp. The crab used its larger claw like a trap door, sealing off its adopted coral house.

In contrast to the high-diversity coral reefs of tropical seas, deep reefs are distinctive in being formed almost exclusively by one coral species, *Lophelia pertusa* (although other species may play an important role in some locations). Their slow growth and fragile nature make *Lophelia* reefs highly vulnerable to irreversible damage from human disturbance. Hazards to *Lophelia* include commercial fishing (bottom trawls, bottom longlines, traps, and weighted angling gear), ship anchoring, subsea cable and pipeline laying operations, and hydrocarbon exploration and development activities.

**Fish Community:** The *Lophelia* coral habitat supports a diverse and distinctive array of fishes and invertebrates. One fish in particular, commonly called the coral hake, *Laemonema melanurum*, seems to be found only within the coral reef habitat. Its distinctive black fin markings contrast strikingly with the bland color pattern of its smaller relative *Laemonema barbatula*, which prefers the rubble field habitat. Other



This deep-sea fish called a green eye exhibits a beautiful iridescent pattern around its large eyes and head.

distinctive fishes closely associated with the coral bush biotope are two species of slimeheads, *Hoplostethus atlanticus*, a bronze-colored, slow-moving fish that hovers near the base of individual colonies and *Beryx splendens*, a large deep red fish that swims with its pectoral fins like a wrasse. Most impressive is the thick-bodied, two-meter long, blue-black conger eel. Shy and reclusive, this ambush predator retreats slowly into the coral matrix when approached. It shares its apex predator role with Mead's catshark, a rarely seen one-meter long shark with dark saddle markings spaced along its back, and other small sharks. Unlike the conger eel, the catshark is constantly on the move, patrolling the coral realm for likely prey. Some large and commercially valuable fishes, such as wreckfish (*Polyprion americanus*), occur on some coral banks, and the status of their populations is unclear. Overall, fishes are not as abundant on *Lophelia* reefs on the North Carolina slope as was expected. The data collected so far by this science party however, are still limited, and they have discovered that there are significant differences in fish communities among various coral banks.

**Invertebrate Community:** Invertebrates seem to be the dominant inhabitants of the deep coral banks. Existing in enormous abundance, one small pink brittle star species inhabits the interstices of the coral matrix. When the manipulator arm of the *JSLII* hoisted a small coral bush into the collection



Spidercrabs, such as the one shown here, are very common perched atop the *Lophelia* bushes.

basket, thousands of brittle stars streamed from the coral. The food source of these echinoderms is unknown, but it may consist of organic current-borne particles trapped by the coral matrix. In contrast to the cryptic brittle star, another dominant invertebrate, the large red galatheid crab, perches in plain view atop the coral bushes. These crabs probably gain a feeding advantage by perching atop the coral bushes, getting their claws higher in the water column to intercept food particles. This crab also exists in high population densities, as do certain species of anemones that use the tips of *Lophelia* branches as footholds. Large spider crabs are evident moving among the coral bushes and through the rubble fields.

**Ecology:** On the bleak, current-swept plain of the Blake Plateau, *Lophelia* reefs are true biological oases in the deep-sea. The degree to which coral banks along the Blake Plateau are ecologically linked remains unknown. Not only does the coral provide shelter for large mobile animals and the hard substrate allow attaching invertebrates the opportunity to gain a foothold, but the reef also provides an unusual zone of biological/physical interaction. For example, several species of tiny mesopelagic fishes, typically thought of as open-water, deep-sea inhabitants, regularly swim over and through the coral habitat in large numbers. These planktivores are probably attracted by eddy fields that are generated as bottom currents sweep through the coral matrix. Eddy fields slow down and trap plankton, providing a favorable feeding zone for planktivores. In turn, the planktivores become prey to benthic predators that they would otherwise never encounter. During one *JSLII* dive a large, long-clawed red lithodid crab was observed deftly grabbing and devouring a silvery hatchetfish. Until this observation, it was uncertain what the abundant, deceptively immobile lithodids fed upon as they perched atop the coral. However, direct submersible observations revealed that any small fish cruising through the coral must run the gauntlet of nimble claws. The crabs are well-adapted ambush predators, moving very quickly when required.

**Unique Features and Findings:**

- Deep coral banks seem to be more common and much more diverse than previously indicated.
- There is a certain degree of diversity among banks, with different fish communities seeming to populate different banks.
- There is evidence of fishing activity on some deep coral banks, but impacts to habitat and fish populations are unknown.
- Invertebrates seem to dominate the overall fauna of the deep coral banks.
- Midwater fishes also use the habitat, potentially transferring energy back up through the water column.



This brittle star is one of the many invertebrates that inhabit the *Lophelia* reefs.

**Other Outcomes**

**Habitat Mapping:** Using both the surface ship (large areas) and the submersible (small areas), we gathered data on topography, surface ruggedness and profile, and general area bathymetry.

**Ocean Explorer Web Site:** Near real-time postings – stories, pictures and video clips - from mission scientists and educators describing daily at-sea activities and discoveries. Users from all over the world followed the expedition daily.

**Education and Public Outreach:**

During the Mission

- one teacher-at-sea and one co-Principal Investigator whose primary job was education participated aboard the ship,
- lesson plans and hands-on activities that were linked to shipboard research were posted on the North Carolina Museum of Natural Sciences (NCMNS) website ([www.naturalsciences.org](http://www.naturalsciences.org)),
- daily data and logs were posted on the NCMNS website,
- more than 200 questions were answered by scientists at sea via the internet from around the world,
- more than 20 hours of research operations were recorded via High Definition video, and
- newspaper reporters were able to visit at sea.

Post-Mission

- the science team participated in an open house in Charleston, SC that was organized by the NOAA Office of Ocean Exploration,
- presentations by both participating educators were made to various audiences,
- the Islands in the Stream website will be permanently posted on the NCMNS's server,
- a High Definition production was created for the NCMNS,
- a High Definition TV production was created for Capitol Broadcasting
- a presentation on the use of GIS during GIS day, a worldwide celebration of GIS meant to raise awareness about this technology, and
- newspaper stories written about the mission.



## MISSION RATIONALE

Many marine habitats have been overlooked or only cursorily examined. Among those are the outer continental shelves and continental slopes, which are important frontier areas. These regions, generally 100-1000 m in depth, offer a transition from the continental shelf to the true deep sea. Commercial and recreational fishing are pushing further into these areas, and hydrocarbon exploration and development are now able to exploit these depths. Off the coast of North Carolina there are several types of unique and productive habitats between 100-1000 m that can only be adequately sampled with non-conventional methods, such as manned submersibles, because the bottom topography is extremely rugged and/or extreme currents overlie the habitats. Based on past projects and expeditions, this mission targeted these largely unstudied areas for exploration. The strategy of whole-water-column sampling with multiple techniques helped to also identify the full spectrum of fauna and associated hydrography at each study area.

The science party examined poorly-studied outer-shelf hardgrounds (80-200 m) and middle-slope deep coral (mostly *Lophelia*) banks (400-500 m). Throughout most of the study area, these two systems were separated by only a few kilometers. While they share the similarities of being high-profile reef-like structures composed of hard substrates and overlain by the Gulf Stream, they appear to be vastly different in community structure and faunal interactions. There are however possible links between these two systems. Thus, these two "reef" types present a unique opportunity to compare/contrast paired systems in a logistically feasible sampling scheme. This work also allowed comparisons with some northeastern Gulf of Mexico study sites called the "Pinnacles", which are found at similar depths and share many of the same species as the North Carolina sites. The habitat structure of the Pinnacles, however, appears to be different, suggesting that the ultimate productivity of each system has a different base. The data collected will help support and document a proposed Marine Protected Area in this area off North Carolina.



This red sea star was found in the Outer Shelf Hardgrounds area. It was one of the many items collected for further study and sits here in the collection basket of the *JSLII*.

A primary long-range research goal of the science team is to define demersal fish community structure, including trophic interactions, down the outer continental shelf and shelf/slope depth gradient, and across geographic regions along the slope of the southeastern US. The goals for this mission were to

- 1) define faunal composition and transition down the bathymetric trend of deep reef types found off North Carolina, an area for which the science team had already developed a base of information,
- 2) document and quantify sessile invertebrate cover and non-living habitat parameters on deep reefs within reef types, and across reef types proceeding down the bathymetric gradient, and
- 3) collect physical data about the benthic habitat and water column to enable construction of hypotheses concerning the mechanisms underlying control and differentiation of community structure.

## OPERATIONS AND SCHEDULE

This mission combined several distinct types of operations in order to obtain a comprehensive view of the areas being investigated. Specific activities included dive operations using the *JSLII* submersible, surveying operations using the *R/V Seward Johnson's* fathometer, net and dredge operations, dip netting operations using night lights, and hook-and-line fishing. The combinations of operations were designed to maximize use of the submersible and ship. The data collection activities were conducted 24 hours per day, with the exception of four days when the weather was extremely rough. A brief description of each operation is provided.

### Typical Sub Dive

- launch from ship
- descend through water column and transit to target site
- general reconnaissance and sample collection and "points" within target location, video transects
- samples included fishes, invertebrates, sediment, corals
- ascend through water column and recovery by ship

**Surveying Operations:** Building on existing bathymetric data sets, including data collected using a fathometer on previous cruises in these areas, scientists conducted additional fathometer surveys to verify information, add data to their ArcView GIS, and to identify dive targets.

**Submersible Operations:** The *JSLII* submersible was able to dive down to 1000 m and was capable of carrying a pilot, a support technician, and two scientist observers. In addition to two video cameras and digital audio recorders that scientists carried onboard, the submersible was equipped with a color digital video camera for collecting video and still images of habitat and species. The submersible also collected data on environmental conditions using a CTD, and collected samples with a manipulator and suction device. Through-water acoustics provided information about where the submersible was located with reference to the ship and the sea floor.



A catch of various organisms (top), and a pencil urchin, all brought up from the deep ocean using an Otter trawl.

**Shipboard Sampling Operations:** Members of the science party were split into three shifts to conduct complementary sampling operations 24 hours per day. Sampling occurred whenever the submersible was not operating, except for periods of rough weather. Shipboard sampling operations included:

- *Otter trawls* to collect specimens of benthic fishes and invertebrates;
- *epibenthic dredges* to collect specimens of benthic fishes and invertebrates;
- *neuston net tows* to collect specimens of fishes and invertebrates from the top meter of the ocean's surface, especially those associated with the *Sargassum* community;
- *plankton trawls* to collect phyto- and zooplankton from the ocean's surface;
- *dip nets* to collect specimens of fishes and invertebrates, primarily species of flying fish, from the ocean's surface mainly during night lighting operations; and
- *hook-and-line fishing* to collect pelagic and bottom

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species, primarily dolphins, for stomach content and isotopic analysis.



The large aluminum frame of the neuston net is 2 meters high and 3 meters wide. Here the net is being deployed off the starboard side of the *R/V Seward Johnson*. The yellow floats on top of the frame insure that it will not sink any lower that 1 m below the surface.

Efforts to deploy a tucker trawl to collect specimens of mesopelagic fishes and invertebrates from the water column were not possible with this ship. Also, the early loss of both benthic trawls hampered data collections.

**Lab Operations:** Onboard lab operations included the sorting, preservation, and storage of specimens. Additionally, unique species, or specimens that were specifically targeted, were measured and photographed. Some target specimens were sampled for later analysis of stable isotopes.

DATE	LOCATION	HABITAT TYPE	JSLII	Fathometer	Plankton	Neuston	Dip	Otter	Epibenthic	Hook & Line
5-Aug	Transfer	N/A								
6-Aug	Steeple	Shelf-edge Hardground								
7-Aug	Transit	N/A								
8-Aug	Cape Lookout	Sand and Rubble								
9-Aug	Cape Lookout	Sand and Rubble								
10-Aug	Northern Lophelia Banks	Lophelia Coral Reef								
11-Aug	Northern Lophelia Banks	Lophelia Coral Reef								
12-Aug	Northern Lophelia Banks	Lophelia Coral Reef								
13-Aug	Southern Lophelia Banks	Lophelia Coral Reef								
13-Aug	Proposed MPA	Shelf-edge Hardground								
14-Aug	Proposed MPA	Shelf-edge Hardground								
15-Aug	Proposed MPA	Shelf-edge Hardground								

Operations and locations during each day of the mission.

## SAMPLING PROTOCOLS AND PROCEDURES

Standardized methods were used when sampling in order to allow data comparisons between areas and years. The protocols used have been developed over several years of research in the Gulf of Mexico and off the southeast coast of the US.

### Submersible Procedures

The submersible would typically descend through the water column as quickly as possible, with the scientists taking notes of the surrounding fauna. Once settled on the bottom, and if fish abundance was not too low, specimen collection would begin, making use of the submersible suction system, the chemical rotenone, trap deployment, and grab. The amount of time spent on this activity and the amount of time spent moving the submersible to optimize collections, was at the discretion of the scientists on board. After some collection effort, the video camera was then moved to a pre-determined pan/tilt position and the submersible ran 3-5, 10-minute video transects. The transect methods followed those defined by Sulak and Ross (1996) when the bottom was relatively regular, and Parker and Ross (1979) when the bottom was more rugged. Both methods yielded quantitative data, but the methods sometimes needed modifications in heavy coral or rock areas, or if camera angles could not be maintained. Visual observations were also recorded to supplement the video data during transects, and additional specimen collection usually occurred once these transects were complete. At several locations and depths, plugs of sediment and benthic invertebrates may have been collected for stable isotope analysis. Scientists in the bow and stern compartments also had digital audio tape recorders, digital video cameras and still cameras for use within the sub throughout the entire dive.

### Non-Submersible Sampling Procedures

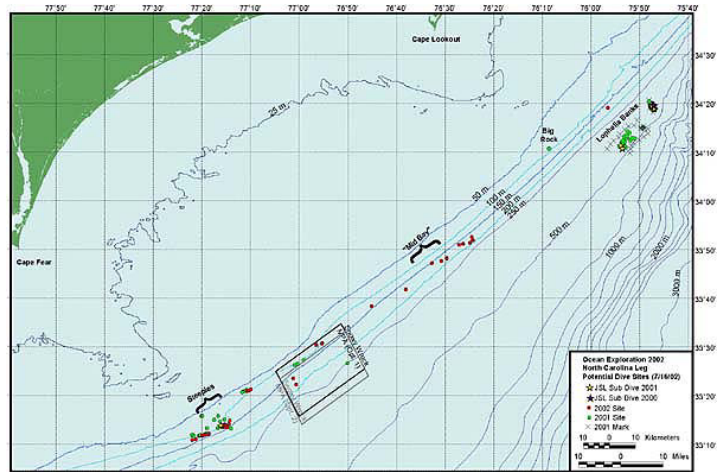
Discrete-depth tucker trawling was not possible during this mission due to ship limitations, however, this is usually a very useful instrument to obtain discrete-depth midwater samples. Other non-submersible sampling activities included a 3x2 m neuston net that was towed at the surface of the water from the side of the ship for 15 minutes at a time, and was often used to sample the sargassum community. A 1-m plankton net was also pulled periodically for short tows on the surface. During several night watches, night lighting was conducted from the side of the ship. For this activity, lights were hung from the port side of the ship, and many species, such as large squid and flyingfishes that are not easily captured by other means, were attracted to the vessel where they were collected by dipnets and cast nets. Hook and line gear was used in a few locations. During days when submersible operations did not take place, as well as at night, a small mesh 5 m headrope bottom trawl was deployed. This net was towed for 30 minutes in the vicinity of both the *Lophelia* reefs and the outer shelf hardground reefs, while not being towed directly over them. This gear was effective for documenting near-reef fauna in more detail than what may have already been identified by the submersible or video camera. It was also useful for collecting juvenile fishes that inhabit the near-reef algal and rubble habitats. Unfortunately, few of these tows were conducted since both trawls were lost early in the cruise due to ship errors. An epibenthic dredge with a small mesh liner was pulled for 30 minutes at a few locations. This gear was used to collect bottom fauna, particularly small invertebrates near the reef structures.



This very dangerous Portuguese Man-O-War jellyfish was caught during "night lighting" sampling.

## SITE AND TARGET SELECTION

Based on past studies, as well as local knowledge, the science team was able to identify and target potential deep reefs for exploration. These target locations were plotted in an ArcView GIS system prior to the mission and each was prioritized according to its probability of being a successful dive location. They were also prioritized according to their probability of being interesting or productive habitats. High profile areas were generally emphasized. Because many of the target sites had not been visited by a scientific vessel, there was some uncertainty about being able to find them. In general, the outer shelf reef systems were more continuous and better known (partly due to commercial exploitation), while the *Lophelia* reefs were much more difficult to locate. In addition, certain dive sites were deliberately selected because they were located within the boundaries of a proposed Marine Protected Area (MPA).



This cruise planning chart of research areas was created with GIS and GPS application software. Different colored dots indicated potential sampling stations.



This submersible, the *Johnson-Sea-Link II*, was used for all of the dives conducted during this mission.

During the mission the target site locations were refined by performing transects of the area using the ship's single beam depth sounder. These data were logged directly into a computer for future bathymetric maps. Using the full GIS system that was aboard the ship, maps were being updated and new maps printed as the cruise progressed. Multiple passes over a site from various directions were required before choosing the final "best" target dive site. This strategy was also used when choosing sites to pull bottom gear (trawl, dredge) to avoid gear damage or loss.

Non-submersible, non-bottom sampling sites were often selected based on location of current fronts (e.g., Gulf Stream), proximity to bottom target sites, or location of sargassum. Beginning points were then given to the ship as locations to launch gear such as plankton nets, neuston nets, or dip nets.

### Typical Day

0000-0600	shipboard sampling and fathometer runs
0600-0800	fathometer runs and dive site selection
0800-1230	submersible dive 1 and sample processing
1230-1500	shipboard sampling, fathometer runs, and dive site selection
1530-1930	submersible dive 2 and sample processing
2000-0000	shipboard sampling and fathometer runs

## INITIAL IMPRESSIONS

### Area 1: Outer Shelf Hardgrounds

Despite years of commercial fishing exploitation, the outer shelf hardgrounds of the Carolinas are still productive habitats. These diverse and complex areas are an important analogue to the tropical coral reef based communities of the Bahamas and Caribbean, and while different in many aspects, they share certain attributes of community structure such as complex food webs, high species richness, and obligate biota. One of the most striking suggestions from this work however, is that the overall ecology and many components of individual life histories of species from these areas are very poorly known. Questions such as how the reef-oriented species use habitat and to what extent they are controlled by habitat characteristics, are virtually unanswered for these systems. This is especially true for the non-commercial species. Even the simplest of data, such as locations and aerial extents of hardgrounds are not widely known or not known at all.

The proposed MPA off the coast of North Carolina is an example of a hardground region of unknown quality, biotic content, and reef structure. The dives and other data collections in this area, along with companion samples from a fishing vessel, represent the first scientific surveys of the proposed MPA. While MPAs are a viable and important fishery management tool, it is critical to know what biota and habitats are being protected, particularly early in the process, to establish a baseline condition.

### Area 2: Lophelia Reefs

Important in their own right as havens of deep-water biodiversity, Lophelia reefs may also function as deep havens for some fish species that are heavily exploited on shallower reefs. Several wreckfish, for example, were observed on a Lophelia reef visited for the first time, echoing similar observations made on another reef in 1993. These grouper-like fish are large; adults can exceed 1.5 meters in length. The deep reef may also be a safe haven for the large conger eel, possibly the same species fished commercially in North Carolina.

Like most complex reef systems, the deep Lophelia reefs concentrate much biota. These "islands" of ecosystems appear to be unique, and at the same time fragile. It is likely that this habitat is much more important and extensive along the southeast US coast than previously thought.

Several species that were thought to be rare were observed or collected. Since these species may be closely tied to this difficult-to-sample environment, however, their abundances may have been misrepresented in past studies.

### Special Feature: Sargassum Community

In order to sample all communities throughout the water column, considerable time was spent documenting animals in the uppermost surface layers. This layer is in constant motion as a result of waves, and is also constantly moving northward with the Gulf Stream. One unique habitat in the Gulf Stream surface waters is the sargassum complex. Sargassum is a brown algae that floats due to attached gas



This tiny spiny puffer fish was found among the clumps of sargassum weed.

bladders, and often forms huge rafts that stretch for miles across the ocean. Numerous animals have adapted to using this floating habitat, and are often camouflaged to match the algae. Some species, such as the Sargassum fish (*Histrio histrio* in the frogfish family), live their whole lives in this difficult-to-sample and poorly-studied habitat. The sargassum complex has been recognized to harbor large numbers of juvenile fishes and invertebrates, many of which are economically important.

Standardized sampling methods were used to sample the upper two meters of the water column. This involved pulling a small mesh frame net for 15 minutes in both open waters and waters containing sargassum. Dip nets and divers with underwater video cameras were also used when the weed lines of sargassum were thick.



A close-up view of a small mass of sargassum weed.

So far 62 fish species (not counting larvae) have been documented to use the sargassum off the coast of North Carolina. Most of these fishes are juveniles that use the habitat for feeding, while taking advantage of it to hide from predators. One of the most common and economically important fishes sampled were the dolphin fish (*Coryphaena* spp. or Mahi mahi). Small dolphin fish live very close to the sargassum, and as they become larger they patrol in schools underneath the complex. Fishermen often look for the sargassum weed lines to improve their chances of catching dolphin fish. Amberjacks, filefishes, and triggerfishes are also dominant groups in sargassum. Flying fishes often take advantage of this floating, mobile, complex community. Sampling has shown that many species, especially larval forms, occur in the open water without sargassum, but the sargassum allows both large numbers of species as well as large numbers of individuals to be concentrated in small areas. The number of individuals that can be supported is directly related to the quantity of algae available.



A juvenile scrawled filefish (*Aluterus scriptus*) found within the mass of sargassum. Its cryptic coloring helps it to avoid predators as it lives among the tangled mass of floating algae.

Continuing studies of the surface communities off the Carolinas will eventually give a more complete view of the community structure and feeding habits of these animals. Only through such knowledge can these valuable resources be adequately managed and protected, ensuring their availability for the future.

## APPLICATION TO MANAGEMENT

The outer shelf hardgrounds are heavily utilized by commercial fishermen, and the deep Lophelia reefs have great potential to be further exploited in similar ways. These habitats could also be subject to degradation via many other activities such as hydrocarbon exploration and cable laying. In the case of the Lophelia reefs, such damage could be permanent or take thousands of years to repair. Studies to document the distributions and morphologies of the reef habitats and gather basic data on the community structures, biology, and ecology of these systems will yield data of direct use to the management of these systems. In addition, the first fishery-independent data on the proposed MPA off North Carolina is being collected, and will facilitate some evaluation of that area in the future.

## MARINE EDUCATION ACTIVITIES

A multifaceted approach to marine education was designed for this mission, which consisted of three primary components: web sites, a teacher-at-sea, and a High Definition (HD) videographer on board the ship. All efforts combined provided education outreach to a wide audience.

### Web Sites

[www.naturalsciences.org](http://www.naturalsciences.org)

The interactive website, [www.naturalsciences.org](http://www.naturalsciences.org), was designed and hosted by the North Carolina Museum of Natural Sciences (NCMNS) and was intended to complement the NOAA Ocean Explorer website. This website allowed students and teachers to follow the mission and ask questions of the educators and researchers at sea. Curriculum materials with six activities related to deep-sea exploration were also available for teachers to download. Some of these activities incorporated data from the mission, which meant that the students returned to the site frequently. Also included was a “meet the researchers” section that featured background information and research interests of the primary scientists. This section was designed to help change the image of a scientist as “a nerdy guy with wild hair and glasses in a white lab coat.”



The introductory page for the Islands in the Stream 2002 section of the [www.naturalsciences.org](http://www.naturalsciences.org) website.

One of the most active sections of the website was the Daily Research Log and Research Data. During the ten working days of this mission, the educators on board wrote user-friendly log entries that captured some of the aspects of life at sea. They described hardships such as bad weather, as well as successes such as finding an unusual species. Additionally, research data were posted daily that included latitude and longitude, the type of equipment used, and a listing of what samples were caught. Using these data, the students could map the travels of the *R/V Seward Johnson* throughout the mission.

Many of the students who were following the mission used the “Ask a Question” section of the website to learn more about the information posted on the Daily Log and Research Data sections. More than 200 questions were posed from first graders through graduate students and adults around the world. Most of the questions came from North Carolina, but they also came from as far away as California, Washington state, and Denmark. The questions were condensed to save email costs and then sent to sea where the educators on board answered them through discussions with the scientists, research with materials on board, or personal experiences. Answers were sent out from the ship in subsequent emails. The NCMNS plans to use this website during future missions, and hopes to expand the offerings on the site to include video clips and a student-friendly GIS mapping component.





This introductory page for the Islands in the Stream 2002 expedition in the oceanexplorer.noaa.gov website leads the reader to the logs, background pieces, lesson plans and summary materials for all three missions.

[oceanexplorer.noaa.gov](http://oceanexplorer.noaa.gov)

The website [oceanexplorer.noaa.gov](http://oceanexplorer.noaa.gov) continues to be one of NOAA's most popular web offerings. Drawing thousands of visitors each month, including hundreds who follow expeditions on a daily basis, this medium provides an enormous opportunity to reach the public in near real-time. During this mission, scientists and educators contributed logs describing daily activities aboard the ship as well as exciting new discoveries (see Appendix 3). Adventures were brought to life through stories, pictures and video clips. Prior to the mission, a background essay, "A Brief View of Open Ocean Midwater Ecology", was composed to help the reader understand the context for this cruise.

## Teacher-at-Sea

Alan Felker, the teacher-at-sea, had the dual role of working alongside the researchers during the second night watch and answering questions posed by the public as they came in from the NCMNS website. Alan, a Milken Fellow and middle school teacher from the mountains of North Carolina, was very excited about participating in research while expanding his own understanding of the ocean environment. Alan wrote the curriculum materials for the web site prior to the mission, which helped him to increase his knowledge of the subject area before coming on board. During the cruise he helped to deploy and retrieve various nets and gear, process the catches that were brought on board, and maintain location information. Additionally, Alan participated in one of the submersible dives on the northern Lophelia banks. Alan wrote about his experience for both the NCMNS website and the NOAA Ocean Explorer website. Additionally, he offered to present information about his experiences at upcoming education conferences.



Enjoying his time at sea, Alan Felker (right), teacher-at-sea, stands next to the *JSLII* on the fantail of the *R/V Seward Johnson*.

## Videographer

Art Howard of Napro Communication was the HD videographer on board. Art was responsible for the NCMNS's award-winning HD film "Wilderness North Carolina", and brought his artistic eye and love of natural sciences to the mission. During the cruise, Art captured more than 20 hours of HD footage, covering everything from the submersible operations, to life at sea, to actually participating in a dive. Art described his experience of seeing the underwater world through the lens of his camera in a log that was posted on the Ocean Explorer website. During the next year, the NCMNS will seek additional funding to create a new movie about deep sea exploration as well as to create a companion HD television piece for Capitol Broadcasting. These two pieces could reach a combined audience of more than 500,000. The

## Mission 2: Exploration of Outer Shelf and Slope Habitats off the Coast of North Carolina

digital nature of HD also allows the NCMNS to explore the option of creating an interactive CD-ROM in the future.

### Other

An ongoing application of the Islands in the Stream mission has been the development of new distance learning programs for the NCMNS. These programs will use video footage as well as real objects to help students gain an understanding of the research off the North Carolina coast. Another outgrowth of the education activities at sea was the opportunity to present the use of geographic information systems (GIS) during the celebration of GIS day on 20 November 2002 ([www.gisday.com](http://www.gisday.com)), a day meant to raise worldwide awareness about GIS. The NCMNS and the North Carolina National Estuarine Research Reserve combined efforts to demonstrate the way GIS was used during Islands in the Stream 2002 ([www.ncsu.edu/scilink/gislive](http://www.ncsu.edu/scilink/gislive)) as a part of the North Carolina contribution to GIS day. Additionally, the NCMNS has been invited to present at the North Carolina GIS conference in late February 2003.

The continuity provided by the relationship between the NCMNS and the North Carolina National Estuarine Research Reserve enhanced the educational components of this leg of Islands in the Stream. Participation in Islands in the Stream 2001 provided strong background knowledge for developing the education activities for Islands in the Stream 2002.

### MEDIA COVERAGE

Post-cruise products, such as annotated digital video highlights and annotated digital still images, were developed and distributed to regional and national markets. An article appeared in a local Wilmington, NC newspaper.



The above article was written by Gareth McGrath and printed on August 17, 2002 in the Morning Star, a newspaper based in Wilmington, NC.

## CONCLUSION

Although the initial two cruises completed by this team to these outer shelf hardgrounds and *Lophelia* reefs were successful, it is believed that only a small fraction of the basic data needed to characterize these systems has been collected. The amount of new data compiled during the two cruises is impressive and suggests that there is much more to learn about basic aspects of these habitats. Also, knowledge of the locations and types of reefs is still quite primitive. There is still very little data on the oceanography that influences these systems.

Since the exploration of *Lophelia* reefs is just beginning, it may be discovered that several commercial fish species inhabit deep coral reefs on the continental slope. It is also important to note that the reefs explored during this mission off North Carolina are relatively small (as compared with other *Lophelia* reefs) and are at the northern limit of their range on the Blake Plateau. They are also living at the extreme upper depth limit for *Lophelia pertusa*. The fish fauna yet to be explored for the many large *Lophelia* reefs populating the main part of the vast Blake Plateau (and extending into the Gulf of Mexico) may be much more diverse and abundant than those yet seen off the coast of North Carolina.

Future studies by this group will continue to emphasize collecting basic biological and physical data. They plan to simultaneously locate and map the reef habitats while collecting relevant data on the inhabitants. These initial studies will lead to more sophisticated hypotheses of how these communities survive and will also lead to more sophisticated management.



Related to the jellyfish, this *Porpida porpida* measures just one inch in diameter and floats feely in the water column.

## Appendix 1: Summary of Submersible Dives

Start Date	Station ID	Duration (hours)	Observer (bow)	Observer (stern)	Site Description	Maximum Depth (ft.)
6-Aug	The Steeples	2	Ross	Sulak	Sand plain: numerous burrows & tracks: pelagic fish	424
6-Aug	The Steeples	2.5	Sulak	Rohde	Scattered boulders: abundant reef fish	292
11-Aug	Northern Lophelia Banks	2.5	Howard	Sulak	Healthy Lophelia banks: diverse species community	1467
11-Aug	Northern Lophelia Banks	2.5	Nizinski	Ross	Healthy Lophelia banks: diverse species community	1393
12-Aug	Northern Lophelia Banks	2.5	Sulak	Felker	Healthy Lophelia banks: extensive rubble fields	1276
12-Aug	Northern Lophelia Banks	1	Ross	Nizinski	Healthy Lophelia banks: numerous sponges	1365
13-Aug	Southern Lophelia	2.5	Ross	Nizinski	Healthy Lophelia banks: species much different	1474
13-Aug	Proposed MPA	3	Rohde	Baird	Pavement-type hardgrounds	270
14-Aug	Proposed MPA	3	Sulak	Rohde	Low relief rocky outcrops	328
14-Aug	Proposed MPA	2.5	Ross	McDonough	Scattered low relief rocky outcrops: extensive sand plain	250
15-Aug	Proposed MPA	2.5	Rohde	Sulak	Eroded rocky ledges: high relief: diverse species community	281
15-Aug	Proposed MPA	2.5	Ross	Rohde	Eroded rocky ledges: high relief: diverse species community	363

## Appendix 2: Summary of Sampling Activities

Station ID	Start Date	Gear Type	Sample Type	Sample Descriptions	Qty.	Measure
The Steeples	8/6/2002	Manipulator	multiple invertebrates and fish	multiple invertebrates and fish	5	individual specimens
The Steeples	8/6/2002	Manipulator	multiple invertebrates	multiple invertebrates	2	individual specimens
The Steeples	8/6/2002	Manipulator	multiple invertebrates and fish	multiple invertebrates and fish	3	individual specimens
The Steeples	8/6/2002	Manipulator	mollusks	mollusks	1	individual specimens
The Steeples	8/6/2002	Manipulator	crabs	crabs	3	individual specimens
The Steeples	8/6/2002	Neuston Tow	sargassum	sargassum	1	bunch
The Steeples	8/6/2002	Neuston Tow	fish	Comet fish	1	individual specimens
The Steeples	8/6/2002	Neuston Tow	fish	Trigger fish	1	individual specimens
The Steeples	8/6/2002	Suction Sampler	multiple invertebrates and fish	Small crab, bits of sponges, and coral fragments	1	individual specimens
The Steeples	8/6/2002	Manipulator	invertebrate	starfish	1	individual specimens
The Steeples	8/6/2002	Suction Sampler	coral	soft corals	3	individual specimens
The Steeples	8/6/2002	Otter Trawl	multiple invertebrates and fish	Flounder, grunts, squid, lizardfish, rock shrimp - 1 container	2	5 gal bucket
The Steeples	8/6/2002	Otter Trawl	multiple invertebrates and fish	Big eyes, tattlers, flounder, octopus, high hats, lizard fish	2	5 gal bucket
The Steeples	8/6/2002	None	fish	Flying fish	1	individual specimens
Onslow Bay	8/8/2002	Hook & Line	fish	Allmaco Jack	1	individual specimens
Cape Lookout	8/8/2002	Dip Net	multiple invertebrates and fish	Mostly needle type fish, crabs, and some squid - 5 containers	1	5 gal bucket
Cape Lookout	8/8/2002	Dip Net	multiple invertebrates and fish	Mostly needle type fish, crabs, and some squid - 4 containers	1	5 gal bucket
Cape Lookout	8/9/2002	Dip Net	multiple invertebrates and fish	Mostly needle type fish, crabs, and some squid - 6 containers	1	5 gal bucket
Cape Lookout	8/9/2002	Dip Net	multiple invertebrates and fish	Mostly needle type fish, crabs, and some squid - 3 containers	1	5 gal bucket
Cape Lookout	8/9/2002	Dip Net	multiple invertebrates and fish	Mostly needle type fish, crabs, and some squid - 4 containers	1	5 gal bucket
Cape Lookout	8/9/2002	Dip Net	multiple invertebrates and fish	Mostly needle type fish, crabs, and some squid - 6 containers	1	5 gal bucket
Cape Lookout Shelf	8/9/2002	Neuston Tow	multiple invertebrates and fish	Sargassum community species	2	500 ml containers
Cape Lookout Shelf	8/9/2002	Neuston Tow	multiple invertebrates and fish	Sargassum community species	3	500 ml containers
Cape Lookout Shelf	8/9/2002	Neuston Tow	multiple invertebrates and fish	Sargassum community species	3	500 ml containers
Cape Lookout Shelf	8/9/2002	Neuston Tow	multiple invertebrates and fish	Sargassum community species	2	500 ml containers
Cape Lookout Shelf	8/9/2002	Plankton Tow	plankton	plankton	2	500 ml containers
Cape Lookout Shelf	8/9/2002	Plankton Tow	plankton	plankton	2	500 ml containers
Cape Lookout Shelf	8/9/2002	Plankton Tow	plankton	plankton	2	500 ml containers
Cape Lookout Shelf	8/9/2002	Plankton Tow	plankton	plankton	2	500 ml containers
Cape Lookout Shelf	8/9/2002	Fishing	fish	Dolphin - <i>Coryphaena hippurus</i> - all adults	17	bags
Cape Lookout Shelf	8/9/2002	Neuston Tow	multiple invertebrates and fish	Sargassum community species	2	500 ml containers
Cape Lookout Shelf	8/9/2002	Neuston Tow	multiple invertebrates and fish	Sargassum community species	3	500 ml containers
Cape Lookout Shelf	8/9/2002	Neuston Tow	multiple invertebrates and fish	Sargassum community species	21	500 ml containers
Cape Lookout Shelf	8/9/2002	None	fish	Flying fish	1	individual specimens
Lophelia Banks	8/10/2002	Otter Trawl	multiple invertebrates and fish	Crabs, shrimp, green eye, sea urchins, sea robins, spotted hake, tube (quill) worms	3	5 gal bucket
Lophelia Banks	8/10/2002	Otter Trawl	multiple invertebrates and fish	Octopus, tunicates, chain dogfish, tube worm, comb jelly, scorpionfish, hake, flounder	4	5 gal bucket
Lophelia Banks	8/10/2002	Otter Trawl	multiple invertebrates and fish	Hagfish, blackbelly rosefish, greeneye, batfish, spider crabs, urchins, tube (quill) worms	10	5 gal bucket
Lophelia Banks	8/10/2002	Otter Trawl	multiple invertebrates and fish	Scorpionfish, tube (quill) worms, <i>Lophelia</i> , brittle stars	3	500 ml containers
Lophelia Banks	8/11/2002	Epibenthic Dredge	multiple invertebrates and fish	Cuttle fish, Lithodid crab, sea urchin	3	individual specimens
Lophelia Banks	8/11/2002	Manipulator	coral	<i>Lophelia</i>	1	bunch
Lophelia Banks	8/11/2002	Manipulator	coral	<i>Lophelia</i>	1	bunch
Lophelia Banks	8/11/2002	Epibenthic Dredge	benthic	brittle stars, small crabs, mollusks, brachiopod shells, tube (quill) worms, dead <i>Lophelia</i>	2	?? ml containers
Lophelia Banks	8/11/2002	Manipulator	coral	Live and dead <i>Lophelia</i>	1	5 gal bucket
Lophelia Banks	8/11/2002	Suction Sampler	multiple invertebrates	crab, brittle stars	2	?? ml containers
Lophelia Banks	8/11/2002	Suction Sampler	fish	Scorpionfish	1	individual specimens
Lophelia Banks	8/11/2002	Manipulator	fish	shark	1	individual specimens
Lophelia Banks	8/11/2002	Epibenthic Dredge	multiple invertebrates	invertebrates - brittle stars, crabs, polychates	1	?? ml containers
Lophelia Banks	8/11/2002	Neuston Tow	multiple invertebrates	3 teropods, 1 turbinaria	1	?? ml containers

## Summary of Sampling Activities (Continued)

Station ID	Start Date	Gear Type	Sample Type	Sample Descriptions	Qty.	Measure
Lophelia Banks	8/12/2002	Neuston Tow	multiple invertebrates	several teropods, some turbinaria	1	500 ml containers
Lophelia Banks	8/12/2002	Epibenthic Dredge	multiple invertebrates	multiple invertebrates	1	500 ml containers
Lophelia Banks	8/12/2002	Neuston Tow	fish	pompano dolphin, lantern fish, turbinaria	2	500 ml containers
Lophelia Banks	8/12/2002	Neuston Tow	algae	Sargassum	1	500 ml containers
Lophelia Banks	8/12/2002	Neuston Tow	algae	Sargassum	1	500 ml containers
Lophelia Banks	8/12/2002	Manipulator	coral	Lophelia	1	bunch
Lophelia Banks	8/12/2002	Suction Sampler	multiple invertebrates	Galatheid crabs	1	500 ml containers
Lophelia Banks	8/12/2002	Manipulator	multiple invertebrates	Glass sponges and coral pieces	1	500 ml containers
Lophelia Banks	8/12/2002	Suction Sampler	fish	Scorpiina	1	individual specimens
Lophelia Banks	8/12/2002	Manipulator	coral	New variety, not <i>Lophelia</i>	1	bunch
Lophelia Banks	8/12/2002	Plankton Tow	plankton	plankton	1	500 ml containers
Southern Lophelia	8/13/2002	Manipulator	coral	<i>Lophelia</i>	1	bunch
Southern Lophelia	8/13/2002	Suction Sampler	fish	Scorpionfish	1	individual specimens
Southern Lophelia	8/13/2002	Suction Sampler	fish	Scorpionfish	1	individual specimens
Southern Lophelia	8/13/2002	Plankton Tow	plankton	plankton	1	500 ml containers
Southern Lophelia	8/13/2002	Plankton Tow	plankton	plankton	1	500 ml containers
Southern Lophelia	8/13/2002	Plankton Tow	plankton	plankton	1	500 ml containers
Proposed MPA	8/13/2002	Suction Sampler	mollusk	Scallop	1	individual specimens
Proposed MPA	8/13/2002	Suction Sampler	fish	lizard fish, small unidentified fish	2	individual specimens
Proposed MPA	8/13/2002	Suction Sampler	fish	soapfish	1	individual specimens
Proposed MPA	8/13/2002	Neuston Tow	multiple invertebrates and fish	Sargassum, juvenile jacks, flying fish	2	500 ml containers
Proposed MPA	8/13/2002	Dip Net	fish	Flying fish, juvenile jacks	1	5 gal bucket
Proposed MPA	8/13/2002	Dip Net	fish	Flying fish, half beaks	1	5 gal bucket
Proposed MPA	8/13/2002	Dip Net	fish	Flying fish, half beaks, juvenile jacks	1	5 gal bucket
Proposed MPA	8/13/2002	Dip Net	fish	Flying fish, squid, half beak	1	5 gal bucket
Proposed MPA	8/13/2002	Dip Net	fish	Flying fish, juvenile jacks, half beak, juvenile spearfish	1	5 gal bucket
Proposed MPA	8/13/2002	Dip Net	fish	Flying fish, half beaks	1	5 gal bucket
Proposed MPA	8/14/2002	Dip Net	fish	Flying fish	1	5 gal bucket
Proposed MPA	8/14/2002	Dip Net	fish	Flying fish, half beaks, juvenile sailfish	1	5 gal bucket
Proposed MPA	8/14/2002	Dip Net	fish	Flying fish, juvenile sailfish	1	5 gal bucket
Proposed MPA	8/14/2002	Dip Net	fish	Flying fish	1	5 gal bucket
Proposed MPA	8/14/2002	Dip Net	fish	Flying fish, reef type eel	1	5 gal bucket
Proposed MPA	8/14/2002	Suction Sampler	fish	small unidentified fish	1	individual specimens
Proposed MPA	8/14/2002	Suction Sampler	fish	small unidentified fish	1	individual specimens
Proposed MPA	8/14/2002	Suction Sampler	fish	Scorpionfish sp	1	individual specimens
Proposed MPA	8/14/2002	Neuston Tow	fish	filefish	1	individual specimens
Proposed MPA	8/14/2002	Neuston Tow	fish	filefish	1	individual specimens
Proposed MPA	8/14/2002	Neuston Tow	multiple invertebrates and fish	crabs, filefish, chub	4	individual specimens
Proposed MPA	8/14/2002	Dip Net	multiple invertebrates and fish	Siphonophores, juvenile jacks, small crabs	1	5 gal bucket
Proposed MPA	8/14/2002	Dip Net	multiple invertebrates and fish	Flying fish, crabs	1	5 gal bucket
Proposed MPA	8/14/2002	Dip Net	multiple invertebrates and fish	Flying fish, siphonophores, juvenile jacks, shrimp, stephanolop	1	5 gal bucket
Proposed MPA	8/14/2002	Dip Net	invertebrate	Portuguese man-of-war	1	individual specimens
Proposed MPA	8/14/2002	Dip Net	fish	Porcupine fish	2	individual specimens
Proposed MPA	8/14/2002	Dip Net	fish	Flying fish, file fish	1	500 ml containers
Proposed MPA	8/15/2002	Dip Net	fish	Flying fish	1	5 gal bucket
Proposed MPA	8/15/2002	Dip Net	fish	Flying fish, squid, juvenile dolphin	1	5 gal bucket
Proposed MPA	8/15/2002	Dip Net	fish	Flying fish, juvenile dolphin	1	5 gal bucket
Proposed MPA	8/15/2002	Dip Net	fish	Flying fish, juvenile dolphin	1	5 gal bucket

### Appendix 3:

## Daily Logs and Background Pieces Written for NOAA's oceanexplorer.noaa.gov Web Site

<b>Date</b>	<b>Title</b>	<b>Author</b>
Background	A Brief view of Open Ocean Midwater Ecology	<ul style="list-style-type: none"> <li>○ Dr. Steve W. Ross, Chief Scientist North Carolina National Estuarine Research Reserve</li> <li>○ Dr. John V. (Jack) Gartner, Jr. St. Petersburg College, St. Petersburg, FL</li> <li>○ Dr. Ken J. Sulak, Co-Chief Scientist USGS, National Biological Survey, Gainesville, FL</li> </ul>
Aug 06, 2002	First Day on the Job	<ul style="list-style-type: none"> <li>○ Bruce Moravchik, Web Coordinator (Mission 2) NOAA Ocean Service</li> </ul>
Aug 07, 2002	Modern Submersibles	<ul style="list-style-type: none"> <li>○ Mike Randall, Biologist US Geological Survey/ AsCI Corporation</li> <li>○ Tara Nye, Research Biologist North Carolina National Estuarine Research Reserve</li> <li>○ Ann Marie Necaise, Research Biologist North Carolina National Estuarine Research Reserve</li> </ul>
Aug 08, 2002	Up Close and Personal on a North Carolina Deep Reef	<ul style="list-style-type: none"> <li>○ Dr. Ken J. Sulak, Co-Chief Scientist USGS, National Biological Survey, Gainesville, FL</li> </ul>
Aug 09, 2002	Sargassum and Open Water Surface Communities	<ul style="list-style-type: none"> <li>○ Dr. Steve W. Ross, Chief Scientist North Carolina National Estuarine Research Reserve</li> <li>○ Tara L. Casazza North Carolina National Estuarine Research Reserve</li> <li>○ Dr. Ken J. Sulak, Co-Chief Scientist USGS, National Biological Survey, Gainesville, FL</li> </ul>
Aug 10, 2002	Perspective from a North Carolina Educator	<ul style="list-style-type: none"> <li>○ Alan Felker, Teacher-at-Sea Hardin Park School, North Carolina North Carolina Museum of Natural Sciences</li> </ul>
Aug 11, 2002	Advances in Technology	<ul style="list-style-type: none"> <li>○ LaVern Taylor, Senior Marine Technician Harbor Branch Oceanographic Institute</li> <li>○ Bruce Moravchik, Web Coordinator (Mission 2) NOAA Ocean Service</li> </ul>
Aug 12, 2002	"1400-feet Down in a Washing Machine"	<ul style="list-style-type: none"> <li>○ Art Howard, Filmmaker Napro Communications</li> </ul>
Aug 13, 2002	Are We There Yet?	<ul style="list-style-type: none"> <li>○ Jacquie Ott, GIS Specialist North Carolina National Estuarine Research Reserve</li> </ul>
Aug 14, 2002	Views Forward, Views Aft	<ul style="list-style-type: none"> <li>○ Dr. Martha Nizinski, Zoologist NOAA, National Marine Fisheries Service</li> <li>○ Dr. Steve W. Ross, Chief Scientist North Carolina National Estuarine Research Reserve</li> </ul>
Aug 15, 2002	What's in a Name?	<ul style="list-style-type: none"> <li>○ Liz Baird, Co-Principal Investigator North Carolina Museum of Natural Sciences</li> </ul>

## Appendix 4: Mission 2 Science Team

<b>NAME</b>	<b>AFFILIATION</b>	<b>ROLE</b>
Dr. Steve W. Ross	NCNERR	Chief Scientist
Dr. Ken Sulak	USGS	Co-Chief Scientist
John McDonough	NOAA/OE	Mission Coordinator
Bruce Moravchik	NOAA/OE	Data Management/Web
Fred Rohde	NCDMF	co-PI, photography
Liz Baird	NCSMNS	co-PI, education leader
Mike Randall	USGS	watch chief
Ann Marie Necaise	NCNERR	watch chief
Art Howard	Videographer	HD Videographer
Tara Casazza	NCNERR	fishing, cruise logistics
Jon Hartsell	NCNERR	watch crew, fishing
Tara Nye	NCNERR	watch crew, fishing, CTD
Alan Felker	NCSMNS	education, watch crew
Jacque Ott	NCNERR	GIS/Data Management/Web
Dr. Martha Nizinski	NMFS	invertebrates
Andrea Quattrini	UNCW	watch crew, fishing
Dr. Randy Edwards	USGS	watch crew, fishing

