INTRODUCTION TO THE INVESTIGATIONS

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INTRODUCTION

There is a rapidly growing social, political, and scientific awareness of the destruction of sensitive deep coral reefs, and the potential loss of unexplored biodiversity by human activities including bottom trawling, anchoring, cable-laying, ocean dumping, pollution, and offshore oil and gas development. In the Gulf of Mexico, the Minerals Management Service (MMS) exercises an ecological stewardship role for sensitive hydrocarbon seep, hard-bottom and reef habitats relative to hydrocarbon exploration and development activities. The present U.S. Geological Survey (USGS) community structure team investigation, together with companion investigations by USGS microbiology and genetics research teams, has addressed gaps in knowledge of *Lophelia pertusa* (Linnaeus, 1758) deep reef ecosystems in the Gulf of Mexico, with particular emphasis on the fish and mobile invertebrate megafaunas. The overall USGS 2004-2006 program of *Lophelia* community studies complemented a concurrent contract study undertaken by Continental Shelf Associates (CSA, 2003) on behalf of the MMS.

OVERALL COMMUNITY STRUCTURE INVESTIGATION OBJECTIVES

The USGS community structure team established a study plan with six main objectives (Sulak 2004), appropriately modified after the first sampling cruise in 2004, as presented below:

1. Define species composition, diversity, and numerical dominance of fishes and mobile megafaunal invertebrates on Gulf of Mexico *Lophelia* reefs and associated biotopes.
2. Define and compare mobile megafaunal, infaunal macrofaunal, and meiofaunal biotope affinities, population densities, biomass, diversity and population dispersion for the *Lophelia* reef biotope, other reef-associated biotopes, and comparative non-reef biotopes (e.g., the soft-substrate biotope of the surrounding open slope biome).

3. Obtain tissue samples (target n = 30 samples per taxon and/or per ontogenetic stage of a taxon) for analysis of stable carbon, nitrogen, and sulfur isotopes. Samples were to be obtained from taxa forming the *Lophelia* community, as well as comparative taxa forming the overall oceanic food web, surface to substrate, including plankton and *Sargassum* carbon sources.
4. Obtain *Lophelia* and soft coral branch/stolon samples to determine ages via ring-count, isotope probe, and/or radiometric methodology. Also employ similar methods to age living coral, and potentially determine growth rate. Obtain reef and substrate rocks to determine origin and age of both *Lophelia* reefs, and of the underlying authigenic substrate. Obtain samples of reef sands and comparative off-reef soft substrate to analyze sediment origins.
5. Contrast megafaunal fish, and mobile invertebrate community structure for Gulf of Mexico versus *Lophelia* reefs known from other regions of the world ocean.
6. Using video and digital still images, document interaction of the *Lophelia* community fauna with the fish and invertebrate megafaunas continuously or facultatively utilizing deep coral and associated or comparative biotopes.

Objectives undertaken specific to molecular biology and microbial investigators:

7. Document biodiversity of *Lophelia* and other scleractinian corals using informative nuclear and mitochondrial DNA markers and appropriate phylogenetic analyses.
8. Develop variable microsatellite DNA markers for Gulf of Mexico *L. pertusa*.
9. Use microsatellite markers to quantify local and regional patterns of genetic variation in *Lophelia*, including an assessment of genetic connectivity between reefs, relative contributions of clonal (asexual) and sexual reproduction, and inferred larval dispersal patterns.
10. Investigate the physiological state of *Lophelia* by determining the expression of genes related to basic life functions such as growth, differentiation, and reproduction.
11. Characterize the microbial community associated with *L. pertusa* and investigate whether the coral-associated microorganisms are acting as symbionts.
12. Determine if specialized sampling gear capable of preserving coral samples at depth and keeping live samples thermally insulated is necessary for microbial diversity and molecular biology studies.

NOTE 1: This report addresses Objectives 1, 2, and 4-9, above. Objective 3 research, stable isotope analyses of trophic structure, is ongoing as of the date of this report, and will be published separately.

NOTE 2: The program of USGS *Lophelia* community structure investigations on Viosca Knoll study sites reported on herein represents a companion program of study to that undertaken by Continental Shelf Associates (CSA) (S. Viada, Lead PI), Viosca Knoll to Green Canyon, on behalf of the MMS. The CSA program of *Lophelia* studies has produced a separate contractor report to MMS, OCS Study, MMS 2007-044 (CSA, 2007).

BACKGROUND AND INTRODUCTION TO THE COMMUNITY STRUCTURE PROGRAM OF INVESTIGATIONS

The objectives specified above were addressed over a series of three cruises, and subsequent laboratory analyses of specimens, video, images, and data. The three cruises were:

USGS-GM-2004-03	July 29 - August 5, 2004
USGS-GM-2005-03	June 1 - 6, 2005
USGS-GM-2005-04	September 16 - 21, 2005

SCIENTIFIC CREW - The overall USGS scientific team comprised of 28 personnel who participated in the cruises (Table1.1), representing several USGS centers (Florida Integrated Science Center (Gainesville and St. Petersburg, Florida), Leetown Science Center, National Center for Wetlands Research, and Eastern Regional Headquarters), nine academic institutions (McMaster University, University of Florida, University of Montreal-Quebec, University of New Orleans, University of North Carolina-Wilmington, University of Pennsylvania, Ohio State University, McGill University, Bournemouth University - UK), and additional scientific agencies and institutions (NOAA National Marine Fisheries Service; NOAA Systematics Laboratory, Smithsonian Institution; and National Undersea Research Program). Expertise spanned diverse disciplines including fisheries biology, fish ecology, marine community ecology, benthic marine ecology, geology, paleoecology, molecular genetics, microbiology, and GIS technology. The mélange of disciplinary expertise was intended to result in multiple new insights into the synecology of the Gulf of Mexico *Lophelia* reef community.

STUDY AREA - Study areas were located in the northern Gulf of Mexico on the continental slope off Louisiana, Mississippi, and Alabama (Fig.1.1). Target study areas were two geological mound features identified by reference to MMS Lease Blocks Viosca Knoll 826 (VK-826), and Viosca Knoll 906 & 862 (VK-906/862) (Fig. 1.1). Twenty multipurpose submersible dives were accomplished on these two sites during two submersible cruises in 2004 and 2005 (Figs. 1.2, 1.3). Additionally, remotely-deployed sampling was conducted from a surface research vessel on these same sites in 2005. Planned sampling in MMS Lease Block Green Canyon and Mississippi Canyon areas was cancelled due to logistics (shortened dive itinerary in 2004, post-hurricane port change in 2005). However, submersible videos of Green Canyon and Mississippi Canyon dives, plus additional Viosca Knoll dives, were obtained from CSA (S. Viada) and from NOAA Ocean Exploration dives (W. Schroeder, Dauphin Island Marine Laboratory) for qualitative comparisons.

SAMPLING PLATFORMS - Sampling platforms for the USGS-GM-2004-03 and USGS-GM-2005-04 cruises were the RV Seward Johnson (SJ I) and the RV Seward Johnson II (SJ II), University-National-Oceanographic-Laboratory-System (UNOLS) research vessels operated by Harbor Branch Oceanographic Institution. These vessels serve as the mother ship tending the Johnson-Sea-Link (JSL) submersibles (JSL I and JSL II). The RV Tommy Munro (TM), a University of Southern Mississippi general purpose oceanographic vessel, was used as the sampling platform for the USGS-GM-2005-03 remote sampling cruise.

ECHOSOUNDER SURVEYS - The SJ II was equipped with a SIMRAD® EQ50 38/50 kHz color echosounder (nonoceanographic, essentially a combination bottom-finder and fish-finder). This echosounder was used along the 500 m isobath and at specific target sites to conduct pre-dive reconnaissance of the bottom topography. It proved to be very effective in identifying *Lophelia* coral reef structure as “fuzzy” (diffuse acoustic strength) blue false-color returns, against a backgroud of well-defined black and red returns (high-strength acoustic returns) identifying hard rock and consolidated sediment substrates (Fig. 1.4). The SJ I was similarly equipped, and also additionally equipped with a Knudsen® oceanographic single beam 3.5 kHz echosounder, specifically tuned to profiling subbottom topography, but also capable of identifying *Lophelia* coral reef as diffuse above-substrate acoustic returns (Fig. 1.5).

IN-SITU SAMPLING GEAR

SUBMERSIBLE - The JSL submersibles were used to collect fish and invertebrate specimens, sediment samples, rock samples, and to conduct high-resolution videography and digital still imagery. The four-person JSL submersible (two pilots, two scientists) is capable of dives to 914 m. The submersible is divided into two atmospheric-pressure chambers; the bow sphere (one pilot, one scientist) and the stern compartment (one pilot, one scientist). The bow scientist typically runs the science mission, designating sampling sites and activities, while the pilot operates the submersible and sampling devices. The bow scientist also has control of the video and still cameras. The stern scientist normally acts as an observer and dive controller, keeping a log of the bow activities, monitoring bottom time, and monitoring video and audio recording activities. The stern pilot accompanies each dive as a backup safety measure. The JSL is equipped with several types of active sampling gear, including a manipulator arm and suction sampler, and a variety of collection containers. The submersible also has the capability of collecting several types of passive information while on the bottom. Environmental information (i.e., water parameters) is collected in real-time using a conductivity, temperature, and depth instrument (CTD) attached to the submersible. This multiprobe monitor records temperature, conductivity, salinity, oxygen concentrations, pH, and depth, and may also be equipped to measure optical transmissivity. The geographic position of the submersible on the bottom was determined using the HBOI custom Trackpoint-II® system, referenced to dual-differential GPS available on either mother ship. On USGS dives this system was married to Navtech® navigational software, with output fed into ArcGIS 9, with navigational extensions.

SPECIALIZED SUBMERSIBLE SAMPLING GEAR - The JSL mechanical arm is provided with both a three-tine, three-axis, 360º rotating claw, and a tubular suction sampler with an internal bore diameter of 3.8 cm, connected by flexible tubing to a multibucket chain-drive daisy wheel collection storage system. Typically the daisy-wheel mechanism is fitted with 12 numbered cylindrical Lexan collection buckets. The system also has a topside funnel-shaped port to allow claw-collected specimens to be deposited directly into the containers. The JSL is typically also alternately equipped with either a mesh-lined forward basket (front basket) or a large-volume solid Plexiglas box, the 'Bio-box', both with remotely-actuated hydraulically-operated lids. USGS master biotechnician, G. Yeargin, constructed an array of custom sampling devices, specifically designed to increase the collection capability of the mechanical arm and suction sampler.

Microbial Isolation/Sterility Chambers – A specialized sampling device ('Kellogg Sampler') was designed by C. Kellogg to collect uncontaminated live and fixed *Lophelia* samples for microbial analyses. The sampler allowed for preservatives to be injected at depth within sealed chambers. This 10-chamber sampler replaced either the front basket or 'Bio-box' during dives devoted to coral microbe collections.

Coral Fork - A specialized coral fork was designed to dislodge and retain live and dead *Lophelia* samples for a variety of investigations. This simple pitchfork-like device worked well, collecting a large number of discrete samples of coral.

Yeargin Sampler - A sampling device was constructed to enable the collection of an entire *Lophelia* bush including all of the fauna living within the coral matrix. The sampling device was 1 m in diameter, barrel-shaped, and constructed of fish-trap wire with a mesh liner. The sampler had a spring-loaded closing mechanism that could be triggered by the submersible's mechanical arm. In the field, the spring-loaded closure mechanism was not strong enough to fully close the bottom skirt of the sampler around resilient coral branches, such that this device did not work as well as anticipated.

Sediment Cores - Sediment coring tubes were designed that could be deployed using the mechanical arm. The Lexan® tubes (5 cm diameter x 30.5 cm length) contained a spring-reinforced valve made from a rubber stopper. Each coring tube was housed in a color-coded PVC sheath. The different colors allowed for specific notation of where individual samples were taken from. Sediment samples were sieved on board the ship through first a 0.5 mm screen followed by a 0.063 mm screen. The invertebrates separated out in the 0.5 mm size fraction correspond to macroinfauna, while those retained in the 0.063-0.49 mm size fraction correspond to meiofauna. After the first few dives, the suction sampler was used to collect sediment instead of the coring tubes. The tubes were found to operate satisfactorily in sampling off-reef soft sediment, but unsatisfactorily in attempting to sample within the very shallow layers of coarse reef-sand sediment typical of Viosca Knoll biotopes. Most on-reef sediment samples were instead obtained using the JSL suction sampler.

Small Buckets – Twenty-four small buckets were fashioned to fit the daisy-chain collection-bucket system. The buckets were 0.15 m in diameter with a 0.5 mm mesh screen covering the top. These small buckets were designed to retain sediment-dwelling macrofauna collected during suction sampling. When used, they replaced the standard twelve-bucket setup, doubling the number of samples possible per dive.

Rotenone Pump - A five-gallon plastic gasoline can was fitted with a 500 gallon per hour bilge pump for high volume dispensing of a rotenone suspension. Rotenone is a natural root extract narcotic which facilitates suction sampler fish collections. The effectiveness of the rotenone suspension was enhanced by increasing its density using a sugar/salt/liquid soap brine as the rotenone carrier.

Sub-deployed Traps - Two different types of traps were deployed to collect small benthic fishes and epifaunal invertebrates. One trap was rectangular shape (61 x 61 x 25 cm high) while the other was designed as a triangular purse (30 x 61 x 27 cm high). Both traps were covered in Vexar® (0.8 cm plastic mesh) to prevent escape, and were baited with frozen squid. Traps were deployed at the beginning of a dive and either collected at the end of that dive or during a latter dive, thus varying the soak time. Although both fishes and crabs were observed to inspect and repeatedly probe the traps, few entered the traps during the limited bottom time of a single JSL dive.

Videocamera and Videorecorders - The JSL videocamera for USGS missions was an 850 TVL high-resolution camera, which sends a serial digital interface (SDI) signal to the sphere. In the sphere this signal was recorded on a JVC Digital-S deck (high density videotape without data overlay), then sent to a SDI-to-analog component converter, which enabled composite video output. The composite video output combines the videocamera digital output with a virtual data overlay displaying the time, date, and physical parameters. The composite data stream was recorded onto a mini-DV deck. Onboard the ship, the Digital-S tapes were duplicated using a BR-D40U recorder/player, which sent a professional analog Y/R-y/B-y 3-line signal to a mini-DV recorder. Mini-DV tapes were then copied to DVD media for distribution and analysis.

Digital Still Camera - The JSL was equipped with a fixed digital camera and strobe, plus accessory HMI lighting available on demand. The camera was a 4-megapixel Canon Powershot G2 in a depth-rated waterproof housing. It stores 11 MB .jpg format images on a Compactflash card with a resolution of 28 pixels cm^{-1}.

REMOTE FISH/INVERTEBRATE COLLECTION - A variety of gear types were utilized for both fish and invertebrate sampling; each gear type is detailed below. Specimens were identified to species when possible and length measurements (standard, fork, or total) were taken for all fish specimens collected. Stomachs were removed from nonphoto fish specimens and preserved in 10% formalin. In the laboratory, fish stomachs were excised for the removal of prey, later to be organized into functional categories. A wet weight will be determined for each functional category after blotting dry. For selected taxa, the size of prey items will be either measured directly for intact items or estimated for broken items. When possible an attempt will be made to identify the dominant food items to species. However, the focus of the present investigation is functional community structure and ecology, not taxonomy. Knowledge of trophic habits and ecological role of each recognizably distinct entity was considered a priority over species-level knowledge of taxonomy.

Angling - Higher-trophic-level “pelagic” species were collected from surface waters and midwater while trolling using artificial bait. The tissue samples obtained are essential to stable isotope analysis of surface to substrate trophodynamics since the ultimate carbon source at the seafloor is phytoplankton production at the surface.

Trawl - A 6.7 m footrope, small mesh otter trawl (3.8 cm bar mesh in the throat and bag, and 0.6 cm mesh in the cod end) was deployed to sample the near-reef and off-reef demersal fauna. Trawl tows were made during nighttime hours. This same trawl was also deployed in midwater well above the substrate to collect water column species. A 3.4 m otter trawl was also used on a few occasions.

Longline - A 15 m length of heavy fishing line, with six short 80-lb monofilament snoods attached (fitted with large tuna circle hooks), was deployed to the bottom with the hydrowinch and a down-weight to sample benthic fish. The line was baited with frozen squid.

Tangles - A multistranded rope bundle, which consisted of many lengths of line, each frayed on its end, was towed along the bottom attached to the cod end of the trawl. This simple device, employed on early 19^{th} century deep-sea expeditions, targeted entanglement of sessile gorgonians, black corals, and small invertebrates.

Epibenthic Sled - A 1.0 m mouth-opening by 30 cm high modified Woods Hole Oceanographic style deep-sea epibenthic sled (0.125 cm mesh) was deployed to collect small benthic fishes and epifaunal invertebrates. The sled was modified to protect its lining from being torn on submerged obstacles by adding a poly-vinyl chaffing guard.

Traps - Four 2.0 m (length) x 1.75 m (width) x 0.66 m (height) Antillean “Z” style fish traps were constructed of 2.5 cm square coated wire mesh. Traps were baited with menhaden, squid, and clams, and deployed singly near reefs from the surface using either 750 m or 1,000 m of 1.3 and 0.95 cm diameter polyethylene line. The surface end of each trap rig was marked and buoyed by yellow 55-gal plastic barrels, tethered to buoyed flag staffs fitted with radar-reflectors and Xenon strobes to facilitate relocation. Traps were deployed to fish for periods of 1-3 days. Each was fitted with a time-release magnesium link secured escape hatch to prevent ghost-fishing, were the trap to be lost on the bottom.

Bandit Rig - A 12-volt DC powered fishing rig spooled with 1,000 m of fine diameter steel cable was used to bottom fish. A vertical bottom rig with 2 or 3 snoods attached to a 5 kg down-weight was deployed, using circle hooks baited with either cigar minnows or squid.

STABLE ISOTOPE COLLECTION - Fish tissue, invertebrate tissue, phytoplankton, zooplankton, sediment, and *Sargassum* samples were taken for stable isotope analysis (nitrogen, carbon, and sulfur). A target number of 30 specimens per taxon or trophic entity was established to insure statistical robustness. Approximately 5 g of tissue from each sample was preserved by freezing in 2.0 ml glass vials. Phytoplankton and zooplankton were sampled using a 0.5 m diameter double-ring plankton net consisting of a 335 µm mesh net sewn inside of a 125 µm mesh net. Plankton samples were concentrated via suction straining through an ash-free carbon fiber filtration disk. *Sargassum* samples were collected using a dipnet, and either left uncleaned, or cleaned of surficial epifauna via mechanical scrubbing and/or acid treatment. All wet samples were dried, weighed, plated in numbered well plates, then sent to the Stable Isotope Facility of the University of California-Davis. For each five tissue samples assayed, two standards were assayed to insure quality control.

WATER CHEMISTRY - A Sea-Bird® Electronics Incorporated (Model SBE 19+) CTD was used to record water parameters. The data measured included the following parameters: temperature (accurate to 0.0000 °C), oxygen concentration (accurate to 0.000 ppm), density (accurate to 0.000 kg/m^3), salinity (to 0.000 PSU), pH (to 0.01 SSU), and elapsed time (to nearest second). Data manipulation was handled in a series of steps. The first three steps (conversion from hexadecimal to text format, derivation of density, salinity, and then depth-bin averaging of data) were processed using the SBE-data processing program, provided by the manufacturer. The fourth step was to import the raw ASCII text file (all converted and derived data) into a Microsoft Excel© spreadsheet.

GEOGRAPHIC INFORMATION SYSTEM (GIS) DATABASE - The cruise track and individual submersible dive tracks were input into ArcGIS 9®. The location of the RV SJ II or RV Tommy Munro was logged at all times using the GPS extension for ArcGIS. The GPS extension allows for real-time position logging from date obtained with a Garmin GPS. Logging was set at 60-sec intervals during transit and 10-sec intervals during dive or sampling operations. The submersible Trackpoint II system logs submersible bottom location on a 1-sec interval by triangulating each of two acoustic beacons mounted on the submarine. The Trackpoint II system has a wide range of error confounded by wave action and boundary layers influenced by differences in water mass sound attenuation. To filter out spurious location data the following protocol was performed by USGS technicians. Allowing for a submersible top speed of 1.0 knot during bottom operation, and allowing for the influences of current upon submersible speed over bottom, it was assumed that maximum bottom velocity would never exceed 1.5 knots. Thus, any recorded positions that required a transit speed over bottom exceeding this 1.5 knot threshold were discarded. Additionally, several times during each submersible dive, the vehicle was held stationary on the bottom for up to several minutes, allowing for a large number of positions to be logged by Trackpoint II. The core of these returns was taken as a 'good bottom fix', each used to more precisely resolve the submersible's actual position at intervals throughout the dive, thereby establishing a reliable dive track.

QUANTITATIVE VIDEO IMAGE ANALYSES TO DEFINE BIOTOPES AND COMMUNITY STRUCTURE - Video transecting and video frame grab analysis methodology are described in detail in Sulak et al. (Chapters 2 and 3) and Sulak et al. (2007).

RESULTS

SAMPLING STATIONS - Sampling was conducted at 89 stations over the three cruises (Table1.2; Figs. 1.6 to1.9). Of these, 22 stations were JSL dives (Table1.3), 46 remote sampling stations were conducted from the SJ II, and 21 remote sampling stations were conducted from the TM. Forty-three stations were conducted on VK-826. Forty stations were conducted on VK-906/862, and six stations were conducted off-site for comparison purposes. Two comparative off-site submersible dives were conducted on soft-substrate sites at the head of DeSoto Canyon. Thirty-three stations were completed during cruise USGS-GM-2004-03, 21 stations during cruise USGS-GM-2005-03, and 35 stations during cruise USGS-GM-2005-04. Surface-deployed stations included trawls, traps, trolling, plankton nets, and dipnets, as well as CTD deployments, and several other experimental sampling techniques.

ECHOSOUNDER SURVEYS - Echosounding transects (e.g., Fig. 1.10) were regularly conducted between daytime submersible dives, and at night. They revealed a dynamic topography on the seabed along the target 500 m isobath (Figs. 1.4, 1.5). A previously unknown *Lophelia* site, designated "Big Blue Reef" by the USGS research team, was discovered on the northeastern quadrant of VK-826 during one of our single-beam acoustic surveys. This proved to be the largest, and best-developed system of *Lophelia* colonies yet discovered in the northern Gulf of Mexico. Acoustic surveys were used extensively to determine where to conduct submersible dives, and where to safely launch near-reef and off-reef bottom trawl sampling.

SUBMERSIBLE OPERATIONS

SUBMERSIBLE DIVES - Of the 22 submersible dives accomplished, 12 were deployed on VK-826 (Fig. 1.2), and eight on VK-906/862 (Fig. 1.3). Two exploratory dives (CEC 4 and CEC 5) on topography suggestive of *Lophelia* mounds turned out to be sedimentary features barren of sessile colonial invertebrates. The 20 dives conducted on the Viosca Knoll sites comprised a total of 44.75 hrs of bottom time. Over 100 hrs of video imagery was recorded, including Digital-S, mini-DV, and accessory through-the-sphere Sony Handicam video. Thirty-two standardized moving 5-minute transects were accomplished during seven submersible dives. These were converted into 8,486 one-second frame grabs to enable quantitative sequential-frame analyses of fish community structure. Frame grabs from non-transect dive segments were additionally used to enable statistically-verifiable quantitative differentiation of biotopes available to mobile fishes, based on occurrences of megafaunal invertebrates (primarily sessile forms). Transect methodology and quantitative video and frame grab analyses results are presented in Sulak et al. (Chapters 2 and 3). Digital still pictures (N = 493) were taken during the dives, including numerous images of *Lophelia* reef, reef-associated fishes and invertebrates, and animals also associated with adjacent non-structured biotopes. Audio recordings were made during each dive by each diving scientist (bow and stern compartments) to document localities, collections, fixes, and other events during the itinerary of a given dive. Each audio recording was manually transcribed to paper and computer logs immediately following each dive. Each submersible dive has been rendered into an interactive dive track tour (Master Appendix A) with embedded video clips (mpegs) documenting the fauna and primary sampling operations undertaken on each dive.

FISH AND INVERTEBRATE COLLECTIONS - Fishes collected by all methods totaled 634 specimens representing 83 different species (Master Appendix B, Table1.4). Fishes were collected at 66 of the 89 total stations sampled. These specimens yielded 255 fish stomach samples (Master

Appendix B, Table1.5), and 59 fish layout voucher images to document taxonomic composition the fauna (Master Appendix B, Table1.6; Master Appendix C). Invertebrates collected represented approximately 90 species (Master Appendix B, Table1.7; Master Appendix D), including octocorallians (i.e., soft corals), scleractinian corals, polychaetes (including chemosynthetic tube worms), arthropods (crabs, shrimps, pycnogonids), echinoderms (sea stars, brittle stars, urchins, crinoids, holothurians), and mollusks (bivalves, gastropods, squids, octopus). Sixty-one different invertebrate specimens were photographed (Master Appendix D). Sediment samples were collected Master Appendix B, Table1.8) both near and away from *Lophelia* bushes for the analysis of benthic infauna. Biotopes from which collections were accomplished are documented in Master Appendix E.

STABLE ISOTOPES - Stable isotope samples (N = 691) were collected from approximately 120 different biotic and abiotic sources (Master Appendix B, Table1.9). During each cruise, multiple patches of *Sargassum* were sampled via dipnet to obtain a mean carbon signature for this potential carbon source. Samples were also obtained of *Sargassum*-associated species found living on and within the matrix of algal stems, 'leaves', and floats (e.g., small crabs and shrimps). Decaying water hyacinth found mixed into the patches (presumably originating from the Mississippi River outflow) were also sampled for comparative purposes.

PALEOECOLOGY - Several coral samples were collected for paleoage and paleoecology analyses during the cruise. Samples for aging were taken from black corals, octocorals, and *Lophelia*. Live *Lophelia* and rubble was also sampled for microscopic analysis, and for determinations of specific gravity, calyx count per unit area, and mean calyx mass per coral growth form. Additionally, several large rocks were collected. Three types of rock were evident. The predominant substrate rock was a dense black goethite (hydrated Ferric hydroxide) (Pequenat et al., 1972), which apparently forms at the interface of salt brine flows and oxygenated bottom water (Aharon et al., 1992). The second rock type collected was a reef-derived carbonate aggregate, formed of weathered *Lophelia*, infilled with semiconsolidated coarse carbonate shell, spine and skeletal fragments and finer weathered carbonate reef sand. A third rock type collected was gray authigenic rock precipitated by chemogenic bacteria (Ferrell and Aharon, 1994). No settled coral larvae were observed on the rock samples. Definitive results of coral growth form, radiometric, paleoecology (and climate change proxies) and gravimetric analyses are reported in Williams et al. (Chapter 7) and Sulak (Chapter 8). Related results of preliminary coral growth chronology trials are reported in Williams and Grottoli (Master Appendix F).

WATER CHEMISTRY - Outflow from the Mississippi River had a major influence on surface water parameters over the study sites. Salinity plots typically displayed a reduced salinity surface water layer with evidence of the watermass mixing to a depth of 40-50 m. Below the 40-50 m depth horizon, salinity stabilized at 35-36 PSU. During most dives, bottom water conditions were very homogeneous. However, during two dives (JSL-4744 and 4747), bottom water parameters displayed atypical variance. For example, during Dive 4744, temperature at depth varied by 3°C, oxygen concentration by 0.4 ppm, and salinity by 0.7 PSU. This indicates some mixing of differential watermasses on or near the bottom.

METADATA

GIS DATA - The master geographic information system database maintained in ArcGIS 9 format is located at the USGS-Florida Integrated Science Center, Gainesville, Florida (FISC-Gainesville). The information contained in the GIS log has been analyzed to define the cruise track and submersible dive tracks (Figs. 1.2, 1.3; Master Appendix A).

ECHOSOUNDER DATA - Hardcopy printouts of the echosounder transects and the paper echosounder log are archived at the FISC-Gainesville.

VIDEO AND DIGITAL STILL IMAGES - The submersible collected video is in two formats, mini-DV tapes and duplicated DVDs. The digital still images are in .tif format. The original video media, backup copies on tape and DVD format, and digital images as computer files are archived at the FISC-Gainesville (contact person: K. Sulak).

AUDIO DATA - The master audiolog files in digital format and transcribed paper logs are located at the FISC-Gainesville.

FISH SPECIMENS - The master specimen log, preserved photo and nonphoto specimens, and collected stomachs are located at FISC-Gainesville. Analysis of stomach contents is ongoing (as of March 2007). Taxonomic voucher specimens will be transferred to zoological museums in stages, when all laboratory analyses and data compilation and validation are complete. Some fish material has already been donated to the U.S. National Museum of Natural History (USNM), Smithsonian Institution. Except for a small local taxonomic reference collection to be donated to the Florida Museum of Natural History, University of Florida, Gainesville, Florida, all remaining study material currently held at the FISC-Gainesville will also be transferred to the USNM.

INVERTEBRATE SPECIMENS - The master specimen log, preserved photo and non-photo specimens are presently located at FISC-Gainesville. The benthic infauna samples will remain with the USGS pending completion of all analyses. Megafaunal invertebrates will be transferred to the U.S. National Museum of Natural History, Smithsonian Institution, for taxonomic identification. Crinoids may be reserved for a taxonomic specialist at Nova-Southeastern University. Taxonomic voucher specimens have been donated to the U.S. National Museum of Natural History, Smithsonian Institution.

MICROBIAL DATA - The master log and microbial specimens are located at the FISC-St. Petersburg, Florida.

GENETICS DATA - The master log and coral genetics specimens are located at the USGS Leetown Center, Leetown, Virginia.

PALEOECOLOGY DATA - The master log, coral and rock aging specimens, and paleoecological specimens are located at McMaster University, Ontario, Canada.

STABLE ISOTOPE DATA - The master log containing all isotope sample information is located at the FISC-Gainesville.

WATER CHEMISTRY DATA - The master log containing all water parameter data is located at the FISC-Gainesville.

PRODUCTS

The present report has been prepared as a 2-DVD set, together with archived supporting databases, in the form of online appendices available at: http://cars.er.usgs.gov/coastaleco/. All components of the present final report are listed in the Table of Contents, which appears immediately after the flyleaf to the front cover. DVD-1 contains the text of the final report, plus Master Appendices B-E. DVD-2 contains Microsoft PowerPoint interactive dive tracks (Master Appendix A) with embedded .mpeg format video for each of the 20 submersible dives conducted in 2004 and 2005.

Certain community structure and function components of the original study plan (Sulak, 2004) remain to be fully completed, as detailed above. Now that benthic ecological expertise has been reestablished within FISC, these components (trophodynamics, macrofauna and meifauna, sediments) will be fully addressed by 1 November 2007, by which date a final report addendum will be prepared and submitted. Updates from other components of the overall program of investigations may also be forthcoming.

DISCLAIMER

LITERATURE CITED

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LIST OF TABLES

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Tables 1.4 to 1.9 comprise Master Appendix B (located on DVD-1 and web accessible)

Table1.1. Scientific Crew

NAME	TITLE	AFFILIATION	CRUISES			RESPONSIBILITY
			USGS-GM 2004-03	**USGS-GM 2005-03**	**USGS-GM 2005-04**	
Andrew J. Quaid	Chemical Oceanographer	USGS/FISC-Gainesville, FL	**X**			GIS, Mapping, CTD Operations, Data Management
Branwen Williams	Graduate Student	McGill University, Montreal, Quebec, Canada	**X**		**X**	Coral Aging
Dr. Andrea Grottoli	Coral Ecologist	University of Pennsylvania Philadelphia, PA			**X**	Coral Aging and Growth
Dr. Cheryl Morrison	Biologist	USGS Leetown Science Center, Kearneysville, WV	**X**		**X**	Coral Genetics
Dr. Christina Kellogg	Microbiologist	USGS/FISC-St. Petersburg, FL	**X**		**X**	Lead PI - Coral Microbes
Dr. Gary Brewer	USGS Program Administrator	USGS Eastern Regional Headquarters Reston, VA			**X**	USGS Program Administrator
Dr. John Caruso	Fish Biologist	Tulane University, New Orleans, LA	**X**			Fish Identification, Layout Photography
Dr. Kenneth J. Sulak	Research Fishery Biologist	USGS/FISC-Gainesville, FL	**X**	**X**	**X**	Chief Scientist, Lead PI - Overall Mission Organization; Report Editor
Dr. Martha Nizinski	Zoologist	NOAA/NMFS Systematics Lab, Smithsonian Institution, Washington, DC	**X**		**X**	Co-PI - Crustacean Specialist
Dr. R. Allen Brooks	Estuarine Ecologist	USGS/FISC-Gainesville, FL	**X**	**X**		Co-PI Macrofaunal/ Meiofaunal Invertebrate Specialist
Dr. Steve W. Ross	Research Fish Biologist	UNCW/CMS, Wilmington, NC & USGS/FISC-St. Petersburg, FL	**X**			Co-PI - Fish Taxonomy and Distribution Specialist

Table 1.1 (continued)

NAME	TITLE	AFFILIATION	CRUISES			RESPONSIBILITY
			USGS-GM 2004-03	**USGS-GM 2005-03**	**USGS-GM 2005-04**	
Dr. Tim King	Research Fishery Biologist	USGS Leetown Science Center, Kearneysville, WV	**X**			LSC Lead PI - Coral Genetics
George Yeargin	Master Biotechnician	USGS/FISC-Gainesville, FL	**X**			Remote Sampling Operations; Safety Officer
Jason Rochelo	Fishery Biotechnician	USGS/FISC-Gainesville, FL	**X**			Data Management Assistant; Image Organization
Jim Murray	Coral Genetics	USGS Leetown Science Center, Kearneysville, WV			**X**	Coral Genetics
Kirsten Luke	GIS Specialist	USGS/FISC-Gainesville, FL & Patuxent, MD			**X**	GIS Analyses & Mapping; Editing
April D. Norem	Wildlife Biologist	USGS/FISC-Gainesville, FL				Post-Cruise Digital Image & Data Analyses; Editing
Melissa Cheung	Student Intern	USGS/FISC-Gainesville, FL		**X**	**X**	Student Assistant
Michael Randall	Fishery Biologist	USGS/FISC-Gainesville, FL	**X**	**X**	**X**	Remote Sampling Operations; Isotope Preparation; Editing
Mike Risk	Professor of Geology and Biology	McMaster University Hamilton, Ontario, Canada	**X**			Co-PI - Coral Aging, Specimen Preparation
Robin Johnson	Coral Genetics	USGS Leetown Science Center, Kearneysville, WV			**X**	Coral Genetics
S. Conor Keitzer	Fishery Biotechnician	USGS/FISC-Gainesville, FL	**X**	**X**		Remote Sampling Operations; Isotope Prep
Steve Hartley	Geographer	USGS National Wetlands Research Center, Lafayette, LA	**X**			GIS

Table 1.1 (continued)

NAME	TITLE	AFFILIATION	CRUISES			RESPONSIBILITY
			USGS-GM 2004-03	**USGS-GM 2005-03**	**USGS-GM 2005-04**	
W. Bane Schill	Research Chemist	USGS Leetown Science Center, Kearneysville, WV	**X**			Coral Genetics
William M. Harden	Fishery Biotechnician	USGS/FISC-Gainesville, FL	**X**	**X**	**X**	Remote Sampling Operations; Photo Specimen Preparation
Buck Albert	Photographer	USGS/FISC-Gainesville, FL		**X**		Remote Sampling Operations; Photo Specimen Preparation
James Berg	Graduate Student	USGS/FISC-Gainesville, FL		**X**		Remote Sampling Operations
William Tate	Fish Biologist	USGS/FISC-Gainesville, FL		**X**		Remote Sampling Operations
Jennifer C. Carr	Undergraduate Intern	USGS/FISC-Gainesville, FL		**X**		Student Assistant

Table1.2. Sampling Station Data

SHIP	STATION NUMBER	DATE	TIME	SITE NAME	LAT N (deg)	LONG W (deg)	Z (m)	COMMENTS
JSL	USGS-GM-2004-03-4744	7/30/2004	09:22:40	VK906/862	29.106792	-88.383792	315	Fish Traps, Video, Photos, Coral, Sediment, Fish collections
JSL	USGS-GM-2004-03-4745	7/30/2004	17:20:01	VK906/862	29.097953	-88.384980	336	MMS Traps, Rock, Fish, Invert, Video, Photo collections
JSL	USGS-GM-2004-03-4746	7/31/2004	08:27:01	VK906/862	29.106138	-88.383095	345	*Lophelia*, Kellogg sampler, Fish Traps, Video, Photos collections
JSL	USGS-GM-2004-03-4747	7/31/2004	16:21:10	VK906/862	29.107122	-88.383500	316	Sediment, *Lophelia*, Fish Collections & Imaging
JSL	USGS-GM-2004-03-4748	8/1/2004	08:30:05	VK826	29.161983	-88.016203	446	*Lophelia*, Sediment, Fish Traps, Invert, *Lophelia*, Video and Photo Collections
JSL	USGS-GM-2004-03-4749	8/1/2004	16:26:45	VK826	29.156618	-88.018590	511	MMS Sampler Deployment, Sediment, *Lophelia*, Invert, Video, Photo collections
JSL	USGS-GM-2004-03-4750	8/2/2004	08:28:32	VK826	29.172778	-88.017007	528	Invert, Fish, Sediment, Coral, Video, Photo collections
JSL	USGS-GM-2004-03-4751	8/2/2004	15:57:57	VK826	29.170160	-88.011490	462	*Lophelia*, Bushmaster, Fish, Invert, Sponge, Video, Photo Collections
JSL	USGS-GM-2004-03-4752	8/3/2004	08:35:10	VK826	29.170288	-88.012413	469	*Lophelia*, Coral, Fish, Egg Case, Sponge, Rock, Video, Photo Collections
JSL	USGS-GM-2004-03-4753	8/3/2004	16:26:04	VK826	29.169957	-88.012760	475	Invert, *Lophelia*, Kellogg sampler, Video, Photo collections
JSL	USGS-GM-2004-03-4754	8/4/2004	08:34:09	CEC 4*	29.448807	-86.962668	738	Fish, Inverts, Video, Photo collections
JSL	USGS-GM-2004-03-4755	8/4/2004	15:57:36	CEC 5*	29.390303	-86.980460	703	Inverts, Fish, Video, Photo collections
SJ	USGS-GM-2004-03-9001	7/30/2004	13:19:00	VK906/862	29.104100	-88.379317	0	Plankton Net, fished at surface
SJ	USGS-GM-2004-03-9002	7/30/2004	13:42:00	VK906/862	29.108483	-88.387067	38	Plankton Net, fished in midwater
SJ	USGS-GM-2004-03-9003	7/30/2004	14:07:00	VK906/862	29.113817	-88.396833	35	Plankton Net, fished in midwater
SJ	USGS-GM-2004-03-9004	7/30/2004	23:04:00	VK906/862	29.093100	-88.496417	327	3.7 m Otter Trawl

Table 1.2 (continued)

SHIP	STATION NUMBER	DATE	TIME	SITE NAME	LAT N (deg)	LONG W (deg)	Z (m)	COMMENTS
SJ	USGS-GM-2004-03-9005	7/31/2004	06:27:00	VK906/862	29.106872	-88.382783	327	Longline
SJ	USGS-GM-2004-03-9006	7/31/2004	13:05:00	VK906/862	29.107100	-88.384200	400	Longline
SJ	USGS-GM-2004-03-9007	7/31/2004	22:18:00	VK906/862	29.054467	-88.368950	536	3.7 m Otter Trawl
SJ	USGS-GM-2004-03-9008	8/1/2004	08:00:00	VK826	29.161983	-88.016300	0	Dip Net
SJ	USGS-GM-2004-03-9009	8/1/2004	09:45:00	VK826	29.160600	-88.017467	0	Dip Net
SJ	USGS-GM-2004-03-9010	8/1/2004	10:08:00	VK826	29.161650	-88.017917	0	Dip Net
SJ	USGS-GM-2004-03-9011	8/1/2004	10:34:00	VK826	29.158817	-88.017383	0	Dip Net
SJ	USGS-GM-2004-03-9012	8/1/2004	12:00:00	VK826	29.141900	-88.000400	0	Trolling for Pelagics
SJ	USGS-GM-2004-03-9013	8/1/2004	21:35:00	VK826	29.182950	-88.032517	457	Benthic Sled - mud
SJ	USGS-GM-2004-03-9014	8/2/2004	01:47:00	VK826	29.190900	-88.078217	382	Benthic Sled
SJ	USGS-GM-2004-03-9015	8/2/2004	04:24:00	VK826	29.159883	-88.052900	519	CTD
SJ	USGS-GM-2004-03-9016	8/2/2004	04:56:00	VK826	29.162933	-88.045533	518	Plankton Net, 100 m
SJ	USGS-GM-2004-03-9017	8/2/2004	20:30:00	South of Ludwig & Walton	29.222450	-87.872283	308	3.7 m Otter Trawl
SJ	USGS-GM-2004-03-9018	8/2/2004	23:13:00	South of Ludwig & Walton	29.251967	-87.869167	325	3.7 m Otter Trawl

Table 1.2 (continued)

SHIP	STATION NUMBER	DATE	TIME	SITE NAME	LAT N (deg)	LONG W (deg)	Z (m)	COMMENTS
SJ	USGS-GM-2004-03-9019	8/3/2004	01:44:00	South of Ludwig & Walton	29.279117	-87.787617	299	CTD
SJ	USGS-GM-2004-03-9020	8/3/2004	19:06:00	CEC 4	29.168500	-88.008833	0	Dip Net
SJ	USGS-GM-2004-03-9021	8/4/2004	12:30:00	VK826	29.166217	-87.987700	0	Trolling for pelagics
TM	USGS-GM-2005-03-0013	6/2/2005	16:55:00	VK906/862	29.092600	-88.388700	360	Bandit Rig
TM	USGS-GM-2005-03-0014	6/2/2005	17:09:00	VK906/862	29.092800	-88.388800	0	Dip Net
TM	USGS-GM-2005-03-0015	6/2/2005	18:01:00	VK906/862	29.093100	-88.388300	360	Bandit Rig
TM	USGS-GM-2005-03-0016	6/2/2005	18:42:00	VK906/862	29.093700	-88.388300	0	Dip Net
TM	USGS-GM-2005-03-0017	6/2/2005	21:14:00	VK906/862	29.086800	-88.388500	360	Trap Deploy
TM	USGS-GM-2005-03-0018	6/2/2005	22:10:00	VK906/862	29.104400	-88.384100	360	Trap Deploy
TM	USGS-GM-2005-03-0019	6/2/2005	23:00:00	VK906/862	29.104400	-88.384100	0	Dip Net
TM	USGS-GM-2005-03-0020	6/3/2005	07:29:00	VK906/862	29.096100	-88.386900	330	Deploy Coral Settling Plates (set 1)
TM	USGS-GM-2005-03-0021	6/3/2005	07:52:00	VK906/862	29.102900	-88.384700	343	Deploy Coral Settling Plates (set 1)
TM	USGS-GM-2005-03-0022	6/3/2005	08:02:00	VK906/862	29.102900	-88.380700	350	CTD
TM	USGS-GM-2005-03-0023	6/3/2005	08:56:00	VK906/862	29.079600	-88.378900	456	Bandit Rig

Table 1.2 (continued)

SHIP	STATION NUMBER	DATE	TIME	SITE NAME	LAT N (deg)	LONG W (deg)	Z (m)	COMMENTS
TM	USGS-GM-2005-03-0024	6/3/2005	10:06:00	VK906/862	29.072800	-88.363500	0	Plankton Tow
TM	USGS-GM-2005-03-0025	6/3/2005	13:04:00	VK826	29.170000	-88.012200	486	Trap #3
TM	USGS-GM-2005-03-0026	6/3/2005	13:38:00	VK826	29.166700	-88.014900	486	Deploy Coral Settling Plates (over dive site 4752)
TM	USGS-GM-2005-03-0027	6/3/2005	14:06:00	VK826	29.158500	-88.017800	486	Trap #4 at 4749
TM	USGS-GM-2005-03-0028	6/3/2005	14:29:00	VK826	29.157100	-88.019600	486	Deploy Coral Settling Plates (set 1)
TM	USGS-GM-2005-03-0029	6/3/2005	14:35:00	VK826	29.156300	-88.020200	486	CTD
TM	USGS-GM-2005-03-0074	6/5/2005	06:40:00	VK826 (4750 + 4752)	29.177600	-88.006500	486	Trap Recover
TM	USGS-GM-2005-03-0075	6/5/2005	07:30:00	VK826 (4749)	29.162600	-88.025900	486	Trap Recover
TM	USGS-GM-2005-03-0076	6/5/2005	10:36:00	VK906/862	29.090600	-88.384600	360	Trap Recover
TM	USGS-GM-2005-03-0077	6/5/2005	11:18:00	VK906/862	29.105300	-88.378700	360	Trap Recover
JSL	USGS-GM-2005-04-4873	9/16/2005	10:41:48	VK906/862	29.107097	-88.384943	315	Kellogg sampler, short dive 4 coral samples, 3 segments video analysed
JSL	USGS-GM-2005-04-4874	9/16/2005	17:23:51	VK906/862	29.107167	-88.384845	316	5 transects and 3 *Lophelia* samples
JSL	USGS-GM-2005-04-4875	9/17/2005	08:21:46	VK906/862	29.104570	-88.384355	337	5 transects, *Lophelia*, bamboo and black coral collection
JSL	USGS-GM-2005-04-4876	9/17/2005	16:16:25	VK906/862	29.106933	-88.384708	312	6 transects, *Lophelia*, black coral and anemone collection, many fish (blacks, snowys, wreckfish)
JSL	USGS-GM-2005-04-4877	9/18/2005	08:25:26	VK 826	29.169612	-88.012003	480	2 transects, sedimant sample, bacteria mat, tube worms and *Lophelia*
JSL	USGS-GM-2005-04-4878	9/18/2005	16:46:56	VK 826	29.170060	-88.011595	465	Kellogg sampler, 6 samples short dive, 1 segment video analyzed

Table 1.2 (continued)

SHIP	STATION NUMBER	DATE	TIME	SITE NAME	LAT N (deg)	LONG W (deg)	Z (m)	COMMENTS
JSL	USGS-GM-2005-04-4879	9/19/2005	08:22:10	VK 826	29.160248	-88.019200	454	4 transects, *Lophelia*, goose fish, crab and mollusk collection
JSL	USGS-GM-2005-04-4880	9/19/2005	16:25:30	VK 826	29.160202	-88.018795	455	8 transects, *Lophelia*, urchin collections
JSL	USGS-GM-2005-04-4881	9/20/2005	08:39:15	VK 826	29.159567	-88.018900	451	Kellogg sampler, 10 samples and 2 transects
JSL	USGS-GM-2005-04-4882	9/20/2005	16:36:34	VK 826	29.169600	-88.012258	478	Grid layout and photo, crab, *Lophelia*, starfish and pencil urchin collection, 4 segments video analyzed
SJ	USGS-GM-2005-04-0001	9/16/2005	13:32:15	VK906/862	29.107827	-88.385855	0	Plankton, fished at surface
SJ	USGS-GM-2005-04-0002	9/16/2005	14:00:15	VK906/862	29.111770	-88.408115	70	CTD, midwater
SJ	USGS-GM-2005-04-0003	9/16/2005	21:49:00	VK906/862	29.115352	-88.385953	30	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0004	9/16/2005	22:44:00	VK906/862	29.114697	-88.386347	60	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0005	9/16/2005	23:26:00	VK906/862	29.111652	-88.378712	0	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0006	9/17/2005	00:45:00	VK906/862	29.113265	-88.385518	0	3 Dip Nets with night-light
SJ	USGS-GM-2005-04-0007	9/17/2005	01:15:00	VK906/862	29.123427	-88.387727	0	3 Dip Nets with night-light
SJ	USGS-GM-2005-04-0008	9/17/2005	02:15:00	VK906/862	29.081697	-88.381975	0	3 Dip Nets with night-light
SJ	USGS-GM-2005-04-0009	9/17/2005	02:45:00	VK906/862	29.089748	-88.382713	0	3 Dip Nets with night-light
SJ	USGS-GM-2005-04-0010	9/17/2005	03:15:00	VK906/862	29.098160	-88.380658	0	3 Dip Nets with night-light
SJ	USGS-GM-2005-04-0011	9/17/2005	14:42:00	VK906/862	29.119122	-88.386175	0	Plankton, fished at surface

Table 1.2 (continued)

SHIP	STATION NUMBER	DATE	TIME	SITE NAME	LAT N (deg)	LONG W (deg)	Z (m)	COMMENTS
SJ	USGS-GM-2005-04-0012	9/18/2005	14:00:00	VK826	29.176023	-88.012492	70	CTD, midwater
SJ	USGS-GM-2005-04-0013	9/18/2005	14:15:00	VK826	29.182490	-88.014627	0	Plankton Net, fished at surface
SJ	USGS-GM-2005-04-0014	9/18/2005	19:01:01	VK826	29.148055	-88.029955	35	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0015	9/18/2005	19:35:37	VK826	29.171578	-88.010897	70	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0016	9/18/2005	20:27:24	VK826	29.211577	-87.986282	80	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0017	9/18/2005	22:50:00	VK826	29.130907	-88.060105	80	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0018	9/19/2005	00:30:00	VK826	29.108075	-88.065925	80	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0019	9/19/2005	20:17:00	VK826	29.181723	-88.052705	66	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0020	9/19/2005	21:41:00	VK826	29.044388	-88.120715	66	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0021	9/19/2005	22:55:00	VK826	29.058938	-88.199783	70	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0022	9/19/2005	23:46:00	VK826	29.071093	-88.242655	200	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0023	9/20/2005	02:04:00	VK826	29.024573	-88.192037	100	6.4 m Otter Trawl (fished in midwater)
SJ	USGS-GM-2005-04-0024	9/20/2005	13:08:00	VK826	29.157005	-88.046300	0	Plankton Net, fished at surface
SJ	USGS-GM-2005-04-0025	9/20/2005	14:08:00	VK826	29.174682	-88.058590	40	6.4 m Otter Trawl (fished in midwater)

* Two submersible dives conducted at sites designated CEC 4 and CEC 5, conducted at the end of Cruise USGS-GM-2004 were not formally part of the present investigation, but did provide comparative soft-bottom data and imagery.

Table1.3: JSL Dive Station Data

SHIP	STATION NUMBER	DATE	TIME	SITE NAME	LAT DD	LONG DD	Z (ft)	Z (ft)	SCIENTIST	OBSERVER	COMMENTS
JSL	USGS-GM-2004-03-4744	07/30/04	09:22:40	VK906/862	29.106792	-88.383792	1035	315	Sulak	Brooks	Fish Traps, Video, Photos, Coral, Sediment, Fish collections
JSL	USGS-GM-2004-03-4745	07/30/04	17:20:01	VK906/862	29.097953	-88.384980	1103	336	Ross	Risk	MMS Traps, Rock, Fish, Invert, Video, Photo collections
JSL	USGS-GM-2004-03-4746	07/31/04	08:27:01	VK906/862	29.106138	-88.383095	1133	345	Nizinski	Kellogg	*Lophelia*, Kellogg sampler, Fish Traps, Video, Photo collections
JSL	USGS-GM-2004-03-4747	07/31/04	16:21:10	VK906/862	29.107122	-88.383500	1038	316	Brooks	Schill	Sediment, *Lophelia*, Fish Collections & Imaging
JSL	USGS-GM-2004-03-4748	08/01/04	08:30:05	VK826	29.161983	-88.016203	1462	446	King	Sulak	*Lophelia*, Sediment, Fish Traps, Invert, Video and Photo collections
JSL	USGS-GM-2004-03-4749	08/01/04	16:26:45	VK826	29.156618	-88.018590	1676	511	Morrison	Nizinski	MMS Sampler Deployment, Sediment, *Lophelia*, Invert, Video, Photo collections
JSL	USGS-GM-2004-03-4750	08/02/04	08:28:32	VK826	29.172778	-88.017007	1732	528	Caruso	Ross	Invert, Fish, Sediment, Coral, Video, Photo collections
JSL	USGS-GM-2004-03-4751	08/02/04	15:57:57	VK826	29.170160	-88.011490	1516	462	Williams	Quaid	*Lophelia*, Bushmaster, Fish, Invert, Sponge, Video, Photo Collections
JSL	USGS-GM-2004-03-4752	08/03/04	08:35:10	VK826	29.170288	-88.012413	1540	469	Risk	Ross	*Lophelia*, Coral, Fish, Egg Case, Sponge, Rock, Video, Photo Collections
JSL	USGS-GM-2004-03-4753	08/03/04	16:26:04	VK826	29.169957	-88.012760	1559	475	Kellogg	Nizinski	Invert, *Lophelia*, Kellog sampler, Video, Photo collections
JSL	USGS-GM-2004-03-4754	08/04/04	08:32:19	CEC 4	29.448807	-86.962668	2426	739	King	Sulak	Site exploration & imaging

Table 1.3 (continued)

SHIP	STATION NUMBER	DATE	TIME	SITE NAME	LAT DD	LONG DD	Z (ft)	Z (ft)	SCIENTIST	OBSERVER	COMMENTS
JSL	USGS-GM-2004-03-4755	08/04/04	15:57:39	CEC 5	29.390303	-86.980460	2305	702	Randall	Shill	Site exploration & imaging
JSL	USGS-GM-2005-04-4873	09/16/05	10:41:48	VK906/862	29.107097	-88.384943	1034	315	Kellogg	Grottoli	Kellogg sampler, short dive 4 coral samples, 3 segments video analyzed
JSL	USGS-GM-2005-04-4874	09/16/05	17:23:51	VK906/862	29.107167	-88.384845	1035	315	Nizinski	Johnson	5 transects and 3 *Lophelia* samples
JSL	USGS-GM-2005-04-4875	09/17/05	08:21:46	VK906/862	29.104570	-88.384355	1106	337	Morrison	Williams	5 transects, *Lophelia*, bamboo and black coral collection
JSL	USGS-GM-2005-04-4876	09/17/05	16:16:25	VK906/862	29.106933	-88.384708	1022	312	Sulak	Luke	6 transects, *Lophelia*, black coral and anemone collection, many fish (blacks, snowy groupers, wreckfish)
JSL	USGS-GM-2005-04-4877	09/18/05	08:25:26	VK 826	29.169612	-88.012003	1573	479	Murray	Randall	2 transects, sediment sample, bacteria mat, tube worms and *Lophelia*
JSL	USGS-GM-2005-04-4878	09/18/05	16:46:56	VK 826	29.170060	-88.011595	1525	465	Kellogg	Johnson	Kellogg sampler, 6 samples short dive, 1 segment video analyzed
JSL	USGS-GM-2005-04-4879	09/19/05	08:22:10	VK 826	29.160248	-88.019200	1490	454	Morrison	Murray	4 transects, *Lophelia*, goose fish, crab and mollusk collection
JSL	USGS-GM-2005-04-4880	09/19/05	16:25:30	VK 826	29.160202	-88.018795	1492	455	Brewer	Sulak	8 transects, *Lophelia*, urchin collection
JSL	USGS-GM-2005-04-4881	09/20/05	08:39:15	VK 826	29.159567	-88.018900	1481	451	Kellogg	Williams	Kellogg sampler, 10 samples and 2 transects
JSL	USGS-GM-2005-04-4882	09/20/05	16:36:34	VK 826	29.169600	-88.012258	1567	478	Trainee Pilot	Nizinski	Grid layout and photo, crab, *Lophelia* starfish and pencil urchin collection, 4 segments video analyzed

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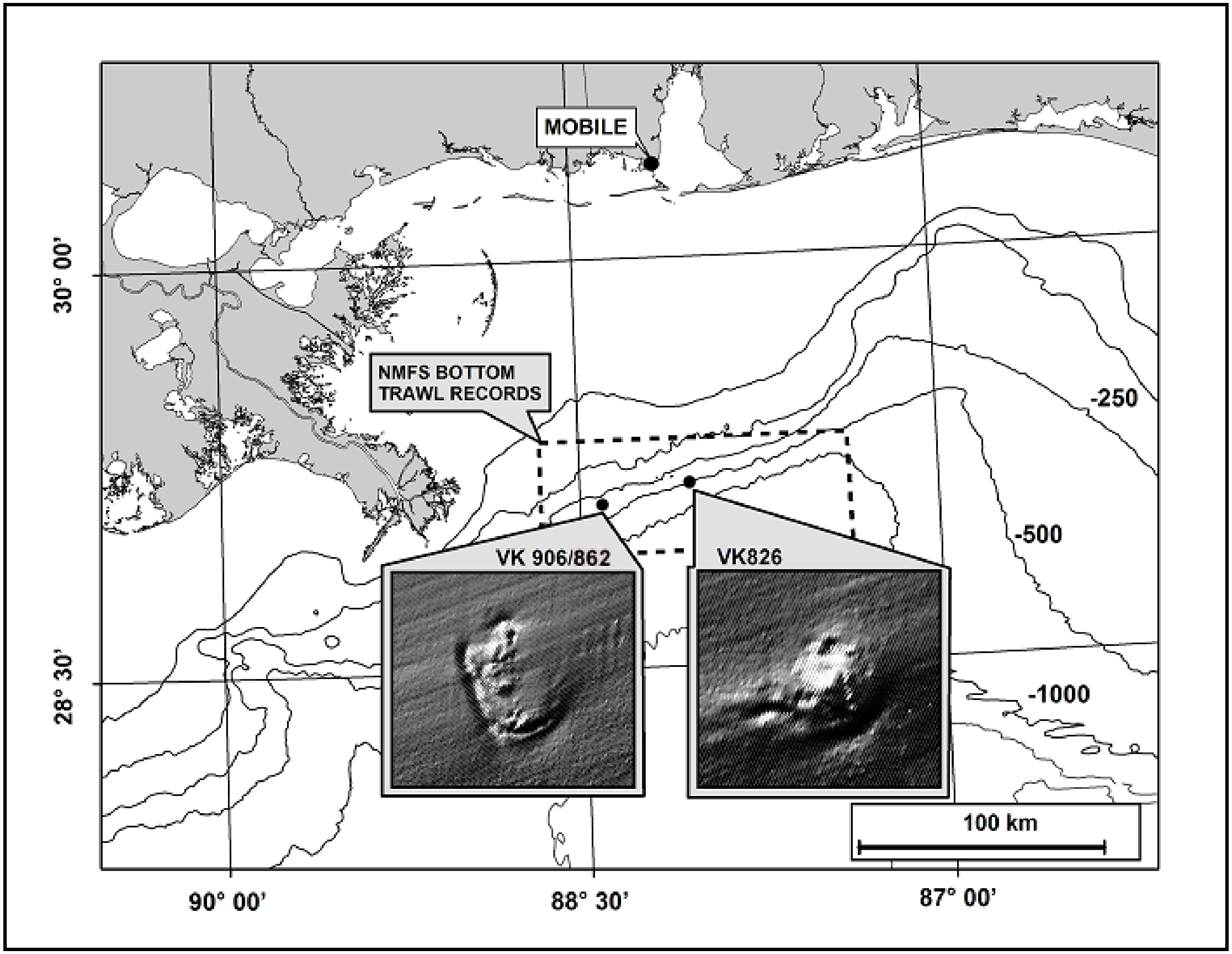

Figure 1.1. Location of Gulf of Mexico study sites VK-826 and VK-906/862.

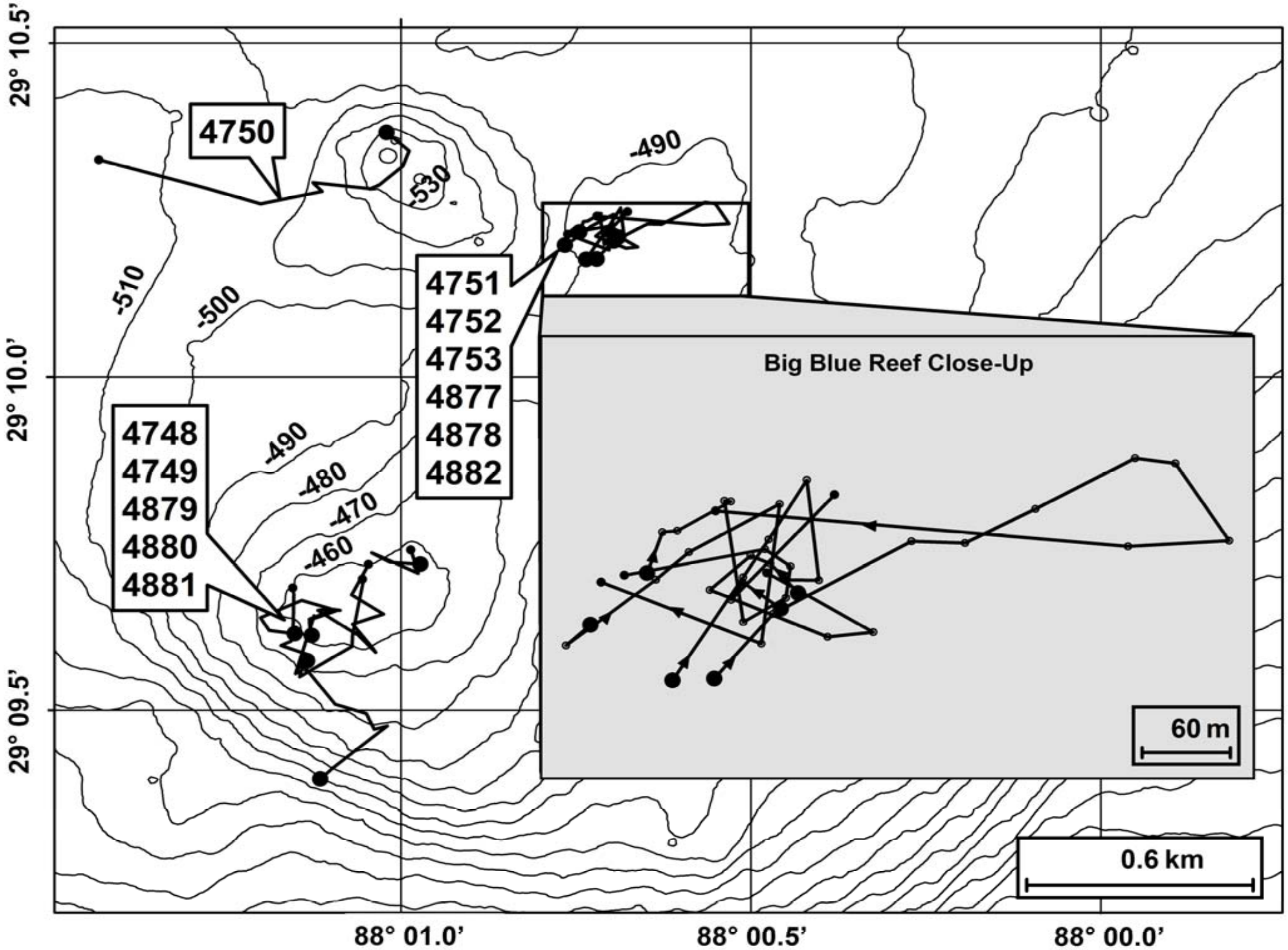

Figure 1.2. Locations of individual submersible dive stations, VK-826, Cruises USGS-GM-2004-03 and USGS-GM-2005-04. Inset shows coverage of dive tracks on 'Big Blue Reef', an area of well-developed *Lophelia* coral thickets.

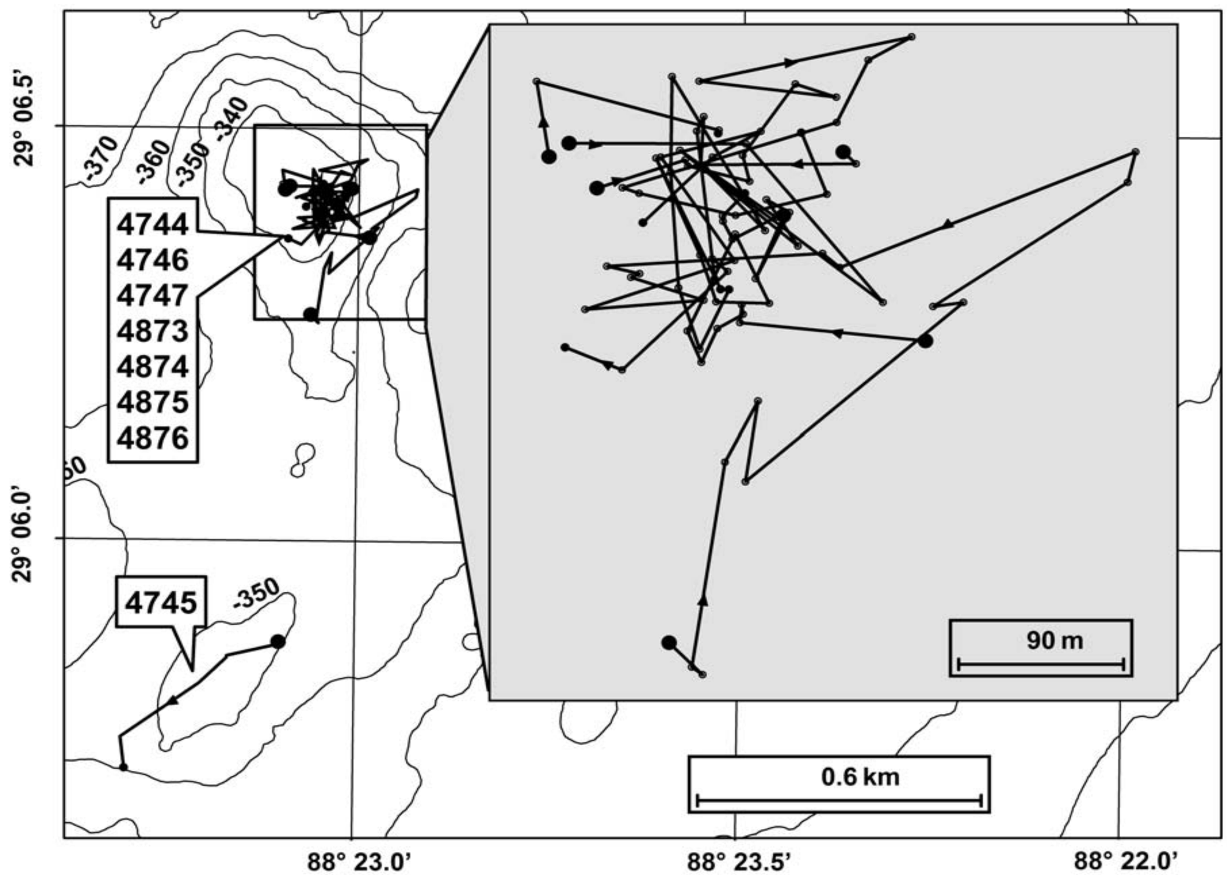

Figure 1.3. Locations of individual submersible dive stations, VK-906/862, Cruises USGS-GM-2004-03 and USGS-GM-2005-04. Inset shows coverage of dive tracks on the top of the central mound, an area of well-developed sessile megafaunal communities.

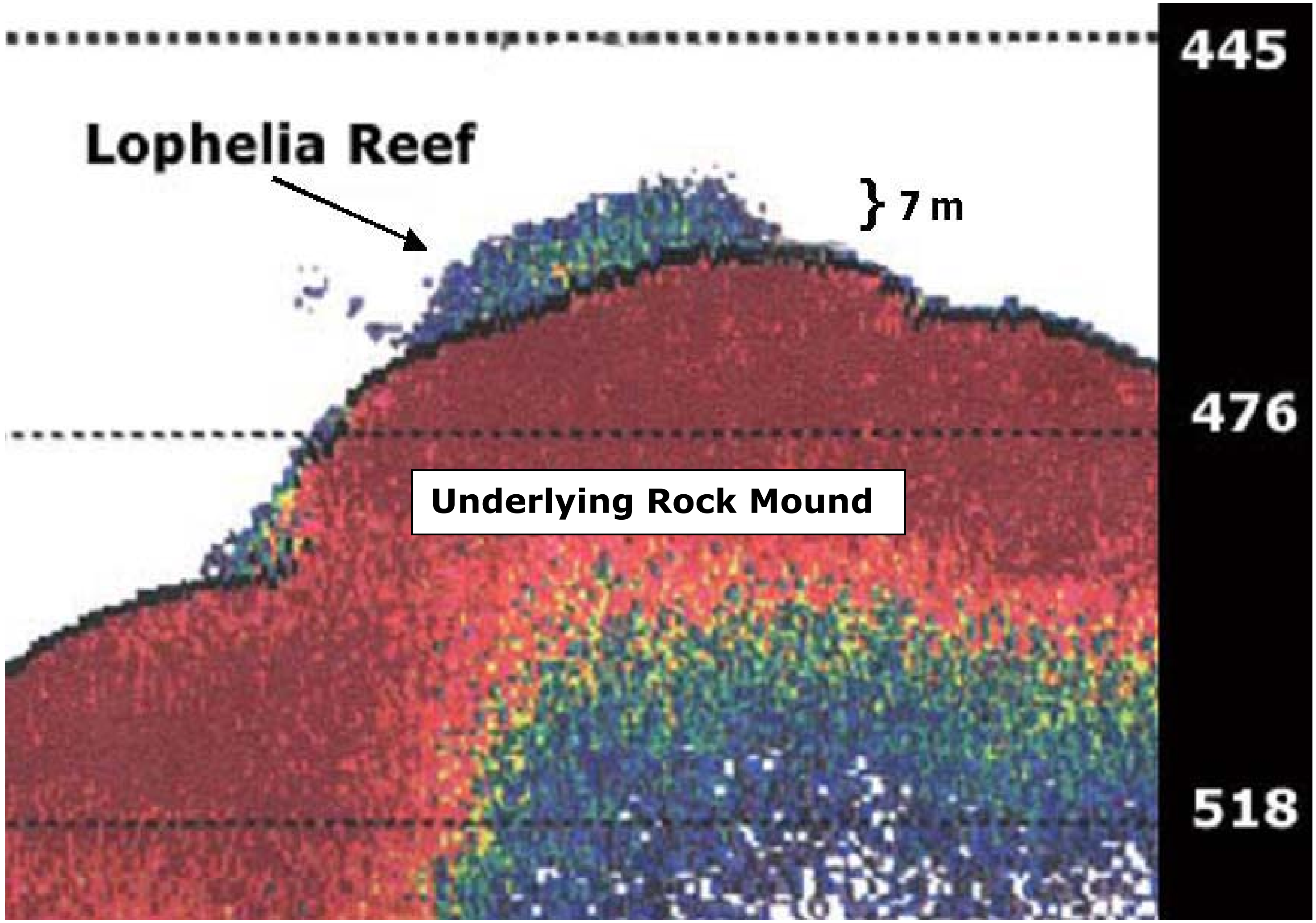

Figure 1.4. Simrad echosounder single beam (38 kHz) acoustic false-color profile of *Lophelia pertusa* reef atop a ridge-mound on Big Blue Reef, northeastern sector of VK-826 study site.

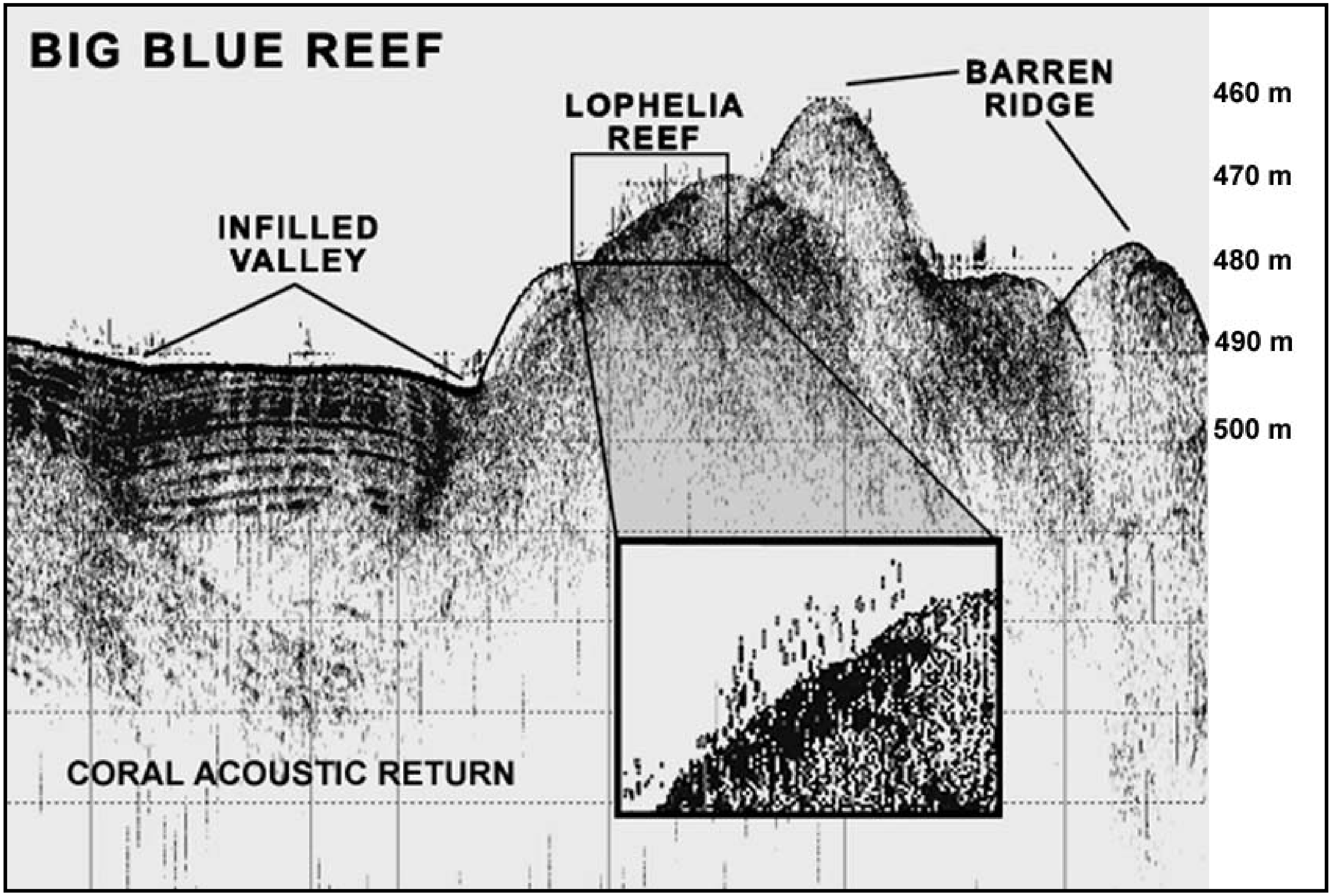

Figure 1.5. Knudsen echosounder single beam acoustic (3.5 kHz) profile of *Lophelia pertusa* coral reef, 'Big Blue Reef', on the flank of a ridge, northeastern sector of VK-826 study site.

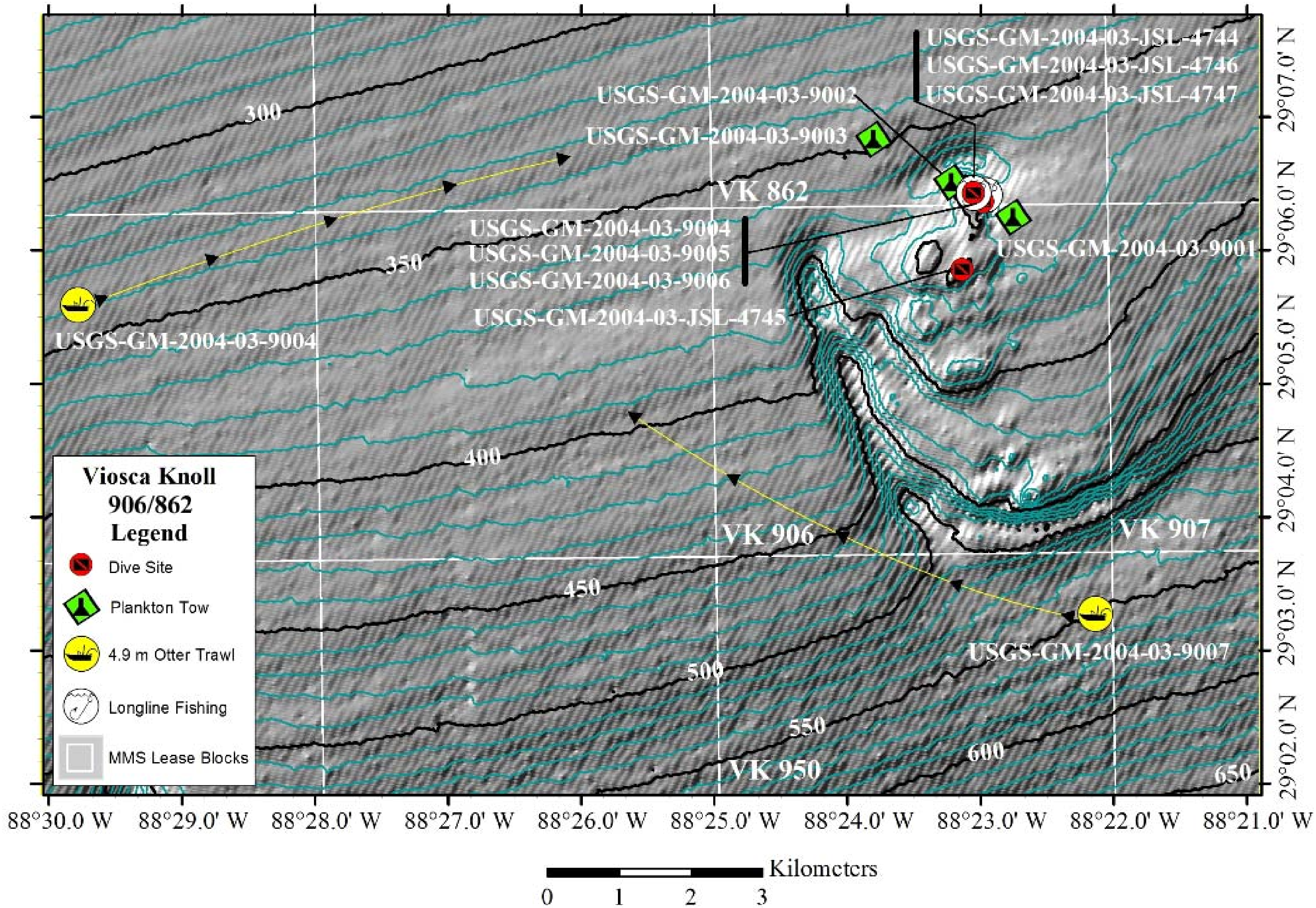

Figure 1.6. Submersible dives and surface-deployed remote sampling stations, VK-906/862, Cruise USGS-GM-2004-03, with boundaries of MMS lease blocks indicated by white grid lines and VK numbers.

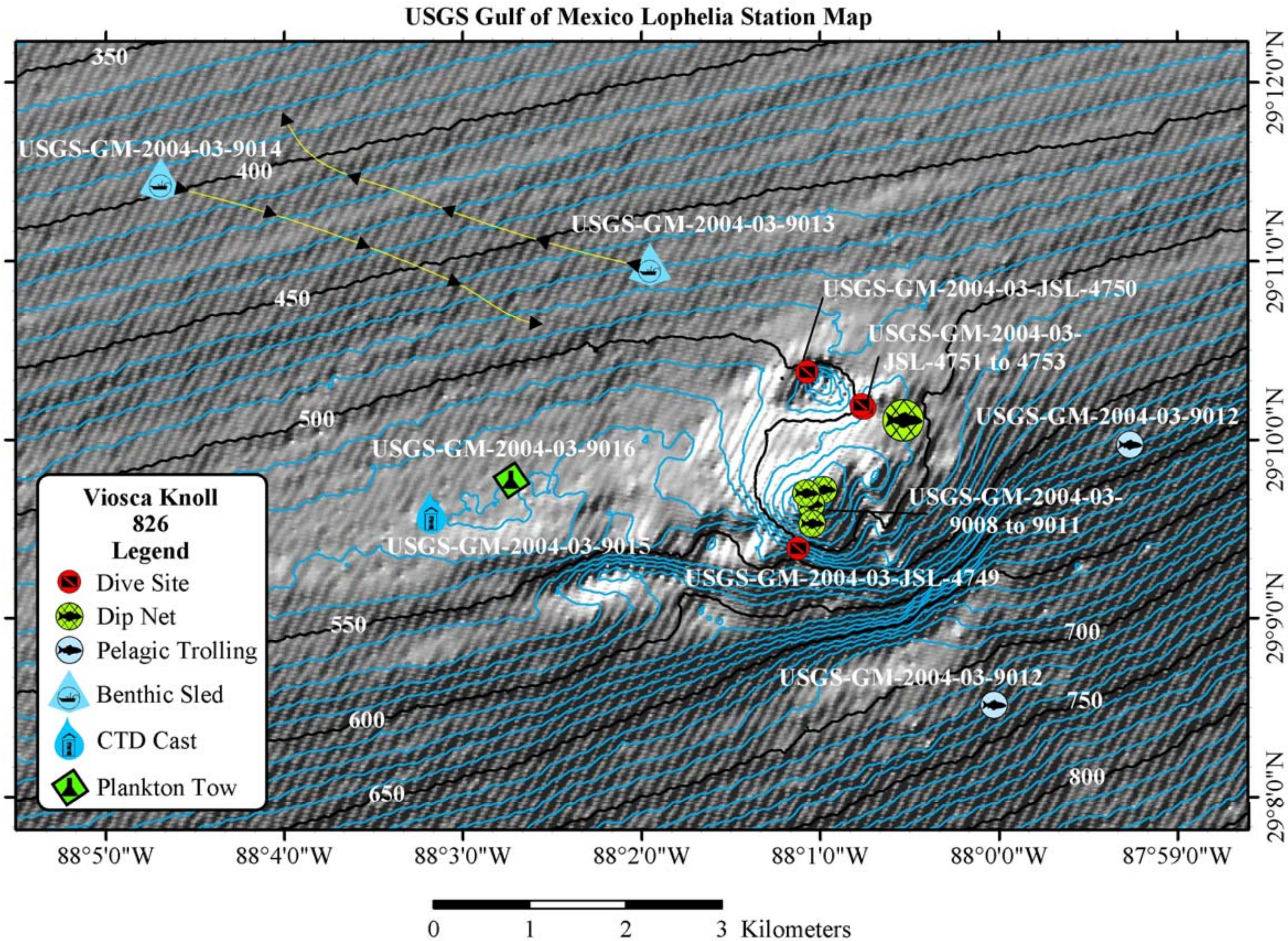

Figure 1.7. Submersible dives and surface-deployed remote sampling stations, VK-826, Cruise USGS-GM-2004-03.

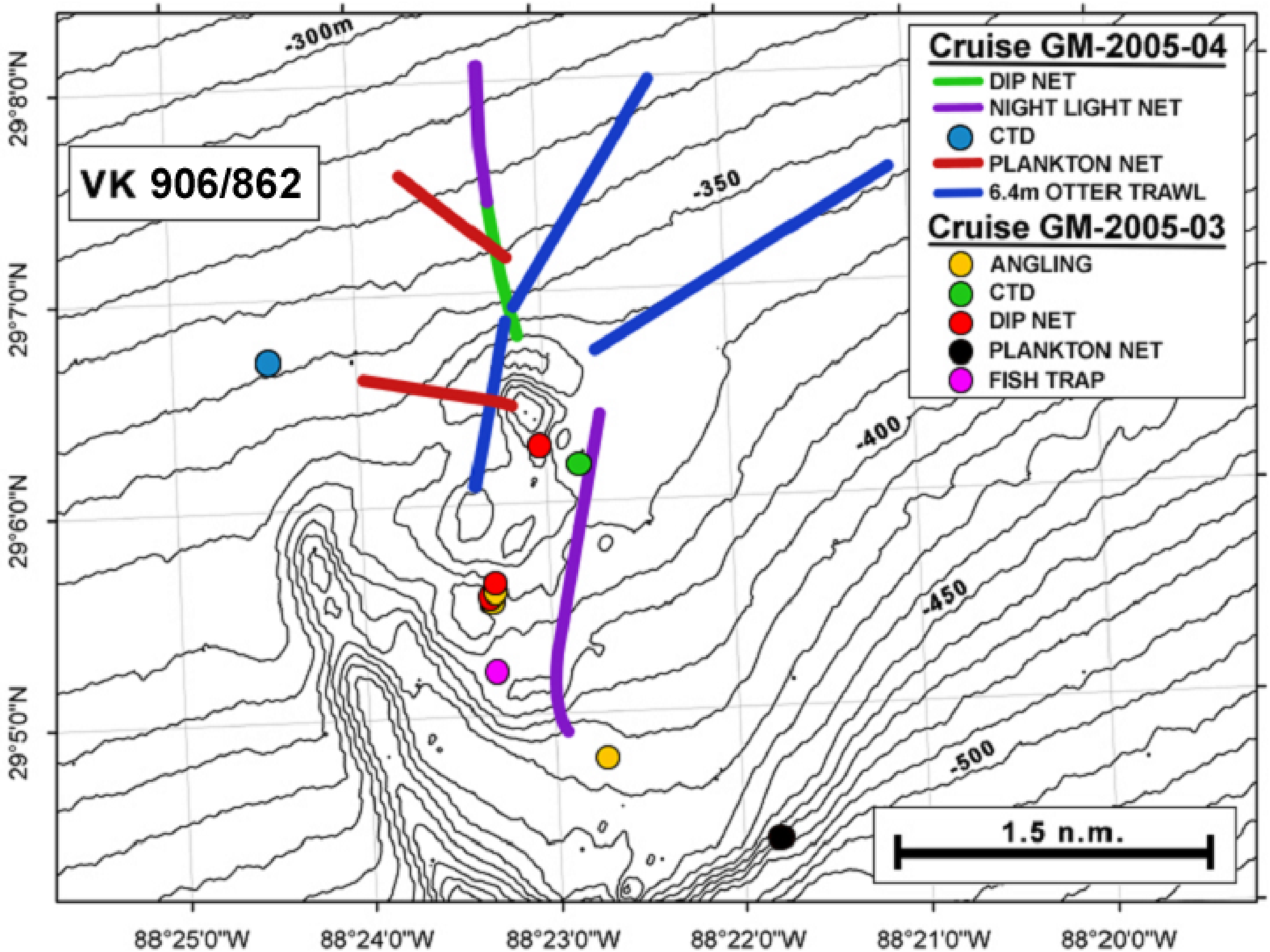

Figure 1.8. Surface-deployed remote sampling stations, VK-906/862, Cruises USGS-GM-2005-03 and USGS-GM-2005-04.

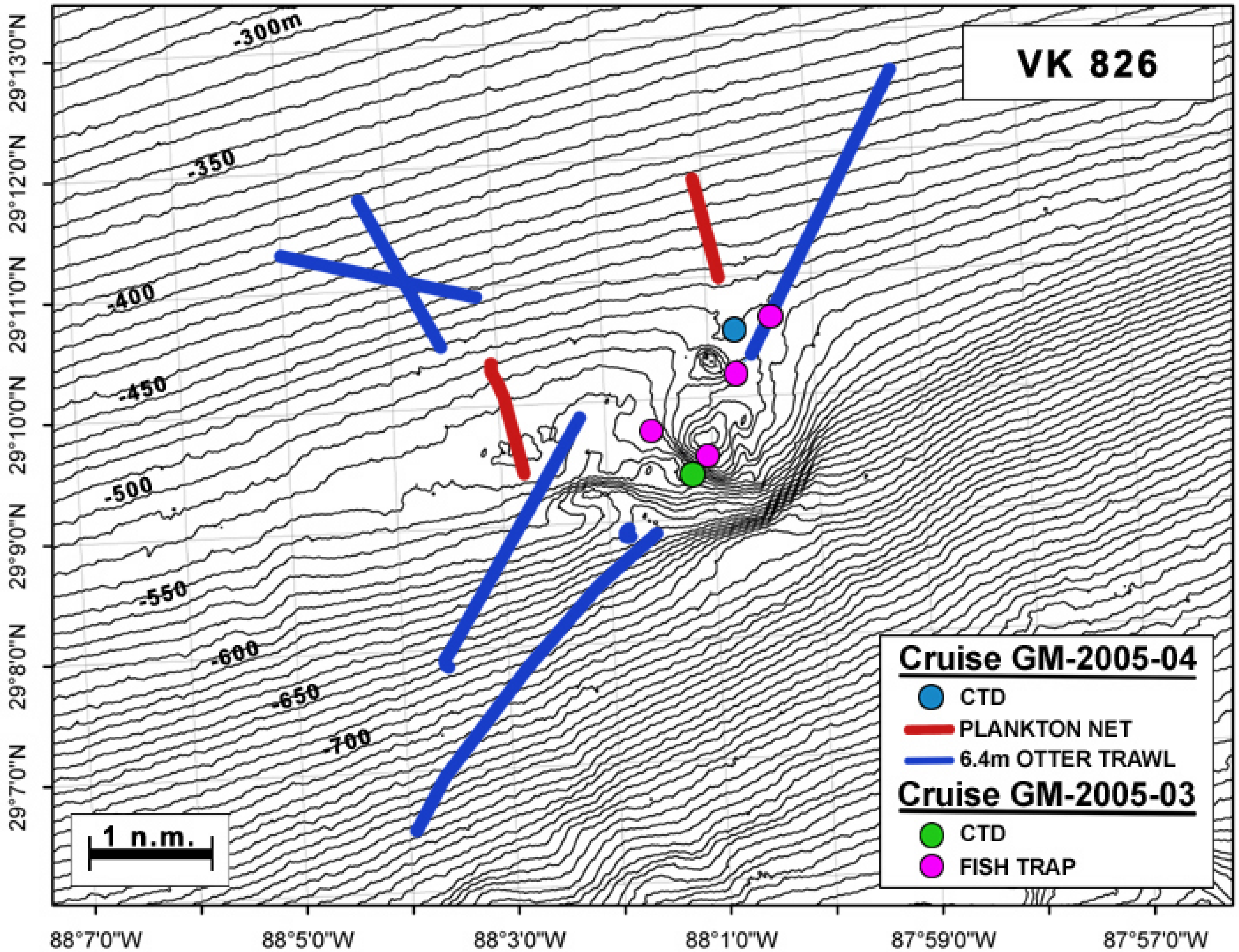

Figure 1.9. Surface-deployed remote sampling stations, VK-826, Cruises USGS-GM-2005-03 and USGS-GM-2005-04.

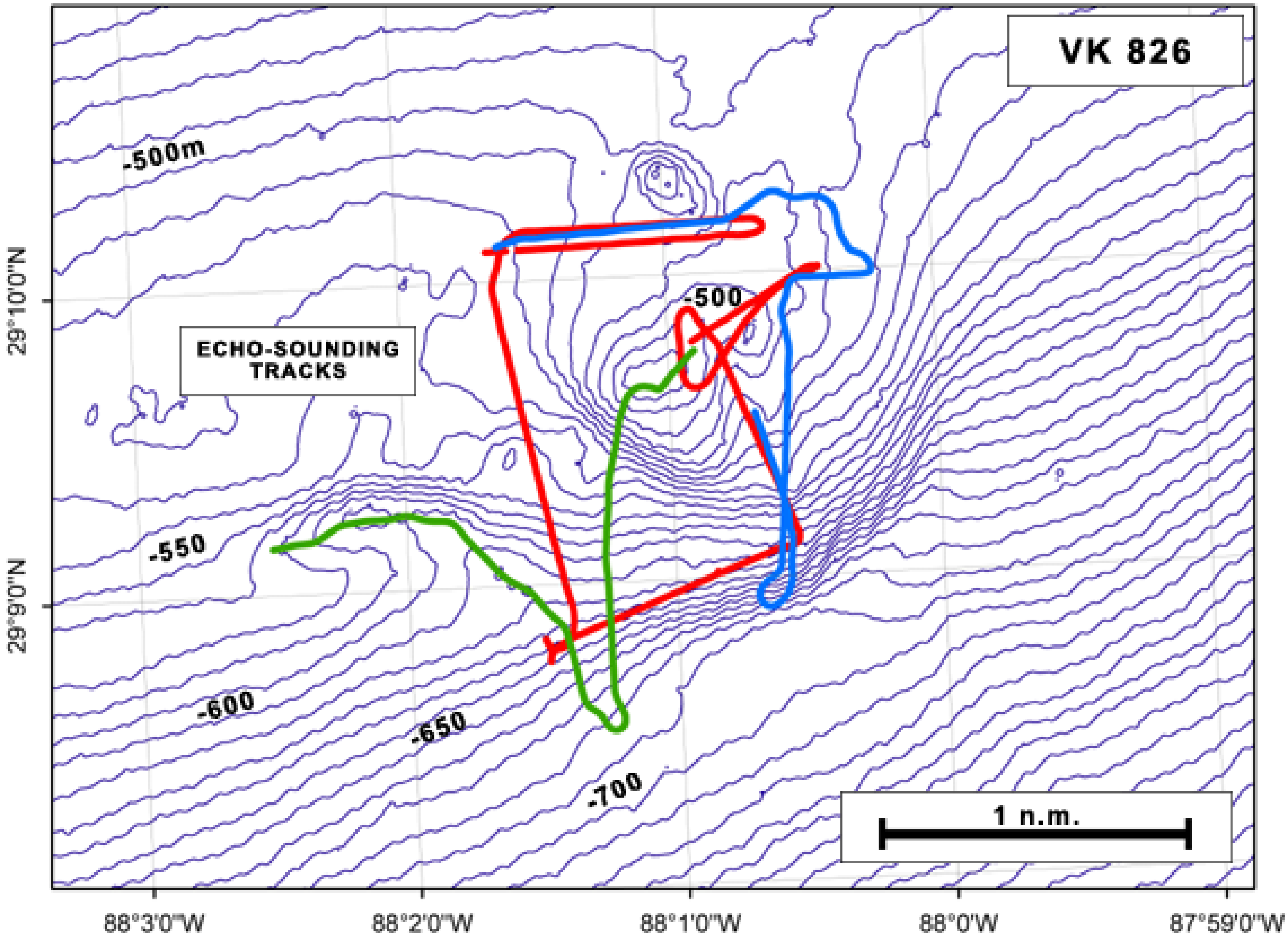

Figure 1.10. Exploratory echosounding tracks, VK-826, Cruise USGS-GM-2005-04.