Flower Garden Banks National Marine Sanctuary

Research Summary 2006

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January 2007

Cover photo: Female barrel sponge, *Xestospongia muta*, releasing eggs into the water column at the East Flower Garden Bank. Photo credit: FGBNMS/Hickerson

A. OVERVIEW

The purpose of this document is to report the activities of the Flower Garden Banks Research Team during 2006. The team included Emma L. Hickerson (Research Coordinator), Doug Weaver (GIS specialist), and Kyle Byers (Research Assistant).

B. SUMMARY

A major event this year was the relocation of the FGBNMS office to Galveston, Texas. This took place in June, 2006. In addition to the move, the FGBNMS research team was involved in 11 research cruises in 2006, at a value of approximately $186K for the shiptime, $113K of which came directly out of FGBNMS FY06 budget. The FGBNMS benefited from 5 days of Nancy Foster shiptime. A pool of 54 sanctuary personnel, scientists, and volunteer divers conducted approximately 1109 SCUBA dives during the 2006 field season. 644 volunteer hours were conducted for FGBNMS research activities. A coral bleaching response cruise was conducted. Other activities included biological surveys and collection, equipment maintenance, and image collection. Thirteen Sanctuary permits were processed, and an additional 10 were ongoing.

C. CRUISES ($ amt. represents approximate shiptime value)

1. **Bleaching response cruise – R/V PT. GLASS ($5,000) -** A significant coral bleaching event was reported and surveyed by the FGBNMS in the late summer and fall of 2005, with approximately 45% of the colonies surveyed being affected by bleaching to some extent. Follow-up surveys were conducted on January 3-4, 2006. A number of belt transects were established, 15 meters long by 1 meter wide, in which every coral colony was counted and scored as to its bleaching condition (totally bleached, partially bleached or unbleached). Transects were established from known reference points (mooring buoy anchor pins). The average number of coral colonies affected by bleaching ranged from 4.5% (West Flower Garden) and 10.3% (East Flower Garden). This is compared to an average of 42% in October, and 46% in November. Of the species affected, only *Millepora alcicornis* and *Montastrea cavernosa* had colonies that were considered still "totally bleached" (1.3%), with most other affected species scored as "partially bleached". Only *Millepora alcicornis* displayed mortality related to bleaching, but over 50% of the surveyed colonies of that species contained areas of dead tissue. This species is not a dominant component of the living coral community, comprising less than 2% of the total. Video was taken along each transect but has not yet been analyzed. Water temperature during the survey was 74 degrees F (23 degrees C).

   An observation of significant concern was an increased occurrence of coral colonies displaying symptoms consistent with that of "white plague" coral disease. In the previous bleaching surveys (October and November) no disease was noted on the transects. During this survey, slightly over 2% of the coral colonies within the transect displayed white plague symptoms, and additional colonies were observed in the vicinity. White plague symptoms were noted on *Colpophyllia natans, Diploria strigosa, Montastraea annularis, M. faveolata,* and *M. franksi*.

2. **FGBNMS Winter Research Cruise – M/V Fling ($12,000).** March 1-3, 2006 . 17 participants conducted 113 SCUBA dives at the West and East Flower Garden Banks and Stetson Bank. Water temperature EFGB and WFGB: 72F and 73F, Stetson Bank: 70F. 2'-4' seas. Participants in the 2006 Flower Garden Bank National Marine Sanctuary Winter Research Cruise included sanctuary personnel and volunteers, and researchers from George Mason University – Bob Jonas and Geoff Cook, NOAA Fisheries – Andy Bruckner, Florida International University – Beth Zimmer, Wildlife Conservation Society – Rachel Graham, University of Houston – Eric Borneman, Bainbridge College – Craig Burnside, Texas A&M University – Mary Wicksten, and Azure Photography – Joyce and Frank Burek. Coral disease and bleaching surveys were conducted at both the East (EFGB) and West Flower Garden Banks (WFGB). Water temperatures were higher than average – according to YSI temperature probe measurements, at least 4 degrees Fahrenheit above average. Bleaching continued to partially or fully affect approximately 4% of the colonies at the WFGB, and 5.6% of the colonies at the EFGB. Species affected are primarily fire coral (*Millepora alcicornis*), and *Montastraea cavernosa*. A coral disease exhibiting symptoms similar to white plague affected at least 8.34% of the colonies at the EFGB, and at least 3.33% of the colonies at the WFGB. At least seven species of coral are affected. Tissue samples of both healthy and diseased corals were obtained. This is the most severe coral disease event ever recorded at the sanctuary. Pelagic observations included spotted eagle rays, tiger sharks, dusky sharks, loggerhead sea turtles, and schools of scalloped hammerhead sharks. Acoustic receivers were placed at depth at the WFGB and Stetson Bank. To date, acoustic transmitters have been placed on two manta rays at the sanctuary.
http://www.sanctuaries.noaa.gov/science/itf/fgbnms_survey.html

3. **FGBNMS Spring Research Cruise ($12,000) – M/V Fling –** May 17-19, 2006. 13 participants conducted 111 SCUBA dives at the West and East Flower Garden Banks and Stetson Bank. Water temperature was around 77F (25C), with at least 80' visibility. Bleaching/Disease surveys were conducted by G.P. Schmahl, Emma Hickerson, Laurie MacLaughlin (FKNMS), Bob Jonas and Geoff Cook (George Mason University), Andy Bruckner (NOAA Fisheries), and Eric Borneman (University of Houston). Bleaching surveys indicated that the bleaching event had subsided with very few colonies showing signs of bleaching. Anecdotally, it appears that the fire coral has succumbed to the bleaching event. The "white plague" type of coral disease event appeared to have slowed down with very low incidence of active lesions. Observations of interest include the first record of *Clypeaster subdepressus*, a deepwater sand dollar, and the corkscrew sea anemone, *Bartholomea annulata*. Two colonies of *Tubastraea coccinea*, an invasive orange cup coral, were found, one of which was successfully removed by Sanctuary personnel. Ocean triggerfish were nesting in sand patches. Three-spot damselfish were guarding nest patches. Stetson was full of action – cobia, amberjacks, loggerhead and hawksbill sea turtles, hammerheads, stingrays, spiny lobster, and sandbar shark were all sighted. A large number of newly settled juvenile mardi gras wrasse (over 300 individuals in 5-6 schools) were also spotted at Stetson Bank.
http://www.sanctuaries.noaa.gov/science/itf/fgbnms_survey.html

4. **FGBNMS East and West Flower Garden Banks Long Term Monitoring ($20,000) – M/V Fling** – June 12-16, 2006. Contractors PBS&J, Dauphin Island Marine Lab, and GeoMarine, Inc. conducted the annual data collection for the Long Term Monitoring of the East and West Bank coral caps. Emma Hickerson participated as a NOAA Observer. Notable observations: 10-12' greater hammerhead shark at WFGB, spotted eagle ray, loggerhead sea turtle, manta, mobula, school of several thousand brown chromis, school of 20 sergeant majors, numerous Xestospongia affected by Hurricane Rita. Sea hares and hammerhead sharks at Stetson Bank.

5. **Stetson Bank Long Term Monitoring – M/V Fling ($12,000)** – June 19-21, 2006. The annual Long Term Monitoring Report was conducted June 19 – 21, 2006. Seventeen participants including the FGBNMS research team, and volunteers and scientists from Texas A&M University (College Station and Corpus Christi), Bainbridge College (Georgia), REEF and Azure Photography conducted 147 dives. This is the sixteenth cruise to photograph repetitive stations, conduct video surveys, and diadema and lobster surveys. A total of 43 photostations were found and photographed – this was an encouraging result, as we were concerned that many photostations had been lost as a result of Hurricane Rita in Fall, 2005. Only three photostations that were photographed in June 2005, were not found. Sea conditions: 2-4' seas, slight current, 80' visibility, intermittent thunderstorms. Sea temperature and salinity profiles were taken several times each day, and documented a fresh water lens – 33.6ppt on the surface, and approximately 36.1ppt at depth. It is a general observation of the team that a significant reduction in *Millepora alcicornis* (fire coral) has occurred due to the 2005 bleaching event.

   The repetitive monitoring stations methodology followed traditional techniques – Nikonos 5 camera with a 15mm lens, mounted on a 1.055m post, with 2 Ikelite strobes. Photographs are taken on a north orientation, and a level bubble was used to ensure consistency in the orientation. This method captures a 1.88 square meter area to compare from year to year. A portion of the stations have been analyzed by Sarah Bernhardt for her thesis project. More recently, a contract is in place with Emily Platzer to analyze all photostations to date.

   REEF's three fish watchers, all advanced team members, (Greg Bunch, Jay Gardner, and Lillian Kenney) conducted 24 fish surveys during the cruise.

   Dr. Mary Wicksten (TAMU) collected new records of a nudibranch, a hermit crab, and a shamefaced crab. Dr. Wicksten worked closely with Joyce and Frank Burek to photodocument the new records.

   Dr. Craig Burnside and student, Jenna Fulghum (Bainbridge College) surveyed for queen conch (*Strombus gigas*). They reported 30 conch in total, 27 of which were adults, and averaged approximately 30cm in length. Interestingly, three juveniles

were observed, measuring approximately 20cm in length, which could suggest a second recruitment event. Four of the 27 adult conch had been previously tagged.

Notable sightings: 100's of mardi gras wrasse – the species currently being described by the FGBNMS research team. The juveniles that were documented in May this year are growing well, and some are changing into the male forms of the fish. Numerous black sea hares (*Aplysia morio*) approximately 25cm in length, were observed free-swimming, and creating "trains" of mating animals. Large charismatic fauna sightings include: loggerhead (*Caretta caretta*) and hawksbill sea turtles (*Eretmochyls imbricata*), scalloped hammerhead shark (*Sphyrna lewini*), sandbar shark (*Carcharhinus plumbeus*), school of 6-8 unidentified reef sharks, tiger shark (*Galeocerdo cuvier*), nurse shark (*Ginglymostoma cirratum*), southern stingrays (*Dasyatis americana*), spotted eagle rays (*Aetobatis narinari*), and manta rays (*Manta birostris*).

http://www.sanctuaries.noaa.gov/science/itf/fgbnms_monitoring.html

6. **Mooring Drilling Cruise – M/V Spree ($20,000) –** July 5-9, 2006. A successful cruise to install mooring buoy anchor bolts within the Flower Garden Banks NMS was conducted July 5th - 9th aboard the M/V SPREE out of Freeport, TX. Five mooring buoy anchors were installed at the East Flower Garden Bank in depths ranging from 63 to 95 feet, four of which are replacement anchors for damaged or missing mooring locations. One of the installations is a new site on the coral area north of the main reef that has never been utilized by recreational divers. It will not be available to the general public, but will be used as a research/control area for monitoring and assessment. The installations were completed by sanctuary staff (Schmahl, Weaver, Platzer) and the crew of "Gulf Diving LLC", a recreational dive charter company who holds the contract for mooring buoy maintenance within the Sanctuary. Two members of the Florida Keys NMS (Rusty Mason and Todd Schultz) mooring buoy team also participated in the cruise to provide regional support and expertise. Thanks to Rusty and Todd for their assistance!

7. **Agency/Industry Cruise – M/V Fling ($12,000)** – July 31 – August 2, 2006. The purpose of this cruise is to allow representatives of government agencies an opportunity to interact with representatives of the offshore oil and gas industry in an informal atmosphere. This cruise is funded jointly (50/50) by the sanctuary and an industry group consisting of representatives of companies that conduct activities in the vicinity of the Flower Garden Banks. The industry group was headed this year by Tim Gibson of Diamond Offshore Drilling, Inc., who is the alternate representative for oil and gas activities on the Sanctuary Advisory Council. Various topics of interest to everyone were discussed during the cruise, and included formal and informal presentations. Industry participation included representatives from Shell, BP, Anadarko, Univar, Devon, Kerr-McGee, Dominion, BHP Billiton, Williams, Diamond Offshore, Global Santa Fe, and Advantek International. Government participants included six Advisory Council members (MacDonald, Stout, Moore,

Gibson, Melvin and Hardwick); three NMSP HQ representatives (Gittings, Ostrom and Thompson); Dr. John Ogden (Florida Institute of Oceanography and member of the Marine Protected Area Federal Advisory Committee) and his wife Dr. Nancy Ogden; Dr. Wes Tunnell (Director of the Harte Research Institute for Gulf of Mexico Studies); Dr. Quenton Dokken (Director of the Gulf of Mexico Foundation); Herb Leedy and James Sinclair (Minerals Management Service) and Doug Peter (Texas Parks and Wildlife artificial reef program). A highlight of the trip was a sighing of a juvenile (16') whale shark at Stetson Bank!

8. **FGBNMS Coral Spawning Cruise – M/V Fling ($20,000)** – August 14-18, 2006. Sea conditions were excellent with 0-1 foot seas, and no current. Visibility was over 100', and the water temperature was warm – around 85 degrees Fahrenheit. As predicted, the corals spawned spectacularly, although there was some variation from years past in regards to timing of some species. Spawning observations other than corals included barrel sponges, stoplight parrotfish, two species of brittlestars, and christmas tree worms. Spawning barrel sponges have not been observed previously by Sanctuary staff, although reports have been received from recreational divers on one occasion. Two film crews were on board to document the event: a French film crew from Galatee Productions were filming in HD format for a full length feature film, and Bob Cranston and Peter Kragh were out with an HD camera each, filming for the Smithsonian's Oceans Hall. Both crews were thrilled with the spawning, and the footage they were able to collect. Exploratory dives were made to reef locations away from the mooring buoys. A prolific barrel sponge spawning event was observed, and the Sanctuary's first ever photodocumentation was made of the endangered species of goliath grouper – a large 5 footer - very exciting! Rachel Graham and Dan Castellanos joined the cruise from Wildlife Conservation Society to maintain acoustic receivers on all three banks, and to attempt to deploy acoustic and satellite tags onto manta rays and whale sharks. No whale sharks were encountered, but manta rays were out in good numbers – at least eight individuals were seen at the East Flower Garden Bank and Stetson Bank, four of which were successfully tagged with acoustic tags! Rachel and Dan will be back in September to download the receivers and we can get the first glimpse into the manta's use of the Sanctuary. We are continuing our efforts to report a new species of wrasse, named by the Sanctuary as the Mardi Gras Wrasse – four individuals were collected from Stetson Bank by Doug Weaver, as paratypes for the scientific description of the fish. Due to the relatively early dates of the full moon in August, there is a possibility that a second coral spawning will occur in September this year.
http://www.sanctuaries.noaa.gov/news/features/1006_spawning.html

9. **Fish and benthic habitat surveys, M/V Fling ($600)** – August 28 – 30, 2006. GIS Specialist Doug Weaver and Kimberly Woody, research biologist of the National Centers for Coastal Monitoring and Assessment's (NCCOS) Biogeography Team, participated in a two day cruise aboard the MV FLING to test monitoring protocols for benthic habitat characterization and reef fish surveys. SCUBA dives were conducted on West Flower Garden Bank, East Flower Garden Bank, the HIA389A Platform, and Stetson Bank. Observations made by cruise participants included

sightings of three manta rays at East Flower Garden Bank, including an individual bearing an acoustic tag from a previous research cruise. Survey protocols for benthic characterization and reef fish abundance will be implemented on two cruises in mid-late September.

10. **Fall Research Cruise , M/V Fling ($20,000) –** September 13-17, 2006. The timing of the cruise coincided with possible September coral spawning dates (7-10 days after the full moon). The corals spawned spectacularly in August, but due to the early full moon that month, a September spawn was also a considered a possibility. The corals did indeed spawn, but not in the numbers observed in August. The FGBNMS research team has also been attempting to nail down timing of the large barrel sponges, *Xestospongia muta*, based on observations the last couple of years. It appears that they might also spawn predictably around the same time as the mass coral spawning event. Team members witnessed a spectacular sponge spawning event both in August and September. The female sponges resemble snow blowers, as they launch their eggs into the water column. Unlike the corals, the eggs weren't positively buoyant, and resulted in "drifts" of eggs surrounding the base of the sponge. The males resembled smoking cauldrons as they released the sperm into the water. There was such a large amount of gametes in the water that the visibility in the immediate vicinity of the sponges dropped from over 100', down to less than 10'! Dr. Rachel Graham and Dan Castellanos from Wildlife Conservation Society joined the cruise again, and successfully tagged two more manta rays, bringing the count up to eight total tagged individuals. Acoustic receivers have been placed onto all three banks within the Sanctuary boundaries, and are receiving good data from the animals. Dr. Andy Bruckner from NOAA Fisheries has initiated a parrotfish predation study, and conducted surveys looking at this coral reef interaction. Dr. Craig Burnside from Bainbridge College continued to survey for tagged conch. He tagged 21 new conch, and found 34 previously tagged animals. Eric Borneman (University of Houston), Andy DeHart (National Aquarium), and Jessica Spino (National Aquarium) collected coral spawn for the SEACORE program. This program grows out corals from spawn, to provide stock to Aquariums for research purposes. This is an alternative to live coral trade. They successfully settled out thousands of coral larvae during this last cruise. The FGBNMS team collected tissue samples of five spiny lobster at Stetson Bank for Dr. John Hunt from Florida Fish and Wildlife Conservation Commission, who is conducting a Caribbean wide genetics study of the lobster, which is important to demonstrate the source and sinks of stock and larvae. Dan Castellanos is a traditional lobster fisherman from Belize, and provided his expertise in the collection effort. Kimberly Woody (NOS Biogeography) and Doug Weaver (FGBNMS) conducted multiple fish and benthic surveys, as a precurser to the project planned on board the NOAA Ship Nancy Foster during the next two weeks. Three REEF surveyors, James Brooke, Lillian Kenney, and Dave Grenda collected fish survey data. Joyce and Frank Burek (Azure Photography) were on board for photodocumentation support, and Mitchell Tartt from NMSP HQ was on board supporting research activities. Several divers were lucky enough to swim with a 20' whale shark at the West Flower Garden Bank. Four additional specimens of the

mardi gras wrasse were collected as type material and to conduct nuclear gene sequencing for taxonomic studies.

11. **Biogeographic characterization of fish communities within the FGBNMS. A collaboration between FGBNMS and NCCOS Biogeography Team. NOAA Ship Nancy Foster. ($50,000)** September 26-October 1, 2006. Ten divers conducted a total of 148 dives throughout the coral reef cap area of the East and West Flower Garden Banks. NCCOS divers were Chris Caldow, Kim Woody, Randy Clark, Kim Foley, and Charles Menza. FGBNMS divers were: Emma Hickerson, G.P. Schmahl, and Doug Weaver. Steve Gittings from NMSP HQ also participated, as did Lauri MacLaughlin from Florida Keys NMS. A random sampling approach was undertaken to select sites to conduct fish and benthic transects. The majority of the dives were conducted in areas of the coral cap that had not been previously surveyed. Due to inclement weather, the ship-time on the *Foster* was reduced from a nine-day cruise to five days. The five days were only accomplished through generosity and flexibility by the Commanding Officer of the *Foster*, CDR Jamie Verlaque. Additional data will be collected during the 2007 field season. A full report can be viewed at: http://ccma.nos.noaa.gov/ecosystems/sanctuaries/fgb_nms.html and http://www.sanctuaries.nos.noaa.gov/news/features/1006_fgbcruise.html

D. CANCELLED AND/OR POSTPONED CRUISES:

- Drilling Cruise postponed week of May 1
- Drilling cruise postponed week of May 8
- Spring Research Cruise reduced from 5 days to 3 days due to inclement weather.

E. CONFERENCES, MEETINGS, PRESENTATIONS, TRAINING, ETC.

1. January 26, 2006. College Station, TX. Texas A&M Advanced SCUBA and Scientific Diving class presentation. Presented FGBNMS and Aquarius Saturation Diving Experience material. Hickerson.

2. February 8, 2006. Galveston, TX. Sanctuary Advisory Committee. Research presentation. Hickerson

3. February 15 – 17, 2006. Kauai, HI. Research Coordinators Meeting. Hickerson

4. February 18, 2006. Kona, HI. Unmanned Automated Vehicle Demonstration. Hickerson

5. February 19 – 24, 2006. Honolulu, HI. Ocean Sciences Meeting. Presented paper: Patterns of Deep Coral Communities on Reefs and Banks in the Northwestern Gulf of Mexico. Hickerson, Schmahl.

6. February 19-24, 2006. Honolulu, HI. Ocean Sciences Meeting. Presented poster: Ecosystem Approaches to the Identification and Characterization of a Network of Reefs and Banks in the Northwestern Gulf of Mexico. Schmahl, Hickerson.

7. February 20-24, 2006. Honolulu, HI. Information Management and Spatial Technology Meeting. Weaver.

8. March 6, 2006. Washington, DC. Presentation on Flower Garden Banks NMS use of bathymetric information for protected area management during the National Marine Sanctuary Program Congressional Science Briefing. Schmahl.

9. March 7-9, 2006. Seattle, WA. Unit Dive Supervisors Meeting. Hickerson.

10. May 24-26, 2006. St. Petersburg, FL. Regional Science Meeting. Hickerson, Schmahl.

F. PUBLICATIONS:

Schmahl, GP and EL Hickerson. 2006. McGrail Bank, a deep tropical coral reef community in the northwestern Gulf of Mexico. Proceedings of the 10th International Coral Reef Symposium, 1124-1130. Japanese Coral Reef Society, Tokyo, Japan.

Shearer, T. L. and M.A. Coffroth. 2006. Genetic identification of Caribbean scleractinian coral recruits at the Flower Garden Banks and Florida Keys. Marine Ecology Progress Series. Vo. 306: 133-142.

Sosdian, S., Gentry*, D.K., Lear, C., Grossman, E.L., Hicks, D., Rosenthal, Y., 2006. Strontium to calcium ratios in the marine gastropod Conus ermineus: Growth rate effects and temperature calibration, Geochemistry, Geophysics, Geosystems (G3) v. 7, Q11023, doi:10.1029/2005GC001233.

Weaver, D. C., E. Hickerson, and G. P. Schmahl. Deep reef fish surveys by submersible on Alderdice, McGrail, and Sonnier Banks in the Northwestern Gulf of Mexico. NOAA Technical Science Series (In Press).

Zimmer, B., W. Precht, E. Hickerson, and J. Sinclair. 2006. Discovery of *Acropora palmata* at the Flower Garden Banks National Marine Sanctuary, northwestern Gulf of Mexico. Coral Reefs. DOI 10.1007/s00338-005-0054-9.

G. OTHER SCIENCE PRODUCTS

- Updated version of the Habitat Characterization Map
- 2005 Research Report

H. ADDITIONAL SCIENCE ACTIVITIES:

- Submitted shiptime requests and needs.
- Submitted monthly shiptime reports to NMAO.
- Provided funding to REEF to report on last 10 years of REEF surveys at the FGBNMS (Christy Pattengill-Semmens)
- Development of database describing biological and habitat characteristics of over 8000 images collected from ROV surveys (Kyle Byers)
- Provided support and supervision for development of Stetson Bank Long Term Monitoring Database (Emily Platzer)
- Provided funding for Scanning Electron Microscopy of deepwater octocorals from the sanctuary (Peter Etnoyer)
- Participated in peer review panel for the EPA/Florida Keys NMS Water Quality Protection Program research proposals (Schmahl)
- Provided input for design of Research Vessel, R/V MANTA

I. RESEARCH AND SCIENCE PARTNERSHIPS

- Azure Photographic Services
- Bainbridge College
- Dauphin Island Sea Laboratory (DISL)
- Environmental Protection Agency (EPA)
- Feodor Pitcairn Productions, Ltd.
- Florida International University
- GeoMarine, Inc.
- George Mason University
- Harte Research Institute for Gulf of Mexico Studies
- Minerals Management Service (MMS)
- Mote Marine Laboratory
- National Aquarium
- NCCOS - Biogeography
- NOAA Fisheries
- North Carolina Coastal Ocean Service (NCCOS)
- PBS&J
- Reef Environmental Education Foundation (REEF)
- Smithsonian Institute
- Texas A&M University (TAMU)
- Texas A&M University - Corpus Christi (TAMU-CC)
- Texas Parks and Wildlife (TPWD)
- University of Calgary
- University of Houston
- Wildlife Conservation Society (WCS)

J. SCIENTIFIC INTERPRETATION/OUTREACH ACTIVITIES

1. Maintenance of slide library
2. Maintenance of digital slide catalog/library
3. Maintenance of Power Point presentation catalog
4. Maintenance of video library (annotations)
5. Development of PowerPoint presentations for various events
6. Attended Sanctuary Web discussions.
7. Coordination of sighting data from recreational dive vessels.
8. Assisted with DUOY participant selection process.
9. Coordinated diving operations on Agency/Industry Cruise.
10. Assisted with DUOY Teacher Workshop application process.
11. Web-based research reports
12. Immersion Presents support – Bob Ballard/NR1 Expedition

K. MANAGEMENT ACTIVITIES

- Writing of permits for science activities
- Responded to oil and gas industry spill drills in Manager's absence.
- Attended Sanctuary Advisory Committee meetings.
- Participated in development of the State of the Sanctuary Report.
- Attended Mission-Aransas NERR's dedication.

L. TECHNOLOGY

1. Maintenance and development of media equipment.
2. Research for underwater technologies to further Sanctuary's capabilities.