Office of National Marine Sanctuaries/National Centers for Coastal Ocean Science Long-term Agreement (ONMS/NCCOS LTA)

2004 Annual Liaison Report on Existing and Potential ONMS/NCCOS Collaborative Studies at the Florida Keys National Marine Sanctuary (FKNMS)

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December 2004

Executive Summary

This report is the second Liaison's report on activities related to the long-term agreement between NCCOS and NMSP in the Florida Keys National Marine Sanctuary. The first portion of the report is the same document as the FY03 report and provides background information on funding and research coordination for the NCCOS/NMSP long-term agreement. The second part of the report includes; 1) an update on reported NCCOS research activities in FKNMS in FY04, 2) research activities funded under other sources and a status report on funding opportunities in FKNMS, 3) a series of appendices including project descriptions and reports funded under the long-term agreement, and 4) summaries of research permitted in the FKNMS by the Sanctuary for FY02 and FY03.

1. **Introduction**

The Florida Keys National Marine Sanctuary (FKNMS) was designated by Congress in 1990 to conserve, manage and ensure sustainable use of a 9500 km^2 area of submerged land located on the southern and southwestern margins of the Florida peninsula. The sanctuary extends 360 km in a northeast to southwest arc between the southern tip of Key Biscayne, south of Miami, to beyond, but not including, the Dry Tortugas National Park. The coastal and oceanic waters immediately surrounding most of the 1,700 islands that make up the Florida Keys contain important ecological and cultural resources including seagrass and algal beds, bank barrier coral reefs, patch reefs, hard bottom and soft bottom invertebrate and vertebrate communities, mangrove islands, a wide diversity of other wetland types, upland hammocks and submerged cultural resources such as shipwrecks. The marine environment of the Keys contain tropical and subtropical waters supporting over 6,000 species of plants, fishes and invertebrates and includes the Nation's only coral reef tract adjacent to the continent. The entire Keys ecosystem is dominated by extensive and biodiverse seagrass communities covering 80% of the submerged

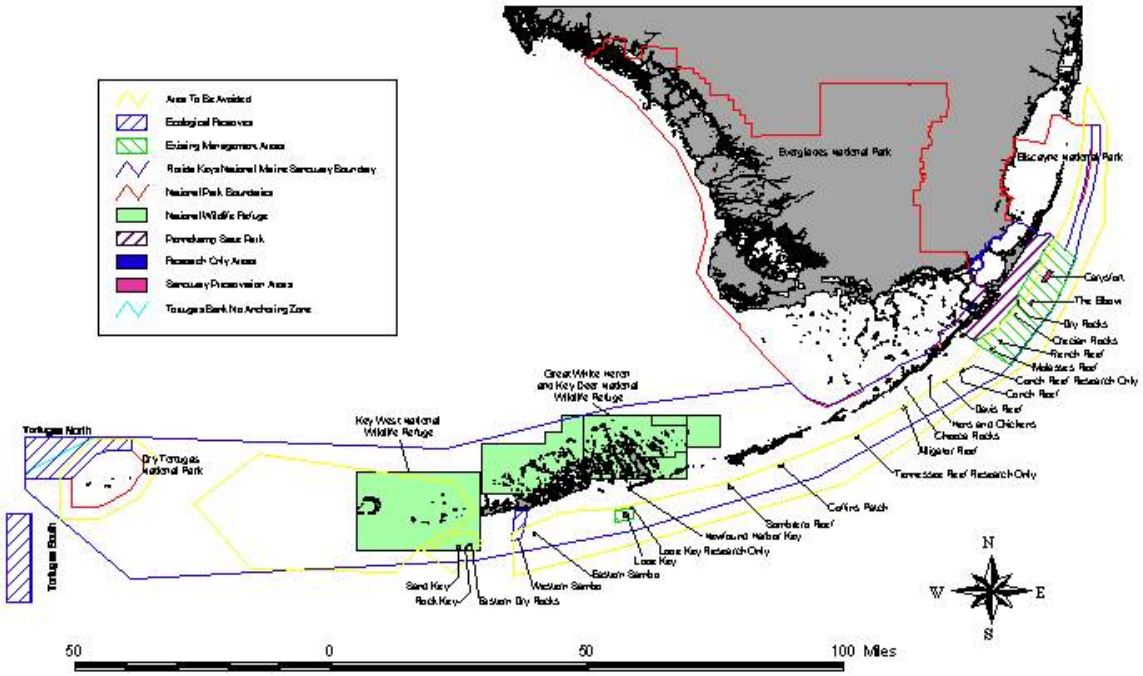

Figure 1. Map of the Florida Keys National Marine Sanctuary

land in the sanctuary distributed among soft bottom and hard bottom substrates which are nursery areas and fishing grounds for diverse recreational and commercial fisheries and the venue for important recreational diving and snorkeling activities, boating, swimming, and ecotourism.

The FKNMS was established to stem mounting threats to the health and ecological future of a significant portion of the south Florida ecosystem as part of the Federal government's overall efforts in south Florida including three large National Parks, a National Preserve, and extensive National Wildlife Refuges. Coincidental with these widespread threats were a series of ship groundings in the fall of 1989 that damaged significant portions of coral reefs and were the final environmental offense that prompted Congress to act and begin the establishment of the FKNMS.

Prior to establishment of the FKNMS, two marine sanctuaries were already designated; the Key Largo National Marine Sanctuary was established in 1975 followed by the designation of Looe Key National Marine Sanctuary in 1981. Today, the federal government manages approximately 96% of all the protected areas in the Keys including four national wildlife refuges, three national parks, a marine sanctuary in co-trustee partnership with the state of Florida, and widely dispersed military properties. Additionally, the state of Florida manages about 5% of all protected areas while local governments, the Nature Conservancy, the Florida Keys Land and Sea Trust, and the National Audubon Society also manage smaller areas interspersed among the Keys and associated waters.

2. Management Goals and Science Planning

In accordance with the National Marine Sanctuaries Act (NMSA), the FKNMS recognizes as part of its mission to "Support, promote, and coordinate scientific research on, and monitoring of, site specific marine resources to improve management decision-making in the Sanctuary". This is consistent with the overall mission of the National Marine Sanctuary Program but the specific objectives of each of the Sanctuaries depends on the environmental setting and the recognized immediate needs to implement an effective management plan supported by scientific documentation. With the recognition of the unique qualities of the Keys and that the economy of the Keys is dependent on a healthy ecosystem, NOAA and the State of Florida joined together to develop a management plan for the sanctuary to preserve and enhance the living marine resources. Recognizing that water quality is critical to the survival of the living marine resources in the sanctuary, Congress also directed the State of Florida and the U.S. Environmental Protection Agency (EPA) to develop a Water Quality Protection Program (WQPP) for the sanctuary (http://floridakeys.noaa.gov/research_monitoring/wqpp_white_paper.pdf.) The size, the complexity of stewardship, the uniqueness and biodiversity of its natural resources, and the long history of societal use has contributed to the difficult challenge of managing the FKNMS. Science has, and continues to play a critical role in developing and influencing the formulation of an effective management plan (see for example, Cowie-Haskell and Delaney, 2003).

The specific science needs of the FKNMS were identified early on in the congressional mandate directing the EPA and the state of Florida to implement a water quality protection program addressing point and non-point sources of pollution and to restore and maintain the living coral reefs and other critical marine life in the sanctuary. Additionally, the NMSA and the Florida Keys National Marine Sanctuary and Protection Act (FKNMSA) mandated establishment of strong communication and cooperation between the scientific community and resource managers to encourage coordination of research efforts to achieve the most beneficial results. These mandates came on the heels of numerous scientific publications and reports citing deteriorating water quality throughout the region, increased coral bleaching, a general decline in coral cover, the die off of the long spined urchin, and declines in reef fish populations.

Concurrently, a large-scale decline in seagrass communities in the adjacent waters of Florida Bay further heightened concern for the overall health of the Keys waters.

Language in the WQPP specifically identified science as an integral part of the management of the sanctuary by directing the need for a comprehensive and long term monitoring program to determine the status and trends of water quality and biological resources. Moreover, it was specified that there be scientific research/special studies designed to identify and understand cause and effect relationships involving pollutants, transport pathways and biological communities in the sanctuary. These have been the centerpiece for identifying scientific needs and providing financial and personnel support for sanctuary science and science planning. Since these original mandates the network of scientific studies in the sanctuary has branched out into many fields, numerous investigators and a wide range of academic, government and non-government research institutions. A comprehensive description and review of recent science programs in the FKNMS can be viewed in a report entitled "Sanctuary Science Report 2001: An Ecosystem Report Card located at the FKNMS web site http://floridakeys.noaa.gov/research_monitoring/welcome.html. This report describes 17 separate research studies in six general categories; Circulation, Long-term Status and Trends, Episodic Event Monitoring, NCCOS Partnership Studies, Groundwater Studies, and Zone Monitoring,

An important driving mechanism for the direction of science in the FKNMS has been the Zone Monitoring Program formulated in the earlier stages of sanctuary planning (see http://floridakeys.noaa.gov/research_monitoring/welcome.html). The zoning network established in the FKNMS in 1997 was the first of its kind in the United States (Murray et al. 1999; Cowie-Haskell and Delaney, 2003) serving as a focal point of research topics involving but not restricted to: the abundance, growth and survival of corals; fishery and shellfish population ecology and; the effectiveness of no-take reserves in fishery management. Five zone types were proposed in the original management plan; Wildlife Management Areas, Replenishment Reserves (now called Ecological Reserves); Sanctuary Preservation Areas (SPA), Existing Management Areas, and Special-use Areas. After preliminary review, a sixth zone was established in the final management plan to protect the endangered American Crocodiles and West Indian Manatees in Lake Surprise. The primary goal of monitoring was to determine, by the year 2002, whether the zones were effective in protecting biodiversity and enhancing human values related to the sanctuary. Effectiveness will be determined through the following performance measures presented as null hypotheses centered around a comparison between zoned areas and non-zoned areas: Changes in coral and algal cover and diversity will differ significantly between the zones and reference sites; Average size of fish will be significantly greater inside the zones than in reference sites; Overall abundance of fish will be significantly greater inside the zones than in reference sites; Average size and overall abundance of lobster will be significantly greater inside the zones than in reference sites. People's perceptions of resource quality and overall compliance with zone restrictions will be significantly higher inside. The monitoring program initially adopted a three-level approach addressing more specific scientific aspects and ecological processes: 1) Ecosystem focus on how ecological processes are modified in the different zones, 2) monitor change in ecosystem structure and human use patterns, and 3) how volunteers can be used to monitor the zones and ecosystem health. Level two has additional special programs addressing rapid ecological assessment, socio-economic monitoring and involvement of fishermen in detecting changes in the spiny lobster fishery.

Level three has developed a rapid biotic assessment team intended for responding to episodic events. For more detailed information on these programs go to the two URLs listed below;
http://floridakeys.noaa.gov/research_monitoring/zmp.html
http://floridakeys.noaa.gov/research_monitoring/zpr98.html#overview

One of the outcomes of the Zone Monitoring Program was the development of the Science and Management Plan for the Tortugas Ecological Reserve, now the largest fully protected marine reserve in the United States (Cowie-Haskell and Delaney, 2003). Taking place in three phases over a two year period between April 1998 and November 2000, the design process made science an integral part of the planning and decision making. Research scientists knowledgeable about the Tortugas region and marine reserves in general were brought on to the Tortugas 2000

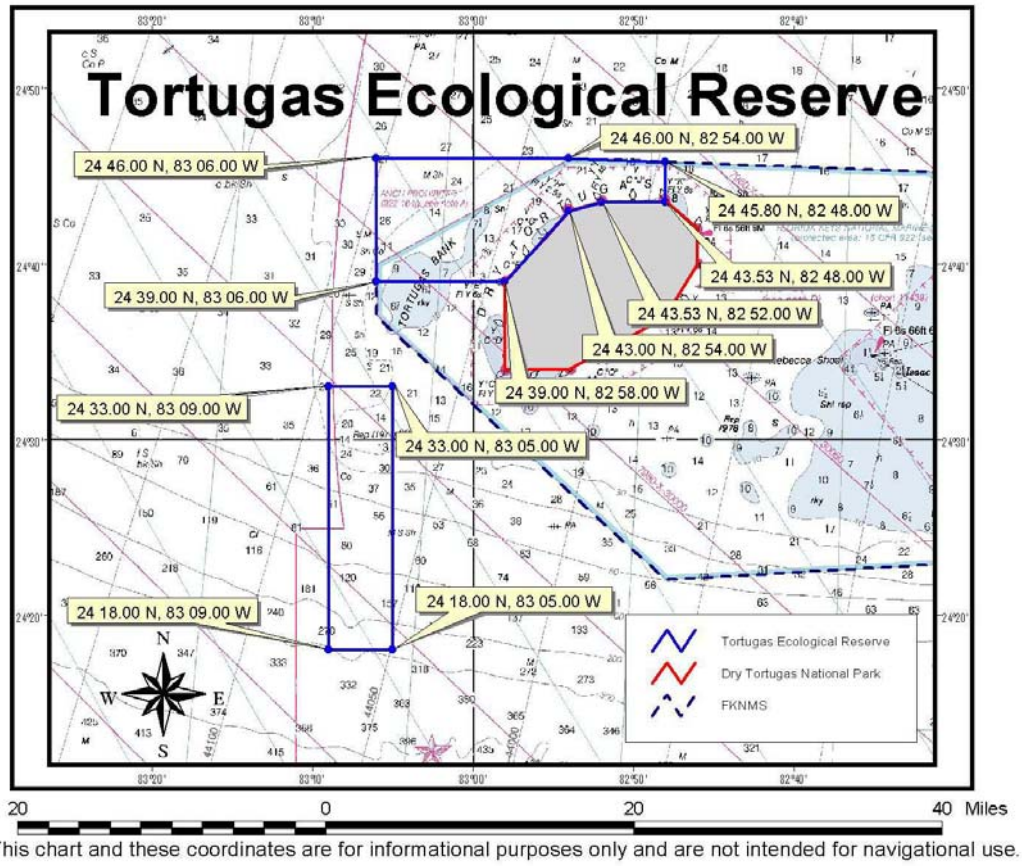

Figure 2. Map of the location and boundaries of the Tortugas Ecological Reserve.

working group to interact with resource managers, regulatory agents, user groups, and non government organizations to design the reserve in an iterative and dynamic process ending with its designation and implementation in July 2001. Scientific contributions included GIS based information on biogeography and habitat maps, analysis and interpretation of remotely sensed data, oceanographic information, and fish ecology especially spawning, distribution and abundance. Essential to the process was making the scientific knowledge available to the user groups and the public that subsequently enhanced their interest and support for the Reserve.

More recently, the development of a science plan has been increasingly influenced by the recognition that the Florida Keys are part of a regional ecosystem in south Florida and the

sanctuary is hydrologically and biologically linked to the Everglades, Florida Bay and the surrounding waters of the Florida Straits, Gulf of Mexico and the Yucatan, Loop, and Florida Currents. Thus, because of the recognizable upstream and downstream connectivity between the ecosystems of south Florida, a science plan for the FKNMS is closely tied to the Comprehensive Everglades Restoration Plan. The draft science plan being formulated now is the result of several years of planning beginning in December 2000 with a presentation of the existing monitoring and research programs by sanctuary scientists and managers to an independent Science Advisory Panel made up of six scientists, four from academic institutions, one from the USEPA and one from the Florida Marine Research Institute (now the Fish and Wildlife Research Institute [FWRI], Florida Fish and Wildlife Conservation Commission). The scientific panel made recommendations to Sanctuary Managers who met in a retreat to discuss the recommendations with representatives from the National Park Service, NOAA's Coastal Ocean Program, and NOAA's National Marine Sanctuary Program. The Science Advisory Panel agreed that the FKNMS had put in place a good baseline monitoring program but needed to identify more "**cause and effect research"** addressing management objectives. The result of this process was the drafting of a comprehensive science plan by the FKNMS Science Coordinator and EPA's Florida Keys Program Scientist that is essentially complete but not yet published (available from Brian Keller, FKNMS Science Coordinator).

The draft plan uses as its centerpiece a conceptual model of the important forcing functions on the major biological components of the Keys ecosystem. The authors recognize that a thorough understanding of the interactions of the forcing functions and stressors acting on different scales on the biotic components is required to set goals and effectively manage the sanctuary. The plan identifies metrics that must be quantified through research and monitoring in order to understand and predict the consequences of environmental change so that anthropogenic impacts can be distinguished from natural processes. Essential to this approach is the integration of different scientific disciplines at temporal and spatial scales that capture the important processes. The essential components of the model identify and include the relevant forcing functions, identification of stressors and biotic components, ecosystem attributes and appropriate ecological measures. Through this exercise the sanctuary has divided science needs into 11 categories and went so far as to identify high priority research and monitoring topics associated with specified management objectives. Examples of some of the management objectives and priorities include, but are not restricted to the list in Table 1. The full complement of management objectives and priorities can be found in the draft comprehensive science plan available from Brian Keller.

Table1. Categories, management objectives and priorities for research identified in the Draft Comprehensive Science Plan for FKNMS.

CATEGORY	MANAGEMENT OBJ.	HIGH PRIORITY
Physical Oceanography	Influence of circulation on water quality.	Expand monitoring network and develop circulation and larval dispersal models.
Water Quality	Quantify relative importance of natural and anthropogenic nutrient and pollution sources.	Develop a nutrient loading model and supplement regular monitoring with event driven monitoring
Coral Reef Communities	Determine the causes of coral decline. Identify	Emphasize cause and effect mechanisms. Develop a

	corrective actions required to enhance coral recruitment and growth	refined coral monitoring program.
Hard bottom Communities	Determine functions and include sponges with consideration for predicting changes in reef communities	Assess the role of hard bottom communities for reef fishes
Seagrass Communities	Identify status and trends and the linkages between water quality and seagrass diversity, distribution and abundance. Understand the influence of seagrass on local communities.	Maintain sanctuary wide monitoring program. Develop and evaluate restoration techniques. Develop correlation between water quality and seagrass distribution.
Algal Communities	Understand dynamics in response to natural and anthropogenic environmental changes.	Develop a model to predict biological community responses to stressors.
Mangrove Communities	Protect mangroves and remove exotic species	Develop a restoration plan.
Fish communities	Maintain a healthy and diverse fish community. Assess the effectiveness of SPAs.	Evaluate and optimize existing status and trends monitoring. Develop a model to predict the effects of zoning on reef fish populations.
Spiny Lobster	Assist fisheries managers where appropriate.	Continue status and trends population monitoring and include zone monitoring.
Other Benthic Invertebrates	Determine functional significance of benthic inverts	Investigate lack of recruitment of Diadema
Queen Conch	Improve management and restoration of Queen Conch populations.	Determine limiting factors to conch reproduction and survival.

Funding for support of these research priorities during the last five years has been tightly linked to EPA and NOAA's Coastal Ocean Program (now the Center for Sponsored Coastal Ocean Research, NCCOS. For example, in FY02 and FY03 CSCOR has funded approximately 50% of the seagrass and coral reef monitoring programs and has also supported oceanography and hard bottom studies. The EPA has contributed substantial funding to support continuation of long-term water quality, coral reef and seagrass monitoring programs while FWRI maintains a high level of institutional support in coral reef monitoring and spiny lobster research. Other funding sources and in-kind support include individual agencies such as NMFS, NOAA's AOML, NMSP and FKNMS, NOAA's Undersea Research Program, NOAA Coral Reef Conservation Program, Sanctuary Friends of the Florida Keys, FWRI, Florida Dept. of Environmental Protection, and

South Florida Water Management District. At present, estimates from permit records indicate that there may be between 60 and 80 active research projects in the FKNMS deriving personnel and financial support from a wide range of academic, government and non-government organizations. Other research projects not requiring a research permit are also occurring but have not been compiled for a complete analysis of the total scope of research activities in the FKNMS.

Nearly concurrent but somewhat independent of the FKNMS planning efforts was the two phase National Science Plan evaluation process conducted by the National Marine Sanctuary Program. The first phase assessed the status of existing science efforts nationally in the Sanctuaries and began development of a system-wide coordinated monitoring program. The second phase was designed to implement adjustments to science plans to address unmet needs. This involved meetings between NMSP staff and Research Coordinators, visits to Sanctuaries, development of a science database and formulation of a questionnaire to identify critical science issues. This was followed by a workshop in January 2001 that brought together NMSP staff and partners to identify critical scientific information needs associated with management issues. During the workshop the participants identified 150 priority scientific endpoints within 9 management categories; Habitat Delineation, Zoning, Assessment of Living Marine Resources, Water Quality Protection, Fishing/Harvest Effects, wildlife Disturbance, Event Response, Restoration and Rehabilitation, and Industrial Uses. Zoning, Assessment of Living Marine Resources and Fishing/Harvest Effects were ranked and identified as needing the greatest increase in scientific effort in FKNMS. Priority endpoints included oceanographic data, food resources for species of importance, environmental effects on habitat and socio-economic impacts on water quality. These results were combined with the independent outside science review conducted by FKNMS to help determine priorities summarized in their Draft Science Plan.

History of NCCOS Research in FKNMS

It is worth noting that NCCOS in its' predecessor organizations has had a long-term, continuing involvement in FKNMS planning and research since before the designation of the s anctuary. For several years NCCOS staff worked both within and external to FKNMS to learn the scientific and policy issues related to many aspects of FKNMS. Staff located at CCFHR and CCMA have been involved in benthic mapping, resource characterization, habitat research, restoration and basic science programs for more than two decades. For example, CCFHR staff at Beaufort, while still under the NMFS, were involved in the development of the original seagrass maps, which were used to help delineate the boundaries of the sanctuary in the early stages of the management planning process. Likewise, CCMA staff conducted biogeography studies of habitats and resources in the sanctuary. Beginning early in the 1980's CCFHR staff initiated restoration research funded jointly by NMFS and the U.S. Army Corps of Engineers that continues today in joint collaborations between NOAA's Damage Assessment Center (DAC), NMSP and the Florida Fish and Wildlife Conservation Commission (FWC). This research has also been supplemented with collaborative support from the Florida Keys Environmental Restoration Trust Fund and the Lignumvitae State Aquatic Management Area Program. The wide diversity of support and recognition for the contribution of NCCOS prior to 1999 was the result of a concerted effort to maintain partnerships with the many organizations and individuals working in the sanctuary.

A cornerstone in the NCCOS relationship with NMSP was the involvement of CCFHR staff with NMSP, FKNMS, DAC and NOAA General Counsel in providing scientific support for claims cases involving natural resource damages in seagrasses and coral reefs under the National Marine Sanctuaries Act requirements. During these interactions NCCOS staff joined case teams made up of other NOAA scientists, economists, FKNMS biologists, academic scientists and attorneys from NOAA and DOJ to litigate resource damage cases. During these litigations CCFHR staff conducted restoration research and developed what is now known as the Mini 312 Damage Assessment and Restoration Program for FKNMS and NMSP in general. The basis for the success of the Mini-312 program has been the capability of NCCOS staff to provide scientific information and publish peer reviewed scientific research supporting the damage assessment and restoration process. With this history of scientific programs and support in place NCCOS was strategically poised to engage in a long-term agreement with NMSP.

Cooperative Research Between NCCOS and NMSP Between FY2000 and FY2003

Beginning in FY2000 NCCOS formally engaged in cooperative research with NMSP initiated with three projects, one from CCEHBR and two from CCFHR. These projects were summarized in a document prepared by NMSP and NCCOS in September 2001 and discussed at the Research Coordinators meeting in Charleston, S.C. in 2002.

CCEHBR's initial work involved assessing coral health in the FKNMS using an integrated molecular biomarker system (MBS). The work focuses on attempting to diagnose the reasons for coral degradation and identify the causative agents. Using various relevant molecular/cellular bioindicators/biomarkers the health status of corals exposed to stressors is characterized. CCEHBR is collaborating with the College of Charleston, Mote Marine Laboratory, Brevard Community College and FKNMS to conduct laboratory and field studies to evaluate a suite of MBS. Included in these studies were evaluations of whether any one or a combination of MBS can be used to predict coral bleaching from environmental and anthropogenic stressors. Products include information transfer and training on MBS technology, information workshops and peer reviewed scientific publications (see http://www.chbr.noaa.gov/images/Coralposter.pdf).
Recently this work has been supplement by South Carolina Sea Grant Consortium funding with the following objective:

1) use the MBS to characterize the health of a coral reef ecosystem in the Florida Keys;
2) verify that the MBS can detect and characterize subtle and chronic effects of environmental stressors on this ecosystem;
3) determine if point-source pollutants or global climate changes (e.g., increased ocean temperatures or UV-B radiation) are stressing coral reef ecosystems;
4) compare the precision, sensitivity and prognostic capabilities of the MBS to those of traditional measures of ecosystem health, and
5) encourage the participation and understanding of the general public and scientific, industrial, and managerial communities in using marine biotechnologies to assess and manage the health of coral reef ecosystems.

This work has now being extended into the Gray's Reef and the Flower Garden Banks National Marine Sanctuaries as a multi-sanctuary project. Below is a list of manuscripts in different stages of preparation related to this work. For preprints, reprints or specific details on these projects contact Cheryl Woodley at Cheryl.woodley@noaa.gov.

In Preparation:

C. A. Downs, John E. Fauth, Charles Robinson, Richard Curry, Brenda Lanzendorf, John Halas, Judith Halas and Cheryl Woodley. Cellular Diagnostics and Coral Health: declining coral health in the Florida Keys. In Preparation.

Submitted:

Downs, A.G., C. A. Downs, R.B. Jonas, K.Marino-Briggs, T. Capo, and C.M. Woodley. IMCOMP-MP: An assay to determine the effects of toxins on coral innate immunity. Submitted .

In Press:

Fauth J. E., C. A. Downs, J. C. Halas, P. Dustan, and C. M. Woodley. Mid-range prediction of coral bleaching: a molecular diagnostic system approach. In D. Scavia and N. Valette-Silver, eds. NOAA Technical Report on Ecological Forecasting, in press.

Published:

Cheryl M. Woodley, Craig A. Downs, John E. Fauth, Erich Mueller, John C. Halas, John A. Bemiss, Yael Ben-Haim, and Eugene Rosenberg,"A novel molecular biomarker system to assess the physiological status of corals". In M.K. Kasim Moosa, S.Soemodihardjo, A.Nontji, A.Soegiarto, K. Romimohtarto, Sukarno and Suharsono. 2002 (Editors) Proceedings of the Ninth International Coral Reef Symposium, Bali, Indonesia, October 23-27 2000. Published by the Ministry of Environment, the Indonesian Institute of Sciences and the International Society for Reef Studies. 1267-1272 pp. ISBN 979-8105-97-4.

Craig A. Downs, John E. Fauth, John Halas, Phillip Dustan, John Bemiss, and Cheryl M. Woodley. "Oxidative Stress and Seasonal Coral Bleaching", Free Rad. in Biol. Med. 33: 533-543 (2002)

Craig A. Downs, Robert T. Dillon, Jr., John E. Fauth, and Cheryl M. Woodley**,** "A Molecular Biomarker System for Assessing the Health of Gastropods (Ilyanassa obsoleta) Exposed to Natural and Anthropogenic Stressors", J. Exp. Mar. Biol. Ecol. 259: 189-214 (2001).

Craig A. Downs, John E. Fauth and Cheryl M. Woodley, “Molecular Biomarker System for the Health Assessment of the Grass Shrimp, Palaemonetes pugio, Exposed to Heat Stress, Cadmium, Endosulfan, Atrazine, Diesel Fuel and Bunker Fuel”, Mar. Biotechnol., 3: 380-397 (2001).

Craig A. Downs, Erich Mueller, Susan Phillips, John E. Fauth and Cheryl M. Woodley. "A Molecular Biomarker System for Assessing the Health of Coral (*Montastraea faveolata*) during heatstress”,J.Mar.Biotechnol.2:533-544,(2000).

CCFHR conducted two research projects during the initial agreement phase; 1) Ecological characterization and analysis of seagrass injury and recovery on shallow seagrass-Porites coral banks in FKNMS, and 2) Comparative analysis of the functioning of disturbed and undisturbed coral reef and seagrass ecosystems in the Tortugas: Phase I – Establishing a baseline.

The Tortugas research at CCFHR is a multi-scale and multidisciplinary cross team research project. Studies include characterizing spawning aggregations and developing a probabilistic model of the fate of snapper larvae, comparing disturbed and undisturbed shallow and deep benthic communities and their contributions to fishery resources using repeated surveys of invertebrate and vertebrate communities in a BACI design. Also included are studies using stable isotopes for establishing baseline information on food web structure inside and outside the reserve, determining the accuracy of existing habitat delineations within the reserve and examining how high resolution ecological data of a given habitat can be scaled to larger spatial scales. Collaborators include FKNMS biologists, Univ. of South Florida, Fish and Wildlife Research Institute, CCMA, NOAA Coastal Services Center and FDEP. Products include information transfer to managers, other scientists and the public through presentations, posters, web resources, and peer reviewed scientific publications (see http://shrimp.ccfhrb.noaa.gov/~mfonseca/reports.html and http://shrimp.ccfhrb.noaa.gov/ Efforts to link CCFHR research with ongoing FKNMS funded projects in the Tortugas Ecological Reserve have had mixed success and should be a priority consideration for future attention by the liaison between NCCOS, FKNMS and NMSP. Contact the project leader Dr. Mark Fonseca at mark.fonseca@noaa.gov ,or for information on spawning aggregates and larval transport contact Dr. Jon Hare at jon.hare@noaa.gov

In the second project CCFHR has been collaborating with NMSP, FKNMS, NOAA DAC and General Counsel, and the state of Florida to develop protocols for characterizing benthic resources in the FKNMS, methods for assessing damage to natural resources, and formulation of predictive recovery models for seagrass and coral reef habitat recovery. Products include information transfer to managers, other scientists and the public through presentations, posters, web resources, and peer reviewed scientific publications (see http://shrimp.ccfhrb.noaa.gov/~mfonseca/reports.html and http://shrimp.ccfhrb.noaa.gov/). Recent peer-reviewed publications directly affiliated with this work include survey research, experimental manipulative studies and resource injury recovery modeling (Whitfield et al 2002, Kenworthy et al. 2002, Kenworthy et al. 2000, Fonseca et al. 2000, Fonseca et al. in press, Kirsch et al. in press). For more detailed information contact Dr. Jud Kenworthy at jud.Kenworthy@noaa.gov.

Table 2. First phase of NCCOS research in FKNMS and contact information

PROJECT	PIs	AFFILIATION/CONTACT
Assessing Coral Health in the Florida Keys National Marine Sanctuary Using Molecular Biomarkers	Cheryl M. Woodley	CCEHBR 219 Ft Johnson Rd Charleston , SC 29412 Ph: (843)762-8862 Fax:(803)762-8737 Cheryl.Woodley@noaa.gov
Comparative Analysis of the Functioning of Disturbed and Undisturbed Coral Reef and Seagrass Ecosystems in the Tortugas: Phase I – Establishing the Baseline	Mark Fonseca Jon Hare	CCFHR 101 Pivers Island Rd. Beaufort, NC 28516 Ph (252) 728-8729 Mark.Fonseca@noaa.gov Jon.hare@noaa.gov
Ecological Characterization and Analysis of Seagrass Injury and Recovery on Shallow Seagrass-Porities Coral Banks in the FKNMS	W. Judson Kenworthy	CCFHR 101 Pivers Island Rd. Beaufort, NC 28516 Ph (252) 728-8750 Jud.Kenworthy@noaa.gov

NMSP/NCCOS Long-Term Partnership: FY04

Request for Proposals under the NMSP/NCCOS partnership identified four priority areas for the next four years (04-07);

1) Characterization of sanctuary resources in the context of each sanctuary management plan;
2) Monitoring the changes in sanctuary resources, particularly in response to management decisions,
3) Conducting anticipatory science, and
4) Addressing specialized topics that may be identified by NMSP and NCCOS management as particularly timely or promising.

After discussion between NCCOS scientists, the FKNMS Science Coordinator and the Liaison, eight proposals were submitted by NCCOS scientists and their partners and forwarded to the FKNMS Science Coordinator for consideration and ranking. Five proposals originated from CCFHR, two from CEHBR, and one from CCMA. Six were specifically targeted for FKNMS, and two were multi-sanctuary applications. Three focused on characterization studies, two targeted fisheries and spawning aggregations,

two addressed specific stressor questions relative to corals, one addressed development of GIS based tools to assess and model natural resource damages, and one focused on characterizing physical, biological and water quality parameters in sanctuary waters using satellite data. All of the senior PIs on the proposals contacted the NCCOS liaison to discuss the overall NMSP/NCCOS partnership program and specific aspects of their proposal. It was evident from these discussions and additional discussions between the FKNMS Science Coordinator and the NCCOS Liaison that there needed to be better coordination in discussing the distinctions between the NMSP/NCCOS partnership priorities as outlined in the memorandum and RFP and the ongoing FKNMS science planning process.

After ranking by the FKNMS Science Coordinator and review by NCCOS and NMSP Program Coordinators and two other NMSP and NCCOS senior staff, four of the eight projects were recommended for two year funding. Two projects were considered new, one ongoing, and one new project will not start up until FY 05. According to the recommendations of the project coordinators the financial obligations for each of the projects are listed in Table 3 on the following page. For more specific information on these funded proposals, their content and project plans can be discussed directly with the PIs listed in the table.

Principal Investigator	Abbreviated Title	Type	Cost in Thousands ($)		
Dr. Richard P. Stumpf and Kristine Holderied NCCOS/CCMA, 1305 East West Highway, ms N/SCI1, room 9115 Silver Spring, MD 20910 richard.stumpf@noaa.gov and kris.holderied@noaa.gov Ph: 301-713-3028x173, 301-713-3028 x176	Temperature, chlorophyll and light	New, multi-sanctuary	55 K		
Dr. Cheryl Woodley NCCOS/CCMA 219 Ft Johnson Rd Charleston, SC 29412 Cheryl.Woodley@noaa.gov Ph: (843)762-8862	Irgarol effects on coral reef health	New		60 K	63K
Dr. Mark Fonseca NCCOS/CCFHR 101 Pivers Island Rd. Beaufort, NC 28515 Mark.fonseca@noaa.gov Ph: (252)728.8729	Tortugas; Integrated injury assessment/restoration	Ongoing	95 K	35K	
Dr. W. Judson Kenworthy NCCOS/CCFHR 101 Pivers Island Rd. Beaufort, NC 28515 Jud.Kenworthy@noaa.gov Ph: (252) 728-8750	Fishery resources and tidal passes	New	75K	70K	

Recommended Laison Activities for FY04 and Beyond

After extensive discussions with the FKNMS Science Coordinator and interactions with NCCOS scientists we can see the need to increase coordination between the two science planning processes; the NMSP/NCCOS partnership and the independent FKNMS priorities process that has been the cornerstone for funding opportunities since the inception of the FKNMS. The science planning process ongoing in FKNMS is far more advanced and more complex than what has occurred in many of the younger National Marine Sanctuaries that are still in the earlier stages of research planning. It has also operated longer than the NMSP national planning process and has identified some different priorities unique to FKNMS. The science planning process at FKNMS has utilized outside program reviews, several levels of science panels, and numerous long- and short-term sources of financial support that can also benefit from integration with the NCCOS/NMSP long-term agreement. One of the major objectives of this upcoming year's Liaison activities will be to establish this integration.

During FY04 we will develop a matrix table that clearly identifies all ongoing priority research associated with FKNMS, NMSP and the NMSP/NCCOS long-term agreement. The matrix will identify the PI contact information, the research project description, associated management priorities, funding sources, and the projects affinity with the priorities of the NMSP/NCCOS long-term agreement. The table will serve as a lense through which NCCOS staff can view the full scope of ongoing research and identify the potential for developing more partnerships meeting both the needs of FKNMS and of the NMSP/NCCOS science priorities. Part of this process will include identifying research gaps and future needs that may be met by NCCOS capabilities not yet working in FKNMS. This will include educating and informing FKNMS staff on NCCOS capabilities (see below) and meeting with NCCOS centers to evaluate the matrix table as to how each Center's capabilities may be utilized by FKNMS in the future.

Overview of NCCOS Science Capabilities Available to Assist With Sanctuary Needs

Detailed descriptions of the National Centers for Coastal Ocean Science (NCCOS) can be obtained through the NCCOS website and associated links at <http://www.nccos.noaa.gov>. Highlights of this information (extracted from the website) are presented here as a brief overview of NCCOS programs and capabilities that can be leveraged through the NCCOS-NMSP partnership to help the OCNMS fill data gaps and future management needs.

NCCOS, with headquarters in Silver Spring MD, was formed as a part of the National Ocean Service in March 1999 as a means of consolidating its coastal research capabilities. Five research centers exist at present under NCCOS: the Center for Sponsored Coastal Ocean Research (CSCOR) in Silver Spring, MD; the Center for Coastal Monitoring and Assessment (CCMA) also in Silver Spring, MD; the Center for Coastal Fisheries and Habitat Research (CCFHR) in Beaufort, NC; the Center for Coastal Environmental Health and Biomolecular Research (CCEHBR) with facilities

both in Charleston, SC and Oxford, MD; and the Hollings Marine Laboratory (HML) in Charleston, SC. Collectively across these centers, NCCOS offers a broad range of complementary capabilities in disciplines such as marine ecology and biology, fishery ecology and management, marine pathology, microbiology, molecular and cellular biology, genetics, biochemistry, ecotoxicology, environmental chemistry, marine forensics, remote sensing, biogeography, ecological statistics, GIS analysis, environmental risk analysis, coastal-resource management, and information technology.

NCCOS conducts and sponsors a variety of monitoring, assessment, research, and technical-assistance projects to support the coastal stewardship role of NOS and to help NOAA achieve its related national strategic goal of sustaining healthy coastal ecosystems. The combined capabilities listed above are available to address a broad range of environmental issues pertinent to this mission. Key goals are to:

- Deliver high-quality science in a timely and consistent manner using strong, productive partnerships;
- Develop and maintain relevant research, long-term data collection and analyses, and forecasting capabilities to support people who manage and use coastal resources;
- Build capacity in the private, local, and state sectors by transferring technology and by providing technical assistance and knowledge; and
- Conduct anticipatory science needed to manage potential impacts of multiple stresses on coastal ecosystems.

In addressing these goals, NCCOS currently is focusing its science on five major categories of ecosystem stress:

- Climate change,
- Extreme natural events,
- Pollution,
- Invasive species, and
- Land and resource use.

Understanding how these complex issues affect the quality and quantity of coastal habitats, and the diversity, abundances, and integrity of component living resources, is vital for the effective management of our Nation's coastal ecosystems. NCCOS is attempting to develop this knowledge by focusing its efforts currently on four ecosystem categories: coral reefs, estuaries, National Estuarine Research Reserves, and National Marine Sanctuaries. The latter commitment to working within sanctuaries has been formalized through the ongoing NCCOS-NMSP partnership.

NCCOS also provides a capability to perform Integrated Assessments (IAs) as a strategy for addressing coastal ecosystem effects with respect to any particular combination of the above stressor and ecosystem categories. Integrated assessments consist of the following steps: (1) documenting status and trends of ecosystem and/or cultural resource conditions, (2) relating such trends to their environmental or economic causes and consequences, (3) predicting outcomes of alternative management actions,

and (4) providing guidance for implementing the alternatives. A successful IA is one that is responsive to policy-relevant questions, includes peer review and public participation, is broadly integrative and synthetic, is based on high-quality existing information, and is predictive. The IA approach provides a science-based framework for determining the source and scale of an existing environmental problem and evaluating various alternative management strategies. NOS is currently using an IA approach to examine the effectiveness of the existing network of Marine Protected Areas (MPAs) along the coasts of Washington, Oregon, and California in meeting goals of Executive Order #13158 (i.e., preserving biodiversity, sustaining fisheries, and preserving cultural artifacts).

Each NCCOS center provides a unique set of capabilities that could be utilized to help support sanctuary research and educational needs. These Centers and their corresponding programs include:

Center for Sponsored Coastal Ocean Research (CSCOR). The center is located in Silver Spring, Maryland. CSCOR operates the Coastal Ocean Program (COP), which is a federal-academic partnership providing predictive capabilities for managing coastal ecosystems. COP supports research in three areas: coastal fisheries ecosystems, cumulative coastal impacts, and harmful algal blooms/eutrophication. For further information contact the CSCOR website at <http://www.cop.noaa.gov>.

Center for Coastal Monitoring and Assessment (CCMA). The center is located in Silver Spring, Maryland. CCMA monitors, surveys, and assesses coastal environmental quality, habitats, and resource distribution. CCMA also is home of the National Status and Trends Program (NS&T), which conducts long-term contaminant monitoring at more than 350 estuarine and coastal sites around the country. Information from the Center's monitoring and assessment studies are synthesized and evaluated to determine the impacts of contaminant exposure and changes in coastal habitats on the distribution and abundance of living marine resources. CCMA's major program areas are in biogeographic characterization, bioeffects monitoring, and remote sensing. For further information contact the CCMA website at <http://ccmaserver.nos.noaa.gov>.

The Center for Coastal Fisheries and Habitat Research (CCFHR). The center is located in Beaufort, North Carolina. CCFHR consists of the following teams conducting a combination of laboratory and field research: Fisheries Oceanography and Ecology; Plankton Ecology and Physiology; Applied Spatial Ecology and Habitat Characterizations; Fish Ecology, Habitat Restoration, and Contaminants; and Coastal and Estuarine Ecosystem Restoration Research. Key areas of research include: coastal habitat utilization and restoration, fish ecology, chemical and physiological processes, ecology and oceanography of harmful algal blooms, population dynamics of reef and coastal fish species, and marine protected species (sea turtle and marine mammal). For further information contact the CCFHR website at <http://shrimp.ccfhrb.noaa.gov>.

Center for Coastal Environmental Health and Biomolecular Research (CCEHBR). The center has laboratories both in Charleston, South Carolina and Oxford, Maryland. CCEHBR provides scientific information required to resolve important issues related to

the health of coastal ecosystems, environmental quality, and related public health impacts. Chemical, biomolecular, microbiological, histological, toxicological, and ecological research tools are used to characterize the health of coastal ecosystems, including living resources and their associated habitats, and to assess and predict the causes and consequences of various human and natural stressors on the integrity of these resources. Major research areas include: marine biotoxins and harmful algal blooms, marine ecotoxicology, marine pathology, marine biotechnology and genetics, coral health, invasive species management, health of marine protected species (sea turtles and marine mammals), marine forensics, environmental risk analysis, and coastal ecology. For further information contact the CCEHBR website at <http://www.chbr.noaa.gov>.

Hollings Marine Laboratory (HML). The center, named after Senator E. Fritz Hollings, is located in Charleston, South Carolina. HML, which opened recently in 2002, is a newly established multi-institutional, multi-disciplinary laboratory providing science and biotechnology applications to sustain, protect, and restore coastal ecosystems, with emphasis on linkages between the environment and human health. Major research areas include: environmental/analytical chemistry, marine genomics, molecular biology and physiology, contemporary use of pesticides, ecotoxicology, proteomics, and aquaculture production and disease. HML is co-occupied by several partnering institutions including NCCOS, South Carolina Department of Natural Resources, University of Charleston, National Institute of Standards and Technology (NIST), and the Medical University of South Carolina. It is governed by an Executive Board, a Science Board, and several operational committees, under the leadership of a NOAA/NCCOS laboratory director. For further information contact the HML website at <http://www.nccos.noaa.gov/about/hml.html>.

Contacts

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II. REPORT UPDATE

FISCAL YEAR 2004 NCCOS CENTER ACTIVITIES and OTHER RESEARCH IN FKNMS

1. CCEHBR

As previously indicated in Table 2, CCEHBR was to receive funds from NMSP during the second year of the present two year cycle to support "Assessing Coral Health Using Molecular Biomarkers". Despite no NMSP funding in FY04, CCEHBR, under the direction of Dr. Cheryl M. Woodley, continued this research and anticipates further sampling in FY05. Funding contributions by CCEHBR were not provided for inclusion in this report. A summary of the project is provided below. For more information on this project contact Cheryl.woodley@noaa.gov .

Project Title: Coral Health and Adaptation

Observations:
Inshore/offshore differences in coral cover, diversity and abundance have been observed along the Florida Keys Reef Tract. Observational data indicate that corals in habitats characterized with decreased visibility assumed from elevations in CDOM (colored, dissolved organic material) and perhaps other uncharacterized constituents contributing to a perceived poor water quality, look good with respect to cover and diversity while corals on the outer bank reefs with clear water and low nutrient values, and where much of the research is focused, appear in poor health and degrading.

Management questions:

1) Given that the driving forces are multiple stressors, what are the key components or drivers involved at these sites and responsible for the two very different observations?
2) Can we characterize these places for their "condition" in anticipation of a bleaching (or other climatic or anthropogenic) event?

Approach:

Four regions along the Florida reef tract will be sampled with two sites per region, one inshore 3M site and one offshore 6M site:

Region I: Biscayne National Park
Region II Off Key Largo
Region III Looe Key
Region IV Marquesas (reference site)

Two coral species will be sampled per site, *Montastraea annularis* and *Porites astreoides*.

Due to the broad nature of this research question the initial work will be of necessity exploratory. The methods and indicators chosen for the exploratory analysis will include 1) ecological measures, 2) biological effects measures (i.e., bioindicators), 3) chemical contaminants (water & sediment) and environmental conditions (temperature, turbidity, salinity, pH) to address:

Ecological Measures:

Use AGGRA protocol for site assessments

Biological Effects Indicators:

A. Use Cellular Diagnostic to address:
    1. Whether a general stress is occurring among the sites
    2. Determine general categories of stress, if it is occurring
        a. Xenobiotic (contaminant stress)
            - GST (host)
            - MDR (holobiont)
            - CYP2 (host)
            - CYP6 (host)
        b. Photooxidative stress (determined by bioindicator response patterns)
            i. Photosynthetic origin
            ii. Porphyrin origin
            iii. Biotoxin origin
        c. Oxidative stress
            - Cu/ZnSOD (host)
            - Cu/ZnSOD (zooxanthellae)
            - MnSOD (host)
            - MnSOD (zooxanthellae)

d. Protein metabolic condition
    - HNE conjugated to protein
    - Hsp 60 (host)
    - Hsp 60 (zooxanthellae)
    - Hsp70 (host)
    - Hsp 70 (zooxanthellae)
    - Ubiquitin (holobiont)
    - Ubiquitin ligase (holobiont)

e. Metabolic condition
    - Chloroplast sHsp (zooxanthellae)
    - Ferrochelatase (holobiont)
    - Small Hsp (host)
    - Small Hsp (zooxanthellae) classes I-IV

f. Genomic integrity
    - Mut Y (holobiont)

B. Lesion Regeneration Rates
Use photo documentation of lesion created when coral sampling and calculate the healing rate of corals sampled from each site.

Contaminant chemistry present at sites in water and sediment:
A battery of organic chemicals including PAHs, PCBs and pesticides and herbicides will be measured in water and sediment at each site.

Once these general parameters are explored and coupled with contaminant analyses, we can determine if further assays will be more informative and definitive, whether new assays need development or if no further analysis is required.

Future Laboratory Experiments:
To address the questions regarding adaptation or acclimation of corals in these inshore vs. off shore sites we propose future laboratory experiments in what is referred to as a 'Common Garden Experiment' in which corals will be collected from both habitats and subjected to laboratory exposures to determine level of cellular physiological parameters on a "functional" or "subsystem" basis (i.e. probing different subsystems).

- Example of experiments
    - Heat stress
    - Light stress
    - Heat and Light stress combined
    - Contaminant exposure

These types of experiments will provide a means to characterize coral condition along the Florida Reef Tract with respect to their response capacity to different stressors.

2. CCMA

CCMA is funded by the U.S. EPA Special Studies Program (see earlier discussion) for approximately $100K for a collaborative project between CCMA (Anthony Pait), Fish and Wildlife Research Institute (Bob Glazer) and the University of Florida (Nancy Denslow).

Project Title: Anthropogenic Effects of Queen Conch Reproductive Development in South Florida.

This project is examining the effects of contaminants on disruption of the endocrine system and reproduction in Queen Conch (*Strombus gigas*). Once very abundant in the Florida Keys, conch populations have declined and there is evidence that onshore populations are not reproducing. The study will compare conch reproduction in onshore and offshore populations and look for a source (s) of contaminants that may be responsible for the reproductive failure. A PDF file describing the project is attached to the end of this report (Appendix 1). For questions or for more information on the project contact Tony Pait at CCMA (tony.pait@noaa.gov).

The Harmful Algal Bloom Forecasting Program lead by Rick Stumpf at CCMA is providing bloom forecasts to FKNMS. Contact rich.stumpf@noaa.gov for more information on this project.

Although it was indicated in last year's report that CCMA would be funded to work on a multi-sanctuary project on temperature, chlorophyll and light monitoring by remote sensing, no work was conducted in FKNMS.

3. CCFHR

Two projects were funded for CCFHR and were continuation and expansion of ongoing research CCFHR was undertaking in the FKNMS.

Project Title: Comparative Analysis of the Functioning of Disturbed and Undisturbed Coral Reef and Adjacent Ecosystems in the Tortugas Ecological Reserve.

This is an ongoing study examining the effect of implementing the Tortugas Ecological Reserve on the structure and function of Tortugas Banks and adjacent ecosystems. The most recent summary of progress is provided in a report from CCFHR and is attached to the end of this report (Appendix 2). For questions or more information on this project contact Mark.fonseca@noaa.gov . This project is now in the second year of the most recent funding cycle under the long-term agreement (see the previous table for funding information).

Project Title: Characterization of fishery resources and habitats associated with the coral-seagrass bank channels in the tidal passes of the nearshore biogeographic region in the Florida Keys National Marine Sanctuary (FKNMS).

The main objectives of this project are to; determine the species composition and standing stock of fishery populations in the coral-seagrass bank channels on the northern boundaries of the middle and lower Keys, characterize benthic invertebrate and plant communities from a stratified random sample of the bank channels in the middle and lower keys regions, revise the existing benthic habitat maps for the FKNMS to include the coral-seagrass bank channel systems using in situ surveys and aerial photography, and establish a baseline of human impacts on these habitats while developing an integrated assessment to forecast the effects of vessel traffic and restoration of water flow in Florida Bay on coral-seagrass bank tidal pass systems. This project is now in the second year of the most recent funding cycle under the long-term agreement (see the previous table for funding information). The most recent progress report for this project is attached to the end of this report (Appendix 3). For more information on the project contact jud.kenworthy@noaa.gov .

Other Research in the FKNMS in FY04 and FY05

A research budget of $162,830 provided to the FKNMS Science Coordinator (Dr. Brian Keller) by NMSP was distributed among 8 projects selected by the FKNMS in FY04. The breakout of projects is listed below. For more information on these projects contact brian.keller@noaa.gov

1. $48, 234: Fish and Wildlife Research Institute for sonic tagging of lobsters (Special Studies grant).

2. $4,984: Florida Institute of Oceanography to supplement SEAKEYS project.

3. $24,993: Mote Marine Lab in support for the Marine Ecosystem Event Response and Assessment project.

4. $24,800: Mote Marine Lab to support research by Kim Ritchie on microbial communities in coral mucus.

5. $24,884: Florida Institute of Technology for analysis of FKNMS thermograph data.

6. $24,940: Rosensteil School Marine and Atmospheric Sciences: Support for Tortugas expedition.

7. $4,995: Florida Institute of Oceanography: Supplement for ecosystem process monitoring.

8. $5,000: Gulf and Caribbean Fisheries Institute for sponsorship of 04 annual meeting.

The FKNMS Science Coordinator requested $200K for FY05 but this request has not yet been approved.

In addition to the uncertainty in the Science Coordinator's Budget, the NOAA Coastal Ocean Program's (COP) South Florida Budget is still being determined. Therefore, future long-term funding sources may be needed for two large monitoring projects in FKNMS, the seagrass monitoring program run by Dr. James Fourqurean at FIU, and the coral monitoring program run by Dr. Carl Beaver at FWRI. The Science Coordinator hopes to use $118K from NOAA's Coral Reef Conservation Program in FY05 to continue the rapid ecological assessment program run by Dr. Steven Miller (U. N. Carolina at Wilmington), which has a broader spatial design and greater replication of reef types than the FWRI coral monitoring program.

Research Projects Permitted in FKNMS in FY02 and FY03

Attached to the end of this report are two documents summarizing the research permitted in the FKNMS under their permit program (Appendices 4 and 5). Presumably, these permits capture most of the research undertaken in the sanctuary. In 2002 and 2003 there were 83 and 57 projects permitted, respectively. The Sanctuary Science Coordinator and his staff are in the process of updating the files for permitted research in FY04 to be included in a future liaison report.

Other Funding Sources

Other potential funding sources from NMSP include the National Marine Sanctuary Science Mini Grants Program. A description of the program and the RFP for FY 05 are attached (Appendix 6). Science Mini-Grants will be awarded only to National Marine Sanctuaries, although other federal, state, tribal agencies, academic and non-profit organizations can act as partners, receiving Science Mini-Grants Program funds as part of a qualifying project. Funds for projects approved for FY05 must be obligated before the end of September 2005. Mini-grant funding is not intended to be a sustained funding source for science projects. The priorities of this program are very similar to the priorities of the FKNMS Science Coordinator;

- Site Characterizations (Habitat, Living Marine Resources, Water Quality, Anthropogenic Influences)
- Monitoring (Habitat, Living Marine Resources, Water Quality, Anthropogenic Influences)
- Regional Observing Systems

The FKNMS also considers hypothesis-based science an important priority, especially where it directly addresses critical resource management and zoning issues.

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Murray, S.N and nine others. 1999. No-take reserves networks: Sustaining fishery populations and marine ecosystems. Fisheries November 1999: 11-24.

Whitfield, P.E., Kenworthy, W.J**.**, Fonseca, M.S., Hammerstrom, K. 2002. The Role of Storms in the Expansion of Disturbances Initiated by Motor Vessels on Subtropical Seagrass Banks. J. Coastal Research. 37:86-99.

LIST OF APPENDICES

1. Summary of CCMA Conch Project.
2. Summary of CCFHR Dry Tortugas Project.
3. Summary of CCFHR Channel Banks Characterization Project.
4. List of research permits in FKNMS for 2002.
5. List of research permits in FKNMS for 2003.
6. RFP for NMSP Science Mini Grants Program (FY05).

GROUP A: PROJECT MANAGEMENT

A1. TITLE AND APPROVAL SHEET

Project Title Anthropogenic Effects on Queen Conch Reproductive Development in South Florida

Organizations

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Signatures

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Project Manager

_____ _____
Signature Date

Nancy Denslow [2]
Laboratory Manager

_____ _____
Signature Date

Anthony Pait[3]
Chemistry Manager

_____ _____
Signature Date

A2. Table of Contents

A3. Distribution List

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Laboratory Manager	Nancy Denslow, University of Florida, 352-846-0157 denslow@biotech.ufl.edu
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Field Coordinator	Gabriel Delgado, Florida Fish and Wildlife Commission, 305-289-2330, gabriel.delgado@fwc.state.fl.us
Laboratory Coordinator	Kevin Kroll, University of Florida, 352-846-0157 kkroll@biotech.ufl.edu
Histology Coordinator	Nancy Brown-Peterson, University of Southern Mississippi, 228-872-4288, nancy.brown-peterson@usm.edu
Chemical Safety Officer	William Sharp, Florida Fish and Wildlife Commission, 305-289-2330, bill.sharp@fwc.state.fl.us

A4. Project/Task Organization

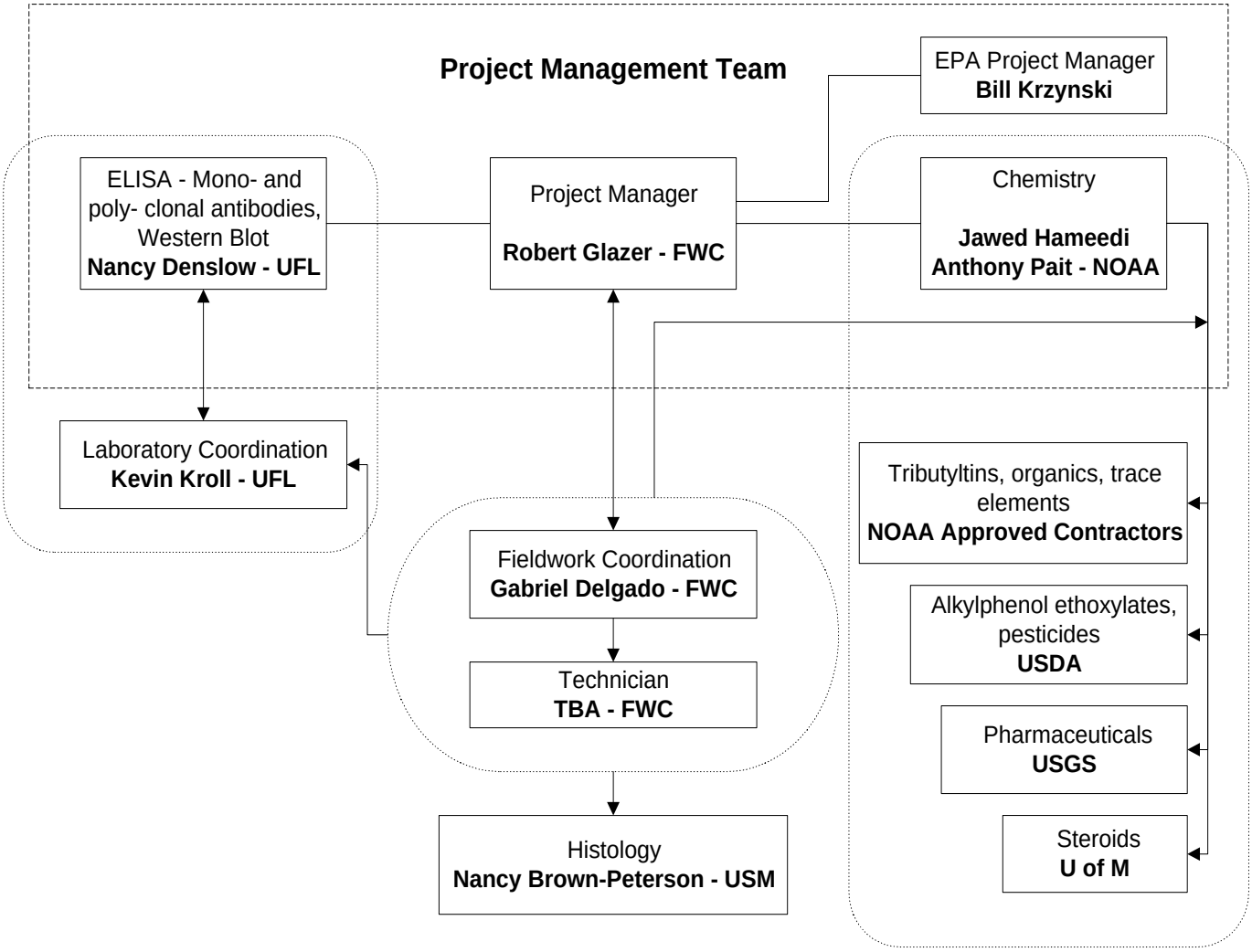

Figure 1. Schematic representation of project management for queen conch endocrine disruption study

A5. Problem Definition/Background

The queen conch, *Strombus gigas*, is a marine gastropod that inhabits the tropical western Atlantic. In south Florida, it once comprised significant commercial and recreational fisheries (Stevely and Warner, 1978). In the mid-1980s, the stock declined precipitously resulting in a moratorium on harvest in 1985 in state waters; this ban was extended to federal waters in 1986. Until very recently, the population showed no sign of recovering (Berg and Glazer, 1995; Glazer and Berg, 1994; Glazer and Delgado, in press).

In south Florida, queen conch exist in two spatially distinct regions: nearshore (i.e., adjacent to the islands and north of Hawk Channel) and offshore (i.e., beyond Hawk Channel) (Glazer and Berg 1994) (Fig. 1). Over the course of our studies, we observed there has been a complete cessation of spawning in adult queen conch from nearshore waters (Glazer and Quintero, 1998; McCarthy et al., 2000; Delgado et al., in review), although, anecdotal reports from as late as the mid-1980's indicate that they used to spawn there (B. Lapointe, Harbor Branch Oceanographic Institution, personalc communication). Histological examinations of gonadal tissues from male and

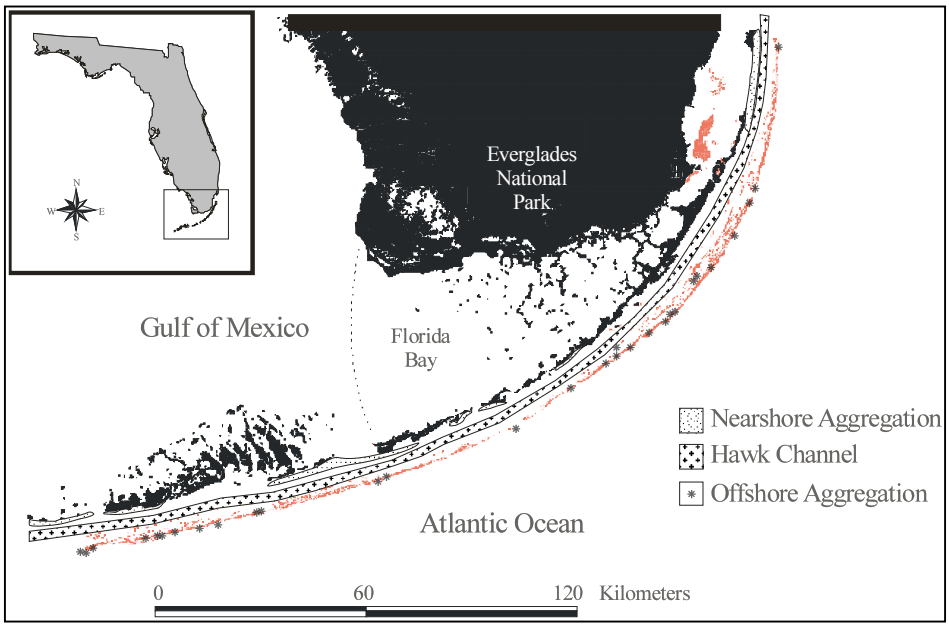

Figure 2. Queen conch distribution in the Florida Keys. Nearshore aggregations are found shoreward of Hawk Channel; offshore aggregations are seaward.

female conch found nearshore showed serious deficits in gonadal condition when compared with their offshore counterparts (Delgado et al., in review). Reciprocal transplant studies demonstrated that the gonads of conch transplanted from offshore to nearshore degraded, whereas those transplanted from nearshore to offshore regenerated their gonads after about six months (McCarthy et al., 2000). The greatest impacts were observed in female conch. These observations are consistent with the mode of action of estrogen mimics.

A variety of xenobiotics introduced into the environment have estrogenic qualities and are suspected of exerting endocrine disrupting effects within biological systems (Arcand-Hoy et al., 1998), especially in wildlife. While some of the causal agents are known, their biological effects are poorly understood. There is widespread belief, however, that these agents damage reproduction, reducing fertility, hatchability, and viability of offspring. They reportedly may impair hormone activity and alter sexual behavior, and there is a possibility that exposure of embryos to these chemicals causes inalterable developmental damage. Special interest has been focused on estrogen mimics because of the critical role that estrogen plays in reproduction and development. Estrogenicity, by its nature, disrupts normal endocrine function (Safe et al., 2000) in-part by activating the gene that codes for vitellogenin production in males; in females, vitellogenin production is retarded.

Among the xenobiotics implicated in endocrine disruption are the alkylphenol ethoxylates (APEs) which have been identified as estrogenic endocrine disrupters (see Gronen et al., 1999 for a review), butyltins implicated as the causative agent in molluscan imposex (see Matthiessen and Gibbs, 1998 for a review), polycyclic aromatic hydrocarbons (PAHs) which depress both female and male reproductive development (Spies and Rice, 1988), current use and banned organochlorine pesticides, a number of which may impact the endocrine system (Celius and Walther, 1998; Cross and Hose, 1988), and human use pharmaceuticals. Additionally, perfluorooctane sulfonate (PFOS), which is used as a stain resistant coating for fabrics, and polybrominated diphenyl ethers (PBDEs), used as flame retardants in products from electronics to textiles, have been implicated in mammalian thyroid dysfunction (Fowles et al., 1994; Meerts et al., 2000).

It is likely that many of these compounds find their way into the nearshore waters of the Florida Keys via sewage discharges (Bright et al., 1981, Kruczynski, 1999), surface water runoff (Heatwole, 1987) shipping discharges and oil spills (Zheng and Van Vleet, 1988), fish house discharges (Heatwole, 1987), discharges from the south Florida mainland (Jaap, 1984), and mosquito pesticide application (Pierce, 1996). Lapointe and Clark (1990), LaPointe et al. (1994), and Szmant and Forrester (1996) showed that point and non-point sources of nutrient discharges have contributed to eutrophication in nearshore waters and that there were nutrient gradients from nearshore to offshore as well as elevated nutrients in nearshore developments. Additionally, Snedaker et al. (1995) found significant levels of *n*-alkanes in Florida Keys waters with greater concentration nearshore than offshore. *n*-Alkanes are indicative of petroleum-based carbon contaminants in the environment.

In 1998, an Advisory Panel report was submitted to the Workshop Steering Committee of the South Florida Ecosystem Restoration Task Force (Atkeson et al.,

1998). The report addressed the development of a strategic plan to address ecological issues in south Florida that require further action. Among those recommendations was the recognition that "pesticides, metabolites, and chemical degradation products should be screened for their endocrine disruption potential." Additionally, they recognized that a variety of other point and non-point sources of contaminants are present and their products may be harmful and should be identified and tested for toxicity.

The lack of reproductive development in nearshore conch, coupled with the long history of mosquito pesticide application, inadequate sewage treatment systems, and other sources of anthropogenic discharges in the Florida Keys suggest a linkage between reproduction and water quality. Furthermore, this relationship may have directly influenced the recent decline in conch abundance by decreasing reproductive output.

During the past two decades, environmental scientists have searched intensively for biomarkers that can detect early physiological or biochemical changes in organisms exposed to anthropogenic chemicals. Vitellogenin (VTG) has been characterized as an ideal biomarker for measuring exposure of oviparous animals to estrogen-mimicking xenobiotics (Denslow et al., 1999). VTG is not normally produced by males; however, exposure to estrogen-mimicking compounds induces them to begin VTG synthesis. VTG is found in detectable concentrations in the plasma of males exposed to estrogen mimics. The chemical structure of VTG is not conserved among species; however, there are short sections that are highly conserved.

A fairly easy method to quantify Vtg production is by producing polyclonal and/or monoclonal antibodies to a species-specific analogue of Vtg. Each has its advantages and disadvantages. Polyclonal antibodies are easier to prepare and are more sensitive than monoclonals; however, they may be less specific and harder to validate. Monoclonal antibodies, on the other hand, are more specific for those sections of the Vtg that are conserved and are therefore very specific. Production of both types of antibodies is a very powerful approach that ensures that Vtg identification is achieved. Vtg antibody specificity must then be validated using a method such as Western blot. After antibodies are produced and validated, Vtg can be detected and quantified using a method such as the widely-used enzyme-linked immunosorbent assay (ELISA).

After the assays are developed, it is fairly easy to test individual animals for the effects of exposure to estrogen mimics. For populations that have shown reproductive impairment, a comprehensive chemical survey of the environment will provide a list of suspected xenobiotics. The comparison of plasma Vtg levels using ELISA for both exposed and control individuals (unexposed) will then detail the effects of that chemical on the reproduction in that species. Histology will then further validate those results.

We will examine the effects of nearshore water quality on the reproductive development of male and female queen conch. We will use an approach designed to examine endocrine disruption by examining vitellin (Vtg) production (Denslow et al., 1999) in conch exposed to environmental contaminants (sensu Gronen et al., 1999). Concentrations of environmental contaminants will be ascertained by NOAA from water column, sediment, and conch tissue samples. This proposal represents a comprehensive partnership among the Florida Fish and Wildlife Conservation Commission's Florida

Marine Research Institute, The University of Florida, and NOAA's National Ocean Service.

2. Objectives

The goal of this project is to examine endocrine disruption in adult queen conch by examining Vtg production, a biomarker sensitive to xenobiotics, in conch exposed to a variety of environmental contaminants present in the nearshore waters of the Florida Keys. The specific objectives of the study are to (1) estrogenize male conch, (2) develop biomarkers to Vtg (polyconal and monoclonal antibodies) using hemolymph from estrogenized conch and control conch, (3) validate the antibodies using Western blot, (4) measure levels of vitellogenin in nearshore and offshore conch, (5) determine if there are higher concentrations of chemical contaminants in conch tissues, water column, and sediment samples from the nearshore environment relative to offshore, (6) test the suspected bioxenic(s) identified from the chemistry on adult male and female queen conch to quantify Vtg production and, therefore, reproductive impairment, and (7) confirm the results obtained by ELISA using histological examinations of conch gonadal tissue. This study will test the following hypotheses: (1) there are no differences in Vtg between male conch exposed to suspected xenobiotic compounds and those unexposed (control), (2) there are no differences in Vtg between female conch exposed to suspected xenobiotic compounds and those unexposed (control), (3) there are no differences in gonadal condition as assessed by histology between male conch exposed to suspected xenobiotic compounds and those unexposed (control), (4) there are no differences in gonadal condition as assessed by histology between female conch exposed to suspected xenobiotic compounds and those unexposed (control).

A6. Project/Task Description

This project will examine reproductive failure in conch found nearshore by employing an endocrine disruption approach. The use of vitellin or vitellogenin, both egg-yolk precursor proteins, have become popular biomarkers for examining exposure of animals to estrogen and estrogen mimics in the environment. Because queen conch found in nearshore waters do not reproduce and their offshore counterparts do, we use vitellin as a biomarker to conduct experiments to determine what is causing the reproductive failure in the nearshore subset of the Florida conch population. More specifically, we will examine estrogenization in conch and develop suitable tools to quantify the effects of xenobiotics on conch gonadal development. Briefly, we will first develop the tools to quantify vitellin specific to queen conch. Then we will examine vitellin levels in wild conch found in the reproducing zone (offshore) and in the non-reproducing zone (nearshore). The vitellin levels will be validated with histological examinations of the gonads of conch in these two zones. After we have quantified and examined the differences in vitellin from conch within these two zones, we will make assessments based on those analyses regarding the likely class(es) of xenobiotic(s) that is (are) causing the reproductive failure nearshore. We will then examine the sediment,

water column, and conch tissues in the two zones for the presence of these chemicals and for differences between the concentrations nearshore and offshore. If we find a likely chemical agent, we will expose unaffected conch (i.e., from the offshore zone) to it and examine the effect it has both chemically (i.e., vitellin production) and histologically. At the same time that vitellin levels are examined, we will also examine histological sections of gonadal tissue to verify that abnormal vitellin levels have a physiological basis in the development of gonads. This is a two-year study commencing in March 2004 (Fig. 3).

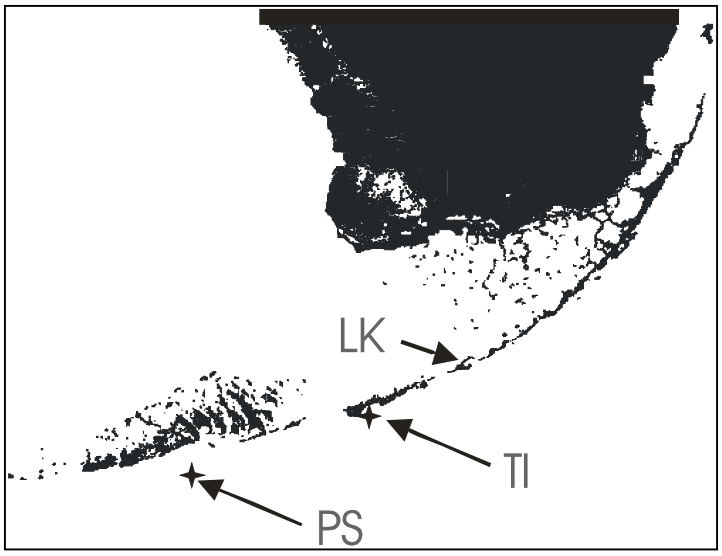

Figure 3. Sites of sampling and collection for queen conch study. The sites from which conch will be obtained for the study are nearshore (Tingler Island, TI), and offshore (Pelican Shoal, PS). The laboratory where conch are to be held is on Long Key (LK).

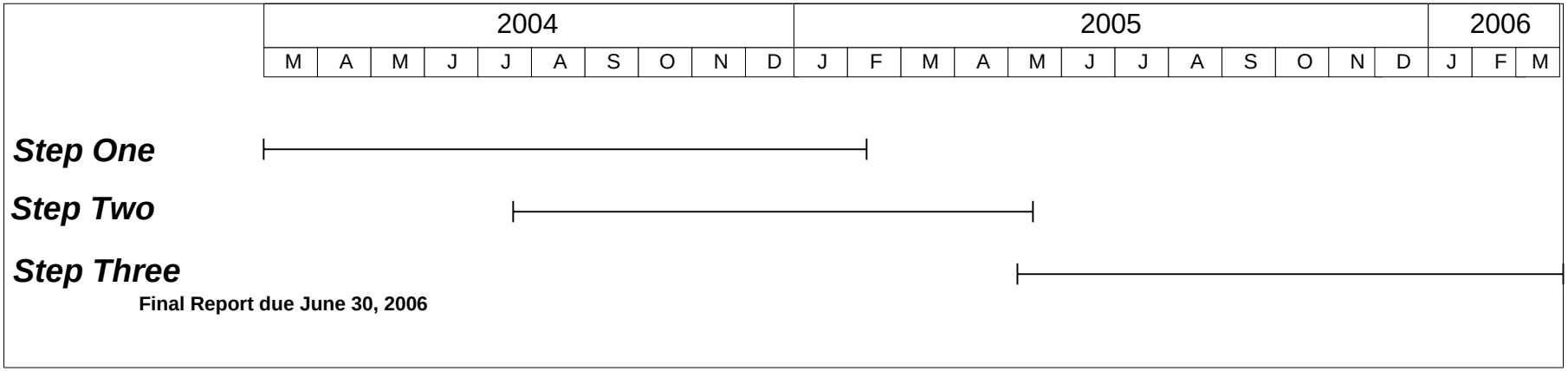

Figure 4. Generalized timeline of queen conch study.

A7. Criteria for Measurement of Data

Histological evaluation of gonadal tissues relies on identification of specific gameotogenic stages. Appendix 5 lists the gonadal maturity classes, and the criteria used to assign these classes, based on gameotogenic stages present. Although gonadal development is a progressive event, the classes identify specific benchmarks (presence or absence of certain gameotogenic stages) to aid in consistent classification. The percentage of gameotogenic tissue in the gonad is measured using an 100-square ocular grid at low power. Duplicate tissue sections will be placed on each slide, and both tissue sections will be evaluated on 10% of the slides (randomly chosen) to assure consistency in assignment of maturity classes and percentage of gameotogenic tissues.

Antibody production will be coordinated by the Hybridoma Core Facility at the University of Florida. Polyclonal antibodies will be obtained from a commercial facility that will use antigens that we develop to inject rabbits. Pre-immune sera will be obtained from each rabbit. After immunization, sera will be tested for crossreactivity with the antigen. This will be performed by the Hybridoma Core Facility on a charge basis, following standard procedures that they have developed. Antibodies will be deemed to be present in sera when the ELISA readings are high. Antibodies will then be tested by Western blot to make sure they are indeed binding only to the antigen used to immunize the rabbits (or mice for monoclonals) and not to other proteins that may be present in hemolymph or conch tissues.

ELISA results using the polyclonal (or monoclonal) antibodies produced against Conch vitellin will follow standard procedures. In general the assays will be performed in triplicate with a standard curve (prepared from purified conch vitellin protein and authenticated by either amino acid analysis or protein sequence information). In addition we will prepare an interassay standard sample that will be used on every assay to assure that the standard curve is behaving properly. The coefficient of variation of the triplicate samples must be within 10% of each other, or the assay will be repeated. The interassay standard must be within 10% of the normal value, or the assay will be repeated. The standard curve will be examined for consistency and shape. If it varies from the normal curve, the assay will be repeated.

Values for ELISA results will be converted to ug/ml hemolymph based on the standard curve. Based on prior experience, we expect the direct ELISA to be sensitive to 1 ug/ml vitellin. We will check for interferences by other components in hemolymph by doing dilutions. The results should be parallel to undiluted samples. If interferences are present, samples will be diluted until parallelism can be demonstrated. From our past experience with fish plasma samples, this is normally a dilution of 1 to 100.

A8. Special Training/Certifications

This project is research based. The qualifications of the researchers are detailed in their CV's in Appendix 4.

A9. Documents and Records

Quarterly reports and a final report will be provided to the EPA grants manager. In addition, when the class of chemical (e.g., estrogenic, antiestrogenic, antiandrogenic) is determined, we will supply an addendum to this Quality Assurance Project Plan to detail the chemicals to be tested and the quality assurance components that are appropriate for those test.

Histological observations will initially be recorded onto laboratory bench sheets. The original sheets will be retained at the University of Southern Mississippi by Nancy Brown-Peterson, and a certified copy will be kept by Bob Glazer at the Florida Fish and Wildlife Commission (FWC). Final diagnosis for each individual will be entered into Excel spreadsheets, and will include the gonadal maturity scale and the percentage of gametogenic tissue present.

Field data (e.g., conch tag number, sex, sample number) will be recorded on plastic underwater slates and then photocopied upon return to FWC. These sheets will be housed in three-hole punch binders and kept by Bob Glazer. Data will then be entered into MSAccess, proofed, and corrected before being used in data analyses.

Laboratory data collected at the University of Florida will be stored on read-only CD's and a copy will be sent to FWC in Marathon for archiving and to be entered into the database.

Data derived from the chemistry will follow the same protocols as that from the UFL lab – all data will be stored on read-only CD's and a copy will be sent to FWC in Marathon for archiving and to be entered into the database.

GROUP B: DATA GENERATION AND ACQUISITION

There are three steps of this project (Fig 4.) Step One is represented in Figure 6, Step Two is in Figure 7, and Step Three is presented in Figure 8. Each control box in each flow chart where a process is conducted is given a numeric code representing the Step and then a sequential letter designation. This is done to help visualize the flow process and for easy reference to the Process Design. Histological examinations are given a separate code, as the process is similar throughout all the stages. Statistical analyses that are used as control points are also given separate codes (e.g., St-1).

The timeline for this project is detailed in Appendix 2.

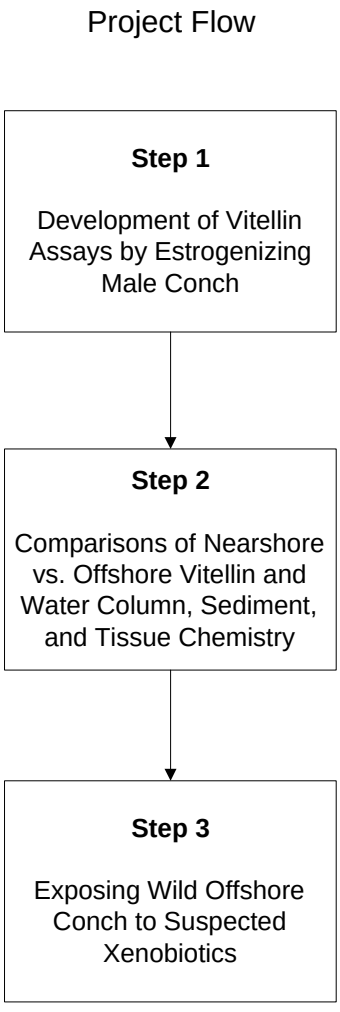

Figure 5 - Queen conch Project Flow - Overview

B1. Sampling Process Design (Experimental Design)

The goal of this project is to determine what xenobiotics or naturally occurring chemicals may be negatively affecting reproduction in queen conch. The general approach is to use standard endocrine disruption approach to quantify vitellin production in male and female conch by using an ELISA. However, in order to determine this, we have designed a 3 Step approach. project This project will be conducted in three-phases (Fig 2). In the first phase, we will develop the tools necessary to quantify vitellin in adult conch exposed to xenobiotics. This will be accomplished by exposing male conch to estrogen, purifying the proteins in the hemolymph, and producing monoclonal and polyclonal antibodies. A Western Blot will be used to validate the antibodies. These antibodies will then be to develop an Enzyme Linked Immunoassay (ELISA).

Step Two will use the tools developed in Step One to examine the vitellin of adult conch found in nearshore, non-reproductive populations and also to examine the vitellin in their offshore, reproducing counterparts. Estrogenic or anti-estrogenic activities will elucidated based on the differences in vitellin levels found in the hemolymph of the two populations of conch. We will then test the sediment, water column, and conch tissue in the two zones (offshore and nearshore) for the presence of these xenobiotics.

Step Three will utilize the results from Step Two to identify the most likely xenobiotics that resulted in the observed differences in vitellin levels between the two populations. If we find xenobiotics that have much higher concentrations nearshore, we will then expose a subset of unaffected conch (i.e., offshore conch) to the xenobiotic and measure the change in vitellin and compare histological samples from conch exposed and control conch. This project is a two-year study (Fig. 3).

Step One - Development of Vitellin ELISA

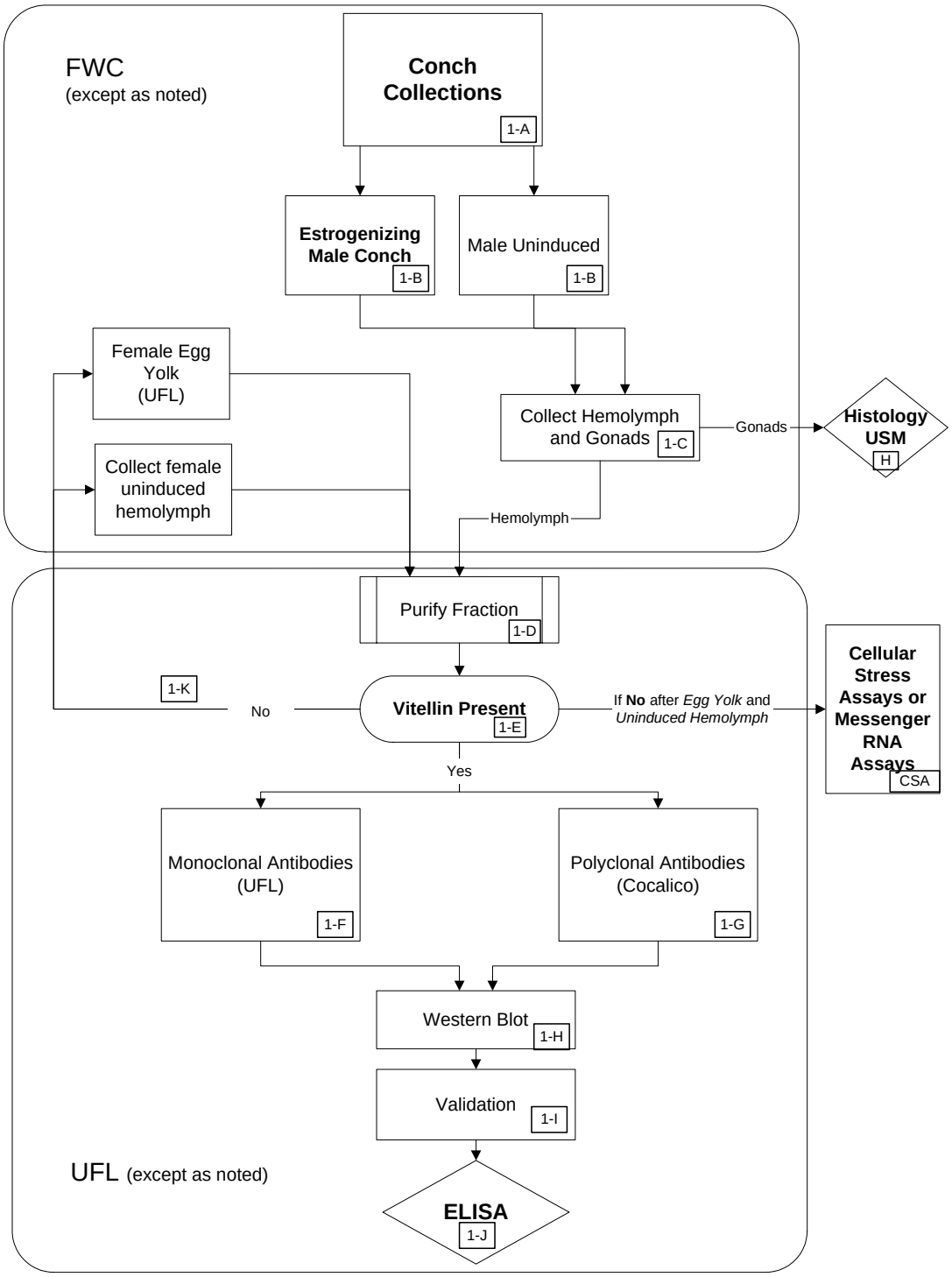

Figure 6. Flowchart detailing Step 2 of queen conch endocrine disruption project.

Step Two - Nearshore vs. Offshore Vitellin and Chemistry

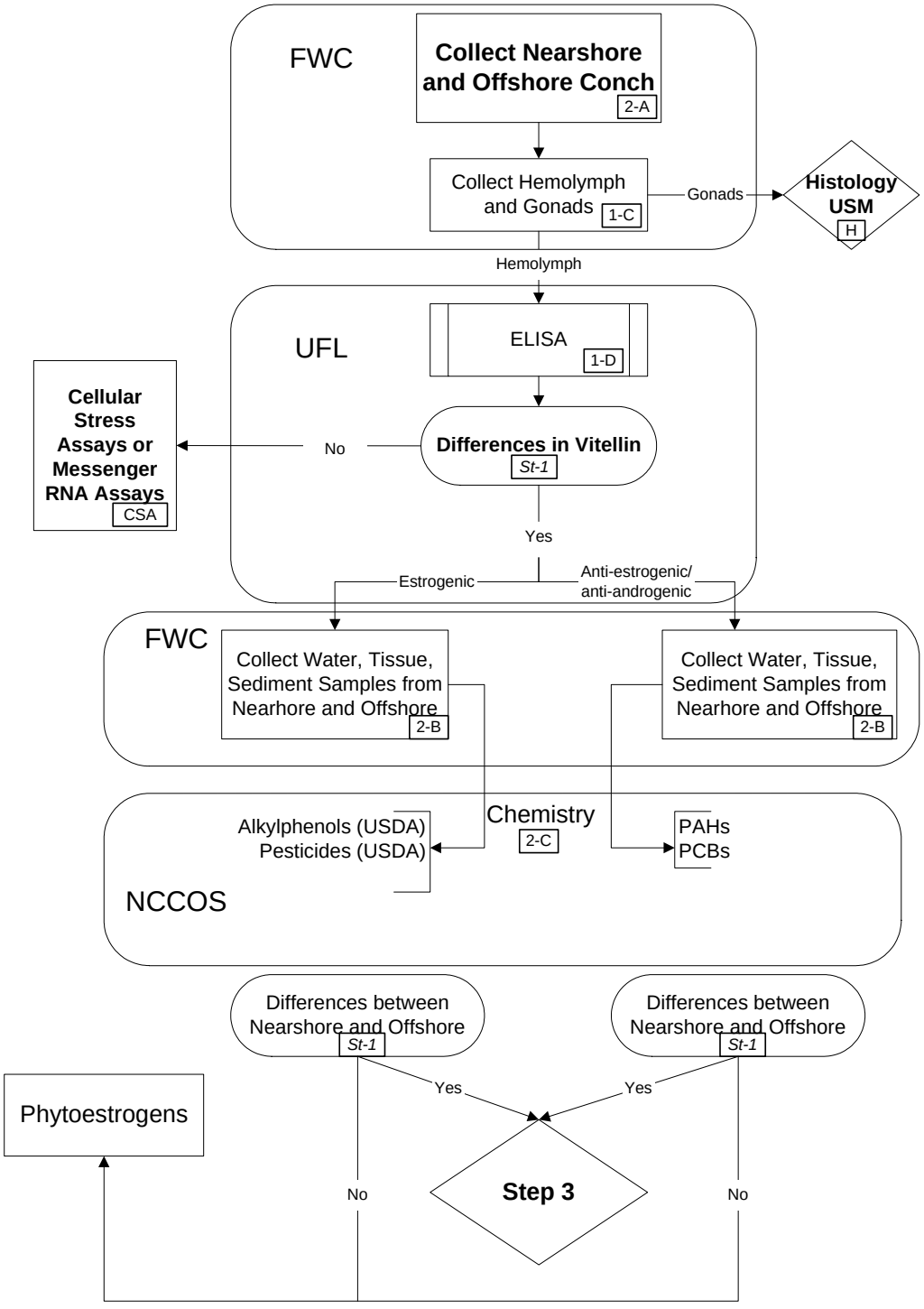

Figure 7. Flowchart detailing Step 2 of queen conch endocrine disruption project.

Step Three - Determine Xenobiotics that Affect Conch Reproduction

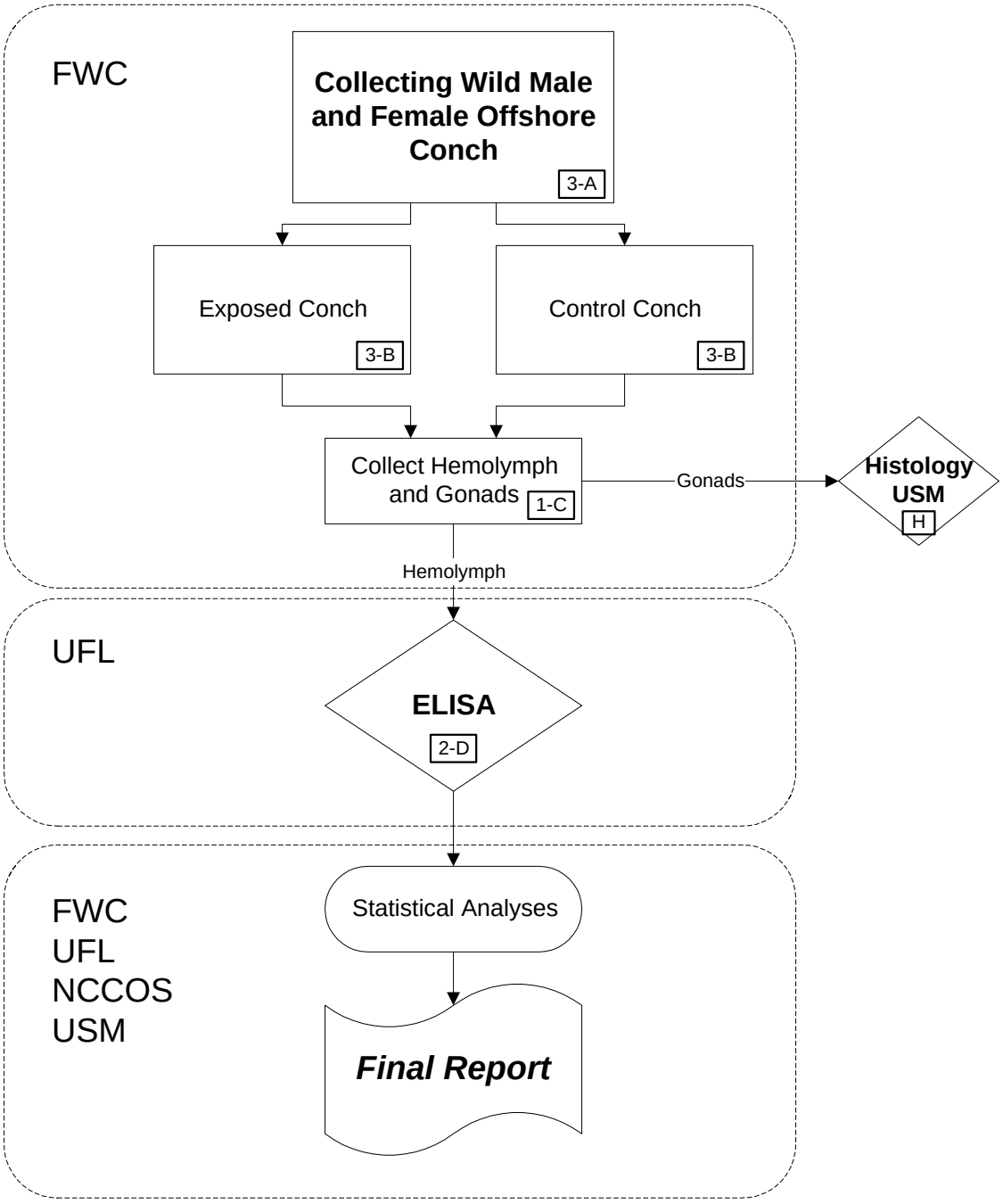

Figure 8. Flowchart detailing Step 3 of queen conch endocrine disruption study.

B2. Sampling Methods

1-A. Conch Collections for Vitellin Purification

Ten male queen conch will be collected in April 2004 from within the offshore aggregation at Pelican Shoal (Fig. 1; 24.50277 N, 81.63073 W) and will be transported to the FWC laboratory on Long Key by vessel. Male conch will be identified by their distinctive verge.

1-B. Estrogenizing male conch

The male conch will be anaesthetized with MgCl at 35 ppt in 34° C seawater and treated with 2.5 mg/kg estradiol by injection. They will then be placed in one of the existing conch culture tanks. The conch will be held in captivity in the existing tanks at Long Key for four weeks. If we are unable to inject estradiol directly into the tissue without causing mortality, we will expose ten male conch to 500 ng/L estradiol in seawater. More details of this method including the list of materials, preparation of estradiol for injection, and specific procedures may be found in Denslow et al., 1999 (attached) under the section titled *Estradiol-stimulation of Animals to Produce Vitellogenin*.

1-C. Collect Hemolymph and Gonads

After four weeks, each conch will be sacrificed and an aliquot of hemolymph will be collected using a syringe. In addition, we will obtain hemolymph from ten untreated males for comparison. The details of the collection of hemolymph including the list of materials and specific procedures may be found in Denslow et al., 1999 (attached) under the section titled *Estradiol-stimulation of Animals to Produce Vitellogenin*. In this instance, however, we will inject the estradiol solution directly into the coelomic cavity at the bae of the foot. Additionally, because conch have no clotting factor, the animals will need to be sacrificed to obtain the hemolymph. The hemolymph will be shipped overnight on dry ice to the UFL laboratory in 3-ml vacutainers as per protocols defined in Denslow et al., 1999 (attached) under section 3.1 titled *Collection of plasma from field samples*. All standard chain of command protocols will be followed and we will use the shipping labels detailed in Appendix 4 to verify transfer of custody.

Gonadal tissue samples from the adult conch that were used for estrogenization and the exposure tests will be collected by FWC for histological examination by the University of Southern Mississippi in order to assess gonadal development. A one-

cm^3 piece of tissue from the middle of the gonad of each animal will be placed in a labeled plastic cassette and preserved in 10% neutral buffered formalin. After 7 to 14 days in fixative, the tissue samples will be rinsed overnight in freshwater and shipped to the University of Southern Mississippi. All standard chain of command protocols will be followed and we will use the shipping labels detailed in Appendix 3 to verify transfer of custody.

2-A Collection of Nearshore and Offshore Conch

Ten male and 10 female conch will be collected in April 2004 from within the offshore aggregation at Pelican Shoal (Fig. 1; 24.50277 N, 81.63073 W). At the same time, an additional 10 male and 10 female conch will be collected from the nearshore aggregation at Tingler Island (24.69032, 81.07712). Male conch will be identified by their distinctive verge and females will be identified by their egg groove. The conch will be transported to the FWC laboratory on Long Key by vessel.

2-B Collect Tissue, Sediment, and Water Column Samples for Chemistry

All field sampling will be conducted from the Florida Fish and Wildlife Commission's laboratory in Marathon, Florida. Two samples will be collected from water column, sediment, and conch tissue samples from the impacted nearshore sites (Tingler's Island and Duck Key) and the offshore control sites (Pelican Shoal and Alligator Reef) (Figure 1). Both sites have been surveyed extensively and there is a good deal of information from conch collected there on abundance (Stoner et al., 1996; FWC, unpublished data), reproductive behavior (McCarthy et al., 2002), and histology (Delgado et al., in review). Collections will conform to established National Status and Trends (NS&T) protocols, which minimize the chances of cross contamination and ensure delivery of samples for analysis in a timely manner. Sediment samples will be collected using Teflon-coated scoops and placed in Teflon containers. Water samples will be collected in solvent rinsed glass containers. Tissues will be collected and shipped whole to the laboratory. All samples will shipped overnight either on regular or dry ice.

B3. Sample Handling and Custody

A Sample Handling and Custody Data Sheet is presented in Appendix 3. The form details the type of sample collected, a unique identification code, the type of analysis to be performed, and custody.

B4. Analytical Methods

1-D. Purify Hemolymph Fraction

Upon receipt of the queen conch hemolymph from FWC, we will purify the vitellin fraction by passing the hemolymph through a Poros HQ anion exchange column and comparing the elution pattern with that of untreated males (Denslow et al., 1999). We expect to see a high molecular weight protein elute off the column at relatively high salt. The purified vitellin will serve to construct a standard curve for quantification.

1-E. Vitellin Present

This protein will be characterized by gel electrophoresis and we will confirm that it is vitellin by Edman chemistry sequence analysis (Folmar et al., 1995).

1-F. Monoclonal Antibody Development

The Hybridoma laboratory in the Biotechnology Program at the University of Florida will prepare the monoclonal antibodies. We will inject mice with the purified antibodies to prepare monoclonal antibodies. Monoclonal antibodies are likely to require at least 6 months to develop. More details of this method including the list of reagents, materials, preparation may be found in Denslow et al., 1999 (attached) under section 2.4 titled *Preparation of Monoclonal Antibodies.* The monoclonal antibodies will be purified using the methods, reagents and materials, and procedures detailed in section 2.5 in Denslow et al., 1999 (attached) under section 2.5 titled *Purification of Monoclonal Antibodies by Affinity Chromatography on Protein G.*

1-G. Polyclonal Antibody Development

The purified protein will be sent to Cocalico, Inc for injection into rabbits to prepare a polyclonal antibody. We expect to have good titre polyclonal antibodies within about 2 months of injection. The specific deatisl of this test More details of this method including the list of reagents and materials, immunization protocol, injections into the rabbits, and other specific procedures may be found in Denslow et al., 1999 (attached) in section 2.3 titled *Preparation of Polyclonal Antibodies against Vitellogenin*.

1-H. Western Blot Development

The Western blot is a validation method to ensure that the antibody is species-specific for Vtg. The method relies on separating the hemolymph proteins by SDS polyacrylamide gels, electro-transferring the proteins to a PVDF membrane and then probing with a specific antibody, in this case with anti-conch vitellin. Using this assay, we can determine whether the antibody is specific for vitellin and see if it cross-reacts with other hemolymph proteins. Quantification of the response can be determined by densitometry. More details of this method including the list of

reagents and materials, sample preparation, and specific procedures may be found in Denslow et al., 1999 (attached) in section 2.6 titled *Validation of Antibody Preparation*.

1-I. Validation of Western Blot

The Western Blot will be validated using the methods detailed in Denslow et al., 1999 (attached) sections 2.6 (Validation of Antibody Preparation) and 3.4, (Quantification of Western blots by a chemi-illuniscent procedure).

1-J. Enzyme Linked Immunosorbent Assay Development (ELISA)

We will develop an ELISA assay with the polyclonal antibodies as soon as they are available using previously employed strategies (Denslow et al., 1999). Either a 'Direct Elisa' or a 'Sandwich Elisa' will be used by employing the reagents, materials and procedures detailed in Denslow et al., 1999 (attached) sections 3.2 and 3.3 respectively.

H Histology

Upon arrival at the University of Southern Mississippi laboratory, the samples will be dehydrated in a series of graded ethanols (one change of 60% ethanol and two changes of 70% ethanol for two hours each) and loaded into an automatic tissue processor (Shandon Hypercenter XP, Shandon Scientific Limited) for dehydration, clearing, and paraffin infiltration. Tissues will then be embedded in Paraplast Plus (Fisher Scientific) and sectioned at 4μm using a rotary microtome. Two serial sections from each tissue sample will be mounted on glass slides, allowed to dry overnight, and stained with hematoxylin 1 and eosin Y (Richard Allen Inc.). All laboratory procedures will follow approved Standard Operating Procedures developed under the Good Laboratory Practices guidelines. A detailed histological inspection of each sample will be made to assess the stage of gonadal maturity and the percentage of gametogenic tissue (relative to the entire gonad). Each animal will be given a score from 1 to 8 to quantify gonadal maturity (Delgado et al., in review; Appendix 4) derived from a maturity scale developed by Egan (1985). In addition, the percentage of gametogenic tissue will also be noted using the following index: <25%, 25-50%, 51-75%, and >75%.

CSA Cellular Stress Assays or Messenger RNA Analsyes

Cellular Stress Assays or Messenger RNA Analyses will be performed in the unlikely eventuality that either of the following occurs: 1) we are unable to isolate vitellin from either hemolymph or egg yolk (Step One) or there are no differences in vitellin between nearshore and offshore conch (Step Two). If either of these occurs, we will amend the QAPP to include these procedures.

2-C Chemistry

The type of chemicals that will be examined will depend upon the results of the differences in the ELISA examinations for vitellin levels (see above Section 1-I). ANOVA will be used to test for differences in vitellin concentrations (Fig. 6; St-1). If significant differences in vitellin levels are found, then water, tissue, and sediment samples can be collected for the appropriate contaminant analyses. For example, if assay results indicate that estrogenic endocrine disrupting compounds may be impacting nearshore queen conch, then the chemical analyses can concentrate on compound classes such as the alkylphenols. If assay results indicate antiestrogenic/antiandrogenic effects, then other classes of contaminants such as the PAHs and PCBs might be more of a priority. Power and minimum detectable difference analyses will be performed in order to ensure appropriate sample sizes for subsequent exposure experiments (Fig. 6; St-1). Thus, the results from the statistical analyses will determine which chemical tests are conducted. When the determinations are completed relative to the likely class of xenobiotics affecting reproduction, we will append to this QAPP with the details regarding the appropriate tests. All chemical analyses will be conducted by either NOAA approved contractors (tributyltins, organics, trace elements), the USDA (alkylphenol ethoxylates, pesticides), the USGS (pharmaceuticals), or the University of Maryland (steroid hormones).

Since 1984, the Center for Coastal Monitoring and Assessment (CCMA) through the NS&T program has routinely monitored bivalves and sediments along the U.S. coasts for organic and trace element contaminants. For this study, CCMA will analyze selected water, tissue, and sediment samples for a variety of contaminants, a number of which have been implicated as endocrine disrupters (Lauenstein et al., 1993; Lauenstein et al., 1998).

CCMA will analyze samples for alkylphenol ethoxylates (APEs), butyltins, polycyclic aromatic hydrocarbons (PAHs), current use pesticides and banned organochlorine pesticides, and human use pharmaceuticals. Selected samples will also be analyzed for perfluorooctane sulfonate (PFOS) which is used as a stain resistant coating for fabrics, and polybrominated diphenyl ethers (PBDEs) used as flame retardants in products from electronics to textiles. Finally, levels of estradiol and ethynylestradiol, the natural and synthetic estrogens, respectively, are also proposed in the analyses.

Many of the analyses will be conducted using gas chromatography following some type of extraction. The APEs will be analyzed using gas chromatography/mass spectrometry (GC/MS). The butyltins (mon-, di-, tri-, and tetrabutyltin) will be analyzed using GC with a flame photometric detector. The PAHs, pesticides, PFOS, and the PBDEs will be analyzed using either GC/MS or GC with an electron capture detector. The pharmaceuticals will analyzed using liquid chromatography/mass

spectrometry (electrospray ionization). Finally, estradiol and ethynylestradiol will be analyzed using an enzyme linked immunosorbent assay (ELISA).

3-B Exposure of queen conch to contaminants

After the first year of research, we will evaluate the results of the chemical analyses by comparing the results from offshore sites (control) with nearshore sites. The power and minimum detectable difference analyses that were performed as part of Step 2 (Fig. 6; St-1) will ensure appropriate sample sizes for the exposure experiments are used. Based on those results, we will expose a sufficent number of male and female conch to those contaminants with concentrations that differ between the two zones or that are found in unusually high levels in the environment or in the tissues from animals at both sites. All test solutions for exposure will be analyzed by one of the laboratories where our environmental chemistry has been conducted. These laboratories meet NOAA and EPA QA/QC standards. Again, details on the t4ests will be provided when the suspected xenobiotics are identified. Samples will be collected at the beginning and end of each exposure as per Section 1C above. The conch will be held in the existing FWC conch culture tanks on Long Key. After a one-week period, hemolymph will be collected from exposed and control conch and shipped overnight to UFL following standard chain of command protocols (see section B2, subsection 1C). Vitellin will be quantified using the ELISA methods developed previously described in Sections B4 (subsections 1-D to 1-I).

B5. Quality Control

All histological slides will be assigned sequential numbers so that the slides can be read "blindly" without prior knowledge of exposure conditions. These sequential numbers will be matched to the actual sample number during data analysis.

The UFL lab has adapted a number of criteria to maintain ELISA data quality. Vitellogenin is easily degraded by freeze/thaw fracture. Hence, samples for ELISA analysis are stored at -80˚C until analysis and then thawed only one time. If the sample needs to be re-analyzed, an aliquot in ELISA buffer (stored at 4˚C) will be used. This aliquot is stable for 1 month. Purified vitellogenin containing protease inhibitor and cryprotectant is remains a liquid at -20˚C and is stable for 1 year; hence, safe from freeze/thaw degradation.

All samples and standards are run in triplicate. The coefficient of variation between the triplicate absorbances should be $\leq$10%. If not, the outliar may be discarded. However, if the CV still exceeds 10%, the sample or standard must be rerun. Standard curve absorbances at 405nm that exceed 1.5 are not used in the regression analysis. The correlation coefficient of the standard curve regression should be $\geq$95% in order to be

used for data analysis. Inter and intra assay variation (CV) using positive control samples should be maintained at <10% and <5%, respectively.

B6. Instrument/Equipment Testing, Inspection and Maintenance

Daily temperature readings of the paraffin in the Shandon Hypercenter XP and the Shandon embedding center will be recorded in the Hypercenter and Embedding center instrument logs to ensure appropriate paraffin temperatures for histology. Daily cleaning and monthly inspections for normal operations will also be recorded. All changes of solutions will be recorded in the instrument log.
Monthly inspection, cleaning and oiling of the microtome used for sectioning will be performed and recorded in the Microtome Maintenance Log at USM/GCRL. A stock of replacement microtome parts are kept in the laboratory. All changes of staining solutions will be recorded in the Staining Log.

The Olympus microscope used for reading slides will be cleaned, inspected and adjusted (if necessary) annually by Bio-Tech Microscope Services.

All equipment in the Molecular Biomarkers Laboratory is State-of-the-Art equipment and is maintained by service contracts. Personnel using specific equipment are trained and have extensive experience in the safe and appropriate us of that equipment. Specific instruments that will be used are described below:

The BioCad Chromatography Work Station (Applied Biosystems) is a computer controlled liquid chromatography unit. It is routinely used to purify antibodies and vitellogenin. Columns are replaced when the quality of the chromatography declines as evidenced by poor peak resolution and peak geometry. The instrument is cleaned thoroughly after each use and is adjusted when necessary by Applied Biosystems service personnel. The work station is calibrated with standards and the highest quality columns are used for separations.

Incubators for growing Hybridoma cells to make monoclonal antibodies are routinely monitored for temperature control and for contamination. The incubators are inspected and adjusted as necessary according to the operational procedures of the Hybridoma Laboratory.

The plate reader is cleaned and inspected before each use. Standards are used to make sure that the instrument is working properly. If the instrument is not working properly, a service engineer is called to calibrate and maintain the instrument.

All personnel are trained in safe laboratory procedures and have been informed of the chemical and health hazards in their laboratory environment. All laboratories are inspected yearly by the University of Florida Environmental Safety Office for safe laboratory practice, safe equipment and work environment.

B7. Instrument/Equipment Calibration and Frequency

pH meters, balances, and pipetors are calibrated every 6 months by service engineers.

Every time the pH meter is used it is calibrated with pH standards at pH 4, 7, and 10. If linearity between these standards is not found, then the pH meter is serviced. The pH probe is cleaned daily and inspected to make sure that it is clean and properly maintained.

Balances are calibrated every time they are used with an external set of weights. They are cleaned thoroughly after use.

Pipetors (Rainin, micropipets) are calibrated every six months by a trained commercial professional. In addition, they are visually inspected every time they are used. If in doubt, microliter amounts of fluid are weighed by balance to make sure that the appropriate amounts are being delivered.

All calibrations are entered into log books and associated experiments. Calibration records are maintained in the laboratory. All relevant data will be maintained in a laboratory notebook and in a computer database.

B8. Inspection/Acceptance of Supplies and Consumables

All supplies entering the laboratory to be used for histological purposes are inspected and accepted by Nancy Brown-Peterson or Marie Wright (Lab manager, Parasitology histology center). Chemicals are deemed acceptable if they are histological grade or better and all containers are intact, unopened and have no visable damage.

All chemicals used are of the highest quality and most will be purchased from Fisher Scientific, or Sigma. All elution buffers used for the chromatography workstation are HPLC grade or better. Electrophoresis standards are obtained from reputable commercial dealers and are of the highest purity. Gels are commercially obtained as well.

All consumables used for Biomarker development are inspected when they arrive to make sure they are intact and have not been tampered and they are stored immediately in the appropriate locations.

B9. Non-direct Measurements

Histological slides that are clearly sectioned and stained will be used for the project. A clearly stained slide allows differentiation between the hemotoxylin and eosin stains and clearly shows each gameotogenic stage Slides with incorrect staining (due to running, water in chemicals, etc.) will be discarded, and new sections cut and stained to meet staining clarity criteria.

All data will be stored in laboratory notebooks and in computer databases and will be available to all researchers. In the case of ELISA results, the experiments will be done in triplicate. The coefficient of variation is normally within 10%. If values differ by more than 10%, the experiment will be repeated. All readings are based on a standard curve, which is checked by a reference sample.

For antibody screening assays, wells producing antibodies that are positive on the first screen will be further tested by Western blot analysis, an orthogonal test to ensure the specificity of the antibody. All antibodies that fail this test will be discarded. Only antibodies that are positive by ELISA, that are directed against the polypeptide chain (not carbohydrate) and that are positive by Western blot analysis will be used.

B10. Data Management

All data will be collected at the respective laboratory and, after proof-reading, will be provided as a non-rewritable CD and hardcopy to the project leader. All data will be archived at the FWC laboratory in Marathon on a secure server and will be backed up regularly each night (differential data) with full back-ups of the entire server conducted each week. Metadata will be developed and will meet standards FGDC-MBII compliant (Federal Geographic Data Committee and National Biological Information Infrastructure) as adopted by FMRI. Back-up data are stored in St. Petersburg and at a secondary off-site facility. Data will be transported as generated and proofread to FMRI by the other laboratories via e-mil or CD as appropriate.

Data will include the paraffin blocks and slides of the histological samples, as well as the histological analysis. Blocks will be stored in trays in cardboard storage boxes and slides will be stored in cardboard slide boxes that hold up to 480 slides. Both blocks and slides will be achieved at the University of Southern Mississippi, Gulf Coast Research Laboratory with other histological specimens. The original bench sheets from histological analysis will be held in a file cabinet at USM/GCRL; certified copies will be sent to FWC. Data will be entered onto Excel spreadsheets. Data fields will include sample number, date of collection, location of collection, treatment, gonadal maturity scale and percentage of gameotogenic tissue.

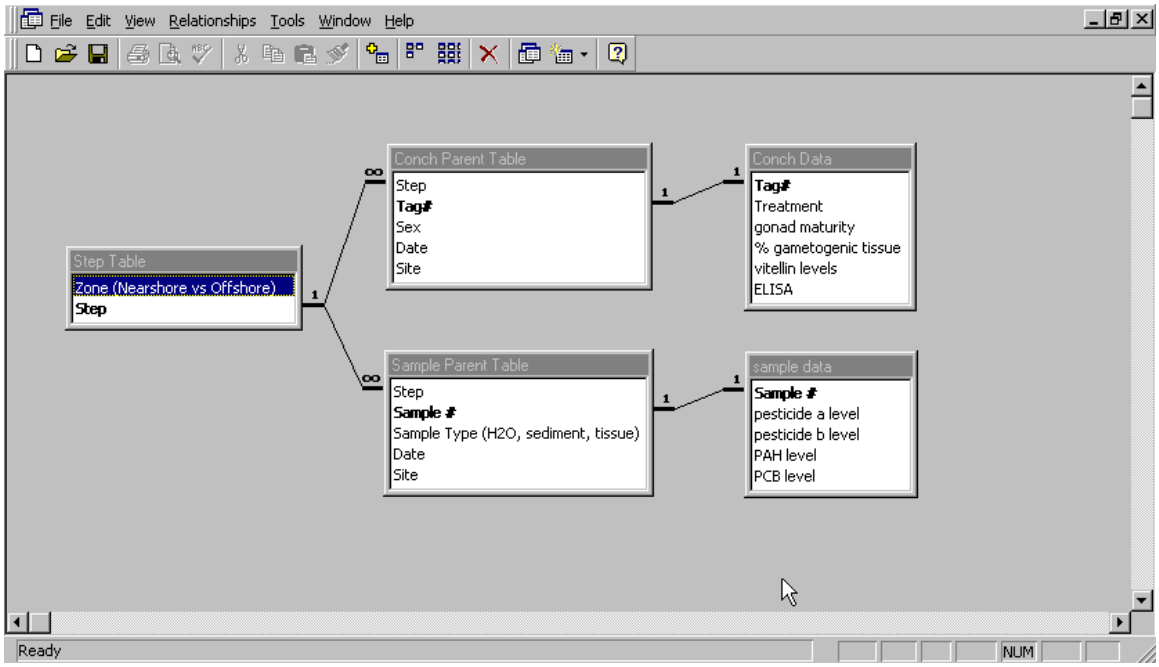

Figure 9 – Sample relational database showing relations between tables. The data tables are related by step in the project process. The highlighted fields are the linking field to ensure data integrity.

GROUP C. ASSESSMENTS AND OVERSIGHT

C1. Assessments and Response Actions

Assessment/Oversight	Period	Action	Corrective Actions/by whom
Technical Reports to Project Manager	Quarterly	Each Investigator will be required as part of their subcontract or purchase order to provide quarterly reports.	Payment withheld by Project Manager
Financial Auditing to Project Manager	Monthly	FLAIR (Florida Accounting Information Resource system)	Reviews with FWC administrative staff

Appending the QAPP - at the time the QAPP needs to be appended to (Step 2 prior to collection of water, sediment, and tissue samples), we will reroute the appended document first through the NOAA office to get their changes and then through the other investigators (exclusive of USM). Additionally, we will append the QAPP if any of the steps

C2. Reports to Management

Each investigator on the project will be required as a condition of their sub-contracts to provide reports 2 weeks prior to the due date for the quarterly reports due to the EPA administrator. The quarterly reports to EPA will be prepared by the Project Manager using the information from the investigators and reviewed by FMRI staff (Fig. 8). The final reports will be compiled and completed by the Project Manager. Each investigator will be responsible for completing their part of the report. The report will include introduction, methods, results, and a discussion. Tables and figures will be included as will literature cited. The final payment to each subcontract will be released to each subcontractor upon receipt of their information for the final report. The responsibilities for each part of the project are detailed in the Figures 1, 6, 7, and 8.

GROUP D. DATA VALIDATION AND USABILITY

D1. Data Review, Validation, & Verification Requirements

Prior to initiation of the project, the project investigators will meet to discuss the structure and goals of the project. From this meeting, a relational database will be developed in Microsoft Access with tables corresponding to each step in the process. The upfront planning will alleviate the need to continually review the goals to ensure that the data collected meets the requirements of the project. Each investigator will be responsible for data for their respective table that will be incorporated into the comprehensive relational database.

D2. Validation and Verification Methods

Data entry will be completed at each laboratory in an MSAccess database with internal error checking and validation. Look-up databases will be developed as appropriate to constrain data entry to appropriate data. All data will be proofread before release to the centralized database at the FMRI office in Marathon.

All data will be provided to the FMRI office in Marathon from UFL, NOAA, and USM on both CD (non-rewritable) and in hardcopy. A backup copy will be archived at each laboratory. In additiona, a backup copy of the database will be archived at the FMRI main laboratory in St. Petersburg.

D3. Reconciliation with User Requirements

A series of statistical tests will be run on the data generated from the research including vitellin, contaminant levels, and a number of water quality parameters to investigate significant differences between means. When necessary, data will be transformed prior to analysis in order to meet the requirements of homogeneity of variance and normality. Standard analysis of variance (ANOVA) will then be carried out followed by appropriate pair-wise comparisons such as Dunnett's Test or Kramer HSD. Data that do not meet the requirements of normality will be analyzed using nonparametric methods such as the Kruskal-Wallis test.

GROUP E - APPENDICES

Appendix I - Literature Cited

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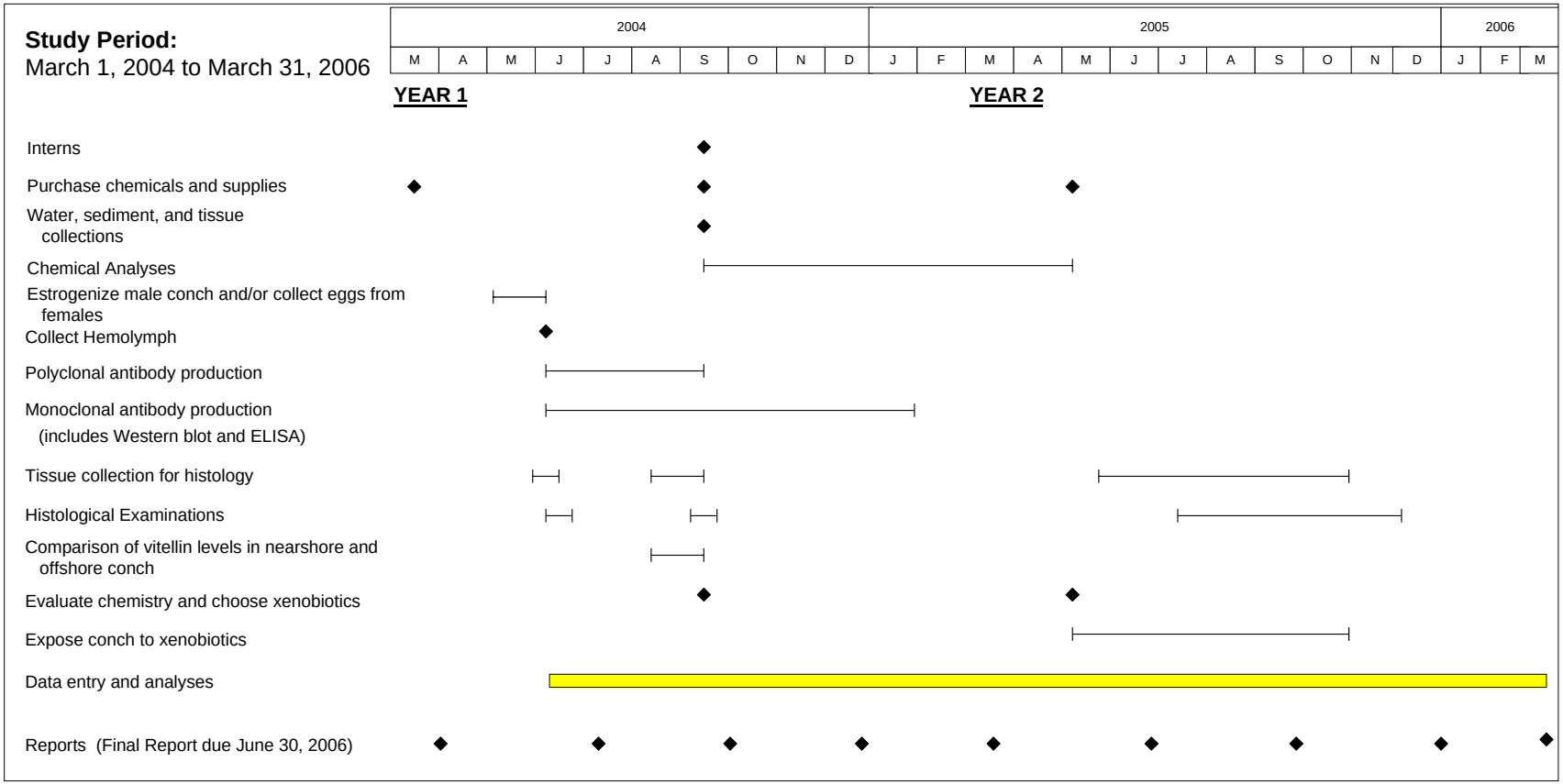
Appendix 2 – Queen Conch Project Timeline



Appendix 3 - Sample Handling Custody Sheet – Queen Conch

Sheet No:

A. Sample Type, Packaging, & Shipment
Sample Type (circle one): hemolymph, gonads, tissue, sediment, water
Collection Date:
Sample Numbers/ID:
Sample Packing:
Date Shipped:
Courier and Tracking Number:

B. Sender & Contact Info
Name:
Organization:
Phone:
e-mail:

C. Sample Receipt & Storage
Date Received:
Recipient:
Organization:
Address:
Phone:
e-mail:
Storage:

D. Sample Analysis
Individual Responsible:
Responsible Organization and/or Lab:
Analyses to be Performed:
Date Shipped: *****
Courier and Tracking Number: *****
Received By: *****

Date Received: *

E. Sample Disposal
Responsible Person:
Responsible Organization:

***** if needed

Appendix 4 – Resumes of Investigators

Curriculum Vitae

PERSONAL

Robert Glazer
Associate Research Scientist

Florida Fish and Wildlife Conservation Commission

2796 Overseas Highway, Ste. 119
Marathon, Florida USA 33050

305-289-2330
305-289-2334 (fax)
bob.glazer@fwc.state.fl.us

FMRI Certified Watercraft Operator, Class A-1
SCUBA Certified, PADI and FMRI, Open Water Diver
NITROX Certified, IANTD

EDUCATION

University	**Major**	**Dates Attended**	**Degree**
Colorado State University	Fishery Biology	1974-1979	B.S.

EXPERIENCE

Dates	**Organization**	**Position**
1990 - present	Florida Fish and Wildlife Conservation Commission	Principal Investigator/Associate Research Scientist
1999 - 2001	Gulf and Caribbean Fisheries Institute	Chairman, Board of Directors
1999 - present	Caribbean Pearl Company	President
1986 - 1990	Florida Fish and Wildlife Conservation Commission	Assistant Research Scientist
1984 - 1985	Caicos Conch Farm	Systems Manager
1982 - 1983	Aquaculture Research Company	Director of Research
1980 - 1982	Pigeon Point Aquaculture Center	Biologist

1979 - 1980 Wyoming Game and Fish Commission Assistant Fisheries Biologist

HONORS and ACTIVITIES

Gulf and Caribbean Fisheries Institute Board of Directors – 1997 to present
Outstanding Young Environmentalist – Florida JAYCEES – 1995
Florida Marine Research Institute Dive Control Board – 1990- present

PROFESSIONAL ORGANIZATIONS

1997 - Gulf and Caribbean Fisheries Institute - Board of Directors
1999-2001 – Gulf and Caribbean Fisheries Institute – Chairman, Board of Directors

PUBLICATIONS

Glazer, R. A. and G. A. Delgado. 2003. Estimating queen conch (Strombus gigas) home ranges using acoustic telemetry: implications for the design of marine protected areas. In: R. A. Appeldoorn (ed) Caribbean Marine Protected Areas: Practical Approaches to Achieve Economic and Conservation Goals. Gulf and Caribbean Research

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CURRICULUM VITAE

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FMRI Certified Watercraft Operator, Class A-1
SCUBA Certified, PADI and FMRI Open Water Diver

EDUCATION

University	**Major**	**Dates Attended**	**Degree**
University of Miami	Marine Biology and Fisheries	1994-1997	M.S.
University of Miami	Marine Science and Biology	1990-1993	B.S. cum laude

EXPERIENCE

Professional

Dates	**Organization**	**Position**
2000-present	Florida Fish and Wildlife Conservation Commission	Marine Research Associate
1999-2000	Everglades National Park	Fisheries Technician
1998-1999	Florida Department of Environmental Protection	Research Staff
1998	University of Miami	Consultant
1993-1994	The Nature Conservancy	Assistant Marine Biologist

Educational

Dates	**Organization**	**Position**
1999	Florida Keys Community College	Adjunct Professor
1994-1996	University of Miami	Teacher's Assistant

HONORS and ACTIVITIES
GCFI Member – 5 years
RSMAS Anonymous Donor Grant Award
Lerner-Grey Fund for Marine Research Grant Award (American Museum of Natural History)

PUBLICATIONS

Books

Bustamante, G., M. Chiappone, **G.A. Delgado**, F.X. Geraldes, E. Pugibet, Y. Rodriguez, E. Schmitt, R.D. Sluka, K.M. Sullivan, R.E. Torres, J. Tschirky, and M. Vega. 2001. Fisheries Investigations and Management Implications in Marine Protected Areas of the Caribbean: A Case Study of Parque Nacional del Este, Dominican Republic. M. Chiappone (Ed.). Publications for Capacity Building, The Nature Conservancy, Arlington, VA. 145pp.

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Delgado, G.A., M. Chiappone, F.X. Geraldes, E. Pugibet, K.M. Sullivan, R.E. Torres, and M. Vega. 1998. Abundance and size frequency of queen conch in relation to benthic community structure in Parque Nacional del Este, Dominican Republic. Proceedings of the Gulf and Caribbean Fisheries Institute 50: 1-31.

DENSLOW, Nancy Derrick	Scientist and Scientific Director of Protein Chemistry and Molecular Biomarkers Facilities, University of Florida

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Mary Washington College, Fredericksburg, VA	B.S. w/honors	1966	
Yale University, New Haven, CT		1967	Biochemistry
University of Florida, Gainesville, FL		1975	Biochemistry
University of Florida, Gainesville, FL		1977-81	Biochemistry

Positions and Employment

Visiting Professor of Biochemistry, University of Ceara, Brazil, 1976-1977
Assistant Scientist, Dept. of Biochemistry and Molecular Biology, University of Florida, 1981-1993
Technical Director, Protein Chemistry Core Facility, Interdisciplinary Center for Biotechnology Research, University of Florida, 1988-1993
Scientific Director, Protein Chemistry and Molecular Biomarkers Core Facility, Interdisciplinary Center for Biotechnology Research, University of Florida, 1993-Present
Associate Scientist, Dept. of Biochemistry and Molecular Biology, University of Florida, 1994-2001
Scientist, Dept. of Biochemistry and Molecular Biology, and Interdisciplinary Center for Biotechnology Research University of Florida, 2001-present

Other Experience and Professional Memberships

American Society for Biochemistry and Molecular Biology
Society of Toxicology
Society for Environmental Toxicology and Chemistry
Association of Biomedical Research Facilities, committee member

Editorial Boards

Environmental Chemistry and Toxicology, 2002-present
Applied Genomics and Proteomics, 2002- present

Selected peer-reviewed publications (in chronological order):

(Publications selected from 74 peer reviewed publications)

Folmar, L.C., **N.D. Denslow**, V. Rao, M. Chow, D.A. Crain, J. Enblom, J. Marcino, and L.J. Guillette, Jr. "Vitellogenin Induction and Reduced Serum Testosterone Concentrations in Feral Male Carp (*Cyprinus carpio*) Captured Near a Major Metropolitan Sewage Treatment Plant", *Environ Health Perspect* **104**:1096-1101 (1996).

Singh, L.P., **N.D. Denslow,** and A.J. Wahba, "Modulation of Rabbit Reticulocyte Guanine Nucleotide Exchange Factor Activity by Casein Kinases 1 and 2 and Glycogen Synthase Kinase 3. *Biochemistry*, **35**: 3206-3212 (1996).

Heppell, S.A., **N.D. Denslow**, L.C. Folmar and C.V. Sullivan 'Universal' Assay of Vitellogenin as a Biomarker for Environmental Estrogens. *Environmental Health Perspect.* **103** (S7):9-15 (1995).**35**: 3206-3212 (1996).

Denslow, N.D., Chow, M.M., Folmar, L.C, Bonomelli, S.L., Heppell, S.A., and Sullivan, C.V. "Development of Antibodies to Teleost Vitellogenins: Potential Biomarkers for Environmental

Estrogens", Environmental Toxicology and Risk Assessment: Biomarkers and Risk Assessment. 5th Vol. ASTM STP 1306, David A. Bengston and Diane S. Henshel, Eds. American Society for Testing and Materials. 1996.

Schegg, K.M., **N.D. Denslow**, T.T. Anderson, Y.A. Bao, S.A. Cohen, A.M. Mahreuholz and K. Mann, "Quantitation and Identification of Proteins by Amino Acid Analysis". Techniques in Protein Chemistry VIII (O. Marshale, ed). Academic Press - 1997.

Denslow, N.D., Bowman, C.J., Lee, H.S., Ferguson, R.J., Hemmer, C.J., and Folmar, L.C., Biomarkers of Endocrine Disruption at the mRNA Level, in Environmental Toxicology and Risk Assessment: 8th Volume. ASTM STP 1364, (D. Henshel, Ed.), American Society for Testing and Materials, 1999. pp 24-35.

Parks, L.G., A.O. Cheek, **N.D. Denslow**, S.A. Heppell, J.A. McLachlan, G.A. LeBlanc and C.V. Sullivan. "Fathead Minnow (Pimephales promelas) Vitellogenin: Purification, Characterization and Quantitative Immunoassay for the Detection of Estrogenic Compounds," Comparative Biochemistry and Physiology, *Comparative Biochemistry and Physiology, Part C* 123:113-125 (1999).

Gronen, S., N**. Denslow**, S. Manning, S. Barnes, D. Barnes, and M. Brouwer, "Serum Vitellogenin Levels and Reproductive Impairment of Male Japanese Medaka (*Oryzias latipes*) Exposed to 4-*tert*-Octylphenol," Environmental and Health Perspectives, 107:385-390 (1999).

Orlando, E.F., **N.D. Denslow**, L.C. Folmar, and L.J. Guillette, Jr., "A Comparison of the Reproductive Physiology of Largemouth Bass, *Micropterus salmoides*, Collected from the Escambia and Blackwater Rivers in Florida," Environ. Health Perspect. 107:199-204, 1999.

O'Brien, T.W., S.E. Fiesler, **ND Denslow**, B. Wittmann-Liebold, B. Thiede, EB Mougey, JE Sylvester, and HR Graack, "Mammalian Mitochondrial Ribosomal Proteins (2): Amino Acid Sequencing, Characterization and Identification of Corresponding Gene Sequences." J. Biol. Chem. 274:36043-36051, 1999.

Denslow, N.D., M. Chow, KJ. Kroll and L. Green "Vitellogenin as a Biomarker of Exposure to Estrogen or Estrogen Mimics." Ecotoxicology, 8:385-398, 1999.

Bowman, C.J., and **Denslow, N.D.** Development and Validation of a Species- and Gene-Specific Molecular Biomarker: Vitellogenin mRNA in Largemouth Bass (*Micropterus salmoides*) Ecotoxicology, 8:399-416, 1999.

Folmar, L.C., M. Hemmer, R. Hemmer, C. Bowman, K. Kroll, and **ND Denslow**, "Comparative Estrogenicity of Estradiol, Ethynyl estradiol and Diesthylstilbestrol in an *In vivo*, Male Sheepshead Minnow (*Cyprinodon variegatus*) Vitellogenin Bioassay." Aquatic Toxicology, 49:77-88 (2000).

Funkenstein, B., C.J. Bowman, **N.D. Denslow,** M. Cardinali and O. Carnevali. Contrasting Effects of Estrogen on Transthyretin and Vitellogenin Expression in Males of the Marine Fish, *Sparus Aurata*, Molecular and Cellular Endocrinology, 167: 33-41 (2000).

Bowman, C.J., K.J. Kroll, M.J. Hemmer, L.C. Folmar, and **N.D. Denslow**. Estrogen-Induced Vitellogenin mRNA and Protein in Sheepshead Minnow (*Cyprinodon variegatus*), General and Comparative Endocrinol., 120:300-313 (2000).

Hemming, J.M., Waller, W.T., Chow, M.C., **Denslow, N.D.**, and Venables, B. Assessment of the estrogenicity and toxicity of a domestic watewater effluent flowing through a constructed wetland system using biomarkers in male fathead minnows (Pimephales promelas rafinesque, 1820). Environ. Toxicol and Chem. 20:2268-2275 (2001).

Hemmer, M.J., Hemmer, B.L., Bowman, C.J., Kroll, K.J., Folmar, L.C. Marcovich, D., Hoglund, M.D. and **Denslow**, **N.D.** Effect of p-nonylphenol, methoxychlor, and endosulfan on vitellogenin induction and expression in sheepshead minnow (Cyprinodon variegatus). Environ. Tox.Chem. 20:336-343 (2001).

Folmar, L.C., **Denslow, N.D.**, Kroll, K., Orlando, E.F., Enblom, J., Marcino, J., Metcalfe, C., Guillette, L.J. Altered Serum Sex Steroids and Vitellogenin Induction in Walleye (*Stizostedion vitreum*)

Collected Near a Metropolitan Sewage Treatment Plant. Arch. Environ. Contam. Toxicol, 40:392-398 (2001).
Denslow, N.D., Bowman, C.J., Ferguson, R.J., Lee, H.S., Hemmer, M.J. and Folmar, L.C. Induction of Gene Expression in Sheepshead Minnows (Cyprinodon variegatus) Treated with 17-b-Estradiol, Diethylstilbestrol or Ethinylestradiol: The Use of mRNA Fingerprints as an Indicator of Gene Regulation. General Comp. Endocrinol., 121:250-260 (2001).
Denslow, N.D., Lee, H.S., Bowman, C.J., Hemmer, M.J. and Folmar, L.C. Multiple Responses in Gene Expression in Fish Treated with Estrogen. Compar. Biochem. and Physiol. Part B 129: 277-282 (2001).
Bowman, C.J., Kroll, K.J., Gross, T.G., **Denslow, N.D**. Estradiol-induced gene expression in largemouth bass (Micropterus salmoides). Mol. Cell Endocrinol. 196:67-77 (2002).
Larkin, P., Folmar, L.C., Hemmer, M.J., Poston, A.J., Lee, H.S. and **Denslow, N.D**. Array technology as a tool to monitor exposure of fish to xenoestrogens. Marine Environ Res. 54: 395-399 (2002)**.**
Larkin, P., Sabo-Attwood, T., Kelso, J., and **Denslow, N.D.** Gene expression analysis of largemouth bass to estradiol, nonylphenol, and *p,p'*-DDE. Comparative Biochemistry and Physiology 133:543-557 (2002).
Larkin, P., Folmar, L.C., Hemmer, M.J., Poston, A.J., **Denslow, N.D**. Expression Profiling of Estrogenic Compounds using a Sheepshead Minnow cDNA Macroarray, EHP ToxicoGenomics, 111:29-36 (2003).

Ongoing Research Support

BES-9906060 Bitton (PI) 9/1/99-8/31/02
National Science Foundation
Assessment of the Toxicity and Endocrine Disruption Potential of Municipal, Construction and Demolition and Industrial Solid Wastes
Role: Co-PI

P42 ES07375 Denslow (PI) 4/1/00-3/31/05
NIEHS
Molecular Mechanisms of Endocrine Disruption in Largemouth Bass
Role: PI

USEPA #R-82945801-0 11/21/01-11/20/06
EPA/Subcontract from the University of Southern Mississippi
Molecular Indicators of Dissolved Oxygen Stress in Estuarine Crustacea
Role: Co-PI

NIEHS, (1 R43 ES11882-01) , SBIR grant/Subcontract from Aquagene, Inc, lead institution. 10/1/02-9/31/04
Arrays to Measure Endocrine Disruption in Fish
Role: PI of subcontract to the University of Florida

DOD 3/1/03-2/28/08
Biochemical Markers of Brain Injury: An Integrated Proteomics-Based Approach
Role: Co-PI

Completed Research Support

P42 ES07375 Gross (PI) 7/1/95-3/31/2000
NIEHS
Endocrine Disrupting Effects of Chlorinated Hydrocarbons on Wildlife

Role: Co-PI

CR 826357-01-0 Guillete (PI) 2/1/97 - 1/31/2001
EPA
Endocrine Disrupting Contaminants in Southern Florida Wetlands: Effects in Non-Mammalian Vertebrates
Role: Co-PI

Kevin J. Kroll

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(325)-846-0157

EDUCATION:

Master of Science, Animal Science- specializing in fish reproductive physiology & aquaculture
University of California- Davis, Degree 1990, 3.4 GPA
Bachelor of Science, Zoology major & Chemistry minor, University of Wisconsin- Milwaukee,
Degree 1984, 3.4 GPA

SUMMARY OF SKILLS AND EXPERIENCE

CHEMICAL/BIOCHEMICAL ANALYSIS

-Proficient in protein purification (chromatography) and characterization (PAGE)
-Immunological analysis: Antibody synthesis, ELISA development, Western Analysis
-Experience with in-vitro cultures of fish tissues

INSTRUMENTATION

-Expertise using the following equipment: BIOCAD SPRINT (protein purification), Mini-prep cell (purification), BIOMEK robotic (standard/sample dilution & loading), BIACORE (protein interaction, kinetics), GC (quantification), Fluorimetry (quantification), Flame Atomic Absorption

FISH CULTURE

-Over 15 years professional experience with fish culture including endangered species
-Induced spawning, larval rearing, broodstock development of fin fishes
-Diet formulation and proximate analysis
-Design, construction, and maintenance of intensive culture systems for fish & invertebrates
-Histological processing and gonal staging of fish

COMMUNICATION

-Proficient in the transfer of biochemical theory, purification techniques, and result interpretation
-Teaching assistant for the IDP intensive training course (1998, 1999)
-Presentation of research results at professional meetings

EMPLOYMENT HISTORY

Senior Chemist, ICBR Biomarkers/Protein Core,	UF-Gainesville	1998-present
Research Assistant,	UF-Gainesville	1994-1998
Staff Research Associate I (Toxicology)	UC-Davis	1993-1994
Post Graduate Researcher III (Fish Reproduction)	UC-Davis	1989-1993
Research Technician,	UW-Milwaukee	1982-1985
Fish Culturist,	Medical College of Wisconsin	1981-1983

REFERENCES

Dr. Nancy Denslow, Ph.D. (352)-392-9665
ICBR-Biotechnology Core, University of Florida- Gainesville

Dr. Serge Doroshov, Ph.D. (530)-752-7603
Department of Animal Science, University of California-Davis

PUBLICATIONS

Bailey H.C., DiGiorgio C., Kroll K., Miller J.L., Hinton D.E., and Starrett G. (1996). Development of procedures for identifying pesticide toxicity in ambient waters: carbofuran, diazinon, chlorpyrifos. Environ. Tox. Chem. 15(6): 837-845.

Bidwell C.A., Kroll K. J., Severud E., Doroshov S.I., and Carlson D.M. (1991). Identification and preliminary characterization of white sturgeon (Acipenser transmontanus) vitellogenin mRNA. Gen. Comp. Endo. 83:415-424.

Bowman C.J., Kroll K.J., Hemmer M.J., Folmar L.C., and Denslow N.D. (2000). Estrogen-induced vitellogenin mRNA and protein in sheepshead minnow (Cyprinodon variegates). Gen. Comp. Endo. 120: 300-313.

Denslow N.D., Chow M.C, Kroll K.J., and Green L. (1999). Vitellogenin as a biomarker of exposure or estrogen mimics. Ecotox. 8: 385-398.

Folmar LC , Denslow ND, Kroll KJ, Orlando EF, Enblom J, Marcino J, Metcalfe C, Guillette LJ Jr. (2001). Altered serum sex steroids and vitellogenin induction in walleye (Stizostedion vitreum) collected near a metropolitan sewage treatment plant. Arch. Environ. Contam. Toxicol. 40: 392-398.

Folmar, L C, MJ Hemmer, BL Hemmer, C Bowman, KJ Kroll and ND Denslow (2000). Comparitive Estrogenicity of estradiol, ethynl estradiol, and diethylstilbesterol in an in-vivo male sheepshead minnow (Cyprinodon variegates) vitellogenin bioassay. Aquatic Toxicology 49:77-88.

Hemmer, M.J., Hemmer B.L. ,Bowman C.J., Kroll K.J., Folmar L.C., Markovitch D., Hogland M.D.,and Denslow N.D. (2000). Effects of p-nonylphenol, methoxychlor,and endosulfan on vitellogenin induction and expression in sheepshead minnow (Cyprinodon variegates). Environ. Tox. Chem. 20(2): in press

Hemmer, MJ, Hemmer B.L., Bowman C.J., Kroll K.J., Freidman S., Markovitch D., and Denslow N.D. (2000). Plasma clearance of vitellogenin in male sheepshead minnow (Cyprinodon variegates) after cessation of exposure to 17β- estradiol and p-nonylphenol. In progess.

Kroll K.J., and Doroshov S.I. (1991). Vitellogenin: potential vehicle for selenium bioaccumulation in the oocytes of white sturgeon (Acipenser transmontanus). In: P. Williot (editor), Acipenser actes du premier colloque international sur l'esturgeon. Bordeaux, 3-6 Ocotobre, 1989. CEMAGREF, pp. 99-106.

Kroll K.J., Van Eenennaam J.P., and Doroshov S.I. (1991). Improvement of hatchery technology for the paddlefish, Polyodon spathula (Walbaum). Final Report #MCC-88-01-00, Missouri Department of Conservation, 159 pages.

Kroll K.J., Van Eenennaam J.P., Doroshov S.I., Hamilton J.E., and Russell T.R. (1992). Effect of water temperature and formulated diets on larval paddlefish. Trans. Amer. Fish. Soc. 121(4): 583-543.

Kroll K.J., Van Eenennaam J.P., Doroshov S.I., Linares J., Hamilton J.E., and Russell T.R. (1994). Growth and survival of paddlefish fry raised in the laboratory on natural and artificial diets. Prog. Fish. Cult. 56(3): 169-174.

Linares-Casenave J.L., Kroll K.J., Van Eenennaam J.P. and Doroshov S.I. 1994. Development and application of an enzyme-linked immunosorbent assay (ELISA) for the detection of plasma vitellogenin in white sturgeon, (Acipenser transmontanus). In: High Performance Fish, Proceedings of an International Fish Physiology Symposium (D.D. Mackinlay, ed.), Vancouver, Canada, 16-21 July, pp. 165-169.

Moberg G.P., Doroshov S.I., Chapman F.A., Kroll K.J., Van Eenennaam J.P., and Watson J.G. (1991). Effects of various hormone implants on vitellogenin synthesis and ovarian development in cultured white

sturgeon, Acipenser transmontanus.). In: P. Williot (editor), Acipenser actes du premier colloque international sur l'esturgeon. Bordeaux, 3-6 Ocotobre, 1989. CEMAGREF, pp. 389-399.

Moberg G.P., Watson J.G., Papkoff H., Kroll K.J., and Doroshov S.I. (1991). Development of radioimmunoassays for two sturgeon gonadotropins. Proceedings of the Fourth International Symposium on Reproductive Physiology of Fish. Norwich, U.K. 7-12 July 1991.

ANTHONY S. PAIT

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National Centers for Coastal Ocean Science
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104 Casmar St., SE
Vienna, Virginia 22180

EDUCATION

Doctor of Philosophy, Marine Environmental Estuarine Sciences (MEES) Program, University of Maryland, 2001. Dissertation Title: Reproductive endocrine disruption in the killifish *Fundulus heteroclitus* in the Chesapeake Bay. Advisor: Dr. Judd O. Nelson

Master of Science, Marine Environmental Estuarine Sciences (MEES) Program, University of Maryland, 1987. Thesis: Sorption and bioavailability of di(2-ethylhexyl) phthalate in an estuarine system. Advisor: Dr. Jay C. Means.

Bachelor of Science, Biological Sciences, St. Mary's College of Maryland, St. Mary's City, Maryland, May 1980

WORK EXPERIENCE

University of Maryland, July 2001 – present
Adjunct Professor

NOAA, April 2002 – present
Project Manager – Presence of pharmaceutical compounds in the aquatic environment. Develop analytical protocols to determine compounds discharged from wastewater treatment plants (human use, variety of compound types), and in nonpoint source runoff from agricultural areas (animal use, mainly antibiotics). Goal of project is to determine the types and concentrations of compounds that may be found in these areas, and then assess impacts that may occur in resident biota.

NOAA, June 1998 – April 2002
Project Manager - Endocrine disruption in fish. Activity had both an assessment and laboratory/field component. Assessment component involved assembling and reviewing information on compounds implicated in endocrine disruption, along with evidence on the types and degree of impacts in fresh and saltwater species of fish in the U.S. and Europe. Laboratory/field component involved work in the Chesapeake Bay to determine if reproductive endocrine disruption was apparent in the killifish *Fundulus heteroclitus*, and if so, was it related to particular land use types in the watershed. A second related effort involved overseeing work of the University of Florida to investigate endocrine disruption in three species of fish in the St. Lucie Estuary.

NOAA, February 1997 - March 1998
Served as advisor on NOAA/State of Delaware project to develop a special area management plan for the Pea Patch Island Sanctuary in Delaware. Concerns had arisen regarding the impacts of currently used pesticides on juvenile birds in the sanctuary.

NOAA, September 1992 – June 1998

Co-leader of project with EPA's Gulf of Mexico Program and various state and local agencies to develop plans for restoring impacted shellfish (oyster) growing areas in the Gulf of Mexico. As part of an interagency working group, held workshops around the region and got buy-in from stakeholders to develop and implement strategies to reduce human health related impacts resulting from nonpoint source runoff into shellfish growing areas. Demonstration project resulted in several areas in the Barataria-Terrebonne estuarine system in southern Louisiana diverting runoff from productive shellfish areas to wetlands for natural purification.

NOAA, May 1987 – September 1992

Project Manager – Agricultural use of pesticides and aquatic impacts in coastal areas of the Nation. The analysis was conducted on 35 commonly applied agricultural pesticides in 102 coastal watersheds in the contiguous United States. A hazard rating system was developed and employed to target those estuarine systems that may be at risk due to the use of the more aquatically hazardous pesticides. In addition, assessments were made of the seasonality of pesticide application selected upstream areas. Finally, a small survey of documented aquatic impacts (e.g., fish kills, residues in biota, and impacts on estuarine communities) was conducted to assess the types and degree of impacts the inventoried pesticides are having in the Nation's coastal aquatic environment.

Master's Thesis Research, May 1985 - June 1987.

Investigated the sorption and bioavailability of an industrial plasticizer, di(2-ethylhexyl) phthalate (DEHP) under estuarine conditions. Sorption experiments were set up to determine Freundlich partition coefficients (Kd) with sediments of varying organic carbon contents, to investigate the effect of salinity using a modified Setschenow equation, and to assess the degradation of DEHP under a variety of conditions. Bioavailability experiments used the estuarine clam *Macoma balthica* to follow the uptake, depuration, and degradation of DEHP in relation to dissolved and adsorbed concentrations.

Laboratory Technician, University of Maryland, June 1980 - May 1985

Investigated the sorption kinetics of two herbicides, atrazine and linuron, on a variety of sediments, and analyzed field and microcosm samples for the presence of pesticides and their degradation products as part of the Chesapeake Bay Program. In addition to the sorption work, participated in monitoring Chesapeake Bay sediment and biota for organic and heavy metal contaminants. At a hazardous waste site in Baltimore, Maryland, conducted a groundwater monitoring program to assess contamination of water samples for heavy metal and organic contaminants. Operated a variety of analytical instruments including HPLC, GC, GC/mass spectrometers, and atomic absorption spectrometers.

PUBLICATIONS AND REPORTS

Pait, A. S. and J.O. Nelson 2003. Vitellogenesis in male *Fundulus heteroclitus* (killifish) induced by selected estrogenic compounds. (submitted for publication)

Pait, A. S. and J.O. Nelson 2003. A survey of reproductive endocrine disruption in the killifish *Fundulus heteroclitus* in the Chesapeake Bay. (submitted for publication)

Pait, A.S., and J.O. Nelson. Endocrine disruption in fish: an assessment of recent research and results. 2002. NOAA Technical Memorandum NOS NCCOS CCMA 149. 55pp (Abridged version to be submitted to Reviews of Environmental Contamination and Toxicology)

Pait, A.S., D.R.G. Farrow, and B. Ache. 1997. Rerouting stormwater runoff from Larose to Golden Meadow to suitable wetlands. 1997. NOAA's Strategic Environmental Assessments Division. Silver Spring, MD., 28pp.

Pait, A.S., D.R.G. Farrow, and F. Kopfler. 1996. Shellfish challenge plan, part 1: results of strategic assessment. NOAA, Strategic Environmental Assessments Division and EPA's Gulf of Mexico Program. Silver Spring, MD 68pp.

Pait, A.S., P.A. Pacheco, S.J. Arenstam, A.E. DeSouza, D.R.G. Farrow, and J. Higgins. 1994. Gulf of Maine point source inventory. NOAA, Strategic Environmental Assessments Division, Silver Spring, MD 158pp.

Johnson, E., J. S. Plimmer, and A. S. Pait. 1994. The occurrence and distribution of pesticides in Chesapeake Bay. pp105-145. In Steven Nelson and Paul Elliott (editors) Perspectives on Chesapeake Bay, 1994: Advances in Estuarine Sciences. Chesapeake Bay Consortium Publication No. 147, Edgewater, MD.

Clark, J.R., M.A. Lewis, and A.S. Pait. 1993. Pesticide inputs and risks in coastal wetlands. Environmental Toxicology and Chemistry. Volume 12(12), pp 2225-2233.

Pait, A.S., P.A. Pacheco, S.J. Arenstam, A.E. DeSouza, D.R.G. Farrow, J.J. Hayes, M.J. Katz, J. Lowe, and M. Swain. 1993. Point source methods document. NOAA, Strategic Environmental Assessments Division, Silver Spring, MD 270pp.

Lowe, J.A., D. R.G. Farrow, A. S. Pait, S. J. Arenstam, and E. F. Lavin. Fish kills in coastal waters, 1980-1989. 1991. NOAA, Strategic Environmental Assessments Division, Silver Spring, MD. 69pp.

Pait, A. S., A. Desouza, and D.R.G. Farrow. 1992. Agricultural pesticide use in coastal areas: a national summary. NOAA, Strategic Environmental Assessments Division, Rockville, MD. 112 pages.

Pait, A. S., D.R.G. Farrow, J. A. Lowe, and P.A. Pacheco. 1989. Agricultural pesticide use in estuarine drainage areas. NOAA, Strategic Environmental Assessments Division, Rockville, MD. 125 pages.

Wright, D.A., I.P. Zanders, and A. Pait. 1984. Ionic regulation in three species of *Uca*: A comparative study. Journal of Comparative Biochemistry and Physiology. 78A (1) 175 - 177.

Means, J. C., T.W. Jones, A.S. Pait, and R.D. Wijayaratne. 1981. Adsorption of atrazine on Chesapeake Bay sediments and selected soils. pp 285 - 296. In W.M. Kemp et al. (editors) Submerged vegetation in Chesapeake Bay: its ecological role in bay ecosystems and factors leading to its decline. Ref no. UMCEES 81-28 HPEL. USEPA, Chesapeake Bay Program, Annapolis, MD.

AWARDS

NOAA Outstanding Performance Award, 1997
NOAA Outstanding Performance Award, 1996
NOAA Outstanding Performance Award, 1995
NOAA Outstanding Performance Award, 1994
NOAA Superior Performance Award, 1993
NOAA Superior Performance Award, 1992
NOAA Superior Performance Award, 1990
NOAA Superior Performance Award, 1989
National Sea Grant Assistantship 1984

PROFESSIONAL ACTIVITIES

American Chemical Society

VITAE

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EDUCATION

B.A. 1978. University of Delaware, Newark, DE
Major: Biological Sciences; Degree with Distinction

M.A. 1981. College of William and Mary, Virginia Institute of Marine Science,
Gloucester Point, VA Major: Marine Science; Emphasis: Fish Biology

RELEVANT EXPERIENCE

Research Associate. July 1999 - present. Department of Coastal Sciences, University of Southern Mississippi, Ocean Springs, MS. Duties: histological preparation, examination and analysis of tissue specimens with emphasis on reproductive biology; fecundity analysis; tissue culture; DNA isolation, PCR and cloning procedures; analysis and presentation of data; writing and presentation of scientific manuscripts;
Senior Laboratory Technician. February 1995 - June 1999. Department of Coastal Sciences, University of Southern Mississippi, Ocean Springs, MS.
Research Assistant I. January 1992 - January 1995. Department of Biochemistry and Molecular Biology, Mississippi State University, Mississippi State, MS.
Research Assistant II. January 1990 - December 1991. Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS.
Environmental Specialist II. September 1987-September 1989. Florida Department of Environmental Protection, Port St. Lucie, FL.
Research Assistant. June 1987-August 1987. Department of Biological Sciences, University of Southern Mississippi, Hattiesburg, MS.
Laboratory Technician. July 1986-June 1987. Innovative Technology Inc., Hattiesburg, MS
Scientific Research Assistant. February 1982-June 1986. The University of Texas at Austin, Marine Science Institute, Port Aransas, TX.

PROFESSIONAL ACTIVITIES

Taught short course, "Biología Reproductiva en Peces Marinos", at Universidad Nacional Autónoma de Mexico, Iztacala campus, Tlalnepantla, Mexico, October-November 2002.
Student paper judge at national/international scientific meetings, 1997 - present.
Translation of scientific articles from Spanish to English for collegues, 1994 - present.
Reviewed 29 manuscripts/proposals for 12 journals/2 agencies, 1986 - present.
Presented 36 papers at national and international scientific meetings, 1981 - present.
Co-editor of special issue of *Gulf and Caribbean Research*, 2003-2004.

GRANTS

Florida Inland Navigation District, October 1988-September 1990. $171,849 for "Management of the Indian River Lagoon and Associated Spoil Islands". (with L. Poolt, P. Mikkelsen and K. Cairns)

Florida Fish and Wildlife Conservation Commission, December 1998-December 1999. $12,000 for "Histopathological Analysis of Queen Conch Gonadal Tissues from the Florida Keys" (with W.E. Hawkins).

National Council for Air and Stream Improvement, September 2001-June 2004. $11,540 for "Histological Analysis of Gonadal Tissue from Fathead Minnows".

National Marine Fisheries Service, MARFIN, November 2002-October 2005. $825,613 for "Geographic Comparison of Age, Growth, Reproduction, Movement and Survival of Red Snapper off the State of Florida" (with K. Burns and R. Overstreet).

Environmental Defense, January - December 2003. $3,000 for "Jump-starting the Environmental Careers of Minority Students from the Southern Gulf of Mexico" (with M.S. Peterson).

Harte Research Institute, January - December 2003. $2,000 for "English Language Publication of Student Research from the Southern Gulf of Mexico" (with M.S. Peterson).

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Appendix 5 – Gonadal Condition Scale for Queen Conch

Gonadal Condition	Score	Definition
early development	1	primary and cortical alveolar oocytes in females; spermatogonia and spermatocytes in males
mid development	2	vitellogenesis beginning in females; spermatozoa present in males
late development	3	fully developed oocytes in females, none in oviduct; all stages of spermatogenesis, no spermatozoa in vas deferens
ripe	4	oocytes in oviduct for females; spermatozoa in vas deferens for males
spent	5	reabsorption of vitellogenic oocytes in females; empty lobules, residual spermatozoa in males
atresia	6	reabsorption of oocytes and no vitellogenesis in females; reabsorption of spermatozoa in males
regressed	7	only primary oocytes in females; only primary spermatogonia in males
no tissue	8	no gonadal tissue development and no germ cells present; this is an abnormal condition in adult females and males

NOAA NATIONAL OCEAN SERVCE
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Comparative analysis of the functioning of disturbed and undisturbed coral reef and adjacent ecosystems in the Tortugas Ecological Reserve:

Phase II – Measuring the effect of establishing a reserve

November 23, 2004

Cruise and Progress Report for
NOAA Ship NANCY FOSTER cruise NF-04-16-FK
September 21, 2004 – September 30, 2004

Submitted By:

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Mark S. Fonseca
Project Coordinator, CCFHR

Approved By:

_____
David Johnson
Director, CCFHR

_____
Gary C. Matlock
Director, NCCOS

INTRODUCTION

As part of an ongoing comparative examination of the physical and biological resources within and beyond the Tortugas Ecological Reserve (TER), NOAA Ship NANCY FOSTER arrived in Key West, FL on 21 Sept 2004 to support research objectives of the CCFHR and collaborators (CCMA, CSC, FMRI, NURC, USF) in TER. This comparative study began in 2000, one year before the marine Ecological Reserve was designated in the Dry Tortugas, and will continue through 2005. This year marks the third year and completion of the post-implementation data collection for our experimental design (see below). The 2005 season will be a reduced survey season with another complete survey planned for 2006. This was the tenth cruise in support of this mission and it included a total of eighteen scientists representing three federal and state institutions and a private organization participated. Although no definitive conclusions can be made at this stage regarding the effectiveness of the Reserve, some interesting patterns have begun to emerge.

Preliminary stable isotope data, in conjunction with prior results from the west Florida shelf, suggest that the shallow water benthic habitats surrounding the coral reefs of TER will prove to be a significant source of the primary production ultimately fueling fish production throughout TER and downstream throughout the range of larval fish dispersal. The majority of the fish analyzed so far have exhibited a C isotope signature consistent with a food web which incorporates a significant amount of benthic primary production. Shrimp (Penaeidae),grunts *(Haemulon* sp.) and gray snapper (Lutjanidae) were among the groups which exhibited the most enriched C values, consistent with a food web based exclusively on benthic production. There are a number of benthic primary producers in the TER ecosystem, including benthic microalgae (diatoms), benthic macroalgae (e.g. *Udotea, Caulerpa, Halimeda, Dictyota*), seagrasses (*Halodule, Thalassia*) and corals (*Porites, Montastrea, Siderastea*). All of these benthic primary producers have a C isotope signature that is distinct from that of phytoplankton, but there is considerable overlap in the isotope values of the benthic primary producers themselves, making it difficult to identify which particular groups are contributing to a particular food web. In addition to C isotope values, we also have N and S isotope data, and will employ all 3 isotopes to solve isotope mixing models. These models will help to identify the benthic primary producers most likely to be contributing to a paritcular organisms food web.

Benthic chlorophyll analysis of surface sediments provides an estimate of the benthic production and microalgal food resources available. Our results demonstrate that there is significant microalgal biomass at depths between 10 and 30m in the soft sediments at the coral reef interface, and this community may play an important role in the food web supporting reef organisms. Additional results will help us to determine whether there is a significant geographic or reserve effect on the food webs utilized by these reef fish and ultimately the importance of non-reef habitat within the refuge (comprising ~70% of TER) as it is tied to the health of the coral reef community proper.

Differences in fish populations observed from 2001 to 2003 may provide an early indication of the impact of the TER on populations of exploited species. Our counts indicate a significant increase in the abundance of large fish (>20cm) in the reserve relative to the unprotected and park strata. These increasing trends within the TER are surprisingly evident

among a variety of prominent species directly exploited by fisheries, including white grunt, yellowtail snapper, hog fish and red grouper.

As of this year, 2004, preliminary observations suggest that scamp grouper appear to have had a very strong recruitment. However, the need to develop a longer-term data base is required to make more effective comparisons among Use strata. Analysis of census data is ongoing at CCFHR.

Our faunal collections from open and protected soft bottom habitat near the northern boundary of Tortugas North strongly suggest that relaxation of trawling pressure has increased benthic biomass and diversity in this area of TER. The Reserve may act as a refuge for the large pink shrimp targeted by the fishery and their density as well as biomass and diversity of smaller crustaceans was obviously higher in paired protected vs. open bottom samples. It appears that these soft bottom communities respond quickly to the relaxation of trawling disturbances and we hypothesize that further changes will occur over time with increased stabilization from the development of a more established assemblage of attached invertebrates. Although no trawl sampling was conducted this year, data analysis as well as sample processing continues at CCFHR.

As part of the CCFHR effort in the TER, two state-of-the-art satellite images, IKONOS and QuickBird, have been obtained for the area around Fort Jefferson and Loggerhead Key to evaluate the ability of these image sources to detect submerged habitats. These images have been rectified by the commercial entities using Global Positioning System data and other data collected from the satellite at the time of image acquisition and spatial accuracy improved using existing map or image sources. Due to cost constraints, both the IKONOS and QuickBird images for this project were purchased with the least expensive level of rectification, guaranteeing no better than +/- 10m.

To help assess the spatial accuracy of these images, the Simrad EM3000 multibeam system was used to collect two swaths of data in the southern portion of the IKONOS and QuickBird image footprint. The swaths crossed an area 13 to 18 m deep that contained numerous patch reefs from 10 to more than 100m across. These patches present a dark signature that contrasts sharply against the sand background, making them clearly visible in both image sources. The Simrad data, with a horizontal spatial accuracy averaging less than 3m, will be compared to both image sources, to give us for the first time a qualitative idea of the spatial accuracy of these image sources for deep water areas.

These data, collected in a biogeographic context, employing an integrated Before - After Control Impact (BACI) design at multiple spatial scales, leave us certain to document and quantify the post-implementation effects of TER. Combined with the work at Tortugas South, this project represents a multi-disciplinary effort of previously disparate disciplines (fishery oceanography, benthic ecology, food web analysis, remote sensing/geography/landscape ecology, and resource management) and approaches (physical, biological, ecological). We expect the continuation of this effort will yield critical new information for the management of TER and the evaluation of protected areas as a refuge for exploited species.

OBJECTIVES

Programmatic: Over the five year period of this stage work, we have proposed:

1) a preliminary characterization and inventory of the benthic habitat and fish communities in the extreme depths of the Tortugas South reserve component;
2) characterization of spawning aggregations and initiating the development of a probabilistic model of the fate of snapper larvae, focusing on Riley's Hump;
3) comparative characterization of shallow and deepwater seagrass and associated communities and their contribution to fishery resources in disturbed (outside the reserve) and undisturbed sites (inside the Reserve);
4) evaluation of gear impact elimination in the historic Tortugas pink shrimp grounds (northern boundary of the TER) on ecosystem recovery;
5) determination of the accuracy of existing habitat delineations within the proposed ecological reserve as a function of depth and disturbed and undisturbed sites;
6) examination of how high resolution ecological data of a given habitat type can be scaled to the larger spatial context of the proposed ecological reserve;
7) determine the effect of location on coral settlement within Dry Tortugas National Park

(DTNP).

Cruise NF-04-16-FK: Here, our objectives were to:

Primary:

A) Return to the 30 permanent stations (Figure 1) to conduct extensive diver-based surveys, including visual and video fish censuses, habitat transect videos, faunal and flora collections for stable isotope analysis, and sediment extractions.
B) Conduct multibeam sonar transects* at seven discrete survey paths that encompass various clusters of the 30 permanent stations (Figure 2).
C) Conduct crepuscular surveys of fish movement and distribution at various locations using a Simrad EQ33 Echosounder.
D) Conduct light profiles and collect water column samples for chlorophyll analysis at selected stations.
E) Continue coordinated drop camera work and nighttime beam trawling at the northern boundary of Tortugas North in search of evidence for trawling impacts.
F) Conduct exploratory surveys – divers, side-scan, drop camera.
G) Population genetic evaluation of the Tortugas Ecological Reserve as a source of larval recruits for the Florida Keys and mainland Florida populations of commercially important species.

Secondary:

G) Conduct ground truthing for aerial photography using drop cameras around Dry Tortugas National Park (DTNP). May necessitate the use of limited SCUBA diving.

Cruise Components

Vessels:	NOAA Ship Nancy Foster M/V Alexis M (42')	
Duration of cruise:	21 September 2004 30 September 2004	Departed Key West, FL Arrived Key West, FL

Scientific Personnel / Participants:

Mark Fonseca	Chief Scientist, Ecologist	NOS, Beaufort, NC
Don Field	FPC*, Fisheries Biologist	NOS, Beaufort, NC
Christine Addison	FPC, Biological Technician	NOS, Beaufort, NC
Craig Bonn	Chief Diver, Biological Technician	NOS, Beaufort, NC
John Burke	Fisheries Biologist	NOS, Beaufort, NC
Amit Malhotra	GIS Analysts	NOS, Beaufort, NC
Brian Degan	Biological Technician	NOS, Beaufort, NC
Roldan Munoz	Fisheries Biologist	NOS, Beaufort, NC
Paula Whitfield	Ecologist	NOS, Beaufort, NC
Ruth Kelty	Physical Scientist	NOS, Silver Springs, MD
Shay Viehman	Fisheries Biologist	NOS, Beaufort, NC
Abigail Poray	Biological Technician	NOS, Beaufort, NC
John Hackney	Biological Technician	NOS, Beaufort, NC
Brad Teer	Biological Technician	NOS, Beaufort, NC
Jitka Hyniova	Biological Technician	FMRI, St. Petersburg , FL
Manuel Merello	Biological Technician	FMRI, St. Petersburg , FL
Chris Freeman	Sr. Marine Geologist	Geodynamics, Pine Knoll
Dave Bernstein	Surveying / GIS Mapping Specialist	Shores, NC

*FPC = Field Party Chief

Station Location and General Sampling Approach Overview

Approximately two weeks before sampling, the path of hurricane Charley had fallen directly over the Dry Tortugas. The effect of such a disturbance may have a profound effect on the variability in our result between sample years and will be taken into consideration during analysis.

This year's sampling targeted the same 30 permanent stations adopted in the previous years for the Tortugas Ecological Reserve (TER) North, beginning with the February 2001 cruise aboard the NOAA Ship OREGON II (OT-01-01). Six strata which defined the management level used and relation to the prevailing current had been established: **Out North** (outside the reserve/park, north of the prevailing current) **Out South** (outside the reserve/park, south of the prevailing current), **Park North** (inside the park, north of the prevailing current), **Park South** (within the park, south of the prevailing current), **Reserve North** (within the reserve, north of the prevailing current), and **Reserve South** (within the reserve, south of the prevailing current; Figure 1). Five random sample points were selected at the apparent sand-coral interface from within each of the six categories that make up the list of 30 permanent stations as given in Appendix I (see also Fig. 1). A complete log of all sampling operations, dates and locations can be found in Appendix II.

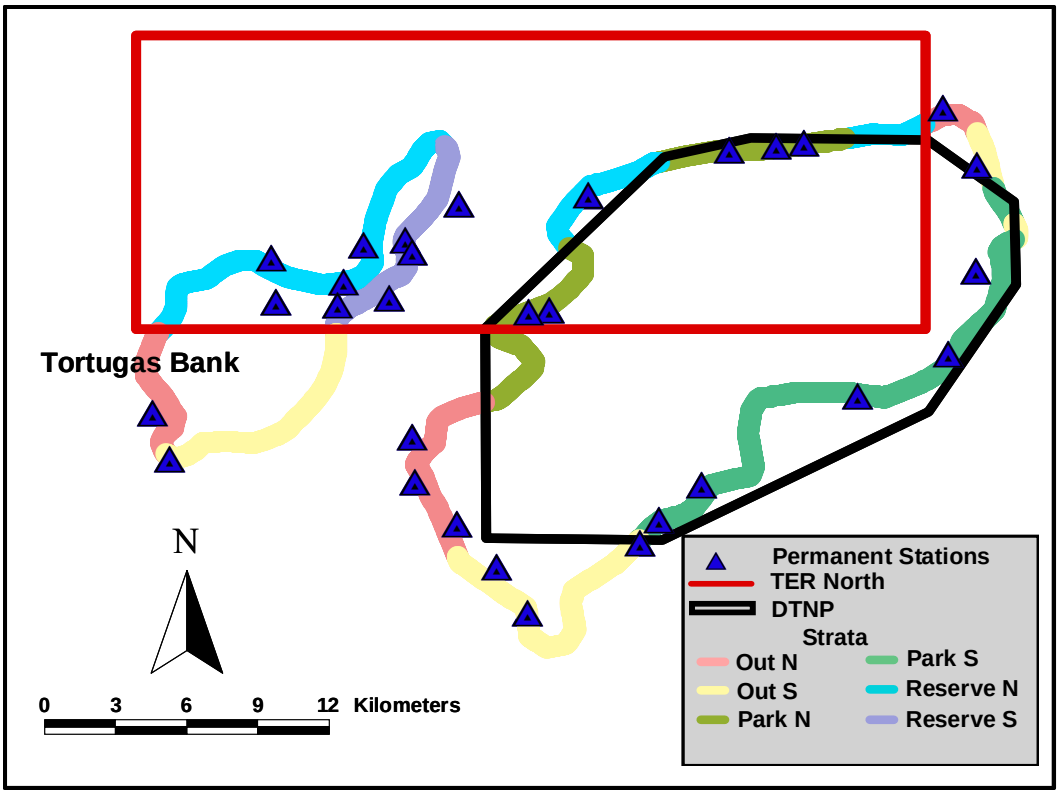

Figure 1. Location of interface strata and 30 permanent stations.

Coarse Scale Habitat Mapping

All 30 stations had been previously mapped during 2001 cruises (OT-01-01, FE-01-07-BL, FE-01-10-BL, and FE-01-11-BL) using the MiniBAT® TOV equipped with a downward facing camera, and QTC VIEW seafloor classification system simultaneously run with a ROXANN® sonar system. In April and June 2002 (FE-02-10-BL and FE-02-14-BL), we began mapping the stations using the Sport Scan® sidescan sonar unit. Based on diver observation of seagrass recruitment at the interface, in 2003 (NF-03-04-FK 013), a portion of the permanent stations where targeted with the Sport Scan® sonar unit for in-depth sidescans. This year CCFHR contracted a team to conduct multibeam sonar surveys in order to obtain high-resolution hydrographic surveys of the 30 permanent stations.

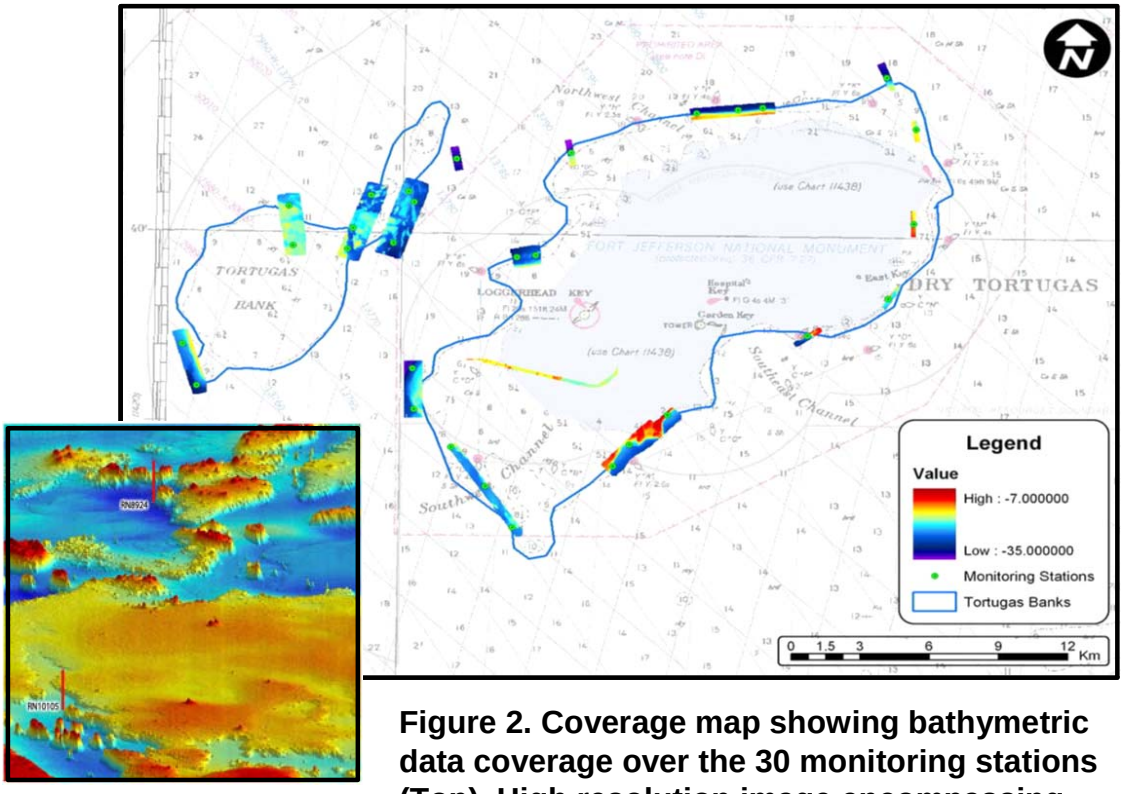

Figure 2. Coverage map showing bathymetric data coverage over the 30 monitoring stations (Top). High resolution image encompassing sites RN10105 and RN8924 (Left side).

Multibeam Sonar Mapping:

The Geodynamics Group employed a Simrad EM3000 shallow water multibeam sonar system to collect spactially dense bathymetric data and snippet data for each of the 30 biological monitoring stations. The EM3000 Multibeam transducer was secured using a

mounting pole off the ships starboard side approximately 4m below the waters surface (Fig. 3). The sonar system produced a swath of sonar approximately 3.5 to 4 times the water depth and collected approximately 400 soundings per square meter. Multibeam Survey totaled approximately 500 line kilometers of multibeam data that comprised approximately 72.5 km2 of area within the 30 biological stations.

Figure 3. EM3000 Multibeam transducer secured using a mounting pole.

Geodynamics has provided a final report containing the edited survey data with GIS compatible file depicting multibeam imagery and high-resolution 3D images of particular areas of interest (Fig. 2).

Fine scale Mapping

Diver video:

Divers were deployed at each station to conduct habitat video transects. When previously installed permanent markers were not located at the specified drop point, divers searched the area for approximately five minutes. If the search revealed no marker, a temporary marker (rebar stake) was installed and removed at the end of dive activities.

A transect line was deployed beginning from the permanent/temporary marker at the interface and running 30 m out in either direction, perpendicular to the interface (sand plain vs. reef). One diver video recorded the substrate following along the length of each transect using a SONY 900 digital video camera contained in an underwater housing and lighting unit (fig. 4). The camera unit was equipped with a measuring device that the diver used to determine and maintain distance off the bottom and allowed the video image to span a fixed 0.4 m^2 area. A SENSUS PRO recorder was affixed to the camera housing, and a continuous depth profile for the duration of the video transect was collected. Data from the SENSUS PRO were downloaded after each dive and will be used to calculate a measure of reef rugosity. Habitat cover along each transect will be determined using Point

Figure 4. Diver conducting Habitat video.

Count for Coral Reefs software. Video analysis is currently underway at CCFHR.

Sediment Characterization

Divers collected three replicate sediment cores (3 cm diameter) at three intervals (0 m, 15 m, and 30 m) along the 30 m sand transect at each permanent station. Sediment analysis is ongoing at CCFHR.

Gear Impact

Drop Camera:

In 2002, as part of a comparative analysis of the effects that the exclusion of shrimp trawling has had in the TER, ten pairs of randomly selected coordinates along the northern boundary of Tortugas North were chosen for beam trawl sampling. In conjunction with the beam trawls, drop camera drifts were made in an effort to capture a video record of trawl disturbance.

As a resultof time constrains due to hurricane Ivan and sampling priority given to the Multibean Sonar Mapping, which was run both into the evening and over night, Beam Trawl sampling was not conducted this year. However, six, fifteen minute drop camera drifts were made using randomly selected coordinate pairs from the previous beam trawl stations in an attempt to capture possible *Halophila* recruitment. The path of each drift was recorded using Trimble® ASPEN Field software. Video processing is currently underway at CCFHR.

Fish Surveys

Visual Census:

Paired band transect visual census were made by divers over the reef and soft bottom habitat along the 30 m transects as described above. Band transects were 6 m in width. Analysis of the fish census data is ongoing at CCFHR.

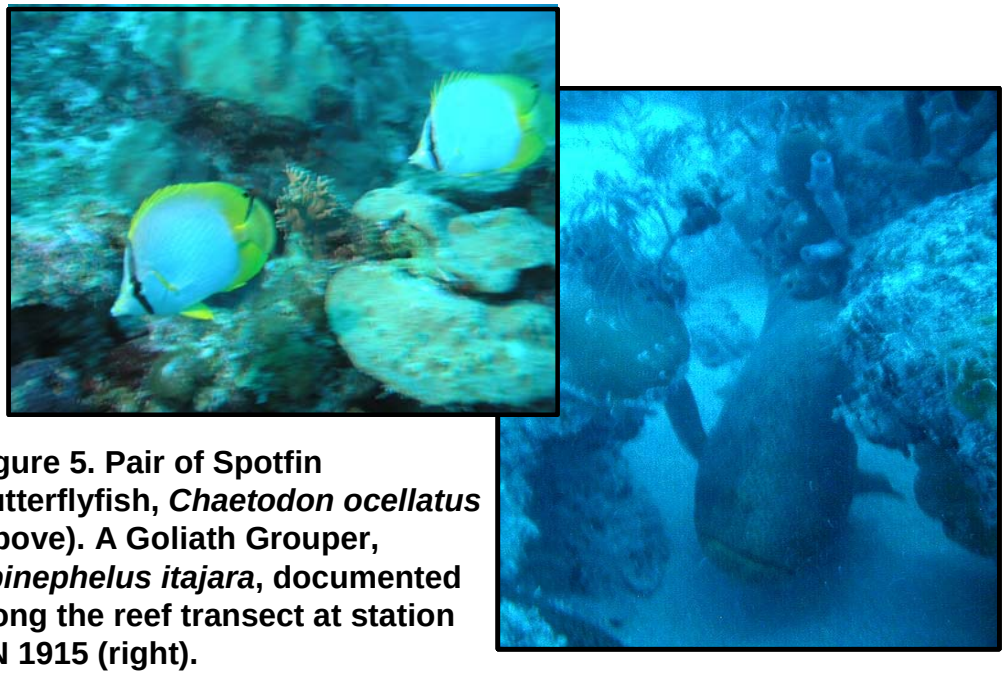

Figure 5. Pair of Spotfin Butterflyfish, *Chaetodon ocellatus* (above). A Goliath Grouper, *Epinephelus itajara*, documented along the reef transect at station RN 1915 (right).

Simrad EQ60 Echo sounder:

Simrad EQ60 Echo sounder surveys, estimating the movement of fish biomas across the TER reef habitat, where collected continuously through out the cruise (Fig. 6). The transducer was deployed through the ships "moon pool" located on the fantail. Initial data analyses will focus on surveys run simultaneously with the multibeam transects through all 30 stations, with special attention toward selected sites for day-night comparisons.

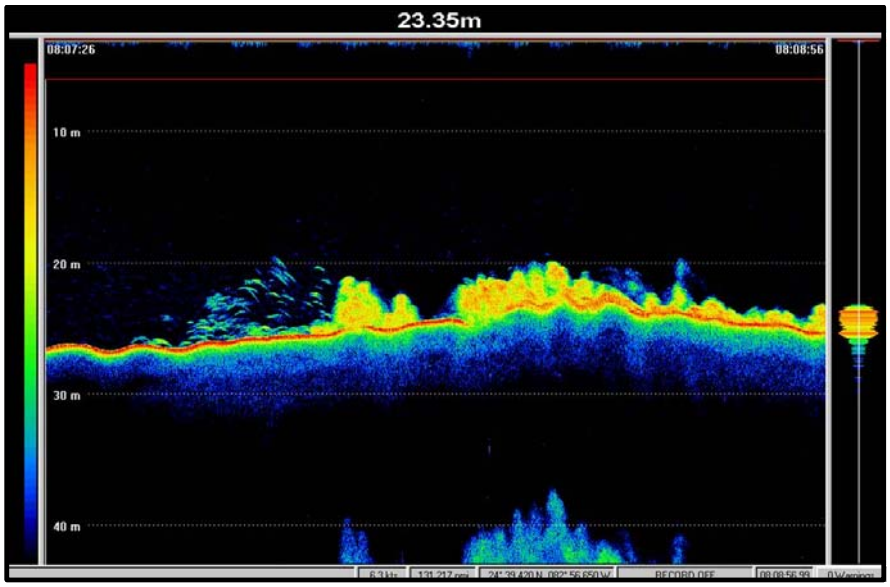

Figure 6. A snapshot taken from a Simrad EQ60 Echo sounder transect line, collected at 4:08 am near station PN 3120. Depicts a large aggregate of fish, "echos" just off the reef. The red line indicating the ocean floor and the bright colored "blimps" rising off the bottom indicating reef.

Light Profiles

Water column light profiles and water column clarity measurements were performed at randomly selected stations (cloud cover permitting). During the cruise, two light profiles were collected using a LI-COR® 4 pi sensor and data logger. The sensor was lowered over the side of the ship at 1 m intervals from the surface down to 15 m. Three replicate profiles were made for each station. In addition, incident radiation was continuously recorded at 1 sec intervals using a LI-COR® 2 pi sensor mounted on an elevated surface on the deck. The data logger was downloaded each night.

Stable Isotopes

Isotope samples from within the permanent stations were collected for use in an analysis of the food web supporting fish production in TER. Samples were collected to a much lesser degree than previous years and focused only on secondary consumers included in a list of target fish species. Several methods of collection were employed including hook and line from the Foster and the Alexis M, and divers armed with sling spears. This sampling and the data obtained will be used to compliment the ongoing examination of stable isotope composition and trophic relationships in the reef-interface zone at CCFHR.

Population Genetics

This year, samples were also collected to examine the genetic structure and connectivity of the fish populations in the Tortugas ecological reserve. The location of six study sites were based on distance, oceanic currents and knowledge gained from local fisherman: one within in the TER, a site in Marquesas Keys (potential nursing grounds), in Florida Keys proper, two in mainland Florida (East/West coasts), and one site in the Caribbean. The location of the study sites with increasing distance from TER will enable an examination of population structure with distance.

Collection consisted of fin clips from approximately 30 haemulid fish (Blue striped, Haemulon sciurus, or white grunt, H. plumieri) from two of the six study sites (see also sample log, appendix IIb). Several methods of collection were employed including hook and line from the Foster and the Alexis M, and divers armed with sling spears. In the lab, amplified fragment length polymorphism (AFLP) genetic markers will be use to determine if the TER serves as a source of larval recruits to downstream populations in the FKNMS and mainland Florida.

APPENDIX I a. Thirty permanent stations. Coordinate display in decimal degrees

Strata	Station	Latitude	Longitude	Interface Depth (ft)	Sand Depth (ft)	Reef Depth (ft)
ON	94	24.7377996	-82.7934824	97	98	92
ON	5527	24.6071167	-82.9948167	100	98	92
ON	5842	24.5891	-82.9939667	85	84	75
ON	6772	24.5726333	-82.97785	72	71	62
ON	11460	24.6167	-83.0933167	79	78	76
OS	1864	24.7150078	-82.780515	61	59	56
OS	6731	24.5648662	-82.9083841	80	81	75
OS	7265	24.5555	-82.9628	79	80	76
OS	7675	24.5374167	-82.9510667	79	78	74
OS	12379	24.5984167	-83.0870833	103	99	89
PN	632	24.723884	-82.8464297	96	94	89
PN	690	24.722818	-82.8569842	97	97	88
PN	1136	24.7211957	-82.8746495	99	100	81
PN	3120	24.6577285	-82.942727	87	82	77
PN	3275	24.6567635	-82.9508205	96	94	84
PS	2780	24.6733613	-82.7809035	54	54	38
PS	3926	24.6402299	-82.7915488	68	68	58
PS	4671	24.623451	-82.8258409	79	74	62
PS	6108	24.5878541	-82.8853109	72	73	56
PS	6493	24.5744955	-82.9014143	78	77	58
RN	1915	24.70315	-82.92815	100	99	85
RN	8924	24.6834333	-83.0135833	92	90	60
RN	9498	24.6782667	-83.0487001	75	78	64
RN	9807	24.6609	-83.0467	57	59	49
RN	10105	24.6687681	-83.0211125	83	80	64
RS	8233	24.6998492	-82.9771463	104	102	89
RS	9042	24.6851833	-82.9974667	82	78	73
RS	9162	24.6806333	-82.9951	82	84	75
RS	10262	24.6623	-83.0036667	91	89	78
RS	10529	24.6595854	-83.0233013	85	84	50

APPENDIX I b. Thirty Permanent stations. Coordinate display in decimal minutes.

Strata	Station	Latitude	Longitude	Interface Depth (ft)	Sand Depth (ft)	Reef Depth (ft)
ON	94	24 44.267976	-82 47.608944	97	98	92
ON	5527	24 36.427002	-82 59.689002	100	98	92
ON	5842	24 35.346006	-82 59.638002	85	84	75
ON	6772	24 34.357998	-82 58.671006	72	71	62
ON	11460	24 37.002006	-83 05.599002	79	78	76
OS	1864	24 42.900468	-82 46.830906	61	59	56
OS	6731	24 33.891972	-82 54.503046	80	81	75
OS	7265	24 33.330006	-82 57.768006	79	80	76
OS	7675	24 32.245002	-82 57.064002	79	78	74
OS	12379	24 35.905002	-83 05.224998	103	99	89
PN	632	24 43.433046	-82 50.785782	96	94	89
PN	690	24 43.369086	-82 51.419052	97	97	88
PN	1136	24 43.271742	-82 52.47897	99	100	81
PN	3120	24 39.46371	-82 56.563626	87	82	77
PN	3275	24 39.40581	-82 57.04923	96	94	84
PS	2780	24 40.401678	-82 46.85421	54	54	38
PS	3926	24 38.413794	-82 47.492928	68	68	58
PS	4671	24 37.407066	-82 49.550454	79	74	62
PS	6108	24 35.271246	-82 53.118654	72	73	56
PS	6493	24 34.46973	-82 54.084858	78	77	58
RN	1915	24 42.189006	-82 55.689006	100	99	85
RN	8924	24 41.005998	-83 00.814998	92	90	60
RN	9498	24 40.696002	-83 02.922006	75	78	64
RN	9807	24 39.654006	-83 02.802006	57	59	49
RN	10105	24 40.126086	-83 01.26675	83	80	64
RS	8233	24 41.990952	-82 58.628778	104	102	89
RS	9042	24 41.110998	-82 59.848002	82	78	73
RS	9162	24 40.837998	-82 59.706006	82	84	75
RS	10262	24 39.738006	-83 00.220002	91	89	78
RS	10529	24 39.575124	-83 01.398078	85	84	50

APPENDIX II a. Sample Log Codes

ASP	ASPEN file
BEAM	beam trawl
CHL_BEN	benthic chl
BONG	bongo tow
BB	Braun Blanquet
RECRUIT	coral recruitment plate
RUG	coral rugosity
CTD	CTD
DIVE	dive ops
DRIFT	drifter release
DROP	drop camera
FVT	fish video transect
FVC	fish visual census
TRUTH	ground truth point
HABTRAN	habitat video transect
HERB	herbivory downrigger
LGT_CONT	light profile (continuous)
LGT_STAT	light profile (stationary)
BAT	MiniBat tow
DV	mini digital video
MLB	multibeam survey
PGEN	Population Genetics
PONAR	PONAR grab
QTC	QTC view
VHS	regular VHS video
ROV	ROV
ROX	ROXANN
SS	SCUBA seine
SECCHI	Secchi disk
SED_PART	sediment particle size
SED_PEN	sediment penetration
SED_TRQ	sediment torque
SEED	seed cores
SENSUS	Sensus Pro dive computer
ECHO	Simrad Echosounder
SMAC	Smith-Mac grab
SPORT	Sport Scan
SI	stable isotope
SI_PHYT	phytoplankton
SI_FISH	fish
SI_INV	invertes
SI_MAC	macroalgae
SI_MIC	benthic microalgae
SI_SG	seagrass
SI_COR	coral
SVHS	Super VHS video
SURF_H2O	surface water with bucket
TEMP	temperature logger
TUCK	Tucker trawl
SLED	video sled
NISK_H2O	water at depth with Niskin
NUT_COL	water column nutrients
WPT	waypoint

APPENDIX II b. Cruise Sample Log

Dive Operations					
Date	**Station#**	**Strata**	**Code ***	**Latitude**	**Longitude**
9/21/2004	ON6772	ON	WPT	24.5726333	-82.97785
9/21/2004	ON6772	ON	DIVE	24.5726333	-82.97785
9/21/2004	OS6731	OS	WPT	24.5555	-82.9628
9/21/2004	OS6731	OS	DIVE	24.5555	-82.9628
9/21/2004	OS7675	OS	WPT	24.5984167	-82.9510667
9/21/2004	OS7675	OS	DIVE	24.5984167	-82.9510667
9/21/2004	OS7675	OS	BEN_CHL	24.5984167	-82.9510667
9/21/2004	OS7676	OS	SED_PART	24.5984167	-82.9510667
9/21/2004	OS7677	OS	SED_PART	24.5984167	-82.9510667
9/21/2004	OS7678	OS	SED_PART	24.5984167	-82.9510667
9/21/2004	PS6108	PS	WPT	24.5878	-82.88531
9/21/2004	PS6108	PS	DIVE	24.5878	-82.88531
9/21/2004	PS6108	PS	BEN_CHL	24.5878	-82.88531
9/21/2004	PS6108	PS	SED_PART	24.5878	-82.88531
9/21/2004	PS6108	PS	SED_PART	24.5878	-82.88531
9/21/2004	PS6108	PS	SED_PART	24.5878	-82.88531
9/22/2004	RN8924	RN	WPT	24.6834333	-83.0135833
9/22/2004	RN8924	RN	DIVE	24.6834333	-83.0135833
9/22/2004	RN8924	RN	BEN_CHL	24.6834333	-83.0135833
9/22/2004	RN8924	RN	SED_PART	24.6834333	-83.0135833
9/22/2004	RN8924	RN	SED_PART	24.6834333	-83.0135833
9/22/2004	RN8924	RN	SED_PART	24.6834333	-83.0135833
9/22/2004	RS9162	RS	WPT	24.6806333	-82.9951
9/22/2004	RS9162	RS	DIVE	24.6806333	-82.9951
9/22/2004	RS9162	RS	BEN_CHL	24.6806333	-82.9951
9/22/2004	RS9162	RS	SED_PART	24.6806333	-82.9951
9/22/2004	RS9162	RS	SED_PART	24.6806333	-82.9951
9/22/2004	RS9162	RS	SED_PART	24.6806333	-82.9951
9/22/2004	RN10105	RN	WPT	24.6687681	-83.0211125
9/22/2004	RN10105	RN	DIVE	24.6687681	-83.0211125
9/22/2004	RN10105	RN	BEN_CHL	24.6687681	-83.0211125
9/22/2004	RN10105	RN	SED_PART	24.6687681	-83.0211125
9/22/2004	RN10105	RN	SED_PART	24.6687681	-83.0211125
9/22/2004	RN10105	RN	SED_PART	24.6687681	-83.0211125
9/22/2004	RS9042	RS	WPT	24.685183	-82.9974667
9/22/2004	RS9042	RS	DIVE	24.685183	-82.9974667
9/22/2004	RS9042	RS	BEN_CHL	24.6687681	-83.0211125

9/22/2004	RS9042	RS	SED_PART	24.6687681	-83.0211125
9/22/2004	RS9042	RS	SED_PART	24.6687681	-83.0211125
9/22/2004	RS9042	RS	SED_PART	24.6687681	-83.0211125
9/22/2004	RS10529	RS	WPT	24.6595854	-83.0233013
9/22/2004	RS10529	RS	DIVE	24.6595854	-83.0233013
9/22/2004	RS10529	RS	BEN_CHL	24.6595854	-83.0233013
9/22/2004	RS10529	RS	SED_PART	24.6595854	-83.0233013
9/22/2004	RS10529	RS	SED_PART	24.6595854	-83.0233013
9/22/2004	RS10529	RS	SED_PART	24.6595854	-83.0233013
9/22/2004	RS10262	RS	WPT	24.6623	-83.0036667
9/22/2004	RS10262	RS	DIVE	24.6623	-83.0036667
9/22/2004	RS10262	RS	BEN_CHL	24.6623	-83.0036667
9/22/2004	RS10262	RS	SED_PART	24.6623	-83.0036667
9/22/2004	RS10262	RS	SED_PART	24.6623	-83.0036667
9/22/2004	RS10262	RS	SED_PART	24.6623	-83.0036667
9/22/2004	RN9807	RN	WPT	24.6609	-83.0467
9/22/2004	RN9807	RN	DIVE	24.6609	-83.0467
9/22/2004	RN9807	RN	SI_FISH	24.6609	-83.0467
9/22/2004	RN9807	RN	AFLP	24.6609	-83.0467
9/22/2004	RN9807	RN	BEN_CHL	24.6609	-83.0467
9/22/2004	RN9807	RN	SED_PART	24.6609	-83.0467
9/22/2004	RN9807	RN	SED_PART	24.6609	-83.0467
9/22/2004	RN9807	RN	SED_PART	24.6609	-83.0467
9/22/2004	RN9498	RN	WPT	24.67925	-83.0487001
9/22/2004	RN9498	RN	DIVE	24.67925	-83.0487001
9/22/2004	RN9498	RN	BEN_CHL	24.67925	-83.0487001
9/22/2004	RN9498	RN	SED_PART	24.67925	-83.0487001
9/22/2004	RN9498	RN	SED_PART	24.67925	-83.0487001
9/22/2004	RN9498	RN	SED_PART	24.67925	-83.0487001
9/23/2004	Fort Macon	Park	SI_FISH	24.6348197	-82.8819266
9/23/2004	RN1915	RN	WPT	24.70315	-82.92815
9/23/2004	RN1915	RN	DIVE	24.70315	-82.92815
9/23/2004	RN1915	RN	BEN_CHL	24.70315	-82.92815
9/23/2004	RN1915	RN	SED_PART	24.70315	-82.92815
9/23/2004	RN1915	RN	SED_PART	24.70315	-82.92815
9/23/2004	RN1915	RN	SED_PART	24.70315	-82.92815
9/23/2004	PN1136	PN	WPT	24.7211957	-82.8746495
9/23/2004	PN1136	PN	DIVE	24.7211957	-82.8746495
9/23/2004	PN1136	PN	SI_FISH	24.7211957	-82.8746495
9/23/2004	PN1136	PN	BEN_CHL	24.7211957	-82.8746495
9/23/2004	PN1136	PN	SED_PART	24.7211957	-82.8746495
9/23/2004	PN1136	PN	SED_PART	24.7211957	-82.8746495

9/23/2004	PN1136	PN	SED_PART	24.7211957	-82.8746495
9/23/2004	PN690	PN	WPT	24.722818	-82.8569842
9/23/2004	PN690	PN	DIVE	24.722818	-82.8569842
9/23/2004	PN690	PN	TEMP	24.722818	-82.8569842
9/23/2004	PN690	PN	BEN_CHL	24.722818	-82.8569842
9/23/2004	PN690	PN	SED_PART	24.722818	-82.8569842
9/23/2004	PN690	PN	SED_PART	24.722818	-82.8569842
9/23/2004	PN690	PN	SED_PART	24.722818	-82.8569842
9/23/2004	PN3275	PN	WPT	24.6567635	-82.9508205
9/23/2004	PN3275	PN	DIVE	24.6567635	-82.9508205
9/23/2004	PN3275	PN	TEMP	24.6567635	-82.9508205
9/23/2004	PN3275	PN	BEN_CHL	24.6567635	-82.9508205
9/23/2004	PN3275	PN	SED_PART	24.6567635	-82.9508205
9/23/2004	PN3275	PN	SED_PART	24.6567635	-82.9508205
9/23/2004	PN3275	PN	SED_PART	24.6567635	-82.9508205
9/23/2004	PN3120	PN	WPT	24.6577285	-82.942727
9/23/2004	PN3120	PN	DIVE	24.6577285	-82.942727
9/23/2004	PN3120	PN	TEMP	24.6577285	-82.942727
9/23/2004	PN3120	PN	BEN_CHL	24.6577285	-82.942727
9/23/2004	PN3120	PN	SED_PART	24.6577285	-82.942727
9/23/2004	PN3120	PN	SED_PART	24.6577285	-82.942727
9/23/2004	PN3120	PN	SED_PART	24.6577285	-82.942727
9/24/2004	ON5527	ON	WPT	24.6071167	-82.9948167
9/24/2004	ON5527	ON	DIVE	24.6071167	-82.9948167
9/24/2004	ON5527	ON	TEMP	24.6071167	-82.9948167
9/24/2004	ON5527	ON	BEN_CHL	24.6071167	-82.9948167
9/24/2004	ON5527	ON	SED_PART	24.6071167	-82.9948167
9/24/2004	ON5527	ON	SED_PART	24.6071167	-82.9948167
9/24/2004	ON5527	ON	SED_PART	24.6071167	-82.9948167
9/24/2004	ON5842	ON	WPT	24.5891	-82.9939667
9/24/2004	ON5842	ON	DIVE	24.5891	-82.9939667
9/24/2004	ON5842	ON	TEMP	24.5891	-82.9939667
9/24/2004	ON5842	ON	BEN_CHL	24.5891	-82.9939667
9/24/2004	ON5842	ON	SED_PART	24.5891	-82.9939667
9/24/2004	ON5842	ON	SED_PART	24.5891	-82.9939667
9/24/2004	ON5842	ON	SED_PART	24.5891	-82.9939667
9/24/2004	ON6772	ON	WPT	24.5726333	-82.97785
9/24/2004	ON6772	ON	DIVE	24.5726333	-82.97785
9/24/2004	ON6772	ON	TEMP	24.5726333	-82.97785
9/24/2004	ON6772	ON	BEN_CHL	24.5726333	-82.97785
9/24/2004	ON6772	ON	SED_PART	24.5726333	-82.97785
9/24/2004	ON6772	ON	SED_PART	24.5726333	-82.97785
9/24/2004	ON6772	ON	SED_PART	24.5726333	-82.97785

9/24/2004	OS7265	OS	WPT	24.5555	-82.9628
9/24/2004	OS7265	OS	DIVE	24.5555	-82.9628
9/24/2004	OS7265	OS	BEN_CHL	24.5555	-82.9628
9/24/2004	OS7265	OS	SED_PART	24.5555	-82.9628
9/24/2004	OS7265	OS	SED_PART	24.5555	-82.9628
9/24/2004	OS7265	OS	SED_PART	24.5555	-82.9628
9/24/2004	Diego		WPT	24.686	-82.06733
9/24/2004	Diego		DIVE	24.686	-82.06733
9/24/2004	RS8233	RS	WPT	24.6998492	-82.9771463
9/24/2004	RS8233	RS	DIVE	24.6998492	-82.9771463
9/24/2004	RS8233	RS	TEMP	24.6998492	-82.9771463
9/24/2004	RS8233	RS	BEN_CHL	24.6998492	-82.9771463
9/24/2004	RS8233	RS	SED_PART	24.6998492	-82.9771463
9/24/2004	RS8233	RS	SED_PART	24.6998492	-82.9771463
9/24/2004	RS8233	RS	SED_PART	24.6998492	-82.9771463
9/24/2004	Texas Roc		WPT	24.680086	-82.886124
9/24/2004	Texas Roc		SI_FISH	24.680086	-82.886124
9/24/2004	Texas Roc		TEMP	24.680086	-82.886124
9/25/2004	Elkhorn		WPT	24.620757	-82.86742
9/25/2004	Elkhorn		TEMP	24.620757	-82.86742
9/25/2004	Elkhorn		SI_FISH	24.620757	-82.86742
9/25/2004	Fort Macon	Park	SI_FISH	24.6348197	-82.8819266
9/25/2004	Fort Macon	Park	SI_FISH	24.6348197	-82.8819266
9/25/2004	ON11460	ON	WPT	24.616955	-83.093269
9/25/2004	ON11460	ON	DIVE	24.6167	-83.0933167
9/25/2004	ON11460	ON	SI_FISH	24.6167	-83.0933167
9/25/2004	ON11460	ON	AFPL	24.6167	-83.0933167
9/25/2004	ON11460	ON	BEN_CHL	24.6167	-83.0933167
9/25/2004	ON11460	ON	SED_PART	24.6167	-83.0933167
9/25/2004	ON11460	ON	SED_PART	24.6167	-83.0933167
9/25/2004	ON11460	ON	SED_PART	24.6167	-83.0933167
9/25/2004	OS12379	OS	WPT	24.5984167	-83.0870833
9/25/2004	OS12379	OS	DIVE	24.5984167	-83.0870833
9/25/2004	OS12379	OS	BEN_CHL	24.5984167	-83.0870833
9/25/2004	OS12379	OS	SED_PART	24.5984167	-83.0870833
9/25/2004	OS12379	OS	SED_PART	24.5984167	-83.0870833
9/25/2004	OS12379	OS	SED_PART	24.5984167	-83.0870833
9/25/2004	PS2780	PS	WPT	24.6733613	-82.7809035
9/25/2004	PS2780	PS	DIVE	24.6733613	-82.7809035
9/25/2004	PS2780	PS	SI_FISH	24.6733613	-82.7809035
9/25/2004	PS2780	PS	AFPL	24.6733613	-82.7809035

9/25/2004	PS2780	PS	BEN_CHL	24.6733613	-82.7809035
9/25/2004	PS2780	PS	SED_PART	24.6733613	-82.7809035
9/25/2004	PS3926	PS	WPT	24.6402299	-82.7915488
9/25/2004	PS3926	PS	DIVE	24.6402299	-82.7915488
9/25/2004	PS3926	PS	TEMP	24.6402299	-82.7915488
9/25/2004	PS3926	PS	SI_FISH	24.6402299	-82.7915488
9/25/2004	PS3926	PS	AFPL	24.6402299	-82.7915488
9/25/2004	PS3926	PS	BEN_CHL	24.6402299	-82.7915488
9/25/2004	PS3926	PS	SED_PART	24.6402299	-82.7915488
9/25/2004	PS3926	PS	SED_PART	24.6402299	-82.7915488
9/25/2004	PS3926	PS	SED_PART	24.6402299	-82.7915488
9/25/2004	OS1864	OS	WPT	24.7150078	-82.780515
9/25/2004	OS1864	OS	DIVE	24.7150078	-82.780515
9/25/2004	OS1864	OS	TEMP	24.7150078	-82.780515
9/25/2004	OS1864	OS	BEN_CHL	24.7150078	-82.780515
9/25/2004	OS1864	OS	SED_PART	24.7150078	-82.780515
9/25/2004	OS1864	OS	SED_PART	24.7150078	-82.780515
9/25/2004	OS1864	OS	SED_PART	24.7150078	-82.780515
9/25/2004	ON94	ON	WPT	24.7377996	-82.7934824
9/25/2004	ON94	ON	DIVE	24.7377996	-82.7934824
9/25/2004	ON94	ON	TEMP	24.7377996	-82.7934824
9/25/2004	ON94	ON	BEN_CHL	24.7377996	-82.7934824
9/25/2004	ON94	ON	SED_PART	24.7377996	-82.7934824
9/25/2004	ON94	ON	SED_PART	24.7377996	-82.7934824
9/25/2004	ON94	ON	SED_PART	24.7377996	-82.7934824
9/27/2004	PS6493	PS	WPT	24.5744955	-82.9014143
9/27/2004	PS6493	PS	DIVE	24.5744955	-82.9014143
9/27/2004	PS6493	PS	TEMP	24.5744955	-82.9014143
9/27/2004	PS6493	PS	BEN_CHL	24.5744955	-82.9014143
9/27/2004	PS6493	PS	SED_PART	24.5744955	-82.9014143
9/27/2004	PS6493	PS	SED_PART	24.5744955	-82.9014143
9/27/2004	PS6493	PS	SED_PART	24.5744955	-82.9014143
9/27/2004	PS4671	PS	WPT	24.623451	-82.8258409
9/27/2004	PS4671	PS	DIVE	24.623451	-82.8258409
9/27/2004	PS4671	PS	TEMP	24.623451	-82.8258409
9/27/2004	PS4671	PS	BEN_CHL	24.623451	-82.8258409
9/27/2004	PS4671	PS	SED_PART	24.623451	-82.8258409
9/27/2004	PS4671	PS	SED_PART	24.623451	-82.8258409
9/27/2004	PS4671	PS	SED_PART	24.623451	-82.8258409
9/27/2004	PS2780	PS	WPT	24.6733613	-82.7809035
9/27/2004	PS2780	PS	DIVE	24.6733613	-82.7809035
9/28/2004	ON5527	ON	WPT	24.6071167	-82.9948167

9/28/2004	ON5527	ON	DIVE	24.6071167	-82.9948167
9/28/2004	ON5527	ON	SI_FISH	24.6071167	-82.9948167
9/28/2004	RN8924	RN	WPT	24.6834333	-83.0135833
9/28/2004	RN8924	RN	TEMP	24.6834333	-83.0135833
9/28/2004	RN8924	RN	DIVE	24.6834333	-83.0135833
9/28/2004	RN1915	RN	WPT	24.70315	-82.92815
9/28/2004	RN1915	RN	TEMP	24.70315	-82.92815
9/28/2004	RN1915	RN	DIVE	24.70315	-82.92815
9/29/2004	PS2780	PS	WPT	24.6733613	-82.7809035
9/29/2004	PS2780	PS	DIVE	24.6733613	-82.7809035
9/29/2004	PS2780	PS	SED_PART	24.6733613	-82.7809035
9/29/2004	PS2780	PS	SED_PART	24.6733613	-82.7809035
9/29/2004	PS2780	PS	SED_PART	24.6733613	-82.7809035
9/29/2004	PN632	PN	WPT	24.723884	-82.8464297
9/29/2004	PN632	PN	DIVE	24.723884	-82.8464297
9/29/2004	PN632	PN	TEMP	24.723884	-82.8464297
9/29/2004	PN632	PN	BEN_CHL	24.723884	-82.8464297
9/29/2004	PN632	PN	SED_PART	24.723884	-82.8464297
9/29/2004	PN632	PN	SED_PART	24.723884	-82.8464297
9/29/2004	PN632	PN	SED_PART	24.723884	-82.8464297
9/29/2004	RN1915	RN	WPT	24.70315	-82.92815
9/29/2004	RN1915	RN	TEMP	24.70315	-82.92815
9/29/2004	RN1915	RN	DIVE	24.70315	-82.92815
9/30/2004	Diego		WPT	24.686	-82.06733
9/30/2004	Diego		DIVE	24.686	-82.06733
9/30/2004	Diego		SI_FISH	24.686	-82.06733

Stationary Light Profile					
Date	**Station#**	**Strata**	**Code**	**Latitude**	**Longitude**
9/24/2004	Diego		Light Profile	24.67782	83.07645
9/27/2004	near 2780	ps	Light Profile	24 40.3510	82 46.0845

Drop Camera					
Date	**Station#**	**Strata**	**Code**	**Latitiude**	**Longitude**
9/30/2004	out reserve N boundary	Outside	Drop	24.768978	-82.856995
9/30/2004	out reserve N boundary	Outside	Drop	24.774488	-82.831402
9/30/2004	in reserve, N boundary	Reserve	Drop	24.750139	-82.816882
9/30/2004	in reserve, N boundary	Reserve	Drop	24.750233	-82.800041
9/30/2004	out reserve N boundary	Outside	Drop	24.768141	-82.801454
9/30/2004	in reserve, N boundary	Reserve	Drop	24.770796	-82.814473

Multibeam Operations					
Date	**Survey Area**	**Line**	**Code**	**Latitude**	**Longitude**
9/21/2004	OS6731, PS6493, PS6108	LN1.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN2.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN3.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN4.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN5.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN6.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN7.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN8.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN9.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN10.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN11.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN12.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN12B.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN13.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN14.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN15.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN16.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN17.XTF	MLB	24.566834	-82.883376
9/21/2004	OS6731, PS6493, PS6108	LN18.XTF	MLB	24.566834	-82.883376
9/22/2004	RS10262, RS9162, RS9042	LN1.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN2.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN3.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN4.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN5.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN6.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN7.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN8.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN9.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN10.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN11.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN12.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN13.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN14.XTF	MLB	24.650126	-83.01895

9/22/2004	RS10262, RS9162, RS9042	LN15.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN15B.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN15C.XTF	MLB	24.650126	-83.01895
9/22/2004	RS10262, RS9162, RS9042	LN15D.XTF	MLB	24.650126	-83.01895
9/23/2004	ON5527, ON5842	LN1.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN1B.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN1C.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN2.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN2B.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN3.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN4.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN4B.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN5.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN6.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN7.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN8.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN9.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN10.XTF	MLB	24.568708	-83.002367
9/23/2004	ON5527, ON5842	LN11.XTF	MLB	24.568708	-83.002367
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN1.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN1A.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN1B.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN2.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN3.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN3B.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN4.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN5.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN6.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN7.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN8.XTF	MLB	24.516824	-82.950047
09/23/2004-09/24/2004	ON6772, OS7265, OS7675	LN14.XTF	MLB	24.516824	-82.950047

09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN1.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN2.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN3.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN4.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN4B.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN5.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN6.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN7.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN8.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN9.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN10.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN11.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN12.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8924	LN12B.XTF	MLB	24.650189	-83.016706
09/24/2004-09/25/2004	RS10529, RN10105, RN8925	LN13.XTF	MLB	24.650189	-83.016706
9/25/2004	RN9498, RN9807	LN14.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN5.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN16.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN17.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN18.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN19.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN20.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN21.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN22.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN23.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN24.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN25.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN25B.XTF	MLB	24.633457	-83.033577
9/25/2004	RN9498, RN9807	LN26.XTF	MLB	24.633457	-83.033577
9/27/2004	PS4671	LN1.XTF	MLB	24.616709	-82.816944

9/27/2004	PS4672	LN2.XTF	MLB	24.616709	-82.816944
9/27/2004	PS4673	LN3.XTF	MLB	24.616709	-82.816944
9/27/2004	PS4674	LN4.XTF	MLB	24.616709	-82.816944
9/27/2004	PS3926	LN5.XTF	MLB	24.63335	-82.78349
9/27/2004	PS3926	LN6.XTF	MLB	24.63335	-82.78349
9/27/2004	PS3926	LN7.XTF	MLB	24.63335	-82.78349
9/27/2004	PS3926	LN8.XTF	MLB	24.63335	-82.78349
9/27/2004	PS2780	LN9.XTF	MLB	24.666749	-82.766758
9/27/2004	PS2780	LN10.XTF	MLB	24.666749	-82.766758
9/27/2004	PS2780	LN11.XTF	MLB	24.666749	-82.766758
9/27/2004	PS2780	LN11B.XTF	MLB	24.666749	-82.766758
9/27/2004	PS2780	LN12.XTF	MLB	24.666749	-82.766758
9/27/2004	PS2780	LN13.XTF	MLB	24.666749	-82.766758
9/27/2004	OS1864	LN14.XTF	MLB	24.716724	-82.766918
9/27/2004	OS1864	LN15.XTF	MLB	24.716724	-82.766918
9/27/2004	OS1864	LN16.XTF	MLB	24.716724	-82.766918
9/27/2004	OS1864	LN17.XTF	MLB	24.716724	-82.766918
9/27/2004	ON94	TLN18.XTF	MLB	24.733501	-82.783558
9/27/2004	ON94	TLN18B.XTF	MLB	24.733501	-82.783558
9/27/2004	ON94	TLN19.XTF	MLB	24.733501	-82.783558
9/27/2004	ON94	TLN20.XTF	MLB	24.733501	-82.783558
9/27/2004	ON94	TLN21.XTF	MLB	24.733501	-82.783558
9/27/2004	RN1915	TLN22.XTF	MLB	24.70018	-82.91682
9/27/2004	RN1915	LN23.XTF	MLB	24.70018	-82.91682
9/27/2004	RN1915	LN24.XTF	MLB	24.70018	-82.91682
9/27/2004	RN1915	LN25.XTF	MLB	24.70018	-82.91682
9/28/2004	RS8233	LN1.XTF	MLB	24.700193	-82.966818
9/28/2004	RS8233	LN2.XTF	MLB	24.700193	-82.966818
9/28/2004	RS8233	LN3.XTF	MLB	24.700193	-82.966818
9/28/2004	RS8233	LN3B.XTF	MLB	24.700193	-82.966818
9/28/2004	RS8233	LN4.XTF	MLB	24.700193	-82.966818
9/28/2004	RS8233	LN5.XTF	MLB	24.700193	-82.966818
9/28/2004	RN3275, RN3120	LN6.XTF	MLB	24.650278	-82.950073
9/28/2004	RN3275, RN3120	LN7.XTF	MLB	24.650278	-82.950073
9/28/2004	RN3275, RN3120	LN8.XTF	MLB	24.650278	-82.950073
9/28/2004	RN3275, RN3120	LN9.XTF	MLB	24.650278	-82.950073
9/28/2004	RN3275, RN3120	LN10.XTF	MLB	24.650278	-82.950073
9/28/2004	RN3275, RN3120	LN11.XTF	MLB	24.650278	-82.950073
9/28/2004	RN3275, RN3120	LN12.XTF	MLB	24.650278	-82.950073
9/28/2004	RN3275, RN3120	LN13.XTF	MLB	24.650278	-82.950073
9/28/2004	RN3275, RN3120	LN14.XTF	MLB	24.650278	-82.950073

9/28/2004	RN3275, RN3120	LN15.XTF	MLB	24.650278	-82.950073
9/28/2004	RN3275, RN3120	LN16.XTF	MLB	24.650278	-82.950073
9/28/2004	SW Channel	Ground-truth	MLB	24.600179	-82.950253
9/28/2004	OS12379, ON11460	LN1.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN1B.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN2.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN3.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN3B.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN4.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN5.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN6.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN7.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN8.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN9.XTF	MLB	24.583515	-82.066901
9/28/2004	OS12379, ON11460	LN10.XTF	MLB	24.583515	-82.066901
9/29/2004	PN632, PN690, PN1136	LN1.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN2.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN3.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN4.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN5.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN6.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN7.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN8.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN8B.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN9.XTF	MLB	24.716794	-82.833365
9/29/2004	PN632, PN690, PN1136	LN10.XTF	MLB	24 43.4601	82 50.1143

Population Genetics (White Grunt)						
Date	**Station#**	**Strata**	**Sample #**	**Code**	**Latitude**	**Longitude**
9/22/2004	RN9807	TER	39	PGEN	24.6609	-83.0467
9/23/2004	Fort Macon	TER		PGEN	24.6348197	-82.8819266
9/23/2004	PN1136	TER			24.7211957	-82.8746495
9/24/2004	Texas Rock	TER		PGEN	24.680086	-82.886124
9/25/2004	ON11460	TER	40	PGEN	24.6167	-83.0933167
9/25/2004	PS2780	TER	41	PGEN	24.6733613	-82.7809035
9/25/2004	PS2780	TER	42	PGEN	24.6733613	-82.7809035
9/25/2004	PS2780	TER	43	PGEN	24.6733613	-82.7809035
9/25/2004	PS2780	TER	44	PGEN	24.6733613	-82.7809035
9/25/2004	PS3926	TER	45	PGEN	24.6402299	-82.7915488

9/25/2004	Elkhorn	TER	46	PGEN	24.620757	-82.86742
9/25/2004	Fort Macon	TER		PGEN	24.6348197	-82.8819266
9/25/2004	Fort Macon	TER		PGEN	24.6348197	-82.8819266
9/27/2004	wg92704	TER	47	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	48	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	49	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	50	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	51	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	52	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	53	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	54	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	55	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	56	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	57	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	58	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	59	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	60	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	61	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	62	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	63	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	64	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	65	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	66	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	67	PGEN	24.68699	-82.78459
9/27/2004	wg92704	TER	68	PGEN	24.68699	-82.78459
9/28/2004	wgd192804	TER	69	PGEN	24.56178	-82.93842
9/28/2004	wg292804	TER	70	PGEN	24.55784	-82.92974
9/28/2004	wg292804	TER	71	PGEN	24.55784	-82.92974
9/28/2004	wg292804	TER	72	PGEN	24.55784	-82.92974
9/28/2004	wg292804	TER	73	PGEN	24.55784	-82.92974
9/28/2004	ON5527	TER		PGEN	24.6071167	-82.9948167
9/29/2004	WG92904MAR	marquesas	74	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	75	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	76	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	77	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	78	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	79	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	80	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	81	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	82	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	83	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	84	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	85	PGEN	24.53389	-82.16926

9/29/2004	WG92904MAR	marquesas	86	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	87	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	88	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	89	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	90	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	91	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	92	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	93	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	94	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	95	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	96	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	97	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	98	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	99	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	100	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	101	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	102	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	103	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	104	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	105	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	106	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	107	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	108	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	109	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	110	PGEN	24.53389	-82.16926
9/29/2004	WG92904MAR	marquesas	111	PGEN	24.53389	-82.16926
9/30/2004	Diego	TER		PGEN	24.686	-82.06733

APPENDIX III. Dive Log

Date	Vessel	Station	Divers	PSI		Local Time		Actual Depth (ft)	Gas
				In	Out	Down	Out		
9/21/2004	Foster	OS 6772	Addison	2800		1532	1540	50	ean32
		Aborted	Degan	3000		1532	1540	35	ean32
			Burke	3000		1532	1540	50	ean32
	Foster	PS6108	Viehman	2700	700	1747	1828	80	ean32
			Kelty	3000	100	1747	1828	80	ean32
			Munoz	2750	500	1747	1828	80	ean32
9/21/2004	Alexis M	OS 7675	Hyniova	2900	1110	1622	1655	78	ean36
			Bonn	3000	800	1622	1655	78	ean36
			Poray	3000	300	1622	1655	78	ean36
	Alexis M	OS 6731	Field	2750	700	1740	1815	83	ean36
			Whitfield	2900	900	1740	1815	83	ean36
			Merello	2700	300	1740	1815	83	ean36
			Hackney	2600	500	1740	1815	83	ean36
9/22/2004	Foster	RS 10529	Viehman	3000	800	0858	0940	84	ean36
			Kelty	2900	1000	0858	0940	85	ean36
			Munoz	2800	500	0858	0940	84	ean36
	Foster	RS 10262	Bonn	3000	1100	1042	1122	89	ean32
			Poray	3000	400	1042	1122	89	ean32
			Hyniova	3000	1000	1042	1122	88	ean32
	Foster	RN 9807	Viehman	3000	700	1340	1430	60	ean36
			Kelty	3000	500	1340	1430	60	ean36
			Munoz	3000	1000	1340	1430	61	ean36
	Foster	RN 9498	Bonn	3000	1000	1553	1628	70	ean36
			Poray	3000	800	1553	1628	70	ean36
			Fonseca	3000	900	1553	1628	70	ean36
9/22/2004	Alexis M	RN 8924	Addison	3000	1000	0849	0925	92	ean32
			Degan	3000	760	0849	0925	92	ean32
			Burke	3250	1200	0849	0925	92	ean32
	Alexis M	RS 9162	Field	3000	1400	1002	1034	85	ean32
			Whitfield	2900	1300	1002	1034	85	ean32
			Merello	3100	1800	1002	1034	85	ean32
			Hackney	3000	1300	1002	1034	85	ean32

	Alexis M	RS 9042	Merello	2800	1250	1424	1452	79	ean32
			Degan	3100	1250	1424	1452	79	ean32
			Burke	3000	1700	1424	1452	79	ean32
	Alexis M	RN 10105	Whitfield	3300	1250	1540	1616	85	ean32
			Field	2850	900	1540	1616	85	ean32
			Hackney	3000	500	1540	1616	85	ean32
9/23/2004	Foster	PN 3275	Poray	3000	780	1157	1235	94	ean32
			Hyniova	3000	1000	1157	1235	94	ean32
			Bonn	3000	900	1157	1235	94	ean32
	Foster	PN 3120	Fonseca	3000	500	1318	1358	85	ean32
			Burke	3000	750	1318	1358	85	ean32
			Degan	3000	900	1318	1358	85	ean32
9/23/2004	Alexis M	RN 1915	Kelty	3100	1000	0944	1024	100	ean32
			Teer	2900	750	0944	1024	100	ean32
			Munoz	3100	300	0944	1024	100	ean32
			Viehman	2900	800	0944	1024	100	ean32
	Alexis M	PN 1136	Field	2750	900	1121	1150	98	ean32
			Whitfield	3100	900	1121	1150	98	ean32
			Hackney	3100	900	1121	1150	98	ean32
			Merello	2750	400	1121	1150	101	ean32
9/24/2004	Foster	Diego	Viehman	2900	700	1157	1240	75	ean32
			Munoz	2800	700	1157	1240	75	ean32
			Kelty	2600	700	1157	1240	75	ean32
			Fonseca	2900	700	1157	1240	75	ean32
	Foster	RS 8233	Degan	3000	750	1404	1441	104	ean32
			Burke	2800	750	1404	1441	104	ean32
			Addison	300	750	1404	1441	104	ean32
	Foster	Texas Rock	Addison	2800	1900	1823	1852	50	ean32
			Kelty	2900	1800	1823	1852	50	ean32
9/24/2004	Alexis M	ON 5527	Whitfield	2900	1300	0907	0938	97	ean36
			Field	2800	900	0907	0938	97	ean36
			Merello	2900	900	0907	0938	97	ean36
			Hackney	2800	600	0907	0938	97	ean36
	Alexis M	ON 5842	Bonn	2800	900	1013	1055	74	ean36
			Hyniova	3000	1200	1013	1055	74	ean36
			Poray	3000	850	1013	1055	74	ean36

	Alexis M	ON 6772	Whitfield	3000	1100	1253	1330	74	ean36
			Field	2850	1200	1253	1330	74	ean36
			Merello	2900	1000	1253	1330	74	ean36
			Hackney	2800	600	1253	1330	74	ean36
	Alexis M	OS 7625	Bonn	2800	1100	1429	1508	79	ean32
			Hyniova	3000	1500	1429	1508	79	ean32
			Poray	3000	1100	1429	1508	80	ean32
9/25/2004	Foster	OS12379	Bonn	3000	800	1020	1101	80	ean36
			Poray	2900	500	1020	1101	80	ean36
			Hyniova	3000	1000	1020	1101	80	ean36
	Foster	ON 11460	Munoz	3000	700	1144	1220	90	ean32
			Whitfield	3000	1200	1144	1220	90	ean32
			Viehman	2900	750	1144	1220	90	ean32
9/25/2004	Alexis M	ON 94	Addison	3000	1250	0943	1022	95	ean32
			Burke	2700	500	0943	1022	95	ean32
			Degan	3000	750	0943	1022	95	ean32
	Alexis M	OS 1864	Merello	2750	800	1103	1149	62	ean32
			Hackney	2750	350	1103	1149	62	ean32
			Field	2750	700	1103	1149	62	ean32
	Alexis M	PS 2780	Addison	3000	1250	1250	1339	60	ean32
			Burke	2750	500	1250	1339	60	ean32
			Degan	2800	500	1250	1339	60	ean32
	Alexis M	PS 3926	Merello	3000	800	1456	1544	70	ean32
			Hackney	3000	500	1456	1544	70	ean32
			Field	2750	900	1456	1544	70	ean32
9/27/2004	Foster	PS 6493	Fonseca	3000	850	0931	1014	78	ean36
			Bonn	3000	1300	0931	1014	78	ean36
			Poray	3000	1300	0931	1014	78	ean36
	Foster	PS 4671	Addison	3000	1000	1112	1159	79	ean36
			Burke	2900	1500	1112	1159	79	ean36
			Degan	2900	800	1112	1159	79	ean36
	Foster	PS 2780	Viehman		1400	1351	1421	56	ean36
			Kelty		1800	1351	1421	56	ean36
9/28/2004	Foster	ON 5527	Addison		1500	0814	0853	95	ean
			Burke		700	0814	0853	95	ean
			Degan		700	0814	0853	95	ean
			Fonseca		700	0814	0853	95	ean

	Foster	RN 8924	Field	3000	850	0957	1030	90	ean32
			Hyniova	3000	1200	0957	1030	90	ean32
			Whitfield	3000	1200	0957	1030	90	ean32
	Foster	RN 1915	Bonn	3000	800	1455	1534	99	ean32
			Poray	3000	500	1455	1534	99	ean32
			Viehman	3000	1200	1455	1534	99	ean32
			Kelty	3000	600	1455	1534	99	ean32
9/28/2004	Alexis	wg292804	Merello	2900	900	0920	1006	48	ean32
			Hackney	2800	600	0920	1017	48	ean32
	Alexis	wg292804	Munoz	2750	300	0925	1017	60	ean32
			Teer	3000	900	0925	1017	60	ean32
	Alexis	wg292804	Teer	3000	1900	1415	1501	35	ean32
			Hackney	2800	900	1415	1501	35	ean32
9/29/2004	Foster	PS 2780	Fonseca	2700	700	0818	0906	53	ean36
			Whitfield	3000	1300	0818	0906	53	ean36
			Hyniova	3000	1400	0818	0906	53	ean36
			Field	2850	900	0818	0906	53	ean36
	Foster	PN 632	Addison	3000	1200	1030	1109	95	ean32
			Burke	2900	900	1030	1109	95	ean32
			Degan	2900	750	1030	1109	95	ean32
	Foster	RN 1915	Kelty	3000	1500	1550	1610	101	ean32
			Bonn	3200	1500	1550	1610	101	ean32
			Poray	3200	2200	1550	1610	101	ean32
			Viehman	3000	1500	1550	1610	101	ean32
9/29/2004	Alexis	WG92904	Teer	3000	900	0924	1051	20	ean32
		MAR	Hackney	2800	900	0924	1051	20	ean32
			Munoz	2800	900	0924	1051	20	ean32
			Merello	3000	900	0924	1051	20	ean32
9/30/2004	Foster	Diego	Bonn	3000	750	0758	0850	72	ean36
			Burke	3000	750	0758	0850	72	ean36
			Degan	3000	500	0758	0850	72	ean36
			Field	3000	750	0758	0850	72	ean36
			Fonseca	3000	500	0758	0850	72	ean36
			Whitfield	3000	1000	0758	0850	72	ean36
			Addison	3000	800	0817	0913	69	ean36
			Kelty	2900	600	0817	0913	69	ean36
			Poray	3000	500	0817	0913	69	ean36
			Viehman	2800	500	0817	0913	69	ean36

ONMS/NCCOS
Sanctuary Project Summary Quarterly Report

Sanctuary: Florida Keys National Marine Sanctuary **Date of Report:** 4 January 2005

Quarterly Report: October, November, December 2004.

Abbreviated Title of Project: Characterization of fishery resources and habitats associated with the coral-seagrass bank channels in the tidal passes of the nearshore biogeographic region in the Florida Keys National Marine Sanctuary (FKNMS).

Task Code: B8K5BDC PBC (FY04 Task Number)

Start Date: *10/1/03* **End Date**: *9/30/05* **Year** 2

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Number of Participants: 8

Project Location(s): *geographic name = area of research, e.g., Hatteras slope or Conch Reef; please include significant, as opposed to incidental sampling locations.*

Site	Geographic Name	Latitude (dd-mm.ss N)	Longitude (ddd-mm.m W)
1	**Red Bay Banks**	**24° 45'43"**	**081° 09'11"**
2	**Bamboo Banks**	**24 ° 49'17"**	**081° 00'13"**
3	**Channel Keys**	**24 ° 48'43"**	**081° 09'11"**
4	**Lower Keys, Johnson Key to Northwest Ship Channel**	**24°45'43"**	**West of 081° 09'11"**
5			

Vessels Utilized (names and Days At Sea): FMRI Mako, CCFHR Parker Carson II, CCFHR Jones Bros. Bateau Killifish. 22.5 sea days, RV Alexis 6 days.

PROJECT DESCRIPTION

I. SUMMARY OF PROJECT:

OBJECTIVES

The shallow seagrass/porites coral banks located along the gulf side (north) of the Florida Keys National Marine Sanctuary (FKNMS) between the northwest ship channel in Key West and east to the outer limits of Florida Bay are a widely distributed system of elevated features occupied primarily by seagrasses, *Porites* coral, a wide diversity of macroalgae, invertebrates, sponges, numerous vertebrate communities and mangroves islands (Figure 1). The banks form part of a nearly continuous live bottom community interspersed within seagrass meadows dominated by a mixture of *Thalassia testudinum* and *Syringodium filiforme.* These communities are distributed along the southernmost extent of the southwest Florida Shelf in the Gulf of Mexico.

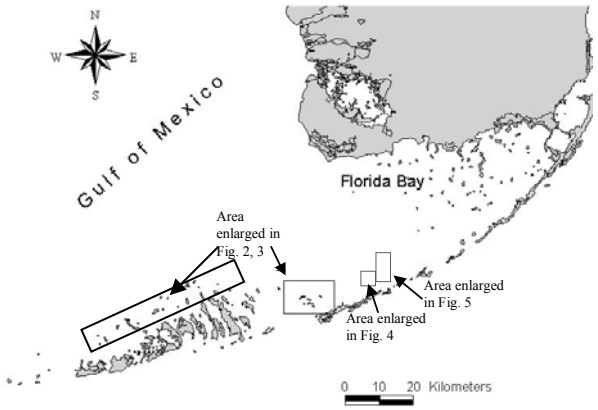

Figure 1. Map of South Florida region showing locations of the study sites in the rectangular boxes.

These bank and channel systems intercept the flow of water through the main passes connecting the Gulf of Mexico directly to the Atlantic side of the Florida Straits in the upper and middle Keys, or in the lower Keys where the channels link the Gulf of Mexico to extensive shallow flats and mangrove Islands. These include the Red Bay North bank system consisting of 14 smaller banks, the Red Bay South bank system with four individual banks, and the Captain Joe bank system with seven banks (Figures 2 and 3). To the south of Red Bay Bank are Bethel Banks with an as yet to be determined number of bank features. To the east of Red Bay Bank are the Bamboo Banks with a total of 9 banks (Figure 4). Further east are the Channel Banks, extending from just south of Channel Key north over 8 km with an as yet to be determined total number of banks (Figure 5). The banks are raised approximately 2 to 5 meters above the surrounding bottom and were formed over several hundred years

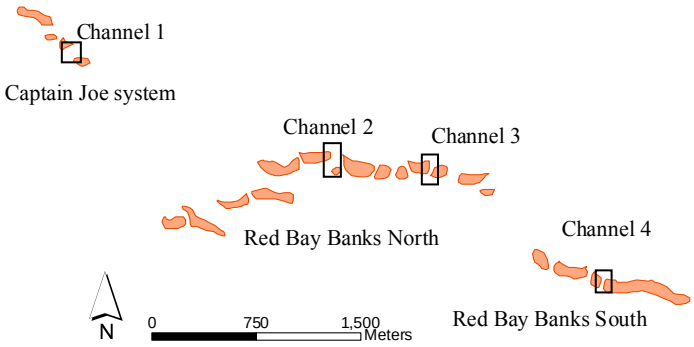

Figure 2. Map of Red Bay Bank system and locations of four release channels sampled during the study.

when the biotic communities, mainly *Porites* coral and seagrasses physically stabilized a large volume of unconsolidated sediment. Because there is a net long-term transport of water from the Gulf of Mexico to the Florida Straits through the main channels, these banks intercept sediments that are resuspended on the shallow shelf in the southeastern Gulf of Mexico. The large volume of material trapped and stored on these banks minimizes the southerly transport of suspended sediments and affords some protection for the coral reef tract to the south. In addition to the longer-term residual flow which transports water between the Gulf of Mexico and the Florida Straits, semi-diurnal tides flowing over these banks and through the channels influence water quality daily, and physically link the bank channel systems with the Florida Straits. Nearly tropical conditions occur during flood tides, while conditions are more similar to the Gulf of Mexico during the ebb cycles, especially during winter. Thus, both daily and seasonal fluctuations in climatic conditions in the Gulf of Mexico have a strong influence on these banks, especially during months when cold fronts extend further south, bringing cooler and more turbid water into the southeastern Gulf of Mexico. On an annual basis the banks experience a wide range of environmental conditions varying on time scales from as little as days to as long as months. These environmental fluctuations have a strong influence on the composition of the bank communities.

As a result of the large volume of water flowing between the Gulf of Mexico and the Florida Straits, strong currents occur in the vicinity of the banks and in the channels. It is common for water velocities to exceed 0.5 m sec^{-1} (1 knot) during a normal tidal cycle and 1.0 m sec^{-1} in association with storm surges. In response to these hydrodynamic conditions, the bank systems have a unique cross-sectional structure; generally oriented perpendicular to the main axis of the tidal currents. The topography of the Red Bay bank and Bethel bank systems is such that the systems tend to slope down in an eastward direction parallel to the prevailing wind, with shallower bank tops on the western edges and deeper bank tops to the east. Further east, Bamboo Banks and Channel Banks are oriented more north and south as the main flow of water exchanges with Florida Bay and the larger Keys channels between Islamorada, Long Key and Grassy Key.

Tidal waters exchanged between the Gulf of Mexico and the Florida Straits flow over the top of the bank systems and through a series of release channels that bisect the individual banks parallel to the flow. The physiography and three dimensional structures resulting from differences in water depth and the distinct substrate characteristics between the bank tops, the surrounding seagrass meadows, and the release channels create a complex landscape similar in many ways to the coral reef tract located just to the south along the edge of the Florida Straits. These physical attributes, along with the potential for large biodiversity and the physical stabilizing properties of the banks make them one of the most important ecological features of this portion of the Florida Keys National Marine Sanctuary (FKNMS).

The overall objective of this study is to conduct a biological characterization of channels and bank systems on the Gulf of Mexico side of the Florida Keys and determine their function as nursery and feeding habitat for fish and invertebrate species. The specific focus of the characterization are: 1) the benthic habitats, especially the seagrass and invertebrate communities and their function if providing habitat for fish and invertebrates, 2) the fish communities utilizing the bank channel systems as primary and secondary nurseries, 3) to compare to channel bank systems to benthic habitats surrounding them in order to determine their extent and function is supporting the biodiversity and productivity of the FKNMS, and 4) identify the potential threats and human induced disturbances to these bank channel communities so that resource managers can implement appropriate conservation measures to protect them.

SIGNIFICANCE

The benthic communities on the Gulf of Mexico side (northern margin) of the Florida Keys National Marine Sanctuary have not been properly characterized to the level of detail needed to: 1) identify their functional role as primary and secondary nursery habitat, 2) their productivity and 3) to establish a baseline for which to detect any future changes associated with the Sanctuary Management Plan and the South Florida/Everglades Restoration. This study will increase the baseline knowledge of the biological and physical characteristics of this region of the FKNMS.

II. SUMMARY OF RESULTS: *accomplishments, benefits, and new research topics:1) preliminary results and significance; 2) success of the mission in terms of project goals; 3) plans for use of the data, for example, management needs, publications, or other products; 4) new research ideas or directions generated.*

METHODS / RESULTS

Biological Characterization of Channels and Banks Systems

In June 2004, we continued the characterization of fish and invertebrate communities and benthic habitat at four channels within the Red Bay Banks system that was initiated during FY 02 and 03. The location of the four channels are shown in Figures 2 and 3**,** with channel 1 in the northern most bank system (Capt. Joe system), channels 2 and 3 in the middle bank system (Red Bay North) and channel 4 on the southeastern banks (Red Bay South). These four channel bank sites have been intensively sampled for three continuous years while the surrounding bank channels have been studied since 1993 by our team of biologists, Sanctuary biologists and Damage Assessment Center staff. We conducted detailed surveys of the benthic habitats in each of the four channels at six sites within each channel. The sites were arranged from north to south on both the east and west sides of the channel (Figure 3: Red Bay Banks habitat and fish sites). We also surveyed six sites on each bank adjacent to the channel. We characterized benthic cover and abundance in situ using the Braun-Blanquet visual assessment method (Braun-Blanquet 1972). Each site was sub-sampled with four 0.25m^2 Braun Blanquet quadrats. A species inventory of seagrass, algae, scleractinian corals, octocorals and other invertebrates was taken at each channel and bank site in the Red Bay Banks system. Additionally, within each of the four channels, at least two digital video lines were recorded (see Figure 6). A visual fish census of fish communities using a 5 minute point count was taken at each channel site and bank site, using a stationary method of surveying fish by species and size class in a 3 meter cone (See Table 1 for description of sampling effort). Cryptic fish and invertebrates were sampled using eel traps. Baited traps were soaked overnight within each of 4 selected channels in the Red Bay Bank system, and approximately 500m to the north and to the south of those channels. Collections were preserved in ethanol for analysis.

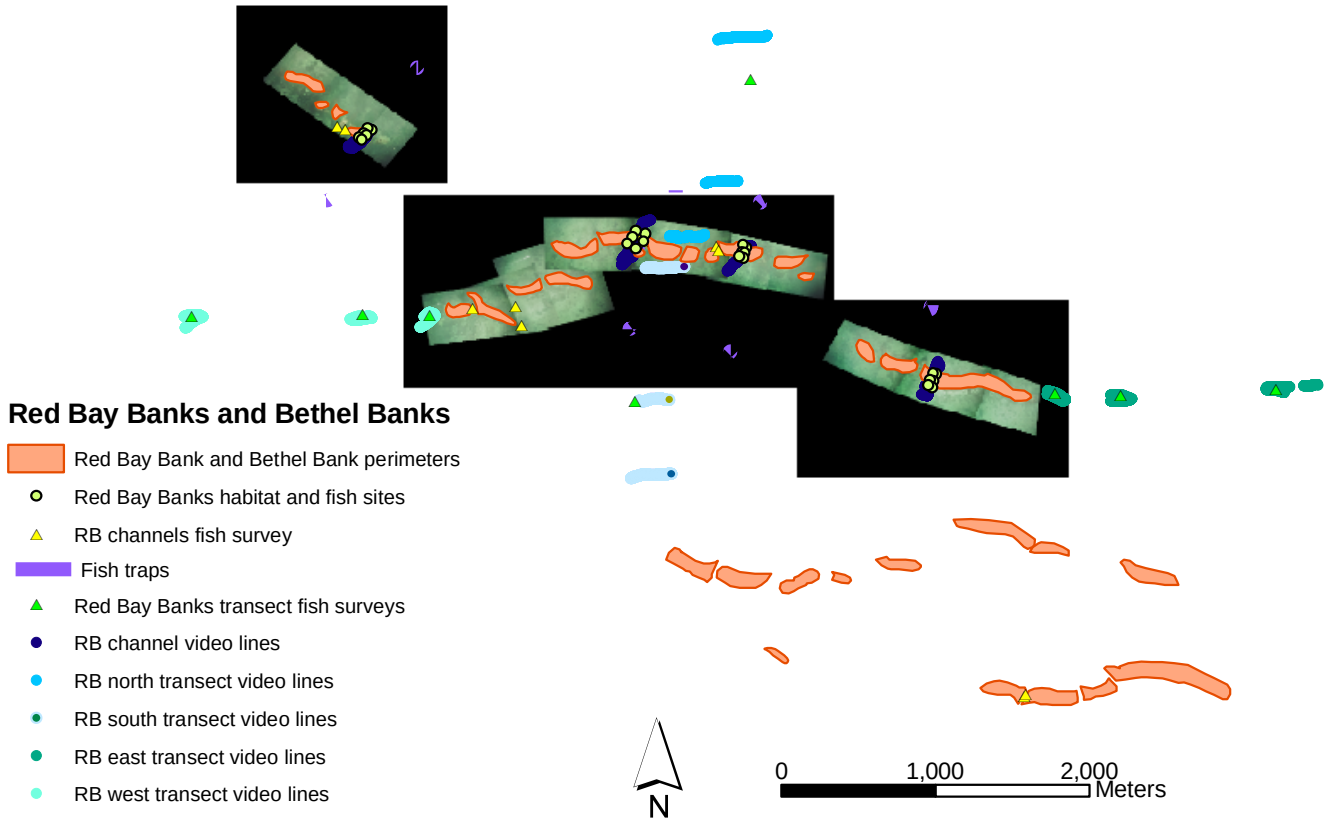

Figure 3. Map of the Red Bay Bank and Bethel Bank systems showing the details of the sampling locations for channels, banks and transects off the banks. Aerial photographs of the banks obtained in May 1992 are overlaid on georeferenced bank features defined in the FKNMS Habitat Atlas.

We compared channel bank systems in each of the Red Bay Banks, Bamboo Banks, and Channel Key Banks systems to sites located away from the bank systems (Figures 3-5). Channels were selected randomly from within each of the three bank systems. At the deepest point within each of these selected channels, fish were surveyed using the five minute point count method described above. Off-bank transect sites for all three bank systems were selected to be 0.1km, 0.5km, and 1.5 km distances from bank system edges on an east-west axis, and oriented to be as much away from other bank systems as possible. At each site on each off-bank transect, two fish surveys were conducted approximately 30 meters east and west of the site. At fish survey sites on the Red Bay Banks off-bank east and west transects, benthic cover and abundance was characterized using visual Braun-Blanquet habitat assessment, with four 0.25m^2 quadrats per site. Digital video lines were recorded at each randomly selected channel within Bamboo Banks and Channel Key Banks (Figures 4-5), at Channels 1-4 on Red Bay Banks (Fig. 3), and on off-bank transects from Red Bay Banks and Bamboo Banks (Fig. 3 and 4). Additional digital video was collected on transects located north and south of Red Bay Banks, at 0.1km, 0.5km, and 1.5km distances from bank system edges (Figure 3)

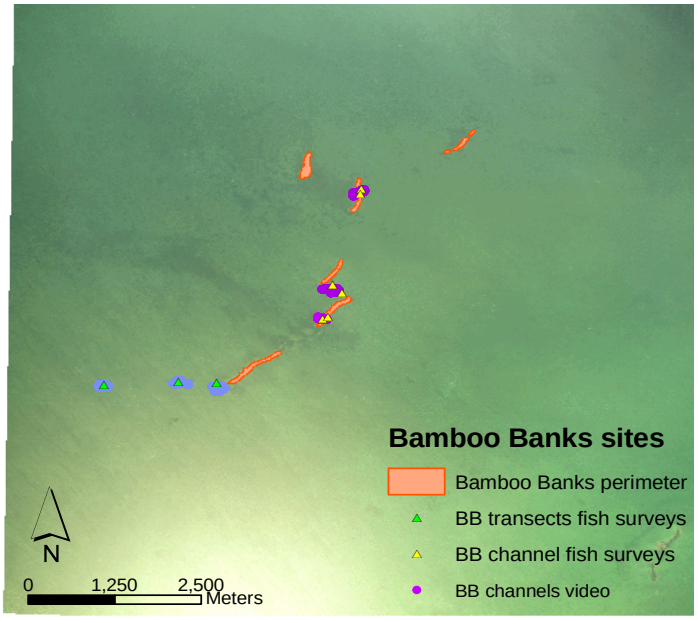

Figure 4. Aerial photograph of Bamboo Banks and delineation of bank locations and sampling sites.

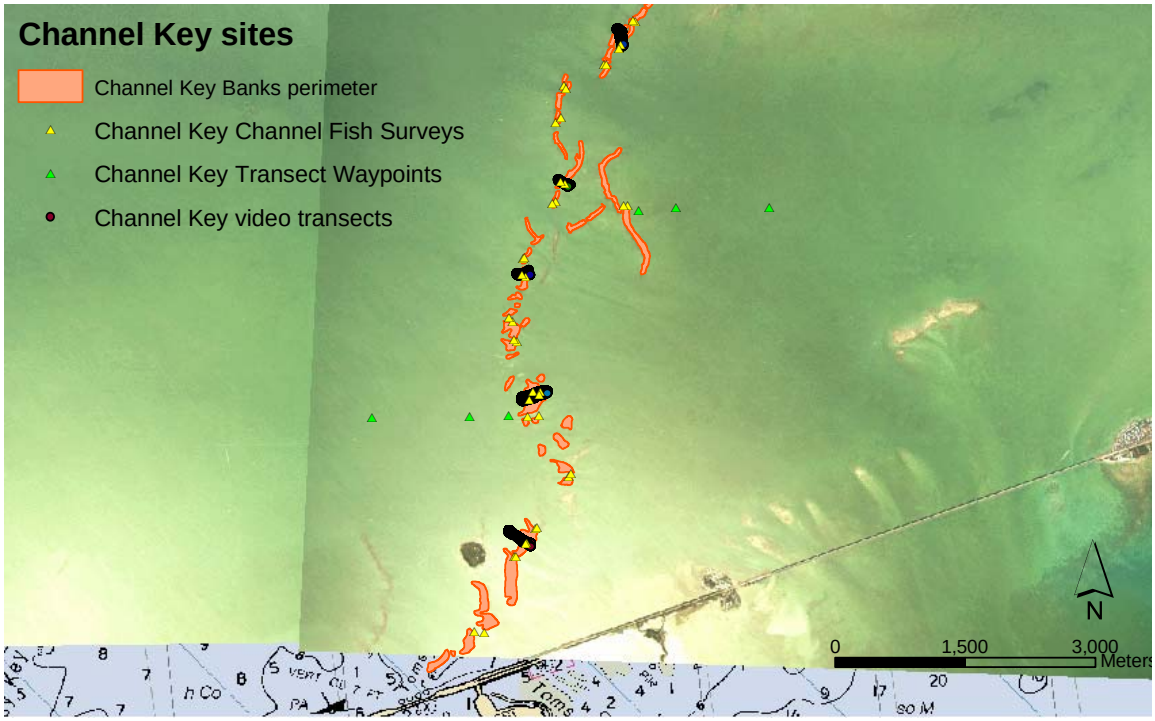

Figure 5. Aerial photograph of channel banks region and designation of bank locations and study sites associated with this bank and channel system.

Video Characterization

As part of the study we developed a video pole system for deployment from a 21ft. center console outboard motor vessel. The pole was designed to record digital video of benthic habitats along line transects (Figure 6). This system, designed specifically for channel sites where current velocities can exceed 2 knots and diver acquisition of video is very difficult, was field tested on the June 2004 trip. Two Seaviewer underwater cameras were affixed to the foot of the video pole. The video pole, mounted on the research vessel gunwale, could be adjusted vertically to maintain camera height/depth of approximately 1 meter off the bottom. A transducer at the base of the video pole foot connected to a Lowrance LCX-15MT depth sounder recorded camera vertical height off the bottom. The system also included a Trimble ProXR Differential Global Positioning System (DGPS) integrated with the video and depth transducer using a Horita so that the time and data were stamped onto the video. One camera recorded directly downward for capture of benthic cover. The second camera faced forward with a slight downward angle, to record a wider-angle view of benthic cover as well as approaching physical contours. Resulting digital video was stamped with the Trimble Pro XR DGPS coordinates and collection time, and was linked to a bathymetric file record of camera height. This video will be characterized in terms of benthic habitat types and layered into a GIS.

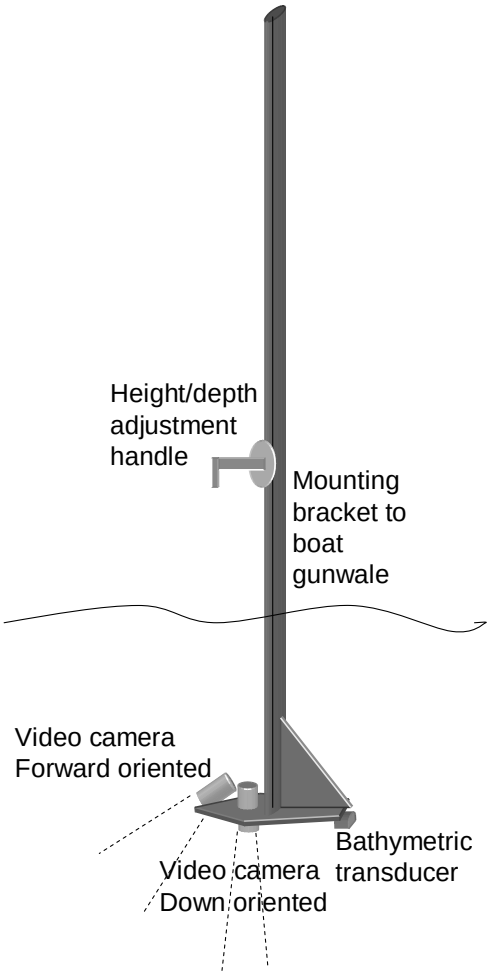

Figure 6. Aluminum pole used to secure and deploy electronic equipment for collecting benthic video transect data from 21 ft. vessel. The pole is secured to a mounting bracket on the gunwale of the vessel. The bracket is designed to allow the entire pole to pivot the cameras and transducer can be lifted from the water. The height and depth adjustment enables the camera to sample at water depths between 0.5 m and 4 m. Cabling for the video camera and transducer are secured to the pole and connected to a Digital Video Recorder and Lowance fathometer located on the deck of the vessel. The entire system including the Trimble DGPS is integrated using a Horita which stamps time, date and DGPS position information on the videotape. The DGPS position information is assembled in a file on the Trimble data logger with the concurrent depth reading from the Lowrance. The Horita time and the Trimble time are calibrated so that the depth readings can be integrated with the video image.

As part of the development and refinement of the video pole and associated data acquisition devices, we contracted an electronics consulting firm, Neve Consulting, to examine and recommend improvements in the pole, camera systems and

computer acquisition of the data. Attached to this report are the summary and recommendations for further development of the video pole for use in this project and other benthic habitat characterization studies in shallow water.

August 2004 Cruise Results

In August 2004 we extended our study sites west into the lower keys region between Harbor Channel and the Key West northwest ship channel (see Figure 7 next page). Using the RV Alexis M for 6 days, a randomly selected set of channels were sampled as described above for habitat characterization and fish and invertebrate communities. The channel selection process included downloading and visually examining the original 1/48000 scale aerial photography obtained in 1992 by NOAA and its State and Federal partners and used to develop the original FKNMS habitat map and Atlas. The photography was loaded into ARC Map, matched to the habitat map layers and visually inspected for site selection.

In this region of the Keys the channels bisect the shallow elevated grass flats and mangrove islands fringing the northern margins of the lower keys, thus hydrologically linking the Gulf of Mexico and Florida Bay to the lower Keys. In addition, the orientation of the bedrock in this geological region is such that the Keys are oriented north and south making the distance from the Gulf of Mexico to the Florida Straits much longer than in the middle and upper Keys regions. Therefore, the connectivity between the Gulf and the Straits is considerably reduced and it is expected that most of the physical/chemical characteristics and biological communities in this region are influenced more by the Gulf of Mexico and Florida Bay than the Florida Straits. These channel bank systems may play an important role as nursery and feeding areas for fish species residing in the Gulf, for organisms transported from more western regions of the FKNMS such as the Marquesas and Dry Tortugas, and for species emigrating from Florida Bay.

The full geographic scope of the study sites are illustrated as a photographic mosaic overlaid on a nautical chart in Figure 8. The different sampling sites are indicated in the figure's legend.

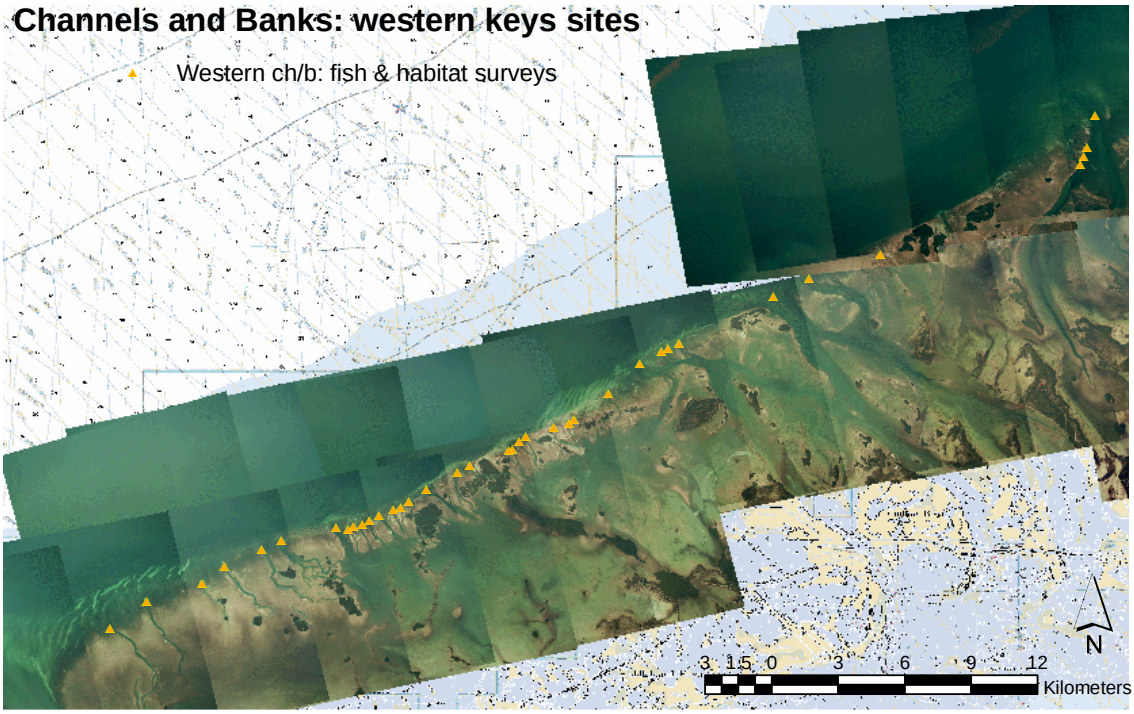

Figure 7. Aerial photomosaic overlaying a nautical chart of the lower Keys. The yellow triangles indicate sampling sights visited during the August 2004 cruise.

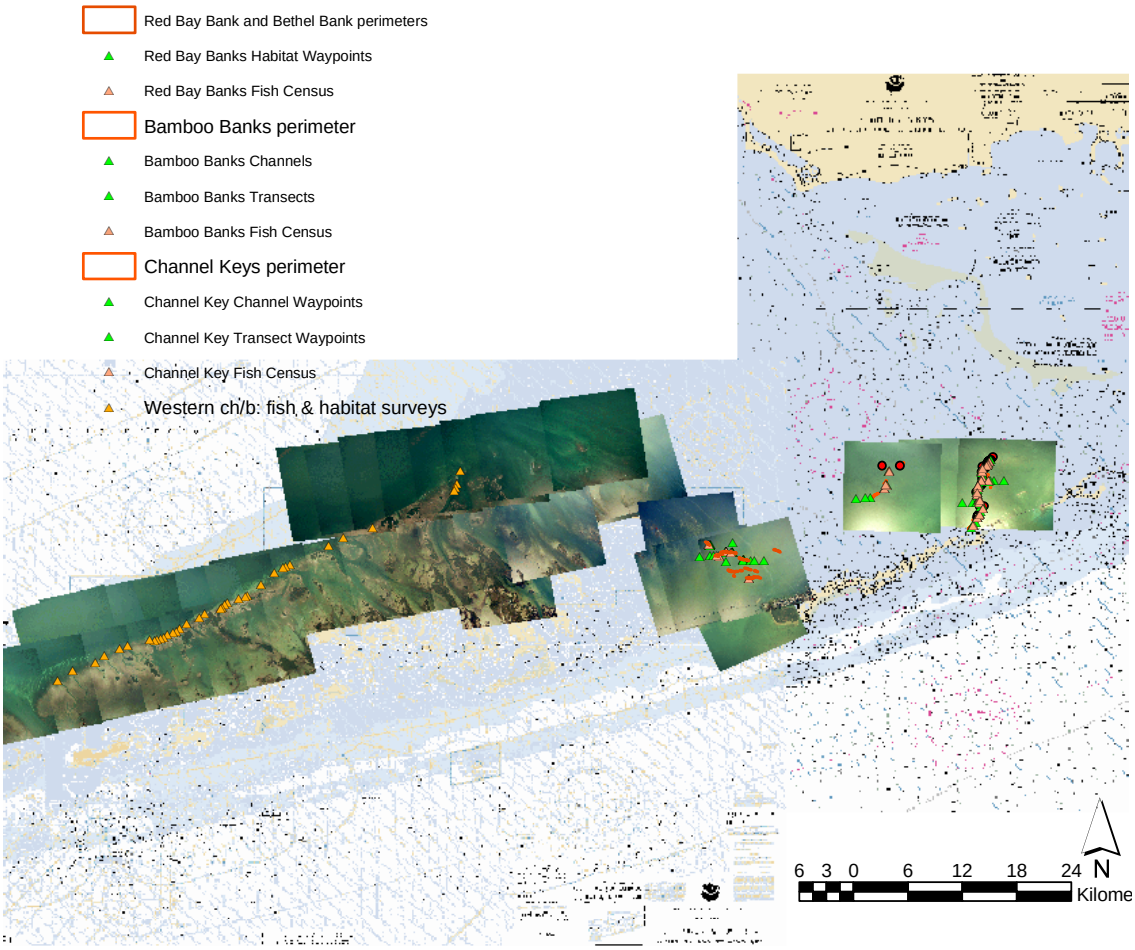

Figure 8. Location of all study sites sampled in 2003 and 2004 with a photomosaic overlaid onto a nautical chart of the region.

Preliminary results for sampling of fish communities in the channel bank systems are presented in tables 1, 2 and 3 below.

Table 1 . Summary of diving (132 dives), fish census (206), habitat assessments (48), and digital video collection effort for the Bank/Channel Survey June 2004. Three systems of banks north of the Florida Keys were sampled: Red Bay and Bethel Banks, Bamboo Banks and the Channel Key Banks.

System	Fixed Station Dives	Fixed Station fish counts	Fixed station habitat surveys	Fixed station video lines	Random Station Dives	Random Station fish counts	Open Bottom Transect Dives	Open Bottom fish counts	Open Bottom transect video lines
Red Bay and Bethel Banks	28	48	48	10	18	36	18	12	12
Bamboo Banks				6	6	12	8	6	3
Channel Key Banks				10	42	80	12	12	

Table 2. Species list and mean number of fishes from point count censuses conducted in three habitats of the channel bank systems during June and August of 2004. 136 point counts were conducted in channel and bank top habitats and 30 point counts were conducted on the open bottom.

Habitat					
Channel		Bank top		Open bottom	
Species	Mean count	Species	Mean count	Species	Mean count
gray snapper	10.65	anchovies	12.55	gray snapper	1.53
white grunt	8.36	gray snapper	3.83	white grunt	1.23
tomtate	5.36	white grunt	2.72	striped parrotfish	0.67
porkfish	2.98	flagfin mojarra	2.12	french grunt	0.53
bluestriped grunt	2.39	striped parrotfish	1.29	slippery dick	0.33
striped parrotfish	1.67	yellowtail snapper	1.18	pinfish	0.23
doctorfish	1.63	pinfish	1.16	doctorfish	0.20
grunt species	1.25	mojarra species	0.74	gray angelfish	0.17
gray angelfish	1.16	grunt species	0.63	yellowtail snapper	0.17
yellowtail snapper	1.04	yellowfin mojarra	0.40	bluestriped grunt	0.13
spiny lobster	0.98	lane snapper	0.33	bridled goby	0.13
lookdown	0.55	bucktooth parrotfish	0.32	bucktooth parrotfish	0.10
atlantic spadefish	0.54	tomtate	0.32	sand perch	0.10
rainbow parrotfish	0.54	bluestriped grunt	0.29	bar jack	0.03
sailors choice	0.48	great barracuda	0.24	blue angelfish	0.03
slippery dick	0.46	slippery dick	0.11	cero mackerel	0.03
great barracuda	0.43	sea bream	0.10	grass porgy	0.03
yellow jack	0.43	stoplight parrotfish	0.08	hogfish	0.03
pinfish	0.35	yellow jack	0.07	lane snapper	0.03
yellowtail parrotfish	0.30	grass porgy	0.07	porkfish	0.03
lane snapper	0.29	pluma	0.07	red grouper	0.03
blue runner	0.28	blue runner	0.06	redband parrotfish	0.03

highhat	0.24	sand perch	0.06	striped burrfish	0.03
bucktooth parrotfish	0.22	sergeant major	0.05	yellow stingray	0.03
hogfish	0.22	sailors choice	0.04		
sand perch	0.16	french grunt	0.03		
queen angelfish	0.15	highhat	0.03		
red grouper	0.15	hogfish	0.03		
chub	0.15	rainbow parrotfish	0.03		
redband parrotfish	0.13	sheepshead porgy	0.03		
pluma	0.12	spiny lobster	0.03		
sheepshead porgy	0.11	yellowtail parrotfish	0.03		
flagfin mojarra	0.10	barred hamlet	0.02		
blue angelfish	0.09	puddingwife	0.02		
grass porgy	0.09	bandtail puffer	0.01		
spotfin butterflyfish	0.09	filefish	0.01		
sea bream	0.07	blue parrotfish	0.01		
stoplight parrotfish	0.07	doctorfish	0.01		
blue parrotfish	0.06	gulf flounder	0.01		
puddingwife	0.06	lantern bass	0.01		
barred hamlet	0.05	longsnout seahorse	0.01		
bandtail puffer	0.04	porkfish	0.01		
belted sandfish	0.04	schoolmaster	0.01		
bridled goby	0.04	spotfin butterflyfish	0.01		
cubbyu	0.04	yellowhead wrasse	0.01		
blue tang	0.03				
gag grouper	0.03				
schoolmaster	0.03				
black grouper	0.02				
bar jack	0.01				
beaugregory	0.01				
cocoa damselfish	0.01				
dusky damselfish	0.01				
french grunt	0.01				
yellowfin mojarra	0.01				
banded butterflyfish	0.01				
crevalle jack	0.01				
gray triggerfish	0.01				
gulf toadfish	0.01				
jackknife fish	0.01				
lefteye flounder	0.01				
ocean surgeonfish	0.01				
polka-dot batfish	0.01				
porcupinefish	0.01				
reef butterflyfish	0.01				
rosy razorfish	0.01				
spotted goatfish	0.01				
yellow stingray	0.01				

Table 3. Summary of fish counted within channel habitat of the Northwest Banks lower Keys (NW Banks, N=48 point counts), Channel Key Banks (N=40 point counts) and Moser Channel Banks (N=18 point counts). Species are ranked according to mean number/point count and the % of each species' count relative to the total count.

	NW banks			Channel Keys Banks			Moser Channel Banks		
Rank	Species	Mean count	%	Species.	Mean count	%	Species.	Mean count	%
1	tomtate	14.73	33.2	white grunt	11.88	25.9	white grunt	7.11	15.1
2	white grunt	8.88	20.0	gray snapper	10.65	23.2	gray snapper	7.00	14.8
3	gray snapper	7.85	17.7	porkfish	6.30	13.7	striped parrotfish	6.33	13.4
4	grunt species	2.71	6.1	doctorfish	2.28	5.0	bluestriped grunt	4.83	10.2
5	porkfish	2.25	5.1	bluestriped grunt	2.23	4.9	doctorfish	3.61	7.6
6	gray angelfish	0.81	1.8	lookdown	1.88	4.1	spiny lobster	2.67	5.6
7	atlantic spadefish	0.65	1.5	slippery dick	1.45	3.2	yellowtail snapper	1.94	4.1
8	yellow jack	0.63	1.4	sailors choice	1.28	2.8	blue runner	1.72	3.6
9	rainbow parrotfish	0.58	1.3	gray angelfish	1.23	2.7	highhat	1.61	3.4
10	spiny lobster	0.50	1.1	atlantic spadefish	1.05	2.3	gray angelfish	1.50	3.2
11	chub	0.42	0.9	striped parrotfish	0.98	2.1	tomtate	1.11	2.4
12	lane snapper	0.40	0.9	spiny lobster	0.80	1.7	yellowtail parrotfish	1.11	2.4
13	sand perch	0.31	0.7	rainbow parrotfish	0.55	1.2	great barracuda	1.00	2.1
14	sheepshead porgy	0.31	0.7	redband parrotfish	0.35	0.8	porkfish	0.94	2.0
15	red grouper	0.29	0.7	yellow jack	0.33	0.7	rainbow parrotfish	0.72	1.5
16	flagfin mojarra	0.27	0.6	bucktooth parrotfish	0.28	0.6	grunt species	0.56	1.2
17	pluma	0.27	0.6	yellowtail parrotfish	0.23	0.5	lane snapper	0.50	1.1
18	grass porgy	0.21	0.5	lane snapper	0.20	0.4	pinfish	0.33	0.7
19	blue angelfish	0.17	0.4	great barracuda	0.18	0.4	sailors choice	0.28	0.6
20	pinfish	0.17	0.4	yellowtail snapper	0.18	0.4	slippery dick	0.28	0.6
21	sea bream	0.17	0.4	blue parrotfish	0.15	0.3	stoplight parrotfish	0.28	0.6
22	sailors choice	0.15	0.3	red grouper	0.15	0.3	hogfish	0.22	0.5
23	barred hamlet	0.13	0.3	sand perch	0.15	0.3	queen angelfish	0.22	0.5
24	belted sandfish	0.13	0.3	hogfish	0.13	0.3	spotfin butterflyfish	0.17	0.4
25	bluestriped grunt	0.13	0.3	puddingwife	0.13	0.3	bridled goby	0.11	0.2
26	hogfish	0.13	0.3	queen angelfish	0.13	0.3	dusky damselfish	0.11	0.2
27	bandtail puffer	0.10	0.2	blue angelfish	0.10	0.2	grass porgy	0.11	0.2
28	bucktooth parrotfish	0.10	0.2	highhat	0.10	0.2	banded butterflyfish	0.06	0.1
29	cubbyu	0.10	0.2	spotfin butterflyfish	0.10	0.2	barred hamlet	0.06	0.1
30	spotfin butterflyfish	0.10	0.2	stoplight parrotfish	0.10	0.2	beaugregory	0.06	0.1
31	yellowtail snapper	0.10	0.2	blue runner	0.05	0.1	black grouper	0.06	0.1
32	schoolmaster	0.08	0.2	bridled goby	0.05	0.1	cocoa damselfish	0.06	0.1
33	blue tang	0.06	0.1	french grunt	0.05	0.1	gag grouper	0.06	0.1
34	gag grouper	0.06	0.1	bandtail puffer	0.03	0.1	pluma	0.06	0.1
35	great barracuda	0.06	0.1	beaugregory	0.03	0.1	puddingwife	0.06	0.1
36	yellowtail parrotfish	0.06	0.1	blue tang	0.03	0.1	red grouper	0.06	0.1
37	bar jack	0.04	0.1	cocoa damselfish	0.03	0.1	redband parrotfish	0.06	0.1
38	black grouper	0.04	0.1	gray triggerfish	0.03	0.1	rosy razorfish	0.06	0.1
39	queen angelfish	0.04	0.1	lefteye flounder	0.03	0.1	sand perch	0.06	0.1
40	blue runner	0.02	0.0	pluma	0.03	0.1	sea bream	0.06	0.1
41	bridled goby	0.02	0.0	reef butterflyfish	0.03	0.1	spotted goatfish	0.06	0.1
42	crevalle jack	0.02	0.0	sea bream	0.03	0.1	yellow stingray	0.06	0.1
43	gulf toadfish	0.02	0.0	yellowfin mojarra	0.03	0.1			
44	jackknife fish	0.02	0.0						
45	ocean surgeonfish	0.02	0.0						
46	polka-dot batfish	0.02	0.0						
47	porcupinefish	0.02	0.0						
48	yellowfin mojarra	0.02	0.0						

COORDINATION WITH ANY ANY OTHER ONMS/NCCOS PROJECTS AT THIS SANCTUARY (e.g. ONMS/NCCOS projects, USGS, State, etc.): *describe how activities and goals are coordinated with other Principal Investigators at this site for this quarter, if any.*

Baseline data collected for the habitat mapping and characterization information is being compiled for inclusion into a database describing the physical and biological injuries to shallow channel and bank habitats caused by motor vessels operating in the FKNMS. This information is being used by FKNMS biologists, NOAA Damage Assessment Center and NOAA General Counsel in NOAA's Mini 312 Damage Assessment and Restoration Program. We are also coordinating with the Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute. Coordination is maintained through monthly conference calls, development of a Programmatic Environmental Impact Statement, email contact, dissemination of reports and revision of reports through electronic and hard copy documents. Periodic meetings are conducted to assess program progress. Staff associated with the project meet in the FKNMS to conduct joint field work, discuss results and coordinate activities.

III. LIST NCCOS STRATEGIC PLAN CENTER ID MILESTONE #'s ADDRESSED BY THIS WORK: *please use the most recent version for this – you may refer to the Spending Plan document as a reference.*

1.1 Protected areas baseline assessment of "resources"

1.4 Coastal managers will have the ability to evaluate alternative actions to accomplish conservation objectives:

1.4.2 Marine Protected Areas

1.5 Decision-making in NOAA's Marine Sanctuaries

IV. LIST ONMS *PRIORITY ENDPOINTS* FOR THIS SANCTUARY ADDRESSED BY THIS WORK:

Please reference - http://sanctuaries.nos.noaa.gov/library/national/science_eval.pdf

1. Habitat Delineation
2. Living Marine Resources
3. Restoration/Rehabilitation

V. PUBLIC INFORMATION RELEASE: *please help us promote undersea science by writing a paragraph highlighting the importance of the research that may be used for public distribution and press releases.*

Not yet complete

VI. DESCRIPTIVE GRAPHICS: *to minimize the number of times you will be queried for graphics that help describe your project, please send relevant graphics with descriptions and attribution; .wmf format preferred (mark.fonseca@noaa.gov).*

APPENDIX 1; VIDEO POLE DESIGN AND IMPROVEMENTS

Overview
The purpose of this document is to describe available options for a new data gathering system. This system would be designed specifically to meet the requirements of the initial project, the characterization of the channel banks, but hopefully would have much broader applications. For the purpose of analysis, the project has been broken in to two main sections, data collection and data processing. Data collection would take place on a small vessel where ease of setup and use are the priority. Data processing would include manipulation of the data to get it in to a usable form, and data analysis to extract and expand upon collected data.

means there needs to be more investigation or a decision.

Data Collection
The data to be collected is both numerical and video. For the initial project, data will include time, position, height of camera off of bottom, and water depth. Future data sources are limitless, but could include distance from a pre-entered waypoint, turbidity, salinity, heading, bottom density, and any other measurement that is available via a RS232 (serial) connection.

Video Generation

Cameras
The current SeaViewer cameras will be used. The each have a single composite video output with an RCA jack. They are small, robust, and take a 12 volt power source. The primary limitation of these cameras is image quality. There would be some big advantages to using cameras with firewire connections, but no viable underwater solutions have been found. It may be worth contacting SeaViewer to see if they have any new products planned.

The two cameras are mounted on a pole attached to the side of the vessel. The pole is manually raised and lowered in an attempt to keep the cameras a constant height above the bottom. At the bottom of the pole, one camera points down, and one camera points forward. The forward camera is used mainly to view up coming terrain and control pole height. The downward facing camera collects the video to be analysed.

Position Overlay
The current Horita video overlay boxes will be used. They will take time and position information directly from the main GPS unit and overlay this information on the video streams.

The Horita units are notoriously hard to set up, and add a layer of hardware complexity. Non-hardware solutions to overlaying data should be investigated.

Data Generation

The ShipModul MiniPlex-42BT multiplexer can collect data from up to four NMEA sources. These sources can be either single function, such as a GPS or composite as in the case of a GPS/fishfinder that outputs both bathymetry and position information. For the initial application we will be looking at position and depth information.

Position
For the initial application, two position sources will be available, the Trimble GPS and a Garmin GPS/fishfinder. Although in theory the Trimble can be much more accurate, in operation on a moving platform with no ability to get an initial non-moving fix, there may be little or no advantage to the Trimble. If this is so, using the Garmin for both position and bathymetry would greatly simplify the system.

The accuracy difference between the Trimble and Garmin in real world applications should be investigated. If there is not much difference, the Trimble could be connected to the depth of water bathymetry unit as a self contained system for mapping water depths while the Garmin is used to collect data that will be correlated with the video. A possible problem of importing the Trimble position and bathymetry data directly to a shape file would be normalizing for tidal variation.

The GPS data will also be used as a time source.

Most GPS units can be set to output their position in different formats and resolutions. As part of a setup checklist, it should be checked that the maximum resolution and decimal position be selected.
Position information should be available with one second resolution.

Depth
The initial configuration will have two bathymetry units, a Garmin GPS/fishfinder, and a 2nd unit (Lowrance?). Although they output the same sentences, this will not be a problem as the multiplexer being used can separate data sources.

All bathy units will have their NMEA outputs wired to the multiplexer's inputs.
One of the bathy units will measure depth of water, the other will measure height of camera

Bathy units should be set to 200 kHz for narrowest beam angle.

Depth information should be available with one or two second resolution.

Data Concentration

The ShipModul MiniPlex-42BT multiplexer can take up to four NMEA inputs at 4800 baud, and output these at 38400 baud. In addition, un-needed sentences can be filtered out. Channel numbers can be added to the data which allows multiple devices that output the same sentences to be used.

The data generated by the multiplexer can be output in two ways, through a RS232 serial port or through a wireless bluetooth connection. The bluetooth option eliminates cables and allows more setup flexibility.

The multiplexer runs off of 12 volts. Because of the way NMEA0138 works, the power negative will need to be common with the negative for the instruments.

PC

PC Hardware
The PC used to capture the data should be either a laptop, or more likely a small form factor or "shoebox" desktop. A PC would allow the use of internal cards for video capture and more hardware flexibility. A PC should also be less expensive for the same capabilities.

Bluetooth capability is available through a simple USB device.

A DVD-R drive could be built in allowing nightly archiving of data to a DVD. Although 8x recorders are becoming available, there are no real-time record to disk solutions yet.

Both Keyboard & pointing devices are available in either wireless or waterproof models.

While there are waterproof displays available, the choice of a display will depend on how the unit is to be used. It need not be large or high quality since it will be used to start and stop data capture, and monitor status. Possible options range from a low cost low quality flat screen monitor to a daylight visible waterproof monitor. Options and costs should be provided.

The PC should have a large fast hard drive in the range of 80GB. This will allow the maximum amount of video storage.

Data Capture
The data capture aspect involves several programs that take the data from the RS232 input to a database.

Shipmodul Mpxconfig
This software allows the configuration of the multiplexer. This includes filtering sentences and adding channel numbers.

Shipmodul Virtualplex
This software uses the channel numbers generated by the multiplexer to send data to different virtual serial ports. This allows the windmill logging software to differentiate devices that output the same sentence. For example two bathymetry units. In conjunction with the multiplexer, it also does away with the need for large serial port expansion cards.

Windmill
The windmill software is used to extract data from multiple serial ports. This data can then be made available to MS excel using Microsoft's DDE.

Microsoft Excel
Macros will need to be written to capture DDE information. Data captured in to Excel files can be post processed for later analysis or exporting.

Video Capture
For video capture there are two hardware options. One comes from the video capture and edit field. It would offer great flexibility and quality, but I have not found any systems that allow the recording of more than one video stream at a time.

Physically these systems are available as PCI cards or external (which could be used with a laptop). If only one camera is used, this may be the best way to go.

If multiple video sources are needed, the solution would come from the video security field. A device such as the Grandtech GXG-4000 4 port PCI card might work best. Being optimized for security cameras, many of the features of this system would be un-necessary, or undesirable, such as motion detection, slow frame rates (5 fps max), or high compression rates. Multiple cameras with motion detection may be a novel way to do fish counts.

Cases
The system will use two Pelican cases, the sensor case and the PC case. The sensor case will contain the multiplexer. It will have the following inputs: a 12 volt power positive power input, common ground, four data inputs, and one data output.

Although all data inputs use an opto-isolated inputs, all of the data sensors use their ground as the low side, rather than an isolated output. This may not be the case for the Trimble. The output would be used for the Horita, but could be shared with other devices if necessary.

The PC case will have a 12 volt or 110 volt input depending on the power source desired. Although there may be PC's with power supplies that use 12 volts DC, no viable options have been found yet. If this remains the case, an inverter or generator will be needed. If an inverter, it will need to be of sufficient size.

The PC case will also contain the Horita(s).

The PC case will have one or more video inputs, a USB port for the keyboard/pointing device, and a monitor connection.

It will also have a two pole NMEA data input for the Horita. It may be possible to get the position data to the Horita via the PC's serial port which would eliminate a cable.

More investigation is needed into specific connector options.

Need a wiring diagram

Other Hardware

In order to monitor the cameras in real time, video splitters can be used between the Horita and external monitors. These monitors could be small black and white CRT screens which are very inexpensive.

Data Processing
Data processing covers everything which will be done after the data is gathered. This will take place nightly during the trip, or upon return to the lab.

Data Backup

As a backup, a DVD-R will be created every night with the day's video and data.

Data Processing

Since the data will be in an excel table, it shouldn't be too hard to perform additional post processing calculations. Examples of post processing include tidal normalization of depths, calculation of distance between samples, calculations of area visible to camera, and perhaps some interpolation of missing data.

Bottom Characterization

It is envisioned that there will be an interactive procedure for characterizing video frames that would facilitate data analysis.

Shape File Generation

Once the data is gathered, it may be processed into a format which can be imported as a shape file. This may require

Other Options & Issues

Direct Video Recorder drives

Direct Video Drives (DVR) such as the FireStore and Laird drives are boxes which have a FireWire video input, and can store video direct to an internal hard drive. They can then be plugged in to a computer and the video can be extracted. Video is recorded in a very high quality format. Extraction of video is very fast.

These drives require Firewire cameras.

Non-PC solution

It may be possible to record the video to DVR drive or other non-PC based video solution while recording the rest of the data to a Palm based device via-bluetooth.

1) Greta Aeby, U.S. Environmental Protection Agency, Gulf Ecology Division (greta@hawaii.edu). FKNMS-2001-001, 1/8/2001 to 3/1/2002 and FKNMS-2002-057, 7/8/2002-12/31/2002 (fish predation component). Effect of Fish Predation on the Health of Corals in the Florida Keys and the Relationship between Increased Levels of MAAs and Protection from UV Stress in Perforate and Imperforate Corals. This project will examine two potential ways in which coral-feeding fish might be affecting the health of corals in the Florida Keys. The role of fish as transmission vectors of black band disease and the affect of fish predation on the tolerance of corals to increased water temperature and UV stress will both be examined. The amended research will test whether there is a relationship between increased MAAs in corals and subsequent protection from UV damage. The MAA content of coral pieces will be manipulated to obtain one group of coral with a high MAA content and one group with a low MAA content. The bleaching response of the two groups of coral when exposed to UV will then be compared. Both perforate (*Porites porites*) and imperforate (*Madracis mirabilis*) corals will be used for these experiments. Science Training in Ecology Program (STEP) a joint cooperation between the U.S. EPA and the Center for Environmental Diagnostics and Bioremediation (UWF).

2) Susan Anderson, University of California at Davis, Bodega Marine Laboratory (susanderson@ucdavis.edu). FKNMS-2001-024, 5/1/2001 to 4/30/2002. UV Effects and Coral Bleaching. We will evaluate the role that climate change may play in altering penetrance of UV radiation over coral reefs and potentially contributing to coral bleaching. In this study, we have combined the investigation of the molecular effects of UV on corals with a remote sensing component. Funding unknown, assume same as previous permit (FKNMS-99-046), which is EPA, NOAA, and NASA that was funded for three years, through 2002.

3) Andrew Baker, Wildlife Conservation Society and Columbia University (abaker@wcs.org). FKNMS-2002-073, 9/23/2002 to 8/31/2003. Symbiont Distributions in Reef Corals as Indicators of Recent Environmental History. This research uses molecular techniques to identify the dinoflagellate symbionts (*Symbiodinium* spp.) of reef-building corals from the Florida Keys reef tract (and the National Marine Sanctuary in particular). It tests for differences in the distribution of symbionts that correlate with environment, and tests the stability of these distributions by transplanting coral colonies between different environments, with and without exposure to a bleaching stimulus. National Undersea Research Program, UNCW.

4) Iliana Baums, University of Miami, Rosenstiel School of Marine and Atmospheric Science/MBF (ibaums@rsmas.miami.edu). FKNMS-2001-009, 3/12/2001 to 12/31/2002. Genetic Status of *Acropora palmata* Populations in the Caribbean. This project will contribute to the status review of Candidate species (under the Endangered Species Act) *Acropora palmata*, by addressing questions relating to species life history and ecology, as well as population status, history and trends. Specifically, we seek to determine the genotypic diversity within local populations of this coral, and the extent to which geographically isolated populations are genetically similar, information that will be essential for future conservation and recovery efforts. These findings will aid in assessing the degree of genetic bottleneck that already threatens *A. palmata* recovery and the potential for natural dispersal to repopulate areas of extirpation. NOAA NMFS Candidate Species Program, Project #CP-01-SEC02.

5) Carole Bewley, National Institutes of Health (cb194k@nih.gov). FKNMS-2002-069, 10/14/2002 to 12/31/2004. Investigations of Carbohydrate-Binding Proteins from Marine Cyanobacteria. Collect cyanobacteria samples from subtropical waters and investigate the presence of carbohydrate binding proteins. If such proteins are present, we will determine their optimal ligands and the source of their natural receptors using biochemical and chemical techniques. National Institutes of Health.

6) Gregory Bodnar, Marine Resources Development Foundation (gbodnar@hotmail.com). FKNMS-2001-070, 9/17/2001 to 9/30/2002. Implementation of Permanent Research Stakes within the FKNMS to Conduct ReefCheck Methodology. Permanent stakes will be installed at Grecian Dry Rocks and Molasses Reef for monthly data collection using the ReefCheck protocols. Systematic data collection of benthic substrate, fish and invertebrate diversity and abundance will be collected using this non-invasive, tested methodology. Marine Resources Development Foundation.

7) James Bohnsack, National Marine Fisheries Service, Southeast Fisheries Science Center (jim.bohnsack@noaa.gov). FKNMS-2000-031, 5/15/2000 to 12/31/2002. Non-destructive Visual Census of Reef Fish Populations in the Florida Keys. This research is part of an ongoing project to assess reef fish populations of the Florida Keys, from Fowey Rocks to the Dry Tortugas. This project is also part of the Sanctuary's Marine Zone Monitoring Program to assess reef fish changes inside and outside fully protected zones. NMFS; NURC support for paired benthic & fisheries assessments in Dry Tortugas. [Summary of findings in annual report]

8) Jill Borger, University of Miami, Rosenstiel School for Marine and Atmospheric Sciences (jborger@rsmas.miami.edu). FKNMS-2001-074, 10/17/2001 to 10/16/2001 and FKNMS-2002-064, 11/27/2002 to 12/31/2003. Coral Disease Ecology and the Effects of Disease on Reproduction. This project is an extension of work begun last year. The permit will cover two projects; the first involves a detailed examination of specific reef sites in order to follow the specific incidence, movement and transmission of coral diseases over time. This will involve non-destructive sampling methods, such as transect lines and quadrats, and detailed maps of each site will be constructed. The second project will examine the effects of disease on coral reproduction. A few samples will be taken from both diseased and healthy colonies and total fecundity, or reproductive output, will be measured histologically. The fecundity values for diseased and healthy colonies will be compared and analyzed. Reitmeister Award and anonymous donation to Jill Borger.

9) Joan Browder, NOAA/National Marine Fisheries Service (joan.browder@noaa.gov). FKNMS-2002-002, 1/3/2002 to 12/31/2003. Post-larval Sampling Project. The purpose of the sampling project is to describe spatial and temporal patterns of postlarval pink shrimp immigration to potential nursery grounds in Florida Bay from offshore spawning grounds. Accessibility of potential nursery grounds to pink shrimp postlarvae (i.e., postlarval ingress rate) may be an important factor limiting the Bay's capacity to produce pink shrimp recruits to the Tortugas fishing grounds. NOAA/NMFS Southeast Fisheries Science Center.

10) Michael Burton, NOAA/National Marine Fisheries Service (michael.burton@noaa.gov). FKNMS-2002-034, 5/8/2002 to 3/31/2003. Biological Characterization of Riley's Hump and

Identification of Spawning Areas. Visual census transects (SCUBA) will be used to quantify mutton snapper abundance in the vicinity of Riley's Hump and compare it to baseline data. Habitat will be characterized by divers using 0.5 m^2 quadrats. NOAA/NMFS Coral Reef Initiative.

11) Mark Butler, Old Dominion University (mbutler@odu.edu). FKNMS-2002-043, 6/5/2002 to 6/4/2003. Characterization of Hardbottom Community Dynamics: Sponges, Octocorals, Lobsters, & Octopus. My research team is currently working on several related projects involving the shallow, hard-bottom communities so common throughout the Florida Keys. In some cases, our research is focused on the ecology of single species of specific ecological or economic importance (e.g., spiny lobster, commercial sponges, octopus). In other cases, our research involves community-level assessment and the influence of environmental (e.g., salinity change) or human factors (e.g., fishing) on the structure of hard-bottom communities over large spatial scales. In both cases, we use a combination of field sampling, field and laboratory experimentation, and computer simulation modeling to test hypotheses of interest. National Science Foundation, OCE-0136894 and NOAA Coastal Ocean Program.

12) Roy Caldwell, University of California, Berkeley (4roy@socrates.berkeley.edu). FKNMS-2002-062, 10/18/2002 to 12/31/2003. The Biology of Stomatopod Crustaceans. This proposal focuses on stomatopod crustaceans, asking basic biological questions about their distribution and abundance, reproductive behavior, larval dispersal, and how they communicate in a colorful underwater world. NOAA/National Undersea Research Center, Key Largo.

13) Mary Alice Coffroth, State University of New York at Buffalo (coffroth@buffalo.edu). FKNMS-2000-029, 5/1/2000 to 2/28/2002. Reef Connectivity: A Study of Larval Supply and Source of Recruits to the Florida Keys and the Flower Garden Banks. The level of local dispersal and source of coral recruits to the Florida Keys and the Flower Garden Banks will be examined in order to assess reef interdependence or connectivity. In this study the population genetic structure of coral at two sites that vary in their potential for genetic exchange (i.e., Florida Keys and Flower Garden Banks) will be used to infer present (or recent) gene flow patterns in two scleractinian corals, the broadcasting species *Montastraea cavernosa* and the brooding species *Porites astreoides*. NURC supported.

14) Mary Alice Coffroth, State University of New York at Buffalo (coffroth@buffalo.edu). FKNMS-2002-011, 3/4/2002 to 6/30/2004. A Study of Population Dynamics of Scleractinians on Conch Reef: A Demographic and Population Genetics Approach. In this study the influence of recruitment in establishing species composition of reefs will be examined using a combined demographic and population genetic approach to record the species composition at two sites on Conch Reef in the Florida Keys. NOAA/National Undersea Research Center.

15) Felicia Coleman, Florida State University (coleman@bio.fsu.edu). FKNMS-2001-005, 2/23/2001 to 2/28/2003. Studies in the Ecology of Red Grouper, *Epinephelus morio*, including their Contribution to Habitat Heterogeneity and Community Structure. The aim of this project is to examine the structure and function of the community of organisms that take up residence in holes occupied by red grouper. These holes, for the most part, appear to be excavated and maintained by red grouper. The resultant communities are rich in sessile invertebrates and

various species of cleaning fish. Marine Conservation Biology Institute, SeaGrant, and Environmental Defense.

16) Carrollyn Cox, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (carrollyn.cox@fwc.state.fl.us). FKNMS-2001-022, 4/23/2001 to 12/31/2002. Spiny Lobster Spawning Potential and Population Assessment: A Monitoring Program for the South Florida Fishing Region. The proposed study is part of the Sanctuary's Marine Zone Monitoring Program and seeks to investigate the effects of no-take management on this important fishery resource. FMRI. [Summary of findings in annual report]

17) Kerry Davies, Florida State University (davies@bio.fsu.edu). FKNMS-2001-066, 8/29/2001 to 9/1/2002. The Identification and Characterization of Bacterial Flora Associated with Spiny Lobsters in the Florida Keys and the Etiology of Shell Disease in the Caribbean Spiny Lobster, *Panulirus argus*. The purpose of this project is to isolate and identify culturable bacterial flora associated with crustaceans (specifically, spiny lobsters), sediment, and seawater in the Florida Keys. The aim is to isolate and identify microorganisms that may be specifically associated with the shell of spiny lobsters in an effort to determine the ecological significance of crustacean associated bacterial flora and its possible role in shell disease related symptoms. FSU/Reeves.

18) Alan Duckworth, Harbor Branch Oceanographic Institution (aduckworth@hboi.edu). FKNMS-2001-049, 7/23/2001 to 9/30/2003. Aquaculture of the Sponge *Forcepia* sp. for the Sustainable Supply of Bioactive Metabolites for Biomedical Research. The sponge *Forcepia* sp. will be farmed for 1 year at a depth of 20-25m near Tennessee Reef to determine if in situ aquaculture can supply sufficient and sustainable quantities of the metabolites lasonolides for biomedical research. The farmed sponges will be harvested at different rates to examine whether regular tissue harvesting can increase overall yield of lasonolide metabolite. Sponges will be farmed in mesh arrays, which will be either pegged flat to the substrate or held upright in the water column. One array will be maintained beyond the 1-year period and will be used as a supply for ongoing, grant-funded research on the lasonolides. HBOI.

19) Peter Edmunds, California State University at Northridge (peter.edmunds@csun.edu). FKNMS-2002-021, 6/1/2002 to 12/31/2003. Global Climate Change and Coral Recruitment: The Interactive Effects of Temperature and Ontogeny on the Biology of *Porites astreoides* Larvae. The goal of this project is to carry out a multidisciplinary analysis of the biology, physiology and genetics of coral larvae in order to understand how global climate change will affect the coral population structure of reefs such as those in the Florida Keys. NOAA/National Undersea Research Center.

20) David Eggleston, North Carolina State University (eggleston@ncsu.edu). FKNMS-2002-061, 7/2/2002 to 12/31/2003. Fish and Caribbean Spiny Lobster Distribution and Abundance in the Great White Heron National Wildlife Refuge: An Initial Assessment and Comparison with the Key West National Wildlife Refuge. We will use aerial photographs, ground-truthing and GIS computer software to identify and map habitats within the GWHNWR within which to quantify fish and Caribbean spiny lobster. We will use visual surveys conducted by SCUBA divers to quantify fish and lobster, as well as measure specific habitat characteristics. The study

will provide baseline data and be used to make research and management recommendations. Grant from The Ocean Conservancy and U.S. Fish and Wildlife Service.

21) Craig Faunce, Audubon of Florida (cfaunce@audubon.org). FKNMS-2001-064, 9/1/2001 to 9/30/2002. Fish Utilization of Mangrove Fringe Habitats in Southeastern Florida. Our research will evaluate the hypothesis that coastal mangrove communities in tropical and subtropical ecosystems directly and indirectly increase the resilience of exploited reef and other fishes by providing critical habitat for juvenile and sub-adult stages. Awards/grants from NOAA/NMFS Coral Reef Initiative, EDF, and USGS.

22) Bill Fitt, University of Georgia, Institute of Ecology (fitt@sparrow.ecology.uga.edu). FKNMS-2001-007, 3/8/2001 to 12/31/2002. Long Term Monitoring of Tissue Biomass from Five Species of Reef Corals. This project is a continuation of a seasonal monitoring program designed to document the relative physiological health of coral tissue and zooxanthellae for five major coral species in the Keys. Tissue biomass, levels of proteins, carbohydrates and lipids, C:H:N analysis and zooxanthellae photosynthetic potential, densities and chlorophyll content will be determined every 2-3 months for five species of corals living on the Florida Reef Tract. Former support of National Undersea Research Center and University of Georgia. We will be applying to NSF this year to fund the long-term work.

23) Bill Fitt, University of Georgia, Institute of Ecology (fitt@sparrow.ecology.uga.edu). FKNMS-2001-063, 8/27/2001 to /1/2003. Potential for *Acropora cervicornis* (staghorn coral) and *Acropora palmata* (elkhorn coral) in Coral Reef Restoration: Genetics, Physiology, and Growth. This proposal addresses two major issues concerning populations of *A. cervicornis* and *A. palmata* in the Caribbean: the genetic structure and diversity, and some basic questions concerning transplantation. We will compare populations of both species from two locations: relatively pristine reefs (low human impact) near the Caribbean Marine Research Center on Lee Stocking Island in the Bahamas vs. relatively high human impact sites in the Florida Keys National Marine Sanctuary. NOAA/National Undersea Research Center.

24) Nicole Fogarty, The Nature Conservancy (nfogarty@tnc.org). FKNMS-2001-012, 4/1/2001 to 12/31/2002. Sea Stewards Monitoring Program. The Sea Stewards program is part of the Sanctuary's Level III Monitoring program. Volunteers are recruited to provide long-term monitoring of the Sanctuary Preservation Areas and associated reference sites. [Summary of findings in annual report]

25) Mark Fonseca, NOAA/Center for Coastal Fisheries and Habitat Research (CCFHR) (mark.fonseca@noaa.gov). FKNMS-2001-023, 5/1/2001 to 6/30/2003. Effects of Crab/Lobster Traps to Seagrass Beds of the Florida Keys National Marine Sanctuary (FKNMS): Damage Assessment and Evaluation of Long-Term Recovery. This project will assess the effect (if any) of stationary fishing gear (i.e. crab/lobster traps) to seagrass beds of the FKNMS. Replicate traps will be randomly placed within randomly selected seagrass beds of varying species composition. Intermittent removal of traps will determine the time it takes to sustain injury to the beds. Injury recovery will be tracked quarterly to semi-annually over the following two years. NOS and NMFS.

26) Mark Fonseca, NOAA/Center for Coastal Fisheries and Habitat Research (CCFHR) (mark.fonseca@noaa.gov). FKNMS-2001-029, 6/11/2001 to 6/30/2003. A Novel Technique for the Restoration of Seagrass Propeller Scars: Does Deployment of Sediment-filled, Biodegradable Fabric Tubes in Propeller Scars Enhance Seagrass Regrowth into These Injured Areas? This project will assess the effectiveness of a new method for propeller scar restoration in the FKNMS. Fabric tubes and bird stakes will be deployed into existing propeller scars in a replicated experiment. Intermittent monitoring of treatments will be tracked quarterly to semi-annually over the following two years. NOS.

27) Mark Fonseca, NOAA/Center for Coastal Fisheries and Habitat Research (CCFHR) (mark.fonseca@noaa.gov). FKNMS-2002-009, 2/15/2002 to 12/31/2003. Characterization and Analysis of Seagrass Injury and Recovery on Shallow Seagrass-Coral Banks in the FKNMS. The objectives of this study are to develop a comprehensive database of the complete range of injury categories and the widest possible range of injury ages and species combinations to be modeled in the Habitat Equivalency Analysis. In addition to these detailed injury sites, we will characterize the current conditions on the entire Red Bay bank system using 1/9600 scale vertical aerial photography integrated with differential global positioning system based ground surveys. We will conduct a replicated experiment to determine the effect of excavation depth on the recovery rate of injured *Thalassia testudinum* meadows. We hypothesize that the severity of injuries to a *Thalassia* meadow will be a function of the depth of sediment excavated by the disturbance. NOAA/National Ocean Service/Office of Coastal Resource Management and National Centers for Coastal Ocean Science/CCFHR. [Summary of findings in annual report]

28) James Fourqurean, Florida International University (fourqure@fiu.edu). FKNMS-2001-035, 8/2/2001 to 12/31/2002. Seagrass Monitoring in the Florida Keys National Marine Sanctuary. This project will provide baseline data on the status, species composition, and distribution of seagrass communities within two of the Sanctuary no-take zones, as well as other sites throughout the Sanctuary. This project is part of the FKNMS and EPA Water Quality Protection Program. U.S. EPA/WQPP, FIU. [Summary of findings in annual report]

29) Robert Glazer, Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission (bob.glazer@fwc.state.fl.us). FKNMS-2001-055, 8/2/2001 to 8/31/2003. Survey and Rehabilitation of Queen Conch within the Florida Keys National Marine Sanctuary. The surveys include visual surveys of sites where conch are sparse, belt-transects of densely populated conch aggregations in offshore reef flats, tag-recapture sampling of nearshore conch aggregations, and sonic tagging experiments. Many of these surveys will be conducted within the Sanctuary Preservation Areas of the Florida Keys National Marine Sanctuary and are conducted as part of the marine zone monitoring surveys. The secondary goal of this research is to determine the spatial and temporal distribution of queen conch larvae in and around the different regions of the Florida Keys. This information will lead to determining the optimal release location of hatchery-reared or transplanted queen conch based upon the probability that conch larvae spawned in that location will recolonize the Keys. FMRI/FWC. [Summary of findings in annual report]

30) Robert Glazer, Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission (bob.glazer@fwc.state.fl.us). FKNMS-2001-056, 8/7/2001 to 8/31/2002.

Transplantation of Wild Queen Conch from the Nearshore Zone to Offshore Spawning Aggregations: A Strategy for Restoring Florida's Conch Population. The goal of this project is to evaluate the efficacy of a large-scale transplantation program designed to restore the local queen conch spawning population. We will also assess the ecological impacts of a large-scale transplantation program. To meet these objectives, we will transplant juvenile and adult conch from nearshore areas where conch do not spawn to the offshore zone where spawning aggregations are located. Previous studies have shown that conch transplanted from the nearshore zone to offshore recover their reproductive capabilities. U.S. Fish and Wildlife Service, Partnerships for Wildlife Grant.

31) Walter Goldberg, Florida International University (goldberg@fiu.edu). FKNMS-2001-061, 9/1/2001 to 8/31/2002 and FKNMS-2001-067, 8/29/2001 to 9/1/2003. Ultrastructure of Aggression in Corals of the Genus *Mycetophyllia*. This project will test the hypothesis that specialized regions occur at the tip of *Mycetophyllia lamarckiana* or *M. ferox* mesenterial filaments and are used during aggressive behavior. FIU.

32) Dale Griffin, U.S. Geological Survey, Center for Coastal and Regional Marine Studies. FKNMS-2002-058, 6/27/2002 to 7/31/2002. Microbial Water Quality in Nearshore and Offshore Sites in the Florida Keys. Sediments, coral mucus, and the water column will be screened for the presence of microbial fecal indicators in nearshore and offshore waters in the Florida Keys. Mucus from diseased and healthy corals of the same species will be utilized to create a microbial community DNA fingerprint that may allow the identification of the disease-causing pathogen. USGS, University of Georgia.

33) Pamela Hallock Muller, University of South Florida (pmuller@marine.usf.edu). FKNMS-2000-011, 3/2/2000 to 12/31/2002. Long-term Monitoring of Stress in Reef-Dwelling Foraminifera. The reef-dwelling foraminifera, *Amphistegina gibbosa,* have exhibited bleaching and associated symptoms on Florida Keys reefs since summer of 1991. This project will continue long-term monitoring of populations at Conch and Tennessee Reefs, will compare symbiont taxa within *A. gibbosa* between these reefs, and will collect solar insolation data using long-term deployable radiometers. USEPA-ORD-NCERQA grant, 10/1/97 - 9/30/2000 (1 year no-cost extension will be requested). Amendment #2 work done in conjunction with Cheryl Woodley of NOAA and is funded by South Carolina Sea Grant.

34) Heather Ann Halter, Nova Southeastern University, National Coral Reef Institute (NCRI), (heatherhalter@angelfire.com). FKNMS-2001-077, 12/1/2001 to 9/30/2002. Comparison of Spatial, Seasonal and Substrate Changes of Net Carbonate Accumulation on Three South Florida Coral Reef Sites. The goal of this study is to differentiate short-term net carbonate accretion/erosion in Ft. Lauderdale versus the Florida Keys according to three variables: location, season, and substrate type. Carbonate tiles will be placed on the hard bottom at two different depths at three sites: two in Ft. Lauderdale and one in the Florida Keys, the Tennessee Reef Research-Only Area. NSU Thesis Tuition Reimbursement.

35) M. Dennis Hanisak, Harbor Branch Oceanographic Institution (hanisak@hboi.edu). FKNMS-2000-058, 9/1/2000 to 9/30/2002. Long-term Monitoring of Benthic Algal Communities at the *Wellwood* Grounding Site, Molasses Reef, FKNMS. The grounding of the

freighter *M/V Wellwood* on Molasses Reef in August 1984 was a catastrophe of unprecedented proportion in the Sanctuary (the damaged area was 4,865 m^2, with the most severe damage in a flattened area of 1500 m^2). Previously, this research team monitored recolonization of the benthic reef community, with major emphasis on algae, at the *Wellwood* site on Molasses Reef for four years (1985-88) after the grounding and did additional monitoring 10 years later (1995-96). The proposed sampling will extend the database previously obtained, which has application, both in terms of reef recovery after physical disturbance, but also to document long-term changes in the benthic algal community that appear to be occurring at this site. Limited resources required are being provided by HBOI.

36) Clay Harris, Middle Tennessee State University (cdharris@mtsu.edu). FKNMS-2001-041, 7/5/2001 to 10/31/2002. The Wreck of the El Lerri: Is One of America's Oldest "Artificial Reefs" Functioning Ecologically as a Patch Reef or a Hard Bottom Community? We propose to perform a survey of attached benthic inhabitants (coral, sponge, and algae) at (1) a ballast pile (i.e. artificial reef), (2) two patch reef sites (PRS-1 & PRS-2), and (3) two hard-bottom communities (HBS-1 & HBS-2) -- all within 0.25 to1.5 nautical miles of shore on the ocean side of Lower Matecumbe and Craig Keys. At each of the five sites we will lay out two 25-m transects of contiguous 1 m^2 quadrats and perform a census of attached benthic organisms to (1) assess coral, sponge, and algae abundance, cover, and health using a consecutive quadrat method and at ELAR, (2) using hand-held, U/W video, develop a coral distribution map for future comparison. If time permits, we will also perform general ecological surveys of the quadrats using hand-held, U/W videography. MTSU grant #2-47401 and PADI Foundation.

37) Clay Harris, Middle Tennessee State University (cdharris@mtsu.edu). FKNMS-2002-003, 1/3/2002 to 12/31/2003. Baseline Assessment of Newfound Harbor Reef System, Big Pine Key, Florida. We propose to perform coral diversity assessments of the 3.8 km long linear reef and patch reefs seaward of the Newfound Harbor Keys, Big Pine Key, and the linear reef of unknown extent seaward of West Summerland Key in the FKNMS. We will investigate coral diversity, abundance, cover, and health using the Atlantic and Gulf Rapid Reef Assessment protocol -- a combined linear transect/random quadrat method -- with more thorough species presence/absence data collected using video transects. Sediment samples will be collected and classified according to grain type and size for comparison with other patch reef sites and existing data for NFHR (Dodd et al., 1973). MTSU grant.

38) Clay Harris, Middle Tennessee State University (cdharris@mtsu.edu). FKNMS-2002-004, 1/3/2001 to 12/31/2002. Decadal-scale Changes in Coral Distribution on a Shoal in Spanish Harbor, Big Pine Key, Florida. We propose to perform a survey of coral and vegetation distribution and abundance on the NW margin of the SHS and at a currently undetermined site farther offshore (SH-HB). For both sites, we will: (1) assess coral, algae, and sea grass diversity, abundance, cover, and health using a consecutive quadrat method covering an area of 112 m^2 and (2) using hand-held, U/W video, develop a coral distribution map for future comparison. We will later compare our results for SHS to that of Kissling (1965), and assess the changes in coral abundance and distribution after 37 years. MTSU grant.

39) Mark Hay, Georgia Institute of Technology (mark.hay@biology.gatech.edu). FKNMS-2002-071, 7/20/2002 to 12/31/2002. Effects of Algal Secondary Metabolites on Feeding by

Herbivorous Fishes and on Spatial Competition with Corals. Our objectives are to (1) determine palatability of common algae to specific species of herbivorous fishes, (2) determine the role of microbial gut symbionts in allowing some species to consume toxic seaweeds, (3) determine which seaweeds are most harmful to corals, and (4) understand how interactions of seaweed defenses, herbivore diversity, and coral-seaweed interactions combine to affect reef structure and function. NOAA National Undersea Research Center, NSF, Teasley Endowment.

40) Michael Heithaus, Mote Marine Laboratory (mheithaus@mote.org). FKNMS-2002-007, 1/24/2002 to 5/31/2002. Acoustic Monitoring of Bull Shark and Great Hammerhead Shark Residency Periods in a Reef Habitat of the Florida Keys. The overall goal of this project is to determine the habitat use and residency periods of great hammerhead (*Sphyrna mokarran*) and bull (*Carcharhinus leucas*) sharks in both the Florida Keys and Charlotte Harbor, FL. This permit application is to deploy four fixed-site monitoring stations near (but outside) the Looe Key Sanctuary Preservation Area to detect the presence of sharks fitted with acoustic transmitters. Every time a shark with a transmitter passes near a station, its identity and time of arrival and departure will be archived. NMFS grant to Mote Marine Center for Shark Research.

41) John Hunt, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (john.hunt@fwc.state.fl.us). FKNMS-2002-005, 1/7/2002 to 12/31/2004. Spiny Lobster Puerulus Monitoring Program. Influx of postlarval spiny lobsters is monitored using artificial settlement collectors that are placed in the nearshore waters on the Atlantic side of Long Key and Big Munson Key. We will replace the existing cinderblock anchoring systems with permanent, low profile stainless steel mooring eyes cemented into the substrate. FMRI base budget.

42) Claudia Jones, University of Pennsylvania (impglee@aol.com). FKNMS-2002-070, 8/23/2002 to 4/1/2003. The Effect of Climate Change and Rising Nutrient Levels on the Health of Selected Reefs in the Eastern Caribbean. Funding source unknown.

43) Brian Lapointe, Harbor Branch Oceanographic Institution (lapointe@hboi.edu). FKNMS-2001-057, 8/9/2001 to 12/31/2002. A Comparative Study of Water Quality and Coral Reef Status at the Content Keys, Looe Key National Marine Sanctuary, and Biscayne National Park. The objective of this project is to monitor, at monthly frequencies, nutrient concentrations, chlorophyll a, and turbidity at three stations along a spatially large eutrophication gradient. Additional research on remote sensing of algal blooms will be conducted. HBOI.

44) Tom Lee, University of Miami, Rosenstiel School of Marine and Atmospheric Science/MPO (tlee@rsmas.miami.edu). FKNMS-2001-006, 2/23/2001 to 2/28/2003. Florida Keys and Florida Bay Circulation and Exchange Project. This project continues work on current patterns and water circulation in the Florida Keys National Marine Sanctuary and Florida Bay that was initiated in 1989. South Florida Ecosystem Restoration, Prediction, and Modeling program under NOAA/COP (Yeung) and RSMAS/U. Miami (Lee). [Summary of findings in annual report]

45) James Leichter, Scripps Institution of Oceanography (leichter@coast.ucsd.edu). FKNMS-2002-035, 5/13/2002 to 12/31/2003. Responses of Benthic Macroalgae to High Frequency Upwelling on the Florida Keys Reef Tract. The goal of this project is to examine the

consequences of high frequency nutrient upwelling for benthic macroalgal populations on and seaward of the Florida Keys reef tract. NOAA/National Undersea Research Center.

46) Niels Lindquist, University of North Carolina at Chapel Hill, Institute of Marine Sciences (nlindquist@unc.edu). FKNMS-2001-010, 3/15/2001 to 12/31/2003. Tracing Marine Sponge Responses to Environmental and Water Quality Gradients and Anti-Predator Defenses Among Marine Hydroids and File Clams. For "Tracing Marine Sponge Responses to Environmental and Water Quality Gradients" we will use natural abundance stable isotope analyses of sponges to provide a unique view of their nutritional ecology, including the contributions of their symbionts to their nutritional needs and to possibly measure the magnitude of symbiont inputs, the effect of water quality on sponge stable isotope values, and the source of bioactive compounds that protect many sponges against predators, competitors and pathogens. For "Anti-Predator Defenses of Marine Hydroids: Alternative Strategies, Biogeographic Patterns, and Ecological Implications", recent studies have demonstrated that hydroids can be defended from predators by two distinctly different mechanisms - stinging nematocysts or distasteful secondary metabolites. Data from our investigations will be used to rigorously test the hypothesis that trade-offs exists among defense systems, particularly in marine organisms. Our studies will also be used to examine the hypothesis that mesofauna abundance and diversity will be lower among nematocyst defended hydroids than among chemically defended hydroids because stinging nematocysts can harm associated mesofauna. For "Evolution of a Chemical Defense Among File Clams (Bivalvia: Limidae) - Relationships Between Bivalve Palatability, Shell Morphology, and Shell Strength", in general, chemically defended organisms lack physically protective structures. We are investigating the robustness of this relationship in using an unlikely group of animals to have a chemical defensive – i.e. bivalve molluscs. The Limidae bivalves are providing an excellent system to test evolutionary relationships among susceptibility to predators and the value of a physical vs. a chemical defense. Furthermore, with the ability to build molecular phylogenies and an excellent fossil record, our data on extant Limidae and other bivalve species may provide a window into ecological and community structure of ancient reef habitats. An additional project, started in September 2002, is a subproject of the above research. Previous studies have shown that small epiphytic algae can alter the palatability of larger macrophyte to various herbivores. Given that marine hydroids are common epibionts on both marine plants and sessile invertebrates, we wish to test that hypothesis that epibiotic hydroids on seaweeds and seagrasses alter their palatability to herbivores. This hypothesis will be tested by offering individual urchins a choice between two pieces of the same seaweed species (mass measured at the beginning of the experiment) one with epibiotic hydroids and one lacking hydroids. The relative rates of herbivory on the two pieces will be statistically compared. This analysis will be run for various combinations of seaweed/seagrass-hydroid combinations. NURC/UNCW #2000-24, NSF (#0002723 and 0082049), and by UNC funding.

47) Diego Lirman, University of Miami, Rosenstiel School of Marine and Atmospheric Science (dlirman@rsmas.miami.edu). FKNMS-2001-027, 6/13/2001 to 12/31/2002. Coral Size-Frequency Distributions as Indicators of Reef Health: Monitoring and Modeling Approaches. We propose to implement a demographic approach to assess the condition of coral populations within patch reefs of the FKNMS that will incorporate individual-based parameters such as growth, survivorship, partial mortality, and fragmentation. These measures can reveal sublethal

differences among populations that abundance and diversity measures alone may miss. NURC project #UNCW2001-07.

48) Carrie MacKichan, Georgia Southern University (carrie_a_mackichan@gasou.edu). FKNMS-2002-010, 4/1/2002 to 12/31/2002. Effects of Ultraviolet Radiation on Newly Settled Coral Recruits. This project will investigate the effects of ultraviolet radiation on newly settled coral recruits and determine their ability to protect themselves from damage by this radiation. Information garnered from this study will help explain patterns of distribution and abundance observed in shallow water coral reef communities. Internship at Mote Marine Laboratory Center for Tropical Research, Georgia Southern University Academic Excellence Grant, faculty advisor support at GSU, and other sources of funding where applied for.

49) Kevin Madley, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (kevin.madley@fwc.state.fl.us). FKNMS-2001-020, 4/16/2001 to 4/15/2003. Florida Inshore Marine Monitoring and Assessment Program (IMAP). The goal of this project is to create a statewide assessment of the environmental quality of inshore habitats by collecting information on various environmental indicators. The project is part of a long-term environmental monitoring program of over two dozen chemical, physical, and biological indicators under the U.S. EPA Coastal 2000 initiative. U.S. EPA Assistance Agreement #CR 827240-01-0.

50) Mikhail Matz, University of Florida (matz@whitney.ufl.edu). FKNMS-2002-039, 5/31/2002 to 6/1/2003. Genetics, Ecology and Evolution of Coloration in Great Star Coral, *Montastraea cavernosa*. In reef-building corals each visually perceptible basic color is essentially determined by the sequence of a single protein, homologous to green fluorescent protein (GFP) from jellyfish *Aequorea victoria*. This provides a unique opportunity to address the question of color evolution in the environment directly by applying the tools of molecular phylogenetics designed for sequence analysis and, in addition, to characterize and monitor variations in coloration in terms of expression of individual genes. The ultimate goal of the project is to understand the evolutionary mechanisms and ecological factors that determine the diversity of coloration in reef-building corals. UF/Whitney Laboratory.

51) Paula Mikkelsen, American Museum of Natural History (mikkel@amnh.org). FKNMS-2000-036, 6/30/2000 to 6/30/2002. Qualitative Survey of Ocean-side Infaunal Molluscan Diversity off the Florida Keys. This multi-phase project will produce the first baseline survey of mollusks associated with coral reef habitats in the Florida Keys. The work proposed here will fill a critical gap in this survey by facilitating equivalent coverage of the coral reef environments now managed by the Florida Keys National Marine Sanctuary. This proposal seeks to resample several deepwater sites as part of the rigorous sampling program of infaunal molluscan communities of the Florida Keys. Private institution funding.

52) Paula Mikkelsen, American Museum of Natural History (mikkel@amnh.org). FKNMS-2002-079, 7/15/2002 to 8/31/2002. International Marine Bivalve Workshop. A 2-wk workshop on marine bivalves with an emphasis on systematics, anatomy, and natural history, will be held to further the scientific knowledge of living marine bivalves of the Florida Keys and to train students in this understudied field of modern malacology. Twelve invited expert scientists from

an international set of renowned academic institutions will work one-on-one in research teams with a similarly diverse group of 12 graduate students, supported by an organizing and support team. A series of refereed, publishable manuscripts on selected bivalve species or groups, one from each of the scientist-student teams, will be published in a dedicated issue of a peer-reviewed academic journal. National Science Foundation, Partnerships in Enhancing Expertise in Taxonomy [PEET] Program, award #9978119. Additional support is provided by the Bertha Lebus Charitable Trust, Comer Science & Education Foundation, The Field Museum, and the American Museum of Natural History.

53) Margaret Miller, National Marine Fisheries Service, Southeast Fisheries Science Center (margaret.w.miller@noaa.gov). FKNMS-2000-050, 7/1/2000 to 12/31/2002. Evaluation of FKNMS Reef Restoration Structures: Elements that Foster Coral Recruitment Success. This project aims to test hypotheses derived from observations of in-situ coral recruitment on the restoration structures at the Elpis and Maitland grounding sites. This study should determine what aspects of structure design account for the observed differences in coral recruitment success, hence providing sound basis for future structure design. NOAA/MSD (Lisa Symons).

54) Margaret Miller, National Marine Fisheries Service, Southeast Fisheries Science Center (margaret.w.miller@noaa.gov). FKNMS-2000-052, 8/14/2000 to 6/30/2002. Restoration of Coral Reef Fisheries Habitat by Enhancement of Coral Recruitment via Improved Substrate Quality, Larval Seeding, and Sea Urchin Re-introduction. This project aims to develop effective ecological restoration techniques for degraded coral reefs via culturing and re-seeding key hermatypic coral species and keystone grazing urchins. National Sea Grant Fisheries Habitat Program (via North Carolina Sea Grant) award.

55) Steven Miller, NOAA National Undersea Research Center/University of North Carolina at Wilmington (smiller@gate.net). FKNMS-2001-080, 11/6/2001 to 6/30/2002. Fish Tracking, Coral Bleaching, and Coral Growth Studies in the Florida Keys National Marine Sanctuary (Development Projects). Fish will be tagged and tracked from topside and from inside Aquarius using two acoustic telemetry systems and an external tagging program. Three hydrophones will be deployed for 6 months within the Conch Reef Research-Only Area and two hydrophones will be deployed approximately one mile outside the Conch Reef ROA toward Pickles Reef and Davis Reef. Coral studies will also be conducted to evaluate how increasing amounts of carbon dioxide in the atmosphere might affect seawater chemistry and coral calcification. NURC/UNCW.

56) Lisa Monk, Center for Marine Conservation (now The Ocean Conservancy) (Lmonk@vacmc.org). FKNMS-2001-003, 2/7/2001 to 2/6/2002 and FKNMS-2002-022, 4/19/2002 to 12/31/2003. RECON (Reef Ecosystem Condition) Program. RECON is a low-tech, rapid monitoring protocol for volunteer divers. RECON divers are trained by CMC-certified RECON instructors to collect information on the condition of coral reef ecosystems. The goals of RECON are to broaden the scope of available information about the benthic organisms on coral reefs, to alert local reef researchers and managers of changing reef conditions (e.g., mass bleaching events, outbreaks of disease, nuisance algal blooms, changes in abundance of key mobile invertebrates), and to increase public understanding of the threats to coral reef ecosystems. U.S. EPA grant.

57) Leonid Moroz, University of Florida (moroz@whitney.ufl.edu). FKNMS-2001-058, 9/10/2001 to 12/31/2003. Coral Screening Project. This project is designed to screen a wide sampling of corals to accomplish two goals from one collection. First, we want to see if any local corals contain yellow or red fluorescing proteins. Second, we want to search for the presence of the enzyme nitric oxide synthase, which generates the gaseous messenger molecule nitric oxide. University of Florida.

58) Alison Moulding, University of Miami, Rosenstiel School of Marine and Atmospheric Science (amouldin@rsmas.miami.edu). FKNMS-2002-014, 4/1/2002 to 3/31/2003. Coral Recruitment in the Florida Keys and the Relationship Among Adult Abundance, Larval Supply, and Recruitment of *Porites astreoides*. The objectives of this study are to examine coral recruitment along the Florida reef tract and to explore the relationship among presence of adult colonies, fertilization success, and recruitment of juveniles of one species of coral common in the Florida Keys: *Porites astreoides*, a hermaphroditic, brooding coral. By including Florida Keys reefs in this study, a better understanding of the mechanisms of supply and recruitment can be obtained. RSMAS and RSMAS Founders Research Fund award.

59) Erich Mueller, Mote Marine Laboratory (emueller@mote.org). FKNMS-2002-013, 3/1/2002 to 2/28/2003 and FKNMS-2003-005, 3/1/2003 to 2/29/2004. Effect of Mosquito Control Pesticides on *Porites astreoides* Planula Larvae. This study aims to determine how mosquito adulticides affect the survival and viability of planula larvae from the scleractinian coral, *Porites astreoides*. Larval responses will be assessed following exposure to the mosquito adulticides, Naled and Permethrin, individually and combined, to simulate synergistic responses. Larvae will be dosed over a lethal and sublethal concentration range and a variety of endpoints recorded. Mote Marine Laboratory Research Fellowship.

60) Ken Nedimyer, Sea Life, Inc. (sealife@terranova.net). FKNMS-2001-069, 9/1/2001 to 12/31/2002. Techniques Development for the Reestablishment of Populations of the Long-Spined Sea Urchin, *Diadema antillarum*, on Two Small Patch Reefs in the Upper Florida Keys. The overarching goal of this project is to monitor and track the success of one technique to enhance and restore coral reef areas. Specifically, the transplantation of large numbers of small *Diadema antillarum* from shallow rubble zones to deeper patch reefs will be evaluated. Additionally, the resulting effects of increased densities of *Diadema antillarum* to approximate pre-plague levels on small, isolated patch reefs will be monitored to determine if a reduction of algal overgrowth will enhance coral growth and settlement. Funded by NMSP.

61) David Palandro, University of South Florida, Institute for Marine Remote Sensing (palandro@seas.marine.usf.edu). FKNMS-2002-067, 7/28/2002 to 8/10/2002. A Multi-Scale and Multi-Sensor Approach to Monitoring the Florida Keys National Marine Sanctuary. This study aims to form a time series of satellite remote sensing images over the past 18 years to map and monitor coral reef ecosystem change. By ground-truthing current reef conditions and benthic coverage it is possible to calibrate archived satellite data to obtain benthic coverage in the past, which will allow us to complete a change detection study. NASA Fellowship (NGT5-30414).

62) Mark Patterson, Virginia Institute of Marine Science (mrp@vims.edu). FKNMS-2002-088, 11/4/2002 to 11/22/2002. Flow Modulated Metabolism: Connection with Coral Bleaching and Reef Oxygen Crises? Our previous NURP and NSF sponsored work demonstrated the importance of flow-modulated metabolism in lower invertebrates, in particular reef corals, at the level of the individual organism (colony). We propose to examine HSP expression within a colony during the (asymmetric) bleaching process. The measurement of reef scale oxygen dynamics using an AUV provides an opportunity to connect what occurs at a microscale around individual corals, to the macroscale. NOAA/National Undersea Research Center, Key Largo.

63) Joseph Pawlik, The University of North Carolina at Wilmington (pawlikj@uncwil.edu). FKNMS-2001-021, 4/16/2001 to 12/31/2002. Investigations of Chemical and Physical Defenses of Reef and Mangrove Demosponges. This research program represents a continuation of the first systematic investigation of the chemical defenses of Caribbean marine sponges. Recruitment processes, natural and human-caused changes to coral reefs, biodiversity and ecosystem structure and function, and new products from the sea will be the focus projects of this research. National Undersea Research Center/UNCW.

64) Gregory Piniak, NOAA/NOS, Center for Coastal Fisheries and Habitat Research (gregory.piniak@noaa.gov). FKNMS-2002-087, 9/1/2002 to 2/28/2003. Fluorescence as a Tool for Enumerating Coral Recruits. Fluorescence technology is useful in locating coral recruits and other small reef organisms that are difficult to detect with the naked eye. We propose a study to determine the capability of fluorescent technologies to identify and enumerate coral recruits, and to rigorously compare these techniques with current methods used to quantify coral recruitment on natural and artificial substrates. NOS.

65) Patrick Pitts, U.S. Fish and Wildlife Service (patrick_pitts@fws.gov). FKNMS-2002-036, 5/13/2002 to 5/12/2003. Florida Keys Tidal Restoration. The Florida Keys Tidal Restoration Project, a component of the Comprehensive Everglades Restoration Plan, is designed to restore tidal circulation in the middle Florida Keys in order to improve water quality and the health and composition of flora and fauna in the project area. The U.S. Fish and Wildlife Service (USFWS) will to provide guidance to the U.S. Army Corps of Engineers, the agency in charge of project construction, regarding ecological and environmental concerns, including threatened and endangered species. In order to provide this guidance, the USFWS will need to conduct field surveys to determine fish and wildlife resources in the project area. Fish and Wildlife Coordination Act transfer funding from the U.S. Army Corps of Engineers.

66) Susan Richardson, Smithsonian Marine Station at Fort Pierce (richardson@sms.si.edu). FKNMS-2002-008, 2/11/2002 to 12/31/2003. Diversity, Distribution, and Abundance of Foraminiferans in Seagrass Habitats, Florida Keys. Benthic foraminiferans, both epiphytic and sediment dwelling, will be sampled from seagrass habitats in the Florida Keys. The diversity, distribution, and abundance of foraminiferal faunas will be characterized and compared and contrasted to similar sites in the Indian River Lagoon and Belize. Smithsonian Institution Postdoctoral Fellowship.

67) Laurie Richardson, Florida International University (richardl@fiu.edu). FKNMS-2001-075, 10/17/2001 to 12/31/2002. Distribution and Etiology of Two Coral Diseases in the Florida Keys

National Marine Sanctuary: Black Band Disease and White Plague Type II. This research constitutes continuation of our work on coral diseases in the FKNMS, and specifically addresses several hypotheses that have grown out of our work and which directly address both overall and specific objectives outlined in the WQPP. Unknown, previously funded by EPA WQPP Special Studies.

68) Eugene Shinn, U.S. Geological Survey, Center for Coastal Geology (eshinn@usgs.gov). FKNMS-2002-080, 8/5/2002 to 10/1/2002. Health, Growth History, and Microbial Content of Large Head Corals at Looe Key. The purpose of this research is to reoccupy and sample large coral heads sampled during NOAA-funded research in 1982 and 1987. The heads will be core drilled by Harold Hudson of NOAA using a smaller diameter core barrel rather than the 4-inch barrel originally used. All holes will be plugged with cement to allow overgrowth of the sample sites. USGS.

69) Shauna Slingsby, University of North Carolina at Wilmington (sns3162@uncwil.edu). FKNMS-2001-037, 7/5/2001 to 12/31/2002. Nutrient Cycling and Accumulation Differences between SPA and non-SPA Sites and Nutrient Enrichment and its Effect on Coral/Algal Interactions. This project will test the following hypotheses: 1) Topographic complexity contributes to higher abundances of coral, algae, and herbivorous fish which effects a reef's internal nutrient cycling and processes of nutrient accumulation. 2) Due to increased nutrient input, certain species of macroalgae, like *Dictyota* spp., quickly colonize dead skeletal areas of stony coral colonies, causing recession of live coral tissue. National Center for Caribbean Reef Research (NCORE) - UNCW and RSMAS/U. Miami.

70) Ned Smith, Harbor Branch Oceanographic Institution (nsmith@hboi.edu). FKNMS-2002-063, 9/16/2002 to 9/30/2003. Nutrient Mass Fluxes between Florida Bay and the Florida Keys National Marine Sanctuary through Florida Keys Passes. Current speed/direction and water level will be measured to estimate volume transport through Long Key Channel and Moser Channel. Volume transports will be combined with nutrient concentrations to calculate nutrient transport. Measurements made during a one-year field study will quantify the magnitude and direction of seasonal and long-term net nutrient transport between Florida Bay and Hawk Channel. NOAA/Coastal Ocean Program.

71) Colette St. Mary, University of Florida (stmary@zoo.ufl.edu). FKNMS-2001-019, 5/1/2001 to 5/1/2003. The Effects of Artificial Reef Habitats on Fish Production. The goal of this project is to quantify the net effect of new habitat on fish production, enhance the sustainability of the marine ornamental fishery, and directly test the attraction-production hypotheses. To successfully conduct the critical field experiment, we need to optimize its design, which will depend upon patterns of spatial and temporal variance in settlement and abundance, the strength of density-dependence and the degree of movement between the artificial and natural reefs (as well as diffusion among the natural reef habitat). We will accomplish this by integrating field studies, quantitative literature syntheses, and mathematical population dynamic models. National SeaGrant Program.

72) Gregg Stanton, Florida State University (gstanton@res.fsu.edu). FKNMS-2000-044, 7/28/2000 to 12/31/2002. Investigation of Skin Lesions in Gray Snapper (Neurofibromatosis).

This study evaluates gray snapper, bicolor damselfish, and other affected snappers with observable signs of neurofibromatosis and also black spots that are potentially associated with a parasite cyst. This project will address public concern over large numbers of diseased fish, investigate disease processes and potentially provide information that will conserve resources. FSU.

73) Peter Swart, University of Miami, RSMAS (pswart@rsmas.miami.edu). FKNMS-2000-018, 4/3/2000 to 12/31/2003. The Origin and Recycling of Nutrients and an Investigation of Trophic Dynamics. The research proposed here is designed to generate an integrated data set, combining work on the sources of nutrients (Swart), cycling and fates of nitrogen and carbon (Swart and Szmant), nutrient flux and interactions with currents (Lee), the production of organic material by algae (Szmant) and energy flow between trophic levels (Cowen and Sponaugle). National Center of Caribbean Coral Reef Research.

74) Alina Szmant, University of North Carolina at Wilmington (szmanta@uncwil.edu). FKNMS-2002-054, 6/17/2002 to 6/30/2003. Research on Nutrient Dynamics, Algal Community Structure, and Algal Productivity. Regional coral reef decline is indicated by rapid loss of coral cover and increases in algal cover. It is important to be able to distinguish between increased algal cover being a symptom of coral decline (e.g. algal colonizing substrate vacated by coral killed by one factor or another) vs. a causative factor (algae over-growing and killing the coral), especially if the latter is the result of anthropogenic nutrient enrichment of reef areas. Thus, a major objective of this NCORE subcontract will be to address factors that affect relative algal dominance. These include nutrient availability and cycling, and grazing pressure. National Center for Caribbean Coral Reef Research at the Univ. of Miami, funded by U.S. EPA. Subcontract to UNCW.

75) Florence Thomas, University of South Florida (fthomas@chuma1.cas.usf.edu). FKNMS-2002-041, 6/1/2002 to 12/31/2003. The Effects of Water Velocity/Hydrodynamics on Mass Transfer of Nutrients: a Partnership in Research and Education. This project explores the relationship between water velocity, nutrient uptake, and the morphology of the predominant community members of nearshore benthic communities, including seagrasses (i.e. *Thalassia testudinum, Halodule wrightii*) and macroalgae (i.e. *Halimeda* sp.). As the title implies, this NSF-funded project links research in hydrodynamics and biomechanics to public, k-12, undergraduate, and graduate education. Minority participation is encouraged at all levels and is the primary focus of recruitment at the undergraduate level. Supported by a 5-year NSF PECASE award to Dr. Thomas (OCE-9701434).

76) John Valentine, Dauphin Island Sea Lab (jvalentine@disl.org). FKNMS-2002-026, 4/29/2002 to 12/31/2002. Trophic Cascades and Spatial Subsidies in a Coral Reef Ecosystem: A Field Test using 'No-Take' Areas in the Florida Keys National Marine Sanctuary. We propose to take advantage of newly created "no-take" protected areas in the Florida Keys to better understand the role of large predatory fishes in controlling the flow of energy between habitats in subtropical and tropical marine ecosystems. Most fundamentally, we hypothesize that the successful restoration of reef food webs will depend on the size and location of nearby seagrass habitats, which provide both nursery and a foraging ground for reef fishes. We predict that there will be substantial differences in the community structure of fishes and invertebrates not only within the reefs of the FKNMS marine reserves but also in adjacent seagrass habitats.

Furthermore, we propose to use the findings from this study to make data-based predictions as to the minimum requirements for the development of effective marine reserves in areas such as the Florida Keys. Andrew Mellon Foundation Ecosystem Research Program 2001-2003. MARFIN grant 2002-2004.

77) John Valentine, Dauphin Island Sea Lab (jvalentine@disl.org). FKNMS-2002-027, 4/29/2002 to 12/31/2002. FKNMS-2002-027, 4/29/2002 to 12/31/2002. The Trade-offs of Living in Mangrove Forests: Finding a Balance between Energetic Needs and Protection. This project will investigate the importance of habitat linkages, between mangroves and seagrass beds, in controlling the density and diversity mangrove-associated consumers. To do this we will conduct a series of manipulative field experiments, collect samples of prey and document the composition of consumers along the intersection between mangroves and seagrass beds in the lower Florida Keys. We anticipate that our data will show that while mangroves provide shelter from predators for smaller fishes, these consumers forage into the adjacent seagrass beds to meet their energetic requirements. Put simply the presence of two habitats will allow higher densities of these consumers to exist then would otherwise be possible if they were forced to hide and feed in a single habitat. From this study, we anticipate that we will be able to provide new evidence that there is a need to focus management activities on the importance of habitat diversity as a tool for managing the nation's coastal food webs. Andrew Mellon Foundation Ecosystem Research Program 2001-2003. MARFIN grant 2002-2004.

78) Douglas Weaver, United States Geological Survey, Florida Caribbean Science Center (doug_weaver@usgs.gov). FKNMS-2001-050, 8/1/2001 to 8/31/2002. Inventory of Deepwater Reef Fishes and Habitat Mapping of Tortugas South Ecological Reserve. This project will assess the relative abundance of large predatory fishes (piscivores and other large carnivores) and identify the relative trophic structure and abundance of the reef fish assemblage (primarily planktivorous fishes) along deep-water areas (50 to ~300m) of Tortugas South Ecological Reserve (TSER). Funds from the National Fish and Wildlife Foundation, Grouper Spawning Aggregation Study #2000-0243 through the University of Florida Department of Fisheries and Aquatic Sciences.

79) Gerard Wellington, University of Houston (wellington@uh.edu). FKNMS-2002-081, 7/31/2002 to 8/31/2003. Genetic Variation and Phenotypic Response of *Montastraea faveolata*. The first, experimental project will estimate the heritability of metabolic and molecular characters related to stress response of *M. faveolata*. To date, heritability of both metabolic and molecular characters related to stress have not been investigated in any coral species. The purpose of the study will be to investigate the contribution of genetic vs. non-genetic (environmental and symbiont association) effects associated with *M. faveolata* response to stress. The second project will be exploratory in nature. Currently, the genetic population structure for *M. faveolata* has not been investigated. The purpose of my project will be to collect preliminary data to test for significant genetic variation along the Florida Keys for *M. faveolata*. Houston Coastal Center.

80) David Wethey, University of South Carolina (wethey@biol.sc.edu). FKNMS-2002-089, 10/1/2002 to 12/31/2002. Decoupling the Effects of Mass Transfer, Water Motion, and Temperature on Reef Health. This project has the interrelated objectives of 1) measuring the

effects of flow speed on oxygen transfer by common species of coral of flat, mound-shaped and branching morphology; 2) experimentally determining the effects of O_2 accumulation on corals in field conditions; 3) quantifying the interaction between temperature and flow on photosynthesis under natural field conditions. NOAA/National Undersea Research Center.

81) Jennifer Wheaton, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (jennifer.wheaton@FWC.state.fl.us). FKNMS-2001-015, 4/16/2001 to 12/31/2003. Coral/Hardbottom Monitoring Project. The coral/hardbottom monitoring project documents status and trends (change) in stony coral species presence and percent cover of selected attached reef benthos. Documentation of degree of bioerosion will be a subset of the project beginning summer 2001. Established in 1995, the project's 43 sampling sites, which include 7 hardbottom, 11 patch, 12 offshore shallow, and 13 offshore deep reef sites are sampled annually. The project's primary goal is to document change in the presence/absence of stony coral species richness and selected disease categories and relative percent cover of corals, octocorals, sponges, macroalgae, and substrate. U.S. EPA, FKNMS. [Summary of findings in annual report]

82) Jennifer Wheaton, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (jennifer.wheaton@FWC.state.fl.us). FKNMS-2001-016, 4/16/2001 to 4/30/2002. Nitrogen Stable Isotope Records in *Plexaura homomalla* from the Florida Keys. Samples of the axis of a common FKNMS gorgonian (*Plexaura homomalla*) will be analyzed to document the nitrogen stable isotope record in the organic fraction of the skeleton as a measure of surface productivity. Collections conducted under U.S. EPA, FKNMS funding for the CRMP. Analyses and writing funding provided by Dr. Michael Risk, McMaster Univ.

83) Cheryl Woodley, NOAA National Ocean Service, National Centers for Coastal Ocean Science (NCCOS), Center for Coastal Environmental Health & Biomolecular Research (cheryl.woodley@noaa.gov). FKNMS-2001-008, 4/1/2001 to 4/30/2003. Assessment of Coral Health in the FKNMS Using a Molecular Biomarker System (MBS). We have developed a Molecular Biomarker System (MBS) capable of determining whether corals are stressed and causative agents associated with that stress. The MBS works because the biomarkers respond to stress along biochemical and cellular pathways common to all organisms, from bacteria and protists to plants and higher animals. National Sea Grant Consortium collaborators include NOAA/NOS/NCCOS, Med. Univ. of South Carolina, FKNMS, Biscayne National Park, Univ. of South Florida, Univ. of Charleston, Coral Shores High School, and EnVirion Biotechnologies, Inc. These specific proposed projects are a subset of larger proposed projects to National Sea Grant and U.S. EPA and form a collaboration between the National Marine Sanctuary Program and NCCOS. [Summary of findings in annual report]

1) Andrew Baker, Wildlife Conservation Society and Columbia University (abaker@wcs.org). FKNMS-2002-073, 9/23/2002 to 8/31/2003. Symbiont Distributions in Reef Corals as Indicators of Recent Environmental History. This research uses molecular techniques to identify the dinoflagellate symbionts (*Symbiodinium* spp.) of reef-building corals from the Florida Keys reef tract (and the National Marine Sanctuary in particular). It tests for differences in the distribution of symbionts that correlate with environment, and tests the stability of these distributions by transplanting coral colonies between different environments, with and without exposure to a bleaching stimulus. National Undersea Research Program, UNCW.

2) Rodney Bertelsen, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (rod.bertelsen@fwc.state.fl.us). FKNMS-2003-069, 11/1/2003 to 10/31/2004. Spillover of Lobsters from the Western Sambo Ecological Reserve and Evaluation of Exchange of Exploited Species Between a Marine Protected Area and an Adjacent Potentially Attractive Unprotected Habitat. There are two projects being undertaken in this research. In the first, we propose to study lobster movement patterns around the patch reef environment in the Western Sambo Ecological Reserve (WSER) using a two-tiered design, tagging lobsters with both traditional antenna tags and sonic tags. Antenna tags will be use to determine abundance and net lobster movement after a one month time interval. Sonic tags will be used to determine fine-scale, inter-patch reef movements on a minute-by-minute basis over the course of a month. We will also use a detailed GIS-based habitat map of the area to determine how benthic habitats may influence lobster movement patterns. In the second study, we propose to monitor and evaluate reproductive migrations and other exchanges of lobsters and fish between the WSER and the adjacent offshore bar by using a combination of diver-based population surveys and monitoring of the movements of tagged individuals using both conventional tags and active and passive ultrasonic telemetry, supplemented by diver and ROV direct observations of the movements and behaviors of tagged individuals. Prior to the initial work with the animals, a habitat map of the study area will be created using a GPS based towable underwater color camera system. Project 1 is funded by the U.S. Environmental Protection Agency. Funding for project 2 is pending from NOAA/National Undersea Research Center, Key Largo.

3) Carole Bewley, National Institutes of Health (cb194k@nih.gov). FKNMS-2002-069, 10/14/2002 to 12/31/2004. Investigations of Carbohydrate-Binding Proteins from Marine Cyanobacteria. Collect cyanobacteria samples from subtropical waters and investigate the presence of carbohydrate binding proteins. If such proteins are present, we will determine their optimal ligands and the source of their natural receptors using biochemical and chemical techniques. National Institutes of Health.

4) Jill Borger, University of Miami, Rosenstiel School for Marine and Atmospheric Sciences (jborger@rsmas.miami.edu). FKNMS-2002-064, 11/27/2002 to 12/31/2003. Coral Disease Ecology and the Effects of Disease on Reproduction. This project is an extension of work begun last year. The permit will cover two projects; the first involves a detailed examination of specific reef sites in order to follow the specific incidence, movement and transmission of coral diseases over time. This will involve non-destructive sampling methods, such as transect lines and quadrats, and detailed maps of each site will be constructed. The second project will examine the effects of disease on coral reproduction. A few samples will be taken from both diseased and healthy colonies and total fecundity, or reproductive output, will be measured histologically. The

fecundity values for diseased and healthy colonies will be compared and analyzed. Reitmeister Award and anonymous donation to Jill Borger.

5) Joan Browder, NOAA/National Marine Fisheries Service (joan.browder@noaa.gov). FKNMS-2002-002, 1/3/2002 to 12/31/2003. Post-larval Sampling Project. The purpose of the sampling project is to describe spatial and temporal patterns of postlarval pink shrimp immigration to potential nursery grounds in Florida Bay from offshore spawning grounds. Accessibility of potential nursery grounds to pink shrimp postlarvae (i.e., postlarval ingress rate) may be an important factor limiting the Bay's capacity to produce pink shrimp recruits to the Tortugas fishing grounds. NOAA/NMFS Southeast Fisheries Science Center.

6) Michael Burton, NOAA/National Marine Fisheries Service (michael.burton@noaa.gov). FKNMS-2002-034, 5/8/2002 to 3/31/2003. Biological Characterization of Riley's Hump and Identification of Spawning Areas. Visual census transects (SCUBA) will be used to quantify mutton snapper abundance in the vicinity of Riley's Hump and compare it to baseline data. Habitat will be characterized by divers using 0.5 m^2 quadrats. NOAA/NMFS Coral Reef Initiative.

7) Mark Butler, Old Dominion University (mbutler@odu.edu). FKNMS-2002-043, 6/5/2002 to 6/4/2003. Characterization of Hardbottom Community Dynamics: Sponges, Octocorals, Lobsters, & Octopus. My research team is currently working on several related projects involving the shallow, hard-bottom communities so common throughout the Florida Keys. In some cases, our research is focused on the ecology of single species of specific ecological or economic importance (e.g., spiny lobster, commercial sponges, octopus). In other cases, our research involves community-level assessment and the influence of environmental (e.g., salinity change) or human factors (e.g., fishing) on the structure of hard-bottom communities over large spatial scales. In both cases, we use a combination of field sampling, field and laboratory experimentation, and computer simulation modeling to test hypotheses of interest. National Science Foundation, OCE-0136894 and NOAA Coastal Ocean Program.

8) Roy Caldwell, University of California, Berkeley (4roy@socrates.berkeley.edu). FKNMS-2002-062, 10/18/2002 to 12/31/2003. The Biology of Stomatopod Crustaceans. This proposal focuses on stomatopod crustaceans, asking basic biological questions about their distribution and abundance, reproductive behavior, larval dispersal, and how they communicate in a colorful underwater world. NOAA/National Undersea Research Center, Key Largo.

9) Mary Alice Coffroth, State University of New York at Buffalo (coffroth@buffalo.edu). FKNMS-2002-011, 3/4/2002 to 6/30/2004. A Study of Population Dynamics of Scleractinians on Conch Reef: A Demographic and Population Genetics Approach. In this study the influence of recruitment in establishing species composition of reefs will be examined using a combined demographic and population genetic approach to record the species composition at two sites on Conch Reef in the Florida Keys. NOAA/National Undersea Research Center.

10) Felicia Coleman, Florida State University (coleman@bio.fsu.edu). FKNMS-2001-005, 2/23/2001 to 2/28/2003. Studies in the Ecology of Red Grouper, *Epinephelus morio*, including their Contribution to Habitat Heterogeneity and Community Structure. The aim of this project is

to examine the structure and function of the community of organisms that take up residence in holes occupied by red grouper. These holes, for the most part, appear to be excavated and maintained by red grouper. The resultant communities are rich in sessile invertebrates and various species of cleaning fish. Marine Conservation Biology Institute, SeaGrant, and Environmental Defense.

11) Carrollyn Cox, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (carrollyn.cox@fwc.state.fl.us). FKNMS-2001-022, 4/23/2001 to 12/31/2002. Spiny Lobster Spawning Potential and Population Assessment: A Monitoring Program for the South Florida Fishing Region. The proposed study is part of the Sanctuary's Marine Zone Monitoring Program and seeks to investigate the effects of no-take management on this important fishery resource. FMRI. [Summary of findings in annual report]

12) Alan Duckworth, Harbor Branch Oceanographic Institution (aduckworth@hboi.edu). FKNMS-2001-049, 7/23/2001 to 9/30/2003 and FKNMS-2003-066, 10/1/2003 to 9/30/2004. Aquaculture of the Sponge *Forcepia* sp. for the Sustainable Supply of Bioactive Metabolites for Biomedical Research. The sponge *Forcepia* sp. will be farmed at a depth of 20-25 m near Tennessee Reef to determine if in situ aquaculture can supply sufficient and sustainable quantities of metabolites called lasonolides for biomedical research. The farmed sponges will be harvested at different rates to examine whether regular tissue harvesting can increase overall yield of lasonolides. Sponges will be farmed in mesh arrays, which will be either pegged flat to the substrate or held upright in the water column. One array will be maintained for a longer period and will be used as a supply for ongoing, grant-funded research on the lasonolides. HBOI.

13) Peter Edmunds, California State University at Northridge (peter.edmunds@csun.edu). FKNMS-2002-021, 6/1/2002 to 12/31/2003. Global Climate Change and Coral Recruitment: The Interactive Effects of Temperature and Ontogeny on the Biology of *Porites astreoides* Larvae. The goal of this project is to carry out a multidisciplinary analysis of the biology, physiology and genetics of coral larvae in order to understand how global climate change will affect the coral population structure of reefs such as those in the Florida Keys. NOAA/National Undersea Research Center.

14) David Eggleston, North Carolina State University (eggleston@ncsu.edu). FKNMS-2002-061, 7/2/2002 to 12/31/2003. Fish and Caribbean Spiny Lobster Distribution and Abundance in the Great White Heron National Wildlife Refuge: An Initial Assessment and Comparison with the Key West National Wildlife Refuge. We will use aerial photographs, ground-truthing and GIS computer software to identify and map habitats within the GWHNWR within which to quantify fish and Caribbean spiny lobster. We will use visual surveys conducted by SCUBA divers to quantify fish and lobster, as well as measure specific habitat characteristics. The study will provide baseline data and be used to make research and management recommendations. Grant from The Ocean Conservancy and U.S. Fish and Wildlife Service.

15) Bill Fitt, University of Georgia, Institute of Ecology (fitt@sparrow.ecology.uga.edu). FKNMS-2001-063, 8/27/2001 to /1/2003. Potential for *Acropora cervicornis* (staghorn coral) and *Acropora palmata* (elkhorn coral) in Coral Reef Restoration: Genetics, Physiology, and Growth. This proposal addresses two major issues concerning populations of *A. cervicornis* and

A. palmata in the Caribbean: the genetic structure and diversity, and some basic questions concerning transplantation. We will compare populations of both species from two locations: relatively pristine reefs (low human impact) near the Caribbean Marine Research Center on Lee Stocking Island in the Bahamas vs. relatively high human impact sites in the Florida Keys National Marine Sanctuary. NOAA/National Undersea Research Center.

16) Bill Fitt, University of Georgia (fitt@sparrow.ecology.uga.edu). FKNMS-2003-004, 2/18/2003 to 12/31/2004. Long Term Monitoring of Tissue Biomass from Five Species of Reef Corals. This project is a continuation of a seasonal monitoring program designed to document the relative physiological health of coral tissue and zooxanthellae for five major coral species in the Keys. Tissue biomass, levels of proteins, carbohydrates and lipids, C:H:N analysis and zooxanthellae photosynthetic potential, densities and chlorophyll content will be determined every 3 months for five species of corals living on the Florida Reef Tract. NOAA/NURP funding for tissue biomass research. NSF funding (5 years) for Adaptive Bleaching Hypothesis research.

17) Mark Fonseca, NOAA/Center for Coastal Fisheries and Habitat Research (CCFHR) (mark.fonseca@noaa.gov). FKNMS-2001-023, 5/1/2001 to 6/30/2003. Effects of Crab/Lobster Traps to Seagrass Beds of the Florida Keys National Marine Sanctuary (FKNMS): Damage Assessment and Evaluation of Long-Term Recovery. This project will assess the effect (if any) of stationary fishing gear (i.e. crab/lobster traps) to seagrass beds of the FKNMS. Replicate traps will be randomly placed within randomly selected seagrass beds of varying species composition. Intermittent removal of traps will determine the time it takes to sustain injury to the beds. Injury recovery will be tracked quarterly to semi-annually over the following two years. NOS and NMFS.

18) Mark Fonseca, NOAA/Center for Coastal Fisheries and Habitat Research (CCFHR) (mark.fonseca@noaa.gov). FKNMS-2001-029, 6/11/2001 to 6/30/2003. A Novel Technique for the Restoration of Seagrass Propeller Scars: Does Deployment of Sediment-filled, Biodegradable Fabric Tubes in Propeller Scars Enhance Seagrass Regrowth into These Injured Areas? This project will assess the effectiveness of a new method for propeller scar restoration in the FKNMS. Fabric tubes and bird stakes will be deployed into existing propeller scars in a replicated experiment. Intermittent monitoring of treatments will be tracked quarterly to semi-annually over the following two years. NOS.

19) Mark Fonseca, NOAA/Center for Coastal Fisheries and Habitat Research (CCFHR) (mark.fonseca@noaa.gov). FKNMS-2002-009, 2/15/2002 to 12/31/2003. Characterization and Analysis of Seagrass Injury and Recovery on Shallow Seagrass-Coral Banks in the FKNMS. The objectives of this study are to develop a comprehensive database of the complete range of injury categories and the widest possible range of injury ages and species combinations to be modeled in the Habitat Equivalency Analysis. In addition to these detailed injury sites, we will characterize the current conditions on the entire Red Bay bank system using 1/9600 scale vertical aerial photography integrated with differential global positioning system based ground surveys. We will conduct a replicated experiment to determine the effect of excavation depth on the recovery rate of injured *Thalassia testudinum* meadows. We hypothesize that the severity of injuries to a *Thalassia* meadow will be a function of the depth of sediment excavated by the

disturbance. NOAA/National Ocean Service/Office of Coastal Resource Management and National Centers for Coastal Ocean Science/CCFHR. [Summary of findings in annual report]

20) Steve Gilbert, U.S. Fish and Wildlife Service (Steve_Gilbert@fws.gov). FKNMS-2003-072, 10/20/2003 to 10/19/2004. Florida Keys Tidal Restoration Study. The goal of this project is to establish baseline conditions to enable detection of positive effects of flushing by potential construction of culverts or a bridge under U.S. Highway 1. U.S. Army Corps of Engineers, South Florida Water Management District.

21) Robert Glazer, Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission (bob.glazer@fwc.state.fl.us). FKNMS-2001-055, 8/2/2001 to 8/31/2003. Survey and Rehabilitation of Queen Conch within the Florida Keys National Marine Sanctuary. The surveys include visual surveys of sites where conch are sparse, belt-transects of densely populated conch aggregations in offshore reef flats, tag-recapture sampling of nearshore conch aggregations, and sonic tagging experiments. Many of these surveys will be conducted within the Sanctuary Preservation Areas of the Florida Keys National Marine Sanctuary and are conducted as part of the marine zone monitoring surveys. The secondary goal of this research is to determine the spatial and temporal distribution of queen conch larvae in and around the different regions of the Florida Keys. This information will lead to determining the optimal release location of hatchery-reared or transplanted queen conch based upon the probability that conch larvae spawned in that location will recolonize the Keys. FMRI/FWC.

22) Walter Goldberg, Florida International University (goldberg@fiu.edu). FKNMS-2001-067, 8/29/2001 to 9/1/2003. Ultrastructure of Aggression in Corals of the Genus *Mycetophyllia*. This project will test the hypothesis that specialized regions occur at the tip of *Mycetophyllia lamarckiana* or *M. ferox* mesenterial filaments and are used during aggressive behavior. FIU.

23) Pamela Hallock Muller, University of South Florida (pmuller@marine.usf.edu). FKNMS-2003-002, 1/15/2003 to 12/31/2004. Larger Foraminifera as Bioindicators of Coral Reef Health: Continued Monitoring of Bleaching Stress, Comparison with an Integrated Molecular Biomarker System, and Temporal and Spatial Variability in Algal Symbionts. The reef-dwelling foraminifera, particularly *Amphistegina gibbosa*, have exhibited bleaching and associated symptoms on Florida Keys reefs since summer of 1991. This project will a) continue long-term monitoring of bleaching activity and its causes in larger foraminiferal populations of Florida Keys Reefs; b) complete a study that compares physiological responses and bleaching in *A. gibbosa,* to physiological responses in corals (*Montastraea* spp.) and other organisms being studied by Craig Downs, Cheryl Woodley and John Halas under separate permits; and c) determine if seasonal or spatial differences in algal symbiont populations influences bleaching in *A. gibbosa*. South Carolina Sea Grant Program; subcontract to USF.

24) Clay Harris, Middle Tennessee State University (cdharris@mtsu.edu). FKNMS-2002-003, 1/3/2002 to 12/31/2003. Baseline Assessment of Newfound Harbor Reef System, Big Pine Key, Florida. We propose to perform coral diversity assessments of the 3.8 km long linear reef and patch reefs seaward of the Newfound Harbor Keys, Big Pine Key, and the linear reef of unknown extent seaward of West Summerland Key in the FKNMS. We will investigate coral diversity, abundance, cover, and health using the Atlantic and Gulf Rapid Reef Assessment protocol -- a

combined linear transect/random quadrat method -- with more thorough species presence/absence data collected using video transects. Sediment samples will be collected and classified according to grain type and size for comparison with other patch reef sites and existing data for NFHR (Dodd et al., 1973). MTSU grant.

25) John Hunt, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (john.hunt@fwc.state.fl.us). FKNMS-2002-005, 1/7/2002 to 12/31/2004. Spiny Lobster Puerulus Monitoring Program. Influx of postlarval spiny lobsters is monitored using artificial settlement collectors that are placed in the nearshore waters on the Atlantic side of Long Key and Big Munson Key. We will replace the existing cinderblock anchoring systems with permanent, low profile stainless steel mooring eyes cemented into the substrate. FMRI base budget.

26) Claudia Jones, University of Pennsylvania (impglee@aol.com). FKNMS-2002-070, 8/23/2002 to 4/1/2003. The Effect of Climate Change and Rising Nutrient Levels on the Health of Selected Reefs in the Eastern Caribbean. Funding source unknown.

27) Sean Kinane, University of South Florida (skinane@helios.acomp.usf.edu). FKNMS-2003-009, 2/24/2003 to 12/31/2004. The Effects of Hydrodynamics on Coral Bleaching: Does Increased Flow Reduce Bleaching? Reduced bleaching is expected in high-velocity water flow based on field observations (e.g., Loya et al. 2001) and some experimentation (Nakamura and van Woesik 2001). This hypothesis will be tested in several coral species. The mechanisms of velocity-enhanced bleaching resistance will be explored including increased mass transfer of toxins out of corals in high flow. This research is partially supported by a 5-year NSF PECASE award to Dr. Thomas (OCE-9701434).

28) John Lamkin, NOAA Fisheries/Southeast Fisheries Science Center (john.lamkin@noaa.gov). FKNMS-2003-008, 2/24/2003 to 2/23/2004. Use of Geochemical Tracers to Elucidate Life History Trajectories of Gray Snapper within South Florida's Marine Ecosystems. It is our intent to map the source of recruits in the Florida Keys National Marine Sanctuary and the Tortugas Ecological Reserve using recent technological developments that allow us to detect trace elemental “fingerprinting” of fish otoliths. Commercially important snapper and grouper communities are believed to recruit to the reef from other areas, such as seagrass and mangrove habitats of Florida Bay, where they are believed to spend their juvenile phase before migrating to the coral reefs as young adults. We have established tentative "Florida Bay" signatures by collecting settled juveniles from the estuaries and now wish to establish "coral reef" signatures of adult fish taken from or adjacent to the coral reef SPAs and the reefs of the Tortugas Ecological Reserve. Comparing the two groups of otolith signatures will allow us to reconstruct the environmental history of individual fish. NOAA Coral Reef Initiative.

29) Brian Lapointe, Harbor Branch Oceanographic Institution (lapointe@hboi.edu). FKNMS-2003-003, 2/1/2003 to 1/31/2005. ECOHAB: Physiology and Ecology of Macroalgal Blooms on Coral Reefs off SE Florida. We propose to use the suspended line-bioassay, described and utilized previously at Looe Key by Littler et al. (1986) and Paul et al. (1987), to assess the consumption rates by grazing icthyofauna of resident macroalgae (scarids, acanthurids, etc.). Our interest is in performing these feeding preference studies at the shallow fore reef, reef crest, and rubble zone of the Looe Key “core area” and the patch reefs in Newfound Harbor Sanctuary

Preservation Area (SPA), to calibrate the importance of nitrogen biochemistry of macroalgae to palatability by a functional reef icthyofaunal assemblage. EPA-ECOHAB program.

30) Tom Lee, University of Miami, Rosenstiel School of Marine and Atmospheric Science/MPO (tlee@rsmas.miami.edu). FKNMS-2001-006, 2/23/2001 to 2/28/2003. Florida Keys and Florida Bay Circulation and Exchange Project. This project continues work on current patterns and water circulation in the Florida Keys National Marine Sanctuary and Florida Bay that was initiated in 1989. South Florida Ecosystem Restoration, Prediction, and Modeling program under NOAA/COP (Yeung) and RSMAS/U. Miami (Lee).

31) James Leichter, Scripps Institution of Oceanography (leichter@coast.ucsd.edu). FKNMS-2002-035, 5/13/2002 to 12/31/2003. Responses of Benthic Macroalgae to High Frequency Upwelling on the Florida Keys Reef Tract. The goal of this project is to examine the consequences of high frequency nutrient upwelling for benthic macroalgal populations on and seaward of the Florida Keys reef tract. NOAA/National Undersea Research Center.

32) Niels Lindquist, University of North Carolina at Chapel Hill, Institute of Marine Sciences (nlindquist@unc.edu). FKNMS-2001-010, 3/15/2001 to 12/31/2003. Tracing Marine Sponge Responses to Environmental and Water Quality Gradients and Anti-Predator Defenses Among Marine Hydroids and File Clams. For "Tracing Marine Sponge Responses to Environmental and Water Quality Gradients" we will use natural abundance stable isotope analyses of sponges to provide a unique view of their nutritional ecology, including the contributions of their symbionts to their nutritional needs and to possibly measure the magnitude of symbiont inputs, the effect of water quality on sponge stable isotope values, and the source of bioactive compounds that protect many sponges against predators, competitors and pathogens. For "Anti-Predator Defenses of Marine Hydroids: Alternative Strategies, Biogeographic Patterns, and Ecological Implications", recent studies have demonstrated that hydroids can be defended from predators by two distinctly different mechanisms - stinging nematocysts or distasteful secondary metabolites. Data from our investigations will be used to rigorously test the hypothesis that trade-offs exists among defense systems, particularly in marine organisms. Our studies will also be used to examine the hypothesis that mesofauna abundance and diversity will be lower among nematocyst defended hydroids than among chemically defended hydroids because stinging nematocysts can harm associated mesofauna. For "Evolution of a Chemical Defense Among File Clams (Bivalvia: Limidae) - Relationships Between Bivalve Palatability, Shell Morphology, and Shell Strength", in general, chemically defended organisms lack physically protective structures. We are investigating the robustness of this relationship in using an unlikely group of animals to have a chemical defensive – i.e. bivalve molluscs. The Limidae bivalves are providing an excellent system to test evolutionary relationships among susceptibility to predators and the value of a physical vs. a chemical defense. Furthermore, with the ability to build molecular phylogenies and an excellent fossil record, our data on extant Limidae and other bivalve species may provide a window into ecological and community structure of ancient reef habitats. An additional project, started in September 2002, is a subproject of the above research. Previous studies have shown that small epiphytic algae can alter the palatability of larger macrophyte to various herbivores. Given that marine hydroids are common epibionts on both marine plants and sessile invertebrates, we wish to test that hypothesis that epibiotic hydroids on seaweeds and seagrasses alter their palatability to herbivores. This hypothesis will be tested by offering individual urchins

a choice between two pieces of the same seaweed species (mass measured at the beginning of the experiment) one with epibiotic hydroids and one lacking hydroids. The relative rates of herbivory on the two pieces will be statistically compared. This analysis will be run for various combinations of seaweed/seagrass-hydroid combinations. NURC/UNCW #2000-24, NSF (#0002723 and 0082049), and by UNC funding.

33) Diego Lirman, University of Miami/RSMAS (dlirman@rsmas.miami.edu). FKNMS-2002-075, 1/1/2003 to 12/31/2004. Coral Size-Frequency Distributions as Indicators of Reef Health: Monitoring and Modeling Approaches. This is the continuation of a previously permitted project that undertakes a demographic approach to assess the condition of coral populations within patch reefs of the FKNMS that incorporates individual-based parameters such as growth, survivorship, partial mortality, and fragmentation. These measures can reveal sublethal differences among populations that abundance and diversity measures alone may miss. Unsure of funding for 2003 and beyond.

34) Kevin Madley, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (kevin.madley@fwc.state.fl.us). FKNMS-2001-020, 4/16/2001 to 4/15/2003. Florida Inshore Marine Monitoring and Assessment Program (IMAP). The goal of this project is to create a state-wide assessment of the environmental quality of inshore habitats by collecting information on various environmental indicators. The project is part of a long-term environmental monitoring program of over two dozen chemical, physical, and biological indicators under the U.S. EPA Coastal 2000 initiative. U.S. EPA Assistance Agreement #CR 827240-01-0.

35) Thomas Matthews, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (tom.matthews@fwc.state.fl.us). FKNMS-2002-076, 1/1/2003 to 3/31/2003. The Evaluation of Marine Reserves as Sanctuaries for Caribbean Spiny Lobster (*Panulirus argus*). We propose to measure the age of spiny lobsters in the Western Sambo Ecological Reserve (WSER) by measuring the concentration of the pigment lipofuscin in the neural tissue of lobsters. This direct aging methodology should help determine the length of time lobsters are afforded protection in the WSER. National Fish and Wildlife Foundation Settlement Grant Agreement, project 1998-0249-005, Marine Reserves (FL) Evaluation for Spiny Lobster.

36) Mikhail Matz, University of Florida (matz@whitney.ufl.edu). FKNMS-2002-039, 5/31/2002 to 6/1/2003. Genetics, Ecology and Evolution of Coloration in Great Star Coral, *Montastraea cavernosa*. In reef-building corals each visually perceptible basic color is essentially determined by the sequence of a single protein, homologous to green fluorescent protein (GFP) from jellyfish *Aequorea victoria*. This provides a unique opportunity to address the question of color evolution in the environment directly by applying the tools of molecular phylogenetics designed for sequence analysis and, in addition, to characterize and monitor variations in coloration in terms of expression of individual genes. The ultimate goal of the project is to understand the evolutionary mechanisms and ecological factors that determine the diversity of coloration in reef-building corals. UF/Whitney Laboratory.

37) Lisa Monk, Center for Marine Conservation (now The Ocean Conservancy) (Lmonk@vacmc.org). FKNMS-2002-022, 4/19/2002 to 12/31/2003. RECON (Reef Ecosystem

Condition) Program. RECON is a low-tech, rapid monitoring protocol for volunteer divers. RECON divers are trained by CMC-certified RECON instructors to collect information on the condition of coral reef ecosystems. The goals of RECON are to broaden the scope of available information about the benthic organisms on coral reefs, to alert local reef researchers and managers of changing reef conditions (e.g., mass bleaching events, outbreaks of disease, nuisance algal blooms, changes in abundance of key mobile invertebrates), and to increase public understanding of the threats to coral reef ecosystems. U.S. EPA grant.

38) Leonid Moroz, University of Florida (moroz@whitney.ufl.edu). FKNMS-2001-058, 9/10/2001 to 12/31/2003. Coral Screening Project. This project is designed to screen a wide sampling of corals to accomplish two goals from one collection. First, we want to see if any local corals contain yellow or red fluorescing proteins. Second, we want to search for the presence of the enzyme nitric oxide synthase, which generates the gaseous messenger molecule nitric oxide. University of Florida.

39) Alison Moulding, University of Miami, Rosenstiel School of Marine and Atmospheric Science (amouldin@rsmas.miami.edu). FKNMS-2002-014, 4/1/2002 to 3/31/2003. Coral Recruitment in the Florida Keys and the Relationship Among Adult Abundance, Larval Supply, and Recruitment of *Porites astreoides*. The objectives of this study are to examine coral recruitment along the Florida reef tract and to explore the relationship among presence of adult colonies, fertilization success, and recruitment of juveniles of one species of coral common in the Florida Keys: *Porites astreoides*, a hermaphroditic, brooding coral. By including Florida Keys reefs in this study, a better understanding of the mechanisms of supply and recruitment can be obtained. RSMAS and RSMAS Founders Research Fund award.

40) Alison Moulding, University of Miami/RSMAS (amouldin@rsmas.miami.edu). FKNMS-2002-077, 1/1/2003 to 12/31/2005. The Role of Restoration in the Recovery of Coral Reefs from Vessel Groundings. This study will examine reef sites damaged by boat or ship groundings and control sites. Some of the damaged sites have undergone restoration, and some have been left to recover naturally. Ecological benchmarks, such as coral recruitment, percent cover of major benthic groups, and three-dimensional structural complexity, will be used to evaluate the reef communities present at the sites and the efficacy of restoration efforts. Biscayne National Park, Cooperative Agreement CA 5250-8-9036.

41) Erich Mueller, Mote Marine Laboratory (emueller@mote.org). FKNMS-2002-013, 3/1/2002 to 2/28/2003 and FKNMS-2003-005, 3/1/2003 to 2/29/2004. Effect of Mosquito Control Pesticides on *Porites astreoides* Planula Larvae. This study aims to determine how mosquito adulticides affect the survival and viability of planula larvae from the scleractinian coral, *Porites astreoides*. Larval responses will be assessed following exposure to the mosquito adulticides, Naled and Permethrin, individually and combined, to simulate synergistic responses. Larvae will be dosed over a lethal and sublethal concentration range and a variety of endpoints recorded. Mote Marine Laboratory Research Fellowship.

42) Gregory Piniak, NOAA/NOS, Center for Coastal Fisheries and Habitat Research (gregory.piniak@noaa.gov). FKNMS-2002-087, 9/1/2002 to 2/28/2003. Fluorescence as a Tool for Enumerating Coral Recruits. Fluorescence technology is useful in locating coral recruits and

other small reef organisms that are difficult to detect with the naked eye. We propose a study to determine the capability of fluorescent technologies to identify and enumerate coral recruits, and to rigorously compare these techniques with current methods used to quantify coral recruitment on natural and artificial substrates. NOS.

43) Patrick Pitts, U.S. Fish and Wildlife Service (patrick_pitts@fws.gov). FKNMS-2002-036, 5/13/2002 to 5/12/2003. Florida Keys Tidal Restoration. The Florida Keys Tidal Restoration Project, a component of the Comprehensive Everglades Restoration Plan, is designed to restore tidal circulation in the middle Florida Keys in order to improve water quality and the health and composition of flora and fauna in the project area. The U.S. Fish and Wildlife Service (USFWS) will to provide guidance to the U.S. Army Corps of Engineers, the agency in charge of project construction, regarding ecological and environmental concerns, including threatened and endangered species. In order to provide this guidance, the USFWS will need to conduct field surveys to determine fish and wildlife resources in the project area. Fish and Wildlife Coordination Act transfer funding from the U.S. Army Corps of Engineers.

44) Terrence Quinn, University of South Florida (quinn@marine.usf.edu). FKNMS-2003-070, 10/16/2003 to 12/31/2003. Coral-Based Reconstruction of Environmental Variability in the Surface Waters of the Dry Tortugas. Our aim is to generate a >100-year environmental record of sea-surface variability from a coral core extracted from a live *Montastraea annularis* from Tortugas Bank. Our ultimate goal is to assess the range of natural climate variability over the past ~ 10,000 yr based on a quantitative comparison between modern and fossil coral-based climate records. The fossil corals have already been collected; it is now time to collect a modern coral so that our study can proceed. National Science Foundation, OCE-0221750.

45) Laurie Richardson, Florida International University (richardl@fiu.edu). FKNMS-2003-011, 3/5/2003 to 3/31/2005. Distribution and Etiology of Two Coral Diseases in the Florida Keys National Marine Sanctuary: Black Band Disease and White Plague Type II. This research constitutes continuation of our work on coral diseases in the FKNMS, and specifically addresses several hypotheses which have grown out of our work and which directly address both overall and specific objectives outlined in the Water Quality Protection Program. Unknown.

46) Susan Richardson, Smithsonian Marine Station at Fort Pierce (richardson@sms.si.edu). FKNMS-2002-008, 2/11/2002 to 12/31/2003. Diversity, Distribution, and Abundance of Foraminiferans in Seagrass Habitats, Florida Keys. Benthic foraminiferans, both epiphytic and sediment-dwelling, will be sampled from seagrass habitats in the Florida Keys. The diversity, distribution, and abundance of foraminiferal faunas will be characterized and compared and contrasted to similar sites in the Indian River Lagoon and Belize. Smithsonian Institution Postdoctoral Fellowship.

47) William Sharp, Florida Marine Research Institute (bill.sharp@fwc.state.fl.us). FKNMS-2003-007, 2/21/2003 to 12/31/2003. The Effect of Sea Urchin Herbivory on a Subtropical Seagrass Community: Experimental Manipulations Within a Manatee Grass-Dominated Meadow in South Florida. In an effort to increase our understanding of the dynamics of urchin herbivory within the Florida Keys National Marine Sanctuary, we propose a series of manipulative field experiments designed to examine the effects of herbivory by *Lytechinus variegatus* on

Syringodium filiforme. Using cages placed in situ within a large *S. filiforme* meadow, we will manipulate urchin densities and quantitatively assess their effects upon seagrass biomass. Florida Fish and Wildlife Conservation Commission and NOAA/Coastal Ocean Program.

48) Ned Smith, Harbor Branch Oceanographic Institution (nsmith@hboi.edu). FKNMS-2002-063, 9/16/2002 to 9/30/2003 and FKNMS-2003-067, 10/1/2003 to 4/30/2005. Nutrient Mass Fluxes between Florida Bay and the Florida Keys National Marine Sanctuary through Florida Keys Passes. Current speed/direction and water level will be measured to estimate volume transport through Long Key Channel and Moser Channel. Volume transports will be combined with nutrient concentrations to calculate nutrient transport. Measurements made during this field study will quantify the magnitude and direction of seasonal and long-term net nutrient transport between Florida Bay and Hawk Channel. NOAA/Coastal Ocean Program.

49) Keith Spring, Continental Shelf Associates, Inc. (kspring@conshelf.com). FKNMS-2003-071, 10/22/2003 to 7/1/2005. Resource Health and Sedimentation Monitoring and Resource Impact Assessment Monitoring for the Key West Maintenance Dredging Project. The proposed monitoring for the Key West Maintenance Dredging Project is being conducted to protect and minimize impacts to marine resources in the vicinity of the project area. Coral and seagrass health measurements will be made at specific locations adjacent to the project area and used as indicators of potential dredging impacts. Repetitive video transects will also be established pre- and post-construction to assess dredging impacts. Sedimentation data will be collected at weekly and monthly intervals. U.S. Navy in association with the dredging contract for the project.

50) Colette St. Mary, University of Florida (stmary@zoo.ufl.edu). FKNMS-2001-019, 5/1/2001 to 5/1/2003. The Effects of Artificial Reef Habitats on Fish Production. The goal of this project is to quantify the net effect of new habitat on fish production, enhance the sustainability of the marine ornamental fishery, and directly test the attraction-production hypotheses. To successfully conduct the critical field experiment, we need to optimize its design, which will depend upon patterns of spatial and temporal variance in settlement and abundance, the strength of density-dependence and the degree of movement between the artificial and natural reefs (as well as diffusion among the natural reef habitat). We will accomplish this by integrating field studies, quantitative literature syntheses, and mathematical population dynamic models. National SeaGrant Program.

51) Peter Swart, University of Miami, RSMAS (pswart@rsmas.miami.edu). FKNMS-2000-018, 4/3/2000 to 12/31/2003. The Origin and Recycling of Nutrients and an Investigation of Trophic Dynamics. The research proposed here is designed to generate an integrated data set, combining work on the sources of nutrients (Swart), cycling and fates of nitrogen and carbon (Swart and Szmant), nutrient flux and interactions with currents (Lee), the production of organic material by algae (Szmant) and energy flow between trophic levels (Cowen and Sponaugle). National Center of Caribbean Coral Reef Research.

52) Alina Szmant, University of North Carolina at Wilmington (szmanta@uncwil.edu). FKNMS-2002-054, 6/17/2002 to 6/30/2003. Research on Nutrient Dynamics, Algal Community Structure, and Algal Productivity. Regional coral reef decline is indicated by rapid loss of coral cover and increases in algal cover. It is important to be able to distinguish between increased algal cover

being a symptom of coral decline (e.g. algal colonizing substrate vacated by coral killed by one factor or another) vs. a causative factor (algae over-growing and killing the coral), especially if the latter is the result of anthropogenic nutrient enrichment of reef areas. Thus, a major objective of this NCORE subcontract will be to address factors that affect relative algal dominance. These include nutrient availability and cycling, and grazing pressure. National Center for Caribbean Coral Reef Research at the Univ. of Miami, funded by U.S. EPA. Subcontract to UNCW.

53) Florence Thomas, University of South Florida (fthomas@chuma1.cas.usf.edu). FKNMS-2002-041, 6/1/2002 to 12/31/2003. The Effects of Water Velocity/Hydrodynamics on Mass Transfer of Nutrients: a Partnership in Research and Education. This project explores the relationship between water velocity, nutrient uptake, and the morphology of the predominant community members of nearshore benthic communities, including seagrasses (i.e. *Thalassia testudinum, Halodule wrightii*) and macroalgae (i.e. *Halimeda* sp.). As the title implies, this NSF-funded project links research in hydrodynamics and biomechanics to public, k-12, undergraduate, and graduate education. Minority participation is encouraged at all levels and is the primary focus of recruitment at the undergraduate level. Supported by a 5-year NSF PECASE award to Dr. Thomas (OCE-9701434).

54) Linda Walters, University of Central Florida (ljwalter@pegasus.cc.ucf.edu). FKNMS-2003-076, 12/1/2003 to 11/30/2005. Killer Algae: Preventing Florida from Becoming the next Invasion Location of *Caulerpa taxifolia* -- Mediterranean strain. This project strives to determine whether DNA sequences of the native algae Caulerpa taxifolia and the invasive Mediterranean strain are significantly different. We will collect *Caulerpa* (green macroalgae) samples for DNA sequencing by Dr. Olsen's lab in the Netherlands. NOAA/National Sea Grant Aquatic Nuisance Species Program, administered by Florida Sea Grant.

55) Gerard Wellington, University of Houston (wellington@uh.edu). FKNMS-2002-081, 7/31/2002 to 8/31/2003. Genetic Variation and Phenotypic Response of *Montastraea faveolata*. The first, experimental project will estimate the heritability of metabolic and molecular characters related to stress response of *M. faveolata*. To date, heritability of both metabolic and molecular characters related to stress have not been investigated in any coral species. The purpose of the study will be to investigate the contribution of genetic vs. non-genetic (environmental and symbiont association) effects associated with *M. faveolata's* response to stress. The second project will be exploratory in nature. Currently, the genetic population structure for *M. faveolata* has not been investigated. The purpose of my project will be to collect preliminary data to test for significant genetic variation along the Florida Keys for *M. faveolata*. Houston Coastal Center.

56) Jennifer Wheaton, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (jennifer.wheaton@FWC.state.fl.us). FKNMS-2001-015, 4/16/2001 to 12/31/2003. Coral/Hardbottom Monitoring Project. The coral/hardbottom monitoring project documents status and trends (change) in stony coral species presence and percent cover of selected attached reef benthos. Documentation of degree of bioerosion will be a subset of the project beginning summer 2001. Established in 1995, the project's 43 sampling sites, which include 7 hardbottom, 11 patch, 12 offshore shallow, and 13 offshore deep reef sites are sampled annually. The project's primary goal is to document change in the presence/absence of stony

coral species richness and selected disease categories and relative percent cover of corals, octocorals, sponges, macroalgae, and substrate. U.S. EPA, FKNMS. [Summary of findings in annual report]

57) Cheryl Woodley, NOAA National Ocean Service, National Centers for Coastal Ocean Science (NCCOS), Center for Coastal Environmental Health & Biomolecular Research (cheryl.woodley@noaa.gov). FKNMS-2001-008, 4/1/2001 to 4/30/2003. Assessment of Coral Health in the FKNMS Using a Molecular Biomarker System (MBS). We have developed a Molecular Biomarker System (MBS) capable of determining whether corals are stressed and causative agents associated with that stress. The MBS works because the biomarkers respond to stress along biochemical and cellular pathways common to all organisms, from bacteria and protists to plants and higher animals. National Sea Grant Consortium collaborators include NOAA/NOS/NCCOS, Med. Univ. of South Carolina, FKNMS, Biscayne National Park, Univ. of South Florida, Univ. of Charleston, Coral Shores High School, and EnVirion Biotechnologies, Inc. These specific proposed projects are a subset of larger proposed projects to National Sea Grant and U.S. EPA and form a collaboration between the National Marine Sanctuary Program and NCCOS. [Summary of findings in annual report]

Science Mini-Grants Program
National Marine Sanctuary Program

Request for Proposals for FY05

Introduction

Funds for four Science Mini-Grants were awarded in FY 2004. The projects were:

- Characterizing and mapping the acoustic habitat of baleen whales within the SBNMS and monitoring the behavior of endangered baleen whales in relation to vessel traffic and vessel sounds (Dave Wiley and partners from Cornell, NMFS, FGBNMS, UNH, HIMB, WHOI, and Whale Center - $50K)
- Evaluation of site fidelity and spillover of commercially important fishes at the Anacapa Island and Santa (Sarah Fangman and James Lindholm (PIER) - $50K)
- Nearshore oceanographic buoy array for hypoxia monitoring and oil spill trajectory modeling (Mary Sue Brancato and Ed Bowlby - $25.7K)
- California coastal marine habitat GIS (Andrew Devogelaere, Steve Lonhart, Jan Roletto, Mary Elaine Dunaway (MMS) and John Steinbeck (TENERA) - $31.5K)

Though a budget for the National Marine Sanctuary Program (NMSP) has not yet been approved for FY05, it is the intent of the NMSP to continue to fund the Science Mini-grant Program. The NMSP Director remains confident that the program will continue if a favorable budget resolution occurs. To promote the success of the mini-grant projects, it is in the interest of the NMSP to select the next slate of projects as soon as possible to enable investigators to begin work as soon as funds become available.

One of the principal strategies of NMSP's Science Mini-Grant Program is to foster the development of long-term science capabilities within each national marine sanctuary. The program also encourages the integration of science, education and outreach through the projects, and activities it supports.

Science Mini-Grants are aimed at creating new and broadening existing programs in conservation science across the NMSP. While all scientific proposals will be considered, FY05 science priorities for the NMSP are similar to those of FY04 and include:

- Site Characterizations (Habitat, Living Marine Resources, Water Quality, Anthropogenic Influences)
- Monitoring (Habitat, Living Marine Resources, Water Quality, Anthropogenic Influences)
- Regional Observing Systems

Applicants are also encouraged to consider projects that will develop or test new technologies or protocols that could enhance capabilities throughout the NMSP. Proposals should highlight

synergies across sanctuaries or other program areas such as education, outreach, and maritime heritage programs. For FY05, a total of $150K may be awarded (divided among several projects) for obligation by the end of the fiscal year.

Science Mini-Grants will be awarded only to National Marine Sanctuaries, although other federal, state, tribal agencies, academic and non-profit organizations can act as partners, receiving Science Mini-Grants Program funds as part of a qualifying project. Funds for projects approved for FY05 must be obligated before the end of September 2005. Mini-grant funding is not intended to be a sustained funding source for science projects.

Factors for Qualification:

The following factors must be addressed for qualification of the application:

1. Proposals must reflect well-developed ideas, be clearly articulated and ready to implement.
2. Project directly involves at least one National Marine Sanctuary or the NWHICRER and must take place within a NMS or the NWHICRER;
3. Project has performance measures;
4. End of project will result in final report and strategy for dissemination of findings, as appropriate;
5. No salaries/wages for NMSP personnel can be included; and
6. While no cost limit is established for any given proposal, a recommended target would be $30 – 50K, allowing several proposals to be funded this fiscal year.

Criteria used for ranking:

1. Proposal advances one or more FY04 science priorities (25 points).
2. Project outcomes could enhance conservation science capabilities throughout the NMSP (25 points).
3. Project outcomes can be evaluated and a report generated (20 points).
4. Proposal leverages mini-grant funds by providing direct cash matching and/or expanding existing partnerships or building new ones in the National Marine Sanctuary for broadening conservation science within the system (max. 15 points);
5. Proposal provides convincing plan for obligating all funds by approximately September 16, 2005 (to allow for processing time by procurement personnel) and for carrying the project to a successful conclusion (15 points).

Proposal Format

Each proposal shall include:

1. Cover sheet to include brief abstract (maximum 200 words) and total funding requested (see example);
2. Narrative description of project (maximum five pages, 12pt font, single spaced), including justification, design, methodology, the science needs that are addressed, expected outcomes and performance measures, and a strategy for dissemination of results;
3. Project timeline;
4. Project budget (see example);
5. Project budget spreadsheet showing 4 columns (national funding, site funding, 3rd party funding, and total) and funding timeline;
6. Supporting information, specifications, and illustrations (maximum ten pages) may also be included, if appropriate; and
7. Support letters signed by managers/superintendents and authorized representatives of participating partners.

Deadlines

November 30, 2004	Science Mini-Grant Program Proposals Due
December 17, 2004	Award Announcement made
January 1, 2005 (tentative)	Dissemination of Funds
October 31, 2005	Quick Look progress report due
March 1, 2006	Grantee Final Report Due

NOTE: Funds must be obligated by September 16, 2005.

Application and Review Procedures

1. Electronic copies of proposals must be submitted by November 30, 2005, to:

   Steve Gittings
   Science Program Manager
   National Marine Sanctuary Program
   (301) 713-3125, x130
   Steve.Gittings@noaa.gov

2. Review panel may include, but is not limited to: NMSP HQ Science staff, NMSP Regional Coordinators or designee, staff from appropriate NMSP branches or sites (depending on proposal content).
3. All proposals will be ranked by reviewers and those that fall within the FY05 Mini-Grant allocation will be submitted for approval by NMSP Director.

4. Funds will be released to the sites as soon as they are available following approval from the NMSP Director.

Review and Selection Process Information

- The review and selection process will be conducted by the NMSP.
- The review and selection process will be a relatively quick and straightforward task involving no travel. Any communications necessary will be conducted by teleconference and email.
- Reviewer comments will be provided anonymously to applicants at their request once the review and selections process is complete.

Cover Sheet (Example)

FY 05 Science Mini-Grants Program
Office of National Marine Sanctuaries
Proposal Cover Sheet

Project Title:
Sanctuary:
Project Lead:
Abstract (max. 200 words)
Requested Funding ($)

Budget Spread Sheet (Example)

FY 05 Science Mini-Grants Program
Office of National Marine Sanctuaries
Proposed Budget Spread Sheet

Equipment				
Travel				
Contracts				
Grants				
Other (specify)				