



**Coral Reef Assessment, Monitoring, and Restoration:  
NCRI Report to the 11<sup>th</sup> Meeting of the U. S. Coral Reef Task Force**

February 24–25, 2004

Department of Commerce

Washington, D.C.



NCRI scientists partner with the State of Florida Dept. of Environmental Protection (FDEP), Florida Fish and Wildlife Commission Florida Marine Research Institute (FMRI), and Broward County Dept. of Planning and Environmental Protection (DPEP) to conduct yearly monitoring at 10 permanent sites in Miami-Dade, Broward, and Palm Beach Counties.

## NCRI Research Keyed to National Coral Reef Interests

Specific NCRI research programs address many of the key coral reef assessment, monitoring, and restoration issues raised in *The National Action Plan to Conserve Coral Reefs*, the *Coral Reef Conservation Act of 2000*, and *Executive Order No. 13089* (Coral Reef Protection) to preserve and protect coral reef ecosystems. These initiatives include:

- Classification of reef habitats and environments using remote-sensing technologies
- Determination of long-term coral density, calcification, and extension for comparison to global CO<sub>2</sub> rise and other parameters/indicators of climate change; Development of software for the rapid collection of coral density data and analysis/display of comparison time series
- Establishment and maintenance of a coral nursery using community outreach and education
- Innovative large-scale coral reef mapping incorporating the latest computer and mapping technologies
- Investigations on marginal reef systems: species distribution, population ecology, and community structure of *Acropora cervicornis* off Fort Lauderdale, Florida
- Inventory and survey of marine fishes on natural and artificial reefs of southeast Florida
- Molecular genetic assessment of dispersal potential and population connectivity in coral reef invertebrates and the implications for future research and applications in marine reserve design
- Restoration design and postrestoration monitoring
- Monitoring (and assessment) of Southeast Florida coral reefs

## NCRI Celebrates 5<sup>th</sup> Anniversary

The National Coral Reef Institute (NCRI) was established by Congressional mandate in 1998 at Nova Southeastern University Oceanographic Center. Contributions of the many NCRI and NSU people who made it possible were recognized in an October celebration of its fifth anniversary. Beginning with NCRI's *International Conference on the Scientific Aspects of Coral Reef Assessment, Monitoring, and Restoration* in Ft. Lauderdale in 1999, NCRI's many projects have continued to concentrate on its primary goal of the protection and preservation of coral reefs through applied and basic research and education on coral reef assessment, monitoring, restoration, and biodiversity.

Information on these and other past projects is generated and disseminated at national and international meetings on a regular basis. Additionally, NCRI is a supporter of and participant in the Local Action Strategy (LAS) initiative adopted at the 8<sup>th</sup> USCRTF Meeting in Puerto Rico, with active involvement in three of the four Southeast Florida Action Strategy Team (SEFAST) issue groups. The "Southeast Florida Coral Reef Initiative" (status reported at the 11<sup>th</sup> USCRTF meeting by the State of Florida), is the Florida LAS for coral reef conservation and management.

## Assessment

### ***Innovative Large-Scale Coral Reef Mapping Incorporates the Latest Computer and Mapping Technologies***

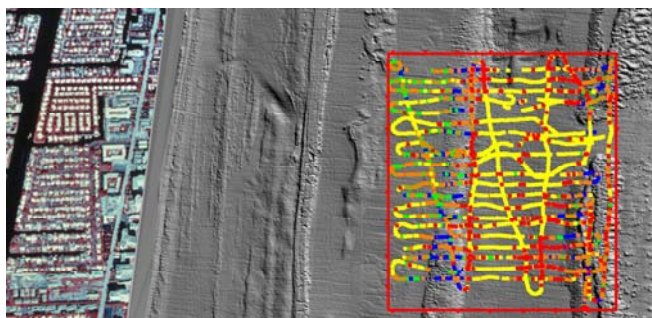
Detailed bathymetric data for a portion of Southeast Florida reefs, from 0-100' depth were developed to serve as the basemap for overlaying the results of biological and geological inventories, assessments, and monitoring. The maps are integrations of several available datasets. Currently NCRI is working as a partner with Broward County Department of Planning and Environmental Protection (DPEP) and with Coastal Planning and Engineering to help provide mapping products most useful for their management function of the reefs, especially with regard to beach renourishment. Plans are to expand the mapping efforts in southern Florida into Palm Beach and Miami-Dade Counties.



### ***Classification of Reef Habitats and Environments Using Remote-Sensing Technologies***

The work being conducted by NCRI is to develop, plan, and initiate a shallow-water biodiversity inventory, to perform associated biogeological assessments, and to participate in a monitoring program of southeast Florida shelf reefs. An integral outcome of this baseline is an accurate and detailed map of biological and geological resources, useful for management and for ecological understanding. Further work regarding the groundtruthing as well as an expansion of the available datasets is currently in progress.

### ***Mapping Southeast Florida (Broward County) Reefs Using***



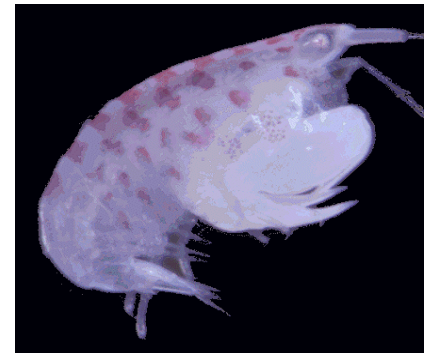
## Acoustic Technology

Mapping of Southeast Florida (Broward County) reefs are being conducted in partnership with the State of Florida Department of Environmental Protection (FDEP) and the Florida Fish and Wildlife Commission Florida Marine Research Institute (FMRI). Mapping will utilize acoustic technology to identify key reef habitats.

### ***Molecular Genetic Assessment of Dispersal Potential and Population Connectivity in Coral Reef Invertebrates and the Implications for Future Research and Applications in Marine Reserve Design***

Criteria upon which to base the design and location of marine protected areas (MPAs) for conserving biodiversity in coral reef and other marine communities are currently receiving considerable attention in the scientific and management communities. An overarching issue regarding the design of MPAs is the process of site selection and boundary delineation to achieve maximum protection and enhancement of marine communities both within and outside the reserve area.

Decisions about design and placement of MPAs requires a comprehensive assessment of patterns of biodiversity and population connectivity in species representing different trophic levels and life-history strategies.



Despite the critical importance of elucidating such patterns for effective MPA design and marine species management, the vastness of the oceans and difficulties of effectively tracking minute reproductive propagules have made obtaining this information an extremely difficult prospect. Fortunately, the development of new and powerful molecular genetic methods is providing an avenue to better infer the historical and present dynamics of dispersal and demographic connections among populations.

### ***Surveys of the Marine Fishes of Southeast Florida***

This is a four-year project to obtain a baseline survey of the coral reef fishes of Broward County. There are three major relict reef tracts in Southeast Florida, which run parallel to the coast in sequentially deeper water. The survey consisted of a non-destructive, visual census using the stationary visual census technique. The census stations were arranged in a grid pattern: a series of nine stations on an east-west line (determined by DGPS) were done every 0.25 nautical mile of the 18 nm coastline. Each series of nine stations was divided into three per reef line, one station at the easternmost edge, one at the westernmost edge, and one at the crest or centrally located. Data collection was completed in August 2002 and the results of 715 fish counts and more than 10,000 lines of data are now being statistically analyzed.

## Multivariate Examination of Spatial Patterns of Grunt (Haemulidae) Recruitment

The grunts (Haemulidae) are a speciose family of coral-reef fishes found, in abundance, within the greater Caribbean area. They are commercially important; directly, in some areas where they are a food source for humans, and indirectly, as a significant forage base for harvested piscivores throughout their range. Further, haemulids are important in the energetic dynamics of coral reefs because they forage off the reef, either on plankton or on benthic invertebrates, and provide a source of exogenous nitrogen to the reef. Despite their importance to coral reef ecology, little is understood of their early life history, particularly the dynamics of settlement and recruitment. However, a recent study which compared recruitment of grunts to hardbottom and artificial reefs called into question the assumption that inshore settlement is an innate preference; the inshore association could be a direct response to specific environmental variables. Effective management of this important group of fishes requires a more complete understanding of the determinants of their early life history. The results of these studies will provide critical information for understanding and managing the distribution of juvenile grunts as well as provide insight into essential fish habitat (EFH) and required criteria for effective habitat mitigation and restoration.

## Investigations on Marginal Reef Systems: Species Distribution, Population Ecology, and Community Structure of *Acropora cervicornis* off Fort Lauderdale, Florida

The importance of marginal reef systems to more highly developed reefs is emerging as an important ecological issue. During previous research by NCRI personnel and NSU OC



graduate students, aggregations of staghorn coral (*Acropora cervicornis*) were found distributed along the coastal waters off Ft. Lauderdale. Persistence and growth of this coral ecosystem in close proximity to highly urbanized coastal features present a valuable research opportunity because this population appears to flourish beyond known temperature constraints and in the

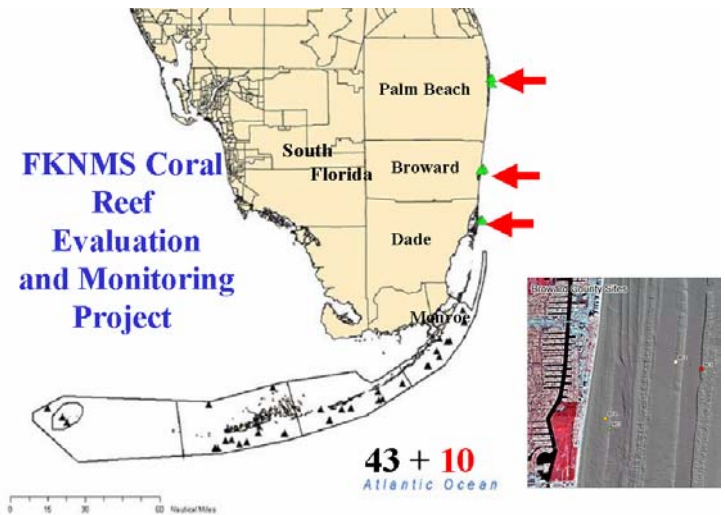
midst of significant anthropogenic stressors.

## Histological Stress Indicators for Corals in Marginal Environments

Observational and tissue-level sediment stress indicators are being developed for important species of hard and soft corals through experimental dosing and field studies. Results will be useful to gage effects of sediment-generating activities, such as dredging and beach renourishment.

## Monitoring Southeast Florida Reef Evaluation and Monitoring

NCRI is partnering with the State of Florida Department of Environmental Protection (FDEP) and Florida Fish and Wildlife Commission Florida Marine Research Institute (FMRI) to conduct yearly monitoring at 10 permanent sites in Miami-Dade, Broward, and Palm Beach Counties. Broward County DPEP, Miami-Dade County DERM, and Palm Beach County ERM are local management collaborators. The monitoring follows the formal protocols developed by FMRI for the CREMP (Coral Reef Evaluation and Monitoring Program) used in the Florida Keys.



## Puerto Rico Reef Monitoring

NCRI intends to take advantage of 18 permanent reef-monitoring sites at deep (20 m) and shallow (10 m) locations spanning the east end of the island of Vieques, Puerto Rico. These sites were established in 2001 and baseline monitoring was performed. Each site consists of a 30-m<sup>2</sup> area where detailed benthic data is collected via in situ diving and photographically. In addition field transects for fish data collection are conducted. We intend to collect subsequent data in a similar fashion for establishing a long-term data set. We intend to integrate protocols and data sharing with Puerto Rico DNER and with Florida DEP/FMRI.

Furthermore, several optical datasets are available for the eastern part of Vieques. It is planned that the spectral qualities of different benthic types be assessed and then an algorithm be built that allows their correlation to the older hyperspectral dataset. Thus, if habitat maps can be generated from an old dataset, a change-detection analysis against a newer dataset could be performed.

## NCRI Research Shows Variable Effects of Climate Change on Coral Reefs

Global climate change has been implicated in causing worldwide degradation of coral reefs with concomitant losses of ecosystem goods and services. Research by NCRI published in the latest issue of the journal *Coral Reefs* shows, however, how different the effects and the expected outcome

of global climate change can be. The study highlighted two high-latitude coral reef areas, consisting of several research sites each to allow for adequate replication, in the Persian Gulf and in South Africa. It was found that the Persian Gulf had experienced an unusually high incidence and rate of recurrence of major disturbances over the last decade, while South Africa had, as one of the very few privileged localities on earth, largely escaped the effects of global sea-surface temperature anomalies. The results were a dramatic decrease in coral coverage in the Persian Gulf but slight increases in South Africa. Corals in the Persian Gulf, however, began to show phenotypic adaptation to elevated SST. These results lead to the hope that indeed not all may be lost for the world's beleaguered coral reefs.

### **Investigations on Coral Growth through Density Banding**

Coral growth rates, based on annual density bands, serve as indicators of environmental change as well as a chronological template for isotopic and elemental analysis of the skeleton. National Coral Reef Institute (NCRI) investigations of these density bands led to our development of the Coral X-radiograph Densitometry System (CoralXDS), a Windows-based program that facilitates the rapid and accurate assessment of long-term growth records from coral skeletons. This program is freely available for download through the NCRI website: <http://www.nova.edu/ocean/coralxds/>, and links to this can also be found on NOAA's Paleoclimatology Program web page (through connections listed on <http://www.ngdc.noaa.gov/paleo/corals.html> and <http://www.ngdc.noaa.gov/paleo/softlib/othersoft.html>). In this project, we are evaluating the relationships between coral growth rates, global warming, and atmospheric carbon dioxide rise, using CoralXDS measurements of coral extension, density, and calcification.



## **Restoration**

### **Restoration Design and Postrestoration Monitoring Project**

The United States nuclear submarine *Memphis* grounded in 30' of water on a tropical coral reef off southeast Florida in February 1993, causing extensive physical and biological damage to the reef substrate and to the coral community. Restoration was planned and is coordinated through NCRI

participation as a hypothesis-based experiment that provides for design and placement of concrete structures with limited



monitoring. Data collection was initiated in October 2001. Donor colonies for the coral transplants were identified, cored, and transplanted into the modules. Monitoring and analysis will continue through 2004. Results from this study will be published in appropriate scientific journals and made available to other programs that are involved in restoration of damaged reefs.

### **Establishment and Maintenance of a Coral Nursery Using Community Outreach and Education**

The Nurseries for Reef Fisheries Habitat Project of Broward County, Florida, (or Coral Nursery Project) promotes coral reef conservation and fishery habitat restoration in a time where natural and anthropogenic pressures on coral reef fishery habitat are a growing concern for managers and scientists. The Coral Nursery Project was conceived earlier, proposed in 1998, and established in 2001 as a cooperative effort among scientists from Nova Southeastern University Oceanographic Center and the National Coral Reef Institute, marine resource managers from the Broward County (Florida) Department of Planning and Environmental Protection (DPEP), and community members from Ocean Watch Foundation Dive Club (OWF), with funding being provided by the National Fish and Wildlife Foundation (NFWF) and its federal partner, the National Oceanic and Atmospheric Administration (NOAA) Fisheries Community-Based Restoration Program for the 2001-2002 years. NCRI and its partners (BD DPEP and OWF) have committed to continuing the project through FY2003. The project was designed with three main objectives in mind: to create a nursery for corals of opportunity that may be used to help restore damaged reefs in the future, to provide reef managers with coral species-specific and colony-size specific transplantation success information, and to recruit volunteers from the community with interests in diving and the marine environment to assist with the project and to learn about coral identification, data collection, and transplantations procedures while also increasing public awareness and education. As of February 2004, 239 of the 249 transplanted colonies were alive and securely attached to the Nursery substrate.

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