NCRI NEWS: Coral Reef Assessment, Monitoring, and Restoration

November 2009

The National Coral Reef Institute (NCRI) was established by Congressional mandate in 1998. NCRI's primary objective is the assessment, monitoring, and restoration of coral reefs through research and education. NCRI operates at the Nova Southeastern University Oceanographic Center near Fort Lauderdale, Florida.

NATIONAL CORAL REEF INSTITUTE CONTINUES RESEARCH COLLABORATIONS AND PRODUCTIVITY

NCRI Teams with NOAA to Co-Host Coral Workshops

Working with National Oceanic and Atmospheric Administration's (NOAA) Coral Disease and Health Consortium (CDHC), the National Coral Reef Institute (NCRI) sponsored the first "Coral Genomics for Non-genomics Scientists" workshop at the Fish and Wildlife Service (FWS) National Conservation Training Center in Shepherdstown, WV. The workshop took place June 21-26, 2009 with twenty invited attendees, which included NCRI research scientists among both attendees and instructors. Participants represented countries ranging from Tanzania, Mauritius, Malaysia, and Columbia and the United States (from Maryland to Hawaii). The intent was to convey the tools and discuss the benefits surrounding the new field of Genomics and its technologies in the context of coral reef biology. Further information can be found at the NCRI website and **http://www.musc.edu/mbes/genomics/.**

A second workshop "Establishing Coral Disease Outbreak Response Teams" was held at the NSU Oceanographic Center in August 2009. Invited attendees included representatives from the Florida Department of Environmental Protection (DEP), Broward County Department of Environmental Protection and Growth Management, Florida Wildlife Resources Institute, NOAA, and the National Park Service. NCRI faculty served as course instructors. This training course is a means of identifying local team members and developing a network of well trained responders to local coral disease outbreaks. The workshop included time in the classroom as well as two days of field work on the local reefs of Broward County. Establishing Coral Disease Outbreak Response Teams is a long-range project to provide local response capabilities across U.S. coral reef jurisdictions to investigate coral disease outbreaks.

NCRI is pleased to participate with NOAA in this new joint-venture and looks forward to similar workshops that are scheduled for 2010.

Instructors and attendees of the "Coral Genomics for Non-genomics Scientists" workshop (left) in Shepherdstown, WV and the "Establishing Response Teams for Coral Disease Outbreaks" (right) at the NSU Oceanographic Center in Ft. Lauderdale, FL.

South Florida Sponge Guide Developed by NCRI Now Available

Researchers at the National Coral Reef Institute (NCRI) announce the launch of the South Florida Sponge Guide at **http://www.nova.edu/ncri/sofla_sponge_guide/index.html**. The guide was produced by NCRI and an international team of experts, with funding from the Florida Fish and Wildlife Conservation Commission, and Mote Marine Laboratory's Protect Our Reefs Grant Program.

The website is a practical, interactive identification guide to the shallow-water marine sponges of South Florida from Indian River Lagoon through the Florida Keys, Florida Bay and the Dry Tortugas, including illustrated keys and descriptions of whole organisms, their diagnostic components (e.g., microscopic spicules) and habitat and biological data. Sponges in this region are far more abundant and diverse than corals, but are often notoriously difficult to identify. The development team has designed the site for a wide range of users, including environmental managers, advanced students, teachers and professional scientists. It will both complement and supplement the recently developed "The Sponge Guide: a picture guide to Caribbean sponges" (Zea, S., Henkel, T.P., and Pawlik, J.R. 2009).

Currently, the South Florida Sponge Guide includes detailed descriptions and images of 51 South Florida sponge species. Additional species will be added as they are discovered and classified.

Monanchora arbuscula, a bushy red sponge found on a shallow reef in Broward County.

National Coral Reef Institute and Management Driven Research

In its effort to support the mandate of the National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Conservation Program (CRCP) for "effective management and sound science to preserve, sustain and restore valuable coral reef ecosystems", a major focus for researchers at NCRI is management-driven science. This applies to all three focus of NCRI research: assessment, monitoring, and restoration.

Assessment

Coral reef assessment research includes mapping, understanding of reef function, molecular genetics of reef populations, and the development of software.

Responsible management of reef resources is greatly aided by detailed knowledge of the resource's extent and distribution in space, which makes maps an indispensable management tool. Coral reef habitat maps are the basis for many management decisions and, as such, are an integral part of successful marine management plans with regards to the identification of essential fish habitat, other ecologically sensitive areas, or specific management purposes.

The coral reefs of southeast Florida extend from the Dry Tortugas in the Florida Keys northward to Martin County, encompassing Monroe, Miami-Dade, Broward, and Palm Beach counties. Working collaboratively with the Florida Department of Environmental Protection's Southeast Florida Coral Reef Initiative (SEFCRI), NCRI researchers have been involved in mapping the shelf from Miami-Dade northward. Researchers use a combination of satellite, aerial photograph, laser, acoustic, and in situ data collection.

NCRI researchers have also collaborated with NOAA researchers in the creation of the Hybrid Mapping Tool (HMT) project. Still a work in progress, the HMT mimics manual digitization, providing quick imagery-to-map conversion and is reproducible with a mathematical basis. While the NCRI component focuses on the coral reef ecosystem, HMT can be applied to both marine and terrestrial environments.

In further NOAA collaborations, scientists from NCRI are also focusing on an accuracy assessment of recent NOAA coral reef mapping projects in the Florida Keys. This project entails error checking of 500 statified random locations.

Internationally, NCRI has assisted in large-scale reef-resource assessments in Mexico, the British Indian Ocean Territory, Saudi Arabia, Qatar, and the United Arab Emirates. NCRI scientists work closely with local colleagues and management agencies and thus aid technology transfer and help giving international relevance to US coral reef science.

Monitoring

Detailed knowledge to understand reef trajectories over time requires data from long-term monitoring. Thus, monitoring is important for management and prediction. Static monitoring results (transects) can be leveraged into dynamic population models and spatial information into dynamic community succession models. The southeast Florida reef system exists offshore a highly urbanized region and is under varied and chronic stressors. SECREMP is a long-term reef monitoring program along Florida's southeast coast (Miami-Dade, Broward, Palm Beach, and Martin Counties), which NCRI performs in collaboration with Florida Department of Environmental Protection, and Florida Fish and Wildlife Commission, Florida Wildlife Resources Institute, . SECREMP is an extension of the Florida Keys Coral Reef Evaluation and Monitoring Project (CREMP), utilizing similar sampling protocols. The goal of SECREMP is to provide local, state, and federal resource mangers an annual report on the status/condition of the southeast Florida reef system. SECREMP is also important for resource mangers because, unlike previous southeast Florida monitoring efforts, the reef status and trend information is independent of marine construction activities and is not tied to the geographic or temporal constraints of those activities.

NCRI research divers surveying corals in southeast Florida during SECREMP surveys.

An important software tool produced by NCRI for managers is Coral Point Count w/Excel (CPCe) Software, which facilitates forecasting. There are currently over 250 registered academic users, 115 government users and more than 150 other users, representing over 40 countries.

Restoration

Damaged reefs often require aid in the natural recovery processes. NCRI coral nursery efforts are expanding thanks to funding supported by The Nature Conservancy and NOAA through the American Recovery and Reinvestment Act (ARRA). Headed by The Nature Conservancy and working with NCRI and other academic partners, staghorn (*Acropora cervicornis*) coral recovery projects have received support to further develop large-scale, in-water coral nurseries and restore reefs along Florida's southern coast and in the U.S. Virgin Islands (USVI). NCRI researchers are spearheading the nursery project off Broward County. NCRI itself will conduct a smaller scale on-land coral nursery to assess feasibility and efficiency.

Habitat Equivalency Analysis (HEA), for which NCRI has developed algorithms and software (Visual_HEA), aids in determination of the amount of compensatory restoration required to provide services that are equivalent to the interim loss of natural resource services following an injury. HEA includes a discounting procedure to account for asset valuation in that the total asset value is equal to the present discounted value of the future stream of all services from the natural resource or the compensatory resource. Discounting is used to include the loss and gain of ecological services of the resources over time. Visual_HEA is a computer program that facilitates input of HEA assumptions and parameters and calculates the compensatory action required for a given set of assumptions about injury and compensation. The ability to formulate many scenarios using the graphical interface is useful to evaluate alternative compensation strategies.

By encompassing management driven research in all its three focus areas – assessment, monitoring, and restoration, NCRI is able to provide useful tools to local and national coral reef resource managers. By supporting NOAA's mandate, NCRI's collaboration with management has a positive impact on coral reef ecosystems.

Top: Ten staghorn, *Acropora cervicornis* fragments epoxied to pucks in the nursery, December 2007.

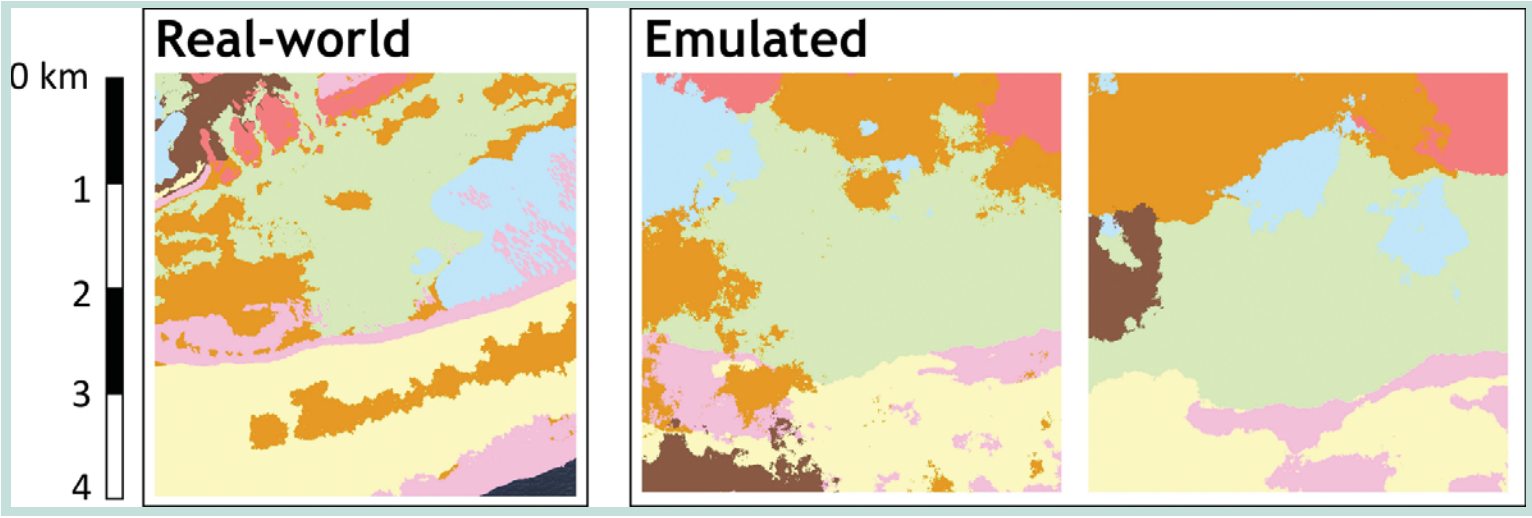
Bottom: Staghorn coral, *Acropora cervicornis* nursery fragments after 11 months of growth, November 2008.

NCRI Establishes Corporate Partnerships

NCRI scientists Dr. Sam Purkis and Kevin Kohler travelled to ExxonMobil headquarters in Houston Sept. 2nd through 4th to present an interim milestone report on the status of a collaborative project with the oil giant. Purkis and Kohler received funding to develop two solutions for the company. Firstly, a toolkit of satellite remote sensing algorithms, and secondly, a model to predict lithology of sub-surface carbonate reservoirs based on fractal statistics. The utility of both deliverables is to explore the use of modern reef environments as proxies for ancient carbonate depositional systems, which are believed to contain up to 50% of all oil and natural gas reserves.

The project is based on the premise that aspects of coral reef architecture are predictable through mathematical scaling laws. Purkis and Kohler have published several articles on this concept and confirmed its validity by querying map products of diverse reef systems. Their recent work further suggests that these scaling laws arise by virtue of the influence of weathering of reef terraces that occurred at times of lower sea-level than today. The effect of eroding limestone by rain produces a particular type of topography, very similar to a fractional Brownian surface, which Purkis and Kohler have shown to be a good statistical mimic of the scaling-laws observed in modern reefs. Because of similar formative processes, today's reefs are considered good analogues to their ancient fossil counterparts of the Miocene epoch, many of which are preserved below the Earth's surface and contain hydrocarbon reserves.

The hope is that information gained from this effort will enable ExxonMobil to recover hydrocarbons from the sub-surface more efficiently and with fewer dry-wells drilled. The work is projected to continue in a new phase of the collaboration through 2010.



Map of a real-world seafloor (left) from which statistical parameters were harvested and used to emulate two alternative visualizations of the landscape (center and right).

NCRI Scientists Receive Coastal America Award and Recognition from President Obama

NCRI Executive Director and NSU Oceanographic Center Dean, Dr. Richard Dodge, and Dr. Robin Sherman, Associate Director/Associate Professor at NSU Farquhar College of Arts and Sciences, received awards during a ceremony in August 2009. Coastal America and Principal Deputy Assistant Secretary of Defense for Reserve Affairs, David L. McGinnis, recognized efforts made by the Florida Artificial Tire Reef Cleanup Team by presenting them with a Coastal America 2008 Partnership award. Recipients of the award received a signed letter from President Barack Obama and the award is the only environmental award issued from The White House. Congressman Ron Klein participated in the award ceremony.

In the 1970s approximately two million tires were placed in the ocean off Broward County in an attempt to create an artificial reef and to enhance fish populations. The project became known as Osborne Reef. While the original intention was commendable, the tires have been displaced after years of weathering currents and storms. Many have made their way to shore – while those remaining are a threat to the fragile skeletal coral sculptures growing about the ocean floor.

A pilot project conducted by NCRI determined the Osborne Reef tire removal and disposal project to be important to protect the natural reefs in the area. Dr. Sherman was the Principle Investigator. In 2006, a group of federal, state and local agencies undertook a mission to determine if these tires could be removed in a coordinated recovery effort. This team discovered that few, if any, living organisms were attached to the tires and these could be easily removed and transplanted to a safe location during the recovery operation.

Understanding the importance of protecting the nearby natural reef, Governor Charlie Crist requested $2 million in the state budget for the much needed Osborne Reef project, available through the Solid Waste Management Trust Fund. The Florida Legislature passed the special appropriation enabling DEP to have a major role in protecting this outstanding coral reef and marine habitat.

From left: Principal Deputy Assistant Secretary of Defense for Reserve Affairs, David L. McGinnis; NSU Associate Professor, Dr. Robin Sherman; NCRI Executive Director, Dr. Richard Dodge: Congressman Ron Klein (FL-22) at the award ceremony.

NCRI Researchers Discover Spotted Eagle Ray Not a Single Species

The discovery of more than one species of spotted eagle ray raises conservation concerns over their future.

The study, by Richards et al., which appeared in the March 2009 Journal of Heredity shows that the spotted eagle ray *Aetobatus narinari* is actually made up of at least two and possibly more species and subspecies. Currently, the ray is classified as a single species worldwide, and is subject to intense and unregulated fisheries, particularly in parts of Southeast Asia.

This discovery, led by a team of marine scientists from NCRI, with additional support from the Save Our Seas Shark Center and the Guy Harvey Research Institute at Nova Southeastern University, has significant conservation implications for the survival of all the spotted eagle rays. Each newly discovered species and subspecies has a smaller distribution and population size compared to a single, globally distributed species, making them more vulnerable to pressures from fisheries.

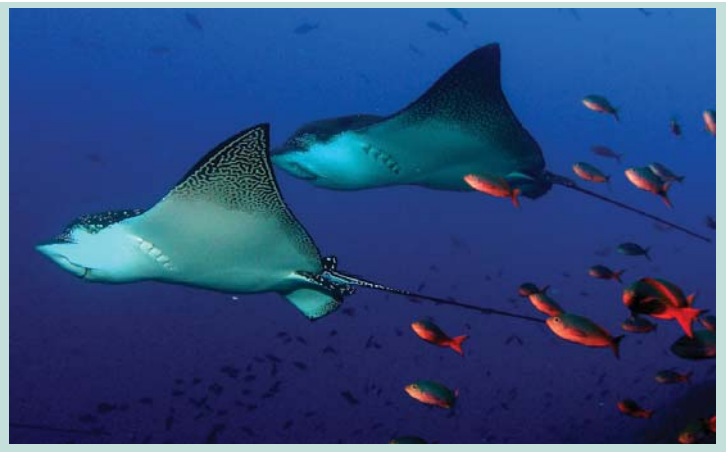


Photo: Bill Watts.

Traditional assessments of species have been based on their physical appearance, but with technological advancements in the field of genetics, many marine organisms considered single species are often found to be more than one species. Conversely, sometimes, animals described as different species based on their appearance are actually found to be just one species based on their DNA. These discoveries are common for small species, such as small fish and invertebrates. It is, however, unusual to make such discoveries in large, charismatic and highly visible species such as the spotted eagle ray.

Results from the study point to an Indo-West Pacific origin for the spotted eagle ray, followed by a movement into the Atlantic and Eastern Pacific, probably via the southern tip of Africa. Over time they have formed highly separated lineages that do not mix and have evolved into different species.

In depth genetic analysis of specimens collected from four locations across the globe shows that the spotted eagle ray ranging through the Western and Central Pacific is genetically very distant from the species that ranges through the Western Central Atlantic and the Eastern Pacific. The latter species is further divided into two subspecies separated by the Isthmus of Panama.

In addition to providing taxonomic clarification and insight into evolutionary history, these findings have direct management implications. The spotted eagle ray is considered highly vulnerable to sustained fishing due to its low reproductive rate. Consequently, it is listed on the IUCN Red List of Threatened Species as "Vulnerable" in Southeast Asia and "Near Threatened" globally. Dr. Mahmood Shivji, who led the study, stresses, "These listings are based on the designation of the ray as a single global species; in light of what we have discovered each of the more regionally distributed species may be more threatened than previously thought. Clarifying uncertainties surrounding the number of species, and their exact distributions and population size is imperative for guiding conservation and management efforts."

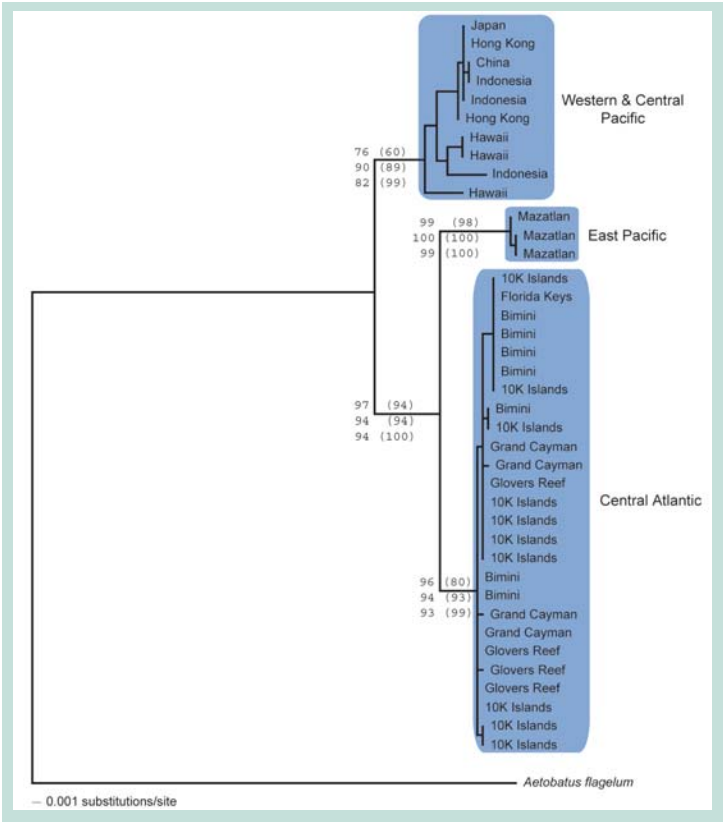


Figure: A phylogenetic tree based on two mitochondrial genes and one nuclear gene. The phylogeny clusters individual eagle rays (*Aetobatus narinari*) sampled from the (i) Western and Central Pacific, (ii) Eastern Pacific, and (iii) Central Atlantic into three distinct groups. Each group is comprised exclusively of individuals from each geographic region suggesting no genetic exchange among these regions. Furthermore, the level of genetic relatedness among the groups is similar to that seen between other ray species. Combined, these findings support independent species status for the eagle ray populations in each of these three geographic regions.

From: Richards, V.P., M. Henning, W. Witzell, and M.S. Shivji. 2009. Species delineation and evolutionary history of the globally distributed spotted eagle ray (*Aetobatus narinari*). **Journal of Heredity** 100(3): 273-283.

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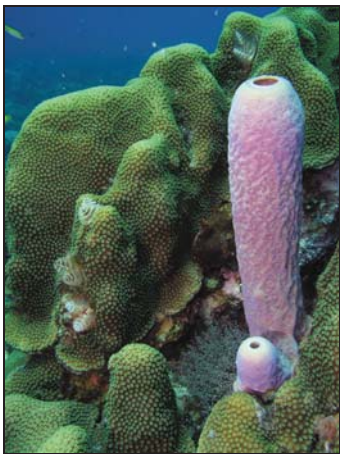

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