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EARTH SYSTEM MONITOR

A guide to NOAA's data and information services

INSIDE

U.S. Department of Commerce
National Oceanic and Atmospheric Administration

Conserving Valuable Coral Reef Ecosystems

Roger Griffis, Program Coordinator for the Coral Reef Conservation Program

Coral reefs are some of the most biologically diverse and economically valuable ecosystems on the planet. Covering less than one percent of the ocean floor, they are home to 25 percent of all marine species. Just ten "coral reef hotspots" support more than half of the world's restricted range marine species, all within 1/100th of a percent of the ocean floor. These "rainforests of the sea" also provide billions of people in over 60 nations with food, jobs, tourism, protection from coastal storms, and other valuable goods and services with a net present value of almost $800 billion. In the Caribbean alone, coral reef ecosystems provide services valued at $3-5 billion annually from fisheries, dive tourism, and shoreline protection. With effective management, healthy reefs can provide sustainable livelihoods and a lucrative foundation for coastal communities.

Unfortunately, coral reef ecosystems are also some of the most endangered marine ecosystems on the planet. Exploding coastal populations have dramatically increased the destructive impacts of overfishing, land-based pollution, and coastal development on fragile reef habitats. Corals are also highly vulnerable to the effects of climate change and warming seas that can cause corals to eject their symbiotic microalgae (very small one-celled plants) that give them their color and energy. Without these algal partners, corals "bleach" and they begin to starve and may die if conditions persist. Recovery of reefs from bleaching and other damaging events can take decades to centuries, with significant impacts on the communities and economies that depend on them.

The good news is effective management can help naturally resilient coral reef ecosystems recover and thrive. The National Oceanic and Atmospheric Administration's (NOAA's) Coral Reef Conservation Program (CRCP) was established in 2000 to support effective management and sound science, preserving, sustaining and restoring valuable coral reef ecosystems. The CRCP is a cross-NOAA matrix program that brings together expertise from four NOAA Line Offices (National Ocean Service, National Marine Fisheries Service, National Environmental Satellite, Data, and Information Service, and Office of Oceanic and Atmospheric Research) and many other partners to support conservation of coral reef ecosystems. The CRCP provides resources and tools that address specific priorities of the U.S. National Coral Reef Action Strategy including:

- Mapping, monitoring, and assessment of coral reefs
- Reducing adverse impacts of fishing
- Improving the use and effectiveness of coral reef protected areas
- Forecasting and addressing the impacts of climate change on reefs
- Reducing international threats to reefs

The CRCP is implemented through three main components: 1) National Program, 2) Grants Program, and 3) Coral Reef Conservation Fund. Working with many partners, the CRCP has helped reduce the following key threats to U.S. and international reefs:

- Completed the 1st comprehensive habitat maps of shallow U.S. reefs
- Removed over 550 tons of marine debris from the Northwestern Hawaiian Islands
- Supported establishment or management of over 25 reef protected areas
- Established the NOAA Coral Reef Watch Program to provide reef managers worldwide with information and forecasts of coral bleaching events
- Established the NOAA Coral Reef Information System (CoRIS) to provide access to NOAA coral reef data ■

For more information on CRCP, visit http://coralreef.noaa.gov.

Letter from the Acting Director Terrance Tielking

This quarter's *Earth System Monitor (ESM)* explores the comprehensive work being done in the coral reefs area by the National Oceanic and Atmospheric Administration (NOAA) and its partners. I look forward to reviewing these articles every issue before publishing as each issue opens up a whole new area of NOAA that I personally have not experienced and provides me with the opportunity to learn more about the great work being accomplished within the NOAA organization.

▲ Terrance Tielking

NOAA's Coral Reef Conservation Program (CRCP) truly incorporates the work of several line offices requiring complete cooperation to ensure effective support is provided to assess and determine appropriate actions to sustain coral reef ecosystems. Within the National Oceanographic Data Center, I am proud of the work that is being done by a small cadre of experts to maintain the Coral Reef Information System (CoRIS). This team consists of Federal employees, contractors, and consultants. They are all dedicated to providing updated information such as published results, images, and documentation of data on the current status of coral reefs for others to use in their analyses.

As we all know, there are several serious issues impacting the continued development of healthy coral reefs. Many reefs have deteriorated to the extent that they are beyond revitalization. The damage that is occurring to coral reefs in the U.S. coastal and territorial waters is not only this country's problem, but a global problem. The same health issues are being observed in the coral reefs off Korea and Australia, requiring international action to rectify the current situation. This edition of *ESM* describes the status of coral reefs and explores some of the rescue efforts underway to help.

As always, to make *ESM* of value to everyone, your comments about this publication are most welcome. ■

Cheers,
Terry

EARTH SYSTEM MONITOR

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The mailing address for the *Earth System Monitor* is:
National Oceanographic Data Center
NOAA/NESDIS E/OC1
SSMC3, 4th Floor
1315 East-West Highway
Silver Spring, MD 20910-3282

Editors
Michael Crane
Telephone: 301-713-3277 ext. 149
Fax: 301-713-3302
E-mail: esm@noaa.gov

Mindy Gaines
Marc Pulliam

U.S. DEPARTMENT OF COMMERCE
Carlos M. Gutierrez, Secretary

National Oceanic and Atmospheric Adminstration
Conrad C. Lautenbacher, Jr.,
Under Secretary and Administrator

The Hawaii Coral Reef Initiative Research Program

Kristine Davidson, Program Director, and Patrick Caldwell, Liaison Officer

As of March 2007, 37 unique accessions have been added to the NODC archive. Over 80 percent of all HCRI grants affiliated with *in situ* collection through 2003 have turned in data to NODC. Of datasets received, 17 were sampled across all the main Hawaiian Islands, 12 were localized studies, 4 were on at least two islands, and 4 were focused on the Northwestern Hawaiian Islands. The data are primarily biological, with only 4 sets exclusively chemical (water quality). Observations of corals are made in 21 of the sets; algae or other flora, 12 sets; and reef fish or other fauna, 11 sets.

Hawaii's coral reef ecosystems have critical national significance. Home to 5,000 marine plants and animals, 25 percent of which are found nowhere else in the world, these habitats contribute over $360 million per year to the state's economy, provide protection from tsunami and storm surge, and imbue aesthetical, educational, societal, and cultural values.

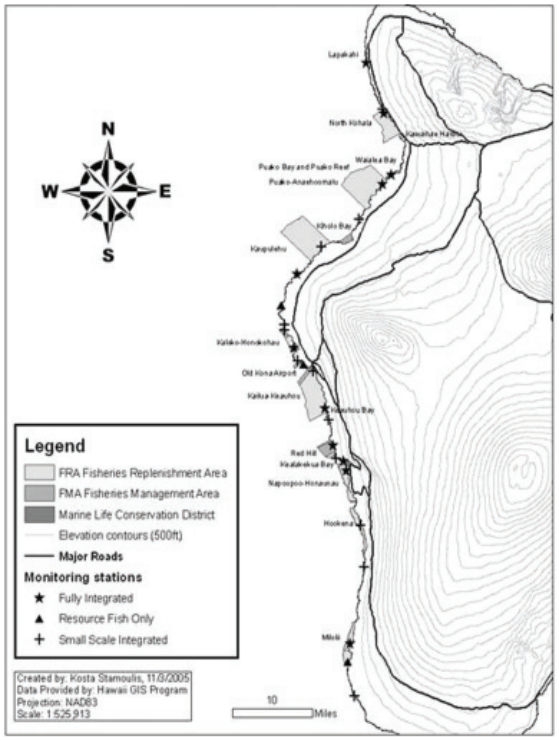
The Hawaii Coral Reef Initiative (HCRI) Research Program supports research, monitoring, outreach, and education focused on mitigating major threats to the state's coral reef ecosystems. Serious threats to Hawaii's coral reef ecosystems continue to increase from alien species, land-based sources of pollution, ocean recreation, and fishing pressure. Without further solution-oriented research and monitoring, Hawaii's coral reefs will continue to decline.

HCRI works with county, state, and Federal agencies, community-based organizations and the private sector to assess coral reefs and related ecosystems and the major threats to their integrity; build resource management capacity; develop database and information systems; conduct public awareness programs; and train present and future scientists and managers.

Since its inception in 1998, HCRI has had many outputs including over 85 management-directed projects, more than 200 briefings and reports to resource managers, over 100 scholarly peer-reviewed publications, more than 110 papers presented at scientific and professional meetings, 67 media articles, and over 150 students supported on research projects and internships.

Preservation and restoration of the coral ecosystems is not possible without a thorough understanding of historical characteristics, distributions, and interactions of species with the temporal and spatial variability of the physical environment. HCRI considers data preservation and availability an integral element of habitat preservation. All HCRI grants require *in situ* measurements and observations be submitted to the National Oceanographic Data Center (NODC), where they are preserved, cataloged, and made readily available. This task is facilitated through collaboration with the NOAA Data Center Hawaii Liaison based at the University of Hawaii. ■

For more information on HCRI, visit www.hcri.hawaii.edu.



▲ The West Coast of the Big Island has been the focus for many HCRI projects, such as the West Hawaii Aquarium Project, the DLNR Fish Resource and Benthic Characterization Study, the Coral Reef Assessment and Monitoring Program, and the Macro-algal Ecology and Taxonomic Assessment.

▲ Sarah McTee, graduate student at the UH Dept. of Zoology, is tagging a yellow tang. Weekly monitoring for all sizes of yellow tang shows a strong fidelity to a home site.

Interview with Michele Newlin, Managing Editor of CoRIS

Many think of data management as a job that is done primarily at a desk, in an office, on land. But as I, Michele Newlin, can attest, this rewarding but solitary job can present amazing outdoor opportunities. In May 2006, I was invited to work as the data manager on the NOAA Ship HI'IALAKAI during a one month trip (September 1 to October 4, 2006) to do reef assessments and monitoring throughout the Northwestern Hawaiian Islands. I jumped at the chance to join in this adventure.

I am the managing editor of the NOAA Coral Reef Information System (CoRIS), which provides web-based access to NOAA's coral data and information. CoRIS collects metadata that describes coral data; provides links to online data, products, and publications; and documents instruments and procedures vital to long term dataset monitoring. All of the data from scientists and researchers working with the NOAA Coral Reef Conservation Program comes to CoRIS where it is archived and made available to the scientists and public.

▲ Michele Newlin on board NOAA Ship HI'IALAKAI.

I lived on the HI'IALAKAI with 21 scientists and about 26 of the ship's crew. I worked with five teams—top predator (shark) team, benthic team, fish team, towed-diver survey team, and the oceanography team—and each team collected data at three to four survey sites per day. During this trip, we visited nine different islands or atolls and stayed at each of the locations for one to three days. Every day while the scientists were out at survey sites, I stayed on board the ship and performed my data manager duties. In a typical day, I would start out the morning by backing up my computer to a separate hard drive so no data throughout the entire mission could ever be lost since everyone's computers were linked directly to mine. Next, I processed the preliminary data the scientists brought back from the survey sites. For example, the position, name or number, and time of each dive for each site had to be recorded for each team as part of the data monitoring process.

In the afternoons, I created metadata. For all data archived, it must have a corresponding metadata record, which is a summary of the data. Everyday, each team recorded their individual and specific data. For example, the benthic team would record coral species they saw and photographed. I would then take this information and create metadata records for the data recorded at each site and location. At the end of the trip, all of the data was saved to several hard disks to ensure preservation by eventually being sent to CoRIS for archiving. This is all part of long term monitoring studies, which enable scientists to study and compare data from previous years.

Scientists were limited with what they could take from the site. They weren't allowed to take a lot of specimens back to the ship so scientists' took more ecological assessments in the form of videos, pictures, and handwritten data collections of the different coral, algae, and fish species. The Northwestern islands, which were recently proclaimed the Papahānaumokuākea Marine National Monument, are one of the few pristine ecosystems left in the United States where scientists have the chance to study their structure, and hopefully are able to apply what they learn to other coral reef ecosystems that are in decline.[1] It has been estimated that 20 percent of coral reefs throughout the world have been lost.[2] In 2005, reefs throughout the Caribbean suffered a record bleaching event where 90 percent of their coral bleached, and at many sites 40 percent of them died.[3]

After work and dinner, a typical evening for me would be to watch movies with everyone in the common room; we were able to watch two a night. The ship's doctor, Captain Woods, was assigned the task to pick all of the movies out. If I wasn't walking around the ship, I was working out in the exercise room (ever try exercising on a moving ship?). I also read a lot of books. The ship crew took pity on me because I was one of a few people who did not get off of the ship everyday to dive so they loaned me books, very diverse reading. They also invited me to the engine room where passengers are not normally allowed to venture. There were weekly safety drills that were performed such as fire drills, abandon ship drills, and man overboard drills.

I didn't think I would be able to venture off the boat, so I was extremely excited when the chief scientist, Dr. Peter Vroom, gave me the opportunity to go along to several sur-

vey sites within five different islands or atolls to do some snorkeling. At Gardner Pinnacles, Captain Woods, Andrea Rivera with the benthic team, and I snorkeled at approximately 30 feet. I watched from above as the oceanography team below changed their instruments, and as an eagle ray, a white-tip reef shark, and a lone monk seal swam by. The instruments the oceanographers were switching were for recording and storing ocean temperatures. I was surprised to find that everything underwater is very loud, and quite clear, from the noise the oceanographers were making to the sounds of the parrot fish nibbling on algae.

My favorite experience was swimming with Andrea Rivera and a diver with the predator team. While we were in the water, 15 Galapagos sharks came right up to us because they were very curious—luckily they were not dangerous. I was also able to swim with sea turtles, spinner dolphins, and lots of different species of fish.

Everyone (scientists and the ship's crew) got to take a rare day off while the ship docked for a day at the island of Midway. Midway is home to one of the most historic battles of World War II, as well as an important nesting ground for several species of albatross. I was able to tour the island and see historic buildings and lots of wild life. However, I was sad to see how much trash was left from when the albatross were nesting and raising their young. The birds pick up toothbrushes, lighters, and other pieces of plastic in the ocean and mistake it for food, which they bring back to the island to feed to their young. The young as well as the adult birds often die because the plastic lodges in their digestive systems.

Overall I had a completely rewarding experience from my time at sea. I enjoyed everything about the experience from the sleepless nights due to rough seas to watching movies. I gained a greater respect for the scientists who go out in the field everyday to study our world, and also gained a greater understanding of the entire data process that needs to take place—from the initial collection to the end product that becomes available from the CoRIS website. I was also highly moved by the first hand experience of the marine debris on Midway—especially by all of the dead birds lying around. Their decomposed bodies showed all of the plastic and trash they digested and it reminded me of big bundles of plastic. I would recommend to anyone who is offered this type of opportunity, whether it is to participate in a scientific research cruise or some other scientific opportunity, to go and have the experience. There is no better way to learn about our world and have a better appreciation for our part in it then to see it first hand. ■

[1] Friedlander, AM., G. Aeby, R. Brainard, A. Clark, E. DeMartini, S. Godwin, J. Kenyon, R. Kosaki, J. Maragos, and P. Vroom. "The State of Coral Reef Ecosystems of the Northwestern Hawaiian Islands," pp. 270-311 (2005). In: J. Waddell (ed.), "The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005." NOAA Technical Memorandum NOS NCCOS 11. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team, pp. 522.

[2] NOAA 200th website, "From Navigation Hazard to Treasured Resource: NOAA's Emerging Leadership in Coral Reef Conservation," (from the Conclusion page), http://celebrating200years.noaa.gov/foundations/coral/welcome.html#con (accessed April 11, 2007).

[3] NOAA 200th website, "What is Coral Bleaching?", http://celebrating200years.noaa.gov/foundations/coral/side3.html (accessed April 11, 2007).

Photos Courtesy of Michele Newlin

▲ Top: Hazardous working conditions at Gardner Pinnacles.

Middle: Towed-Diver Survey Team proceeds to survey site.

Bottom: Ocean swells and waves collide with the rock outcrops along Midway Atoll.

Comprehensive Online Tools for Classroom Teachers on Coral Reef Ecosystems

Bruce Moravchik, Communications and Education Division of the National Ocean Service

The National Oceanic and Atmospheric Administration (NOAA) and the National Science Teachers Association (NSTA) have recently unveiled a series of comprehensive online professional development resources for educators focused on coral reef ecosystems. The Coral Ecosystem SciGuide and four Coral Reef Ecosystem Science Objects were developed collaboratively by NOAA's Ocean Service Communications and Education Division, NOAA's Coral Reef Conservation Program (CRCP), and NSTA, as part of a multiyear cooperative agreement.

"NOAA's Coral Reef Conservation Program is proud to partner with the NSTA to create these innovative, peer-reviewed education resources for teachers," said David Kennedy, manager of NOAA's CRCP. "The Coral Ecosystem SciGuide and Science Objects will help educators understand and teach about the coral animal, the complexity and fragility of coral reef ecosystems, and the vital importance of protecting these valuable ecosystems for future generations."

The Coral Ecosystem SciGuide pulls together the best of the Internet's resources on coral science, and organizes them into three major theme areas: coral reef biology, coral ecosystems, and coral conservation. The web-based resources in the SciGuide are aligned with national science education standards; they were developed, reviewed, and approved by NSTA "master educators" and NOAA scientists. The SciGuide also provides field-tested lesson plans and teaching aids, including samples of student work and lessons learned from pilot teachers.

The four Coral Reef Ecosystem Science Objects provide one-to-two hour online learning experiences teachers can use to quickly enhance their understanding of a particular aspect of coral science. Collectively, Coral Reef Ecosystem Science Objects provide an overview of reef ecosystems, the abiotic (not biological such as temperature) factors that affect these ecosystems, the interdependent relationships between species in reef ecosystems, and the natural and human causes of ecosystem stress. Each Science Object challenges teachers to explore and explain real world phenomena through simulations and practice assessments.

"The Coral Ecosystems SciGuide and Science Objects will be especially useful for early career teachers who need practical ideas, lesson plans, and high-quality curriculum resources to help them learn about coral ecosystems and properly teach science," said Dr. Gerald Wheeler, NSTA executive director. ■

For more information on these online tools, visit the NSTA Learning Center's website at http://learningcenter.nsta.org/products/default.aspx.

Coral Reef Information System

Kelly Logan, Programmer Analyst

Destructive fishing practices, coastal development, increases in sea surface temperatures, habitat destruction, pollution, diseases, and invasive species are the trials in a coral reef's life. The Nation's coral reefs are threatened and their health is declining. It is estimated that 10 percent are now beyond recovery, 30 percent are in a critical stage and may die in the next 10-20 years, and 60 percent may die by the year 2050.[1]

Coral reef ecosystem managers can become overwhelmed by the range of threats encountered on a daily basis. They must repeatedly ask questions such as, "How do I diagnose coral diseases?" "What are others doing about habitat destruction, and how can I learn from their work?" "Which invasive species may inhabit my reef area?" The answers to these questions and many more may be found in the National Oceanic and Atmospheric Administration's (NOAA's) Coral Reef Information System (CoRIS).

NOAA has a long history of collecting a vast array of data and creating diverse scientific data and information products about coral reef ecosystems. NOAA's Coral Reef Conservation Program (CRCP) created CoRIS in 2002 to facilitate enhanced access to coral data and information from Federal agencies. With leadership from CRCP, NOAA researchers continue to collect new coral ecosystems data and develop new information products.

CoRIS is a web-enabled, enhanced Geographic Information System (a mapping display of data) that uses a single web portal to provide access to NOAA's geo-referenced coral reef data and information, activities, and library services. It offers search tools to assist users in discovering data and information on coral reef ecosystems and adjacent habitats and communities.

(*continued on page 9*)

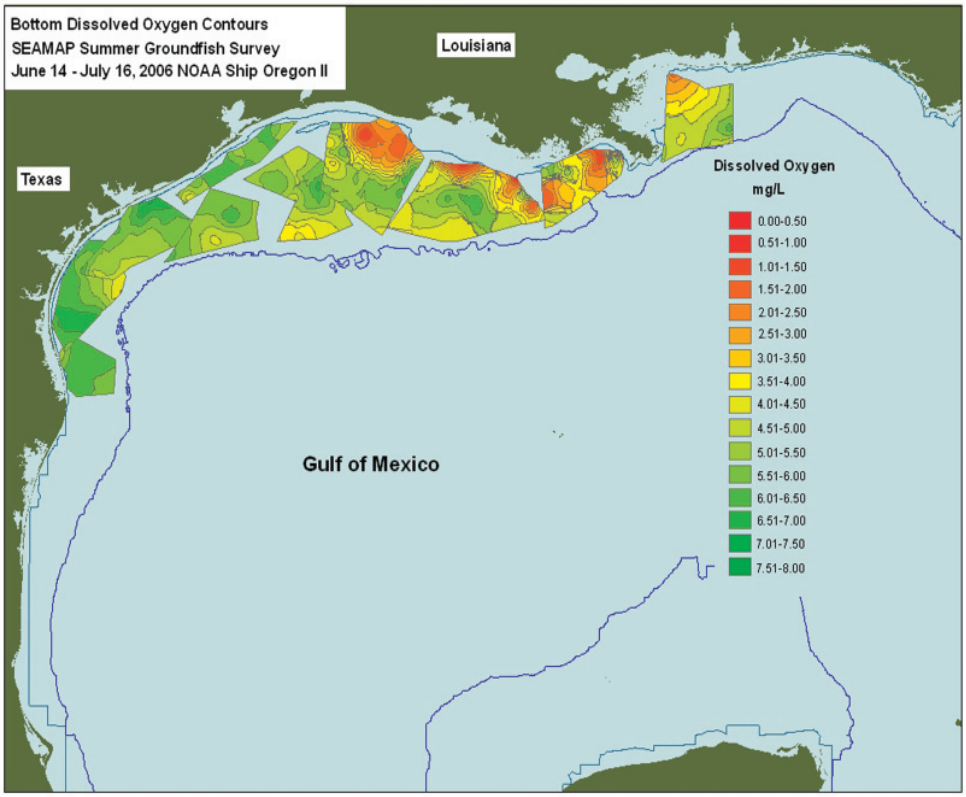
News Briefs

Improve Our Understanding of "Dead Zone" Impacts on the Northern Gulf of Mexico Ecosystem

NOAA awarded funding to support research into the causes and impacts of the hypoxic zone in the northern Gulf of Mexico, known as the Dead Zone. Hypoxia-low dissolved oxygen occurs in many of the world's aquatic environments. The largest zone of oxygen-depleted coastal waters in the United States, and the second largest for the world's coastal ocean, is in the northern Gulf of Mexico on the Louisiana continental shelf.

The NOAA Northern Gulf of Mexico Ecosystems and Hypoxia Assessment (NGOMEX) Program seeks to provide resource managers with new tools, techniques, and information to make informed decisions and assess alternative management strategies regarding hypoxia. Supported projects include the development of a fundamental understanding of the northern Gulf of Mexico ecosystem, with a focus on the causes and effects of the hypoxic zone, and the prediction of its future extent and impacts on ecologically and commercially important living resources.

Through the NGOMEX Program, predictive models have been developed to forecast the spatial and temporal extent of the hypoxic zone given varying human-induced or natural factors that cause hypoxia. This research will improve and validate these forecast models by extending long term monitoring efforts and incorporating processes important to understanding the link between environmental factors, hypoxia, and ecosystem health.



▲ View of bottom dissolved oxygen contours in the Gulf of Mexico.

Pacific Coastal Salmon Recovery Data Management

Jen Johnson, Pacific Coastal Salmon Recovery Fund Coordinator

NOAA Fisheries Northwest Regional Office and Northwest Fisheries Science Center have worked together to develop a database to manage thousands of salmon recovery projects funded by the Pacific Coastal Salmon Recovery Fund (PCSRF). PCSRF Congressional appropriations fund projects in Washington, Oregon, California, Idaho, Alaska, and the Pacific Coastal and Columbia River tribes to conserve and restore Pacific salmon and steelhead. PCSRF projects have improved over 532,000 acres of salmon and steelhead habitat and made more than 5,000 stream miles accessible to fish. PCSRF's effectiveness is evaluated by tracking project outputs and outcomes to evaluate their ability to restore habi tat and recover salmon. Data are used to produce an annual report to Congress, showing how projects address factors that limit salmon recovery and the overall health of salmon populations.

▲ During FY 2005-2006, the Confederated Tribes of the Umatilla Indian Reservation removed 1,400 linear feet of the Fletcher levee and 2,200 cubic yards of associated cobble and rock fill in Camas Creek in the north fork of the John Day River basin in Oregon.

The database can be accessed at http://webapps.nwfsc.noaa.gov/pcsrf.

California Sea Floor Survey Sheds New Light on Big Waves

The NOAA National Marine Sanctuary Program and the California Ocean Protection Council released new data and three-dimensional imagery of the sea floor off California that helps explain why the famed "Mavericks" waves are among the largest in the continental United States. The data illustrates in unprecedented detail the rugged sea floor surrounding the world-famous surfing spot near Half Moon Bay, and sheds new light on ocean ecosystems and phenomena such as large waves and underwater earthquakes.

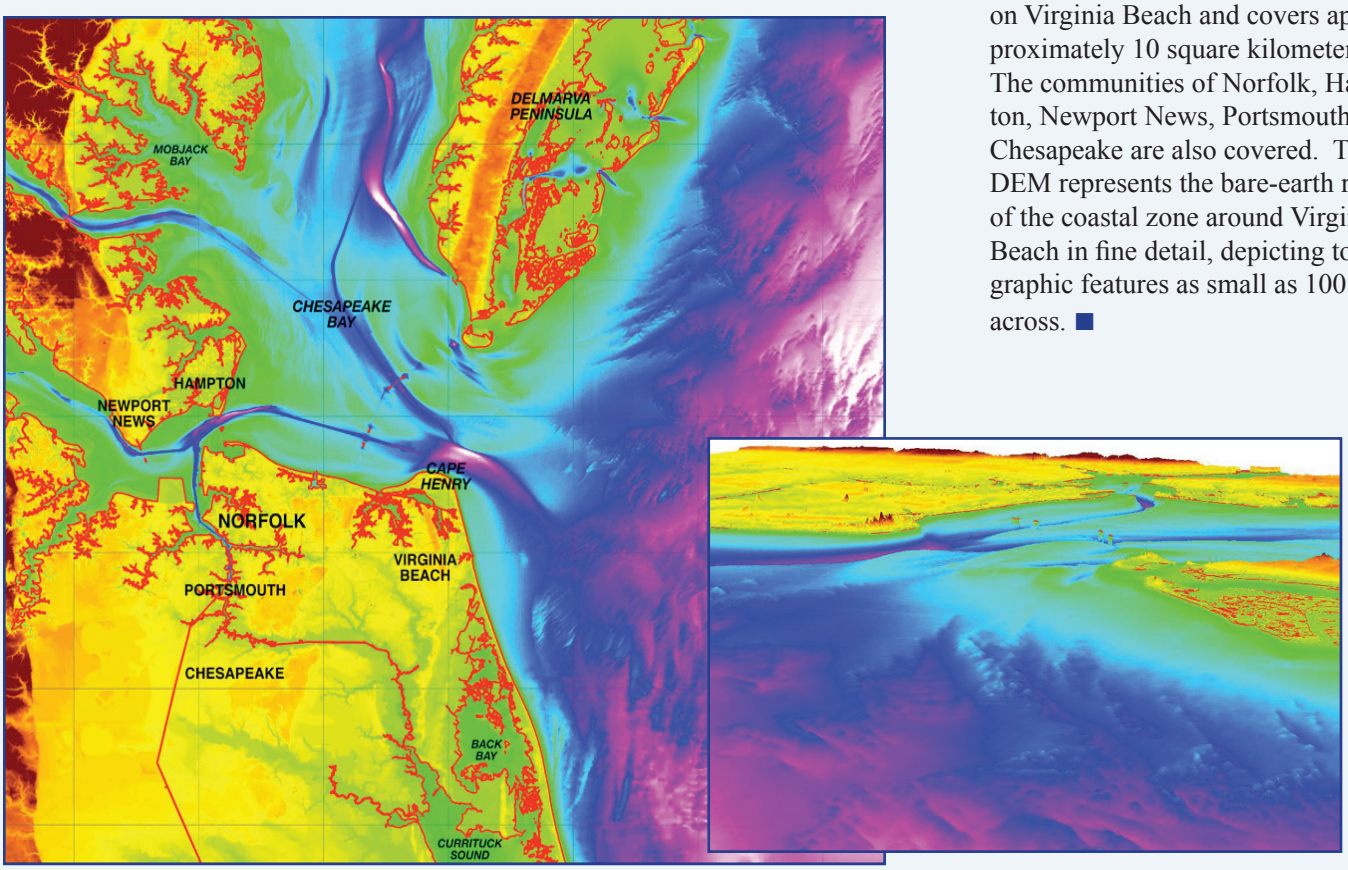
Researchers used advanced sonar equipment and aerial light detection instruments to produce detailed underwater pictures that highlight the faults, chasms, fissures, crevices, and pinnacles on the sea floor. It also helps scientists distinguish critical under-water habitats. Scientists and resource managers will use the information to identify potential biological "hot spots" to aid their understanding of the highly productive, diverse undersea ecosystem along the California coast.

Also significant is the survey's charting of navigational hazards such as hidden reefs and sunken obstacles. Knowing where hazards are located is essential for the safety of vessels that use these waters each year. This is the first time scientists have been able to show the shallow nearshore reef in such detail.

Scientists Help Prepare Virginia Beach for Tsunami, Storm-Driven Flooding

Scientists with the NOAA National Geophysical Data Center and the Cooperative Institute for Research in Environmental Sciences have created a high-resolution digital elevation model (DEM) for the area around Virginia Beach, VA. It is designed to improve forecasting for early tsunami warning systems and to help coastal communities prepare for storm-driven flooding. DEMs are constructed from near-shore seafloor depth and land elevation data to create a detailed representation of coastal relief. It will provide the underlying framework necessary to accurately forecast the magnitude and extent of coastal flooding during a tsunami or storm surge event.

The new relief model is centered on Virginia Beach and covers approximately 10 square kilometers. The communities of Norfolk, Hampton, Newport News, Portsmouth, and Chesapeake are also covered. The DEM represents the bare-earth relief of the coastal zone around Virginia Beach in fine detail, depicting topographic features as small as 100 feet across. ■



▲ Left: View of shaded relief map of Virginia Beach, VA, digital elevation model.

Right: View of the bathymetric-topographic DEM covering the coastal community of Virginia Beach, VA, and the surrounding Chesapeake Bay region.

(*Coral Reef Information System continued from page 6*)

Data and information content includes material on *in situ* biological, chemical, geological, and physical environmental data from divers, remotely operated vehicles, moored buoys, current meters, and other oceanographic instruments. This system also has coastal aerial photographs, nautical charts, tidal data, coral bleaching reports, and much more. ■

[1] Coral Reef Task Force, "The National Action Plan to Conserve Coral Reefs," Washington, DC: U.S. Government Printing Office, p. 3 (2000).

For more information on CoRIS, visit www.coris.noaa.gov.

Satellite Tools for Coral Reef Bleaching and Monitoring

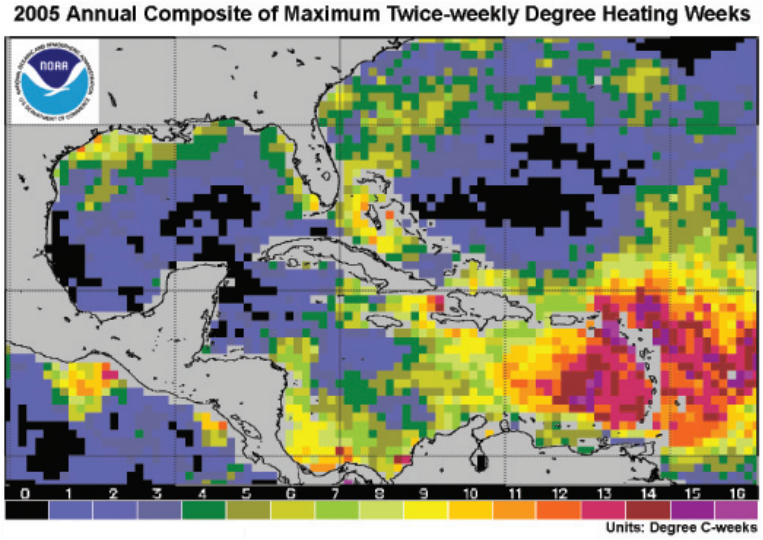
Mark Eakin, Coordinator, NOAA Coral Reef Watch, and Jessica Morgan, Operations Manager, NOAA Coral Reef Watch

In 2005, coral reefs in the wider Caribbean suffered a widespread and severe bleaching event that killed as much as half of the corals in the region. Corals can recover when bleaching is caused by mild, short-lived thermal stress. Prolonged or severe bleaching kills corals. The same high temperatures also lead to outbreaks of coral disease. Corals provide critical habitats and nursery grounds for marine fisheries, tourist attractions, and protection of coastlines from severe storms and wave activity.

NOAA's Coral Reef Watch has developed a variety of operational near-real-time satellite products, such as HotSpots, Degree Heating Week charts, and the Satellite Bleaching Alert System, to monitor conditions conducive to coral bleaching. HotSpots monitor high water temperatures approaching or surpassing bleaching threshold temperatures. Corals can tolerate warm water, but tend to bleach above that threshold. The Degree Heating Week (DHW) product monitors the thermal stress (HotSpots) accumulated over three months. The Satellite Bleaching Alert System sends out automated e-mails when critical DHW levels are reached, alerting managers and researchers of bleaching watches, warnings, and thermal stress levels that give rise to coral bleaching. The latest data on thermal stress is now available for visualization using Google Earth as well as in gridded numerical format that can be accessed and analyzed.

NOAA has been monitoring ocean acidification through satellite data, models, oceanographic cruises, and hydrographic stations. This data provides the coral reef management and scientific community important capacity to track changes in ocean chemistry and the resulting changes in community structure in response to ocean acidification. Rising levels of atmospheric carbon dioxide are causing fundamental chemical changes in surface ocean chemistry. As CO^2 reacts with seawater, pH (or acidification) and the availability of chemical compounds are reduced. They play an important role in shell creation for a number of marine organisms, including corals. These changes reduce the rate at which corals build their skeletal materials and, in coming years, reef production could halt throughout much of the world's oceans.

NOAA's Coral Reef Watch is developing the Reef Metabolic Index to model the metabolic performance of selected reefs. Comparisons of offshore estimates to reef measurements allow monitoring of changes in photosynthesis, respiration, and calcification occurring at community-scales and help us keep track of the influence of both water temperatures and ocean acidification. Coral Reef Watch enables full globe monitoring and modeling services. ■



▲ Composite of maximum values of NOAA Coral Reef Watch Degree Heating Weeks thermal stress accumulations for the record setting 2005 bleaching event.

For more information on NOAA's Coral Reef Watch, visit http://coralreefwatch.noaa.gov.

The Integrated Coral Observing Network

Jim Hendee, Atlantic Oceanographic and Meteorological Laboratory

The National Oceanic and Atmospheric Administration's (NOAA's) Integrated Coral Observing Network (ICON) is a project of the Atlantic Oceanographic and Meteorological Laboratory's (AOML's) Coral Health and Monitoring Program. The ICON vision is to serve as a model for all of NOAA in establishing a high quality *in situ* coral reef monitoring network, and for the integration of near real-time *in situ*, satellite, radar, and other data for ecological forecasting in coral reef ecosystems.

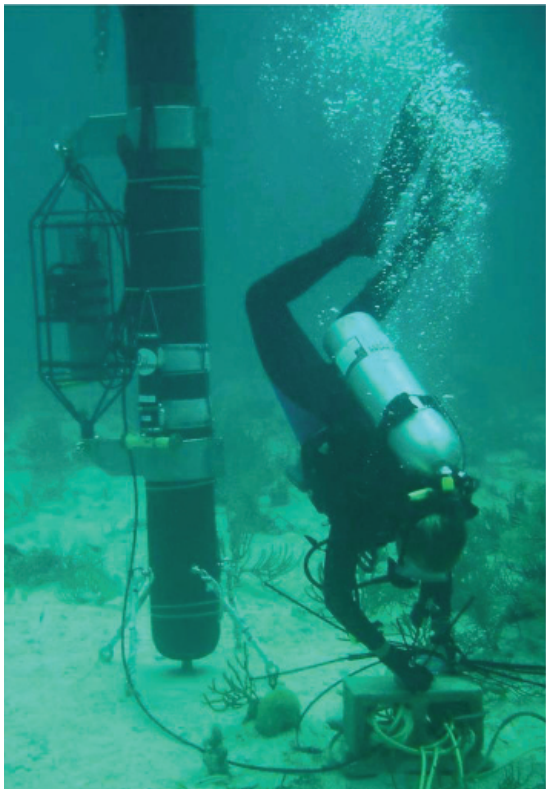
The ICON program is focusing on integrating data from NOAA, academic, and regional sources. This program especially wants to accomplish the following: 1) develop ecological forecasting models for use by the Marine Protected Area (MPA) managers and researchers; 2) ensure consistency with NOAA's Integrated Ocean Observing System (IOOS); 3) forge international partnerships; and 4) facilitate development and transition to operations of *in situ* instrumentation.

The growing ICON network is currently comprised of meteorological and oceanographic monitoring stations in Lee Stocking Island, Bahamas; St. Croix, U.S. Virgin Islands; and La Parguera, Puerto Rico. Several other stations are under construction or being planned for deployment. The standard meteorological station measures air temperature, wind speed and gusts, wind direction, barometric pressure, precipitation, light (above and below water), sea temperature, salinity, and state of tide.

Ecological forecasts predict the impacts of physical, chemical, biological, and human induced change on ecosystems and their components. The ICON program is taking advantage of the many data sources to produce forecasts such as those for coral bleaching, larval drift, spawning, migration, upwelling, and other marine behavioral events and phenomena for the benefit of MPA managers and researchers. These forecasts are very difficult to research and produce because of the complex nature of marine ecosystems. With the help of agency and academic partners, the ICON team has started to produce some effective daily products, which will eventually help the MPA managers better understand and help regulate their MPAs. ■

For more information on ICON, visit www.coral.noaa.gov/prototype.

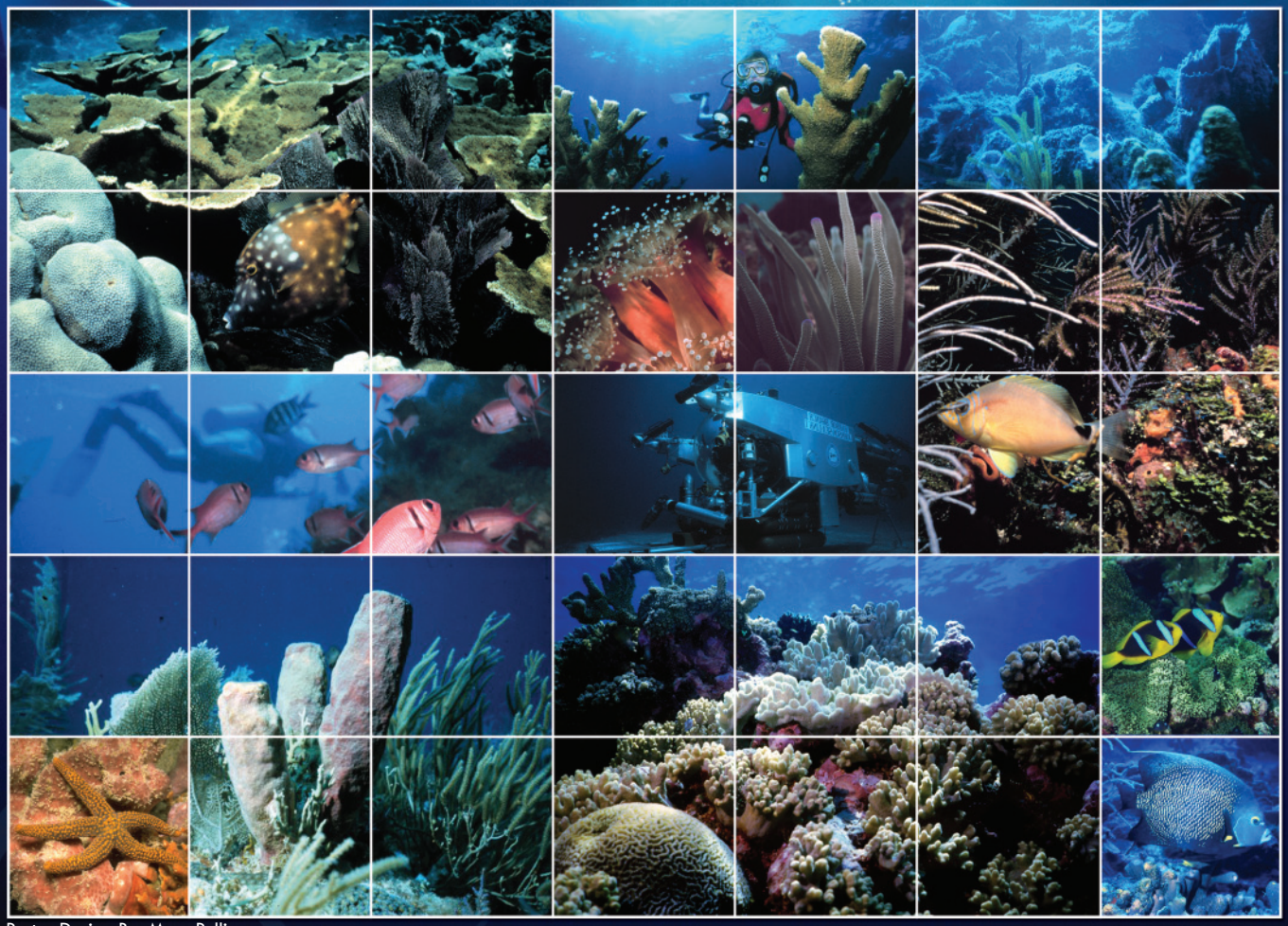
Photos Courtesy of Catherine Booker



▲ Top: NOAA researchers install new sensors on the ICON towers in the Caribbean.

Bottom: A diver prepares Pulse Amplitude Modulating-fluorometry and ocean acidification instrumentation at the ICON station near Lee Stocking Island, Bahamas.

Coral Reefs



Poster Design By: Marc Pulliam

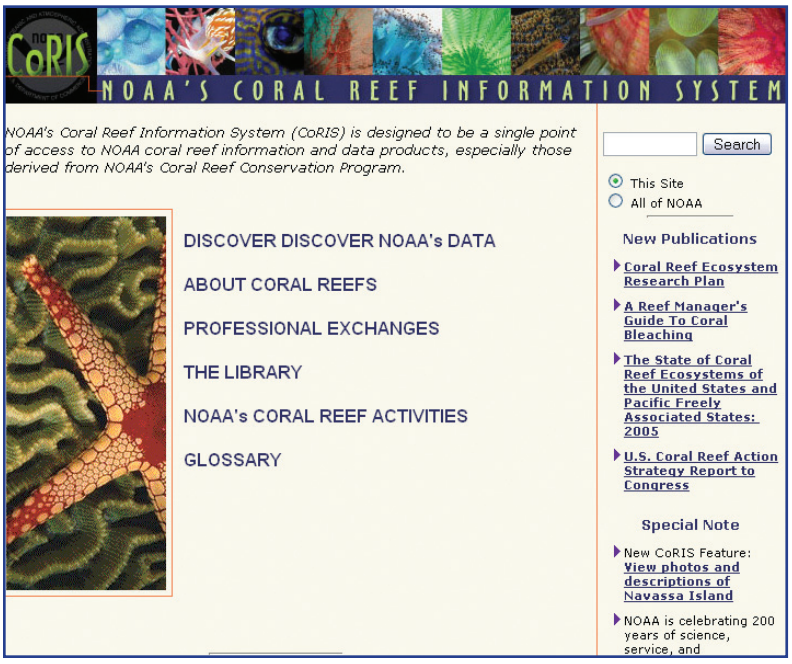
The Coral Reef Digital Library

Dottie Anderson, Librarian, and Eileen McVey, Librarian, at the NOAA Central Library

For years the National Oceanic and Atmospheric Administration's Central Library (NCL) has developed digital (or virtual) libraries that provide online access to selective and specialized collections of information. This type of structured database provides electronic links to abstracts and/or full text of products including articles, reports, or digital maps.

The Coral Reef Information System (CoRIS) Library database identifies specific products derived from the Coral Reef Conservation Program in addition to other NOAA related products. This coral reef information is archived and accessible to scientists and the public. The library database has information on NOAA's coral reef activities, other coral reef websites and publications as well as outreach flyers, brochures, and posters.

The Coral Reef Library is accessible from the CoRIS web portal where users can do simple or advanced searches. There are almost 1,200 items tagged "CoRIS" in the NOAA libraries electronic catalog. This collection reflects the coral reef collections of over 30 NOAA libraries across the Nation. A recent enhancement allows users to search the "CoRIS Library" and the NOAA libraries combined catalog simultaneously. Future plans include adding regional and education key tags to items in both the digital library and catalog. ■



For more information on the Coral Reef Library, visit www.coris.noaa.gov and select The Library link. Users can also visit www.lib.noaa.gov for information on the CoRIS Digital Library.

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