

## Deep Coral Reef Research in the Caribbean



HISTORICALLY AMERICAN.  
UNIQUELY CARIBBEAN.  
GLOBALLY INTERACTIVE.



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**M**esophotic (from Greek *mesos* "middle" and *photos* "light") coral reefs are some of the least studied and most poorly understood reef systems in the world. Available data suggest that these environments are extensive in the Caribbean at depths between 30 and 100 meters. With funding from the NOAA Caribbean Fisheries Management Council, a group of scientists from UVI's Center for Marine and Environmental Studies (CMES) is studying mesophotic coral reefs within a 41 square kilometer marine reserve, the Red Hind Marine Conservation District (MCD) south of St. Thomas.

CMES researchers Dr. Rick Nemeth, Dr. Tyler Smith, Mr. Jeremiah Blondeau, and Ms. Elizabeth Kadison used oxygen-enriched NITROX and closed circuit rebreather diving systems to conduct deep diving operations. Their surveys found coral reefs occupying over 70% of the MCD shelf, with coral cover unusually high for modern Caribbean reefs, often surpassing 40%. According to Dr. Smith, about 95% of the coral belongs to the species *Montastraea* (star corals), the dominant reef-building coral in the Caribbean; Smith also noted the presence of threatened species such as staghorn coral. Furthermore, the reef is home to communities of commercially important fish species such as grouper and snapper, whose abundance may bolster fisheries populations throughout the southern shelf of St. Thomas and St. John.

Exploratory dives and existing data strongly suggest that similar mesophotic coral reefs are extant in a large region of the Virgin Passage between St. Thomas and the Spanish Virgins, Isla Culebra and Vieques. Studies on the health of these coral reefs have revealed important information about their potential to withstand climate change and its impact on water temperature. During a mass bleaching event

in 2005, mesophotic coral reefs suffered relatively little bleaching compared to shallow reefs (20% bleaching prevalence vs. 75%), but they still experienced high mortality (27% cover lost vs. 36%). The surveys in the MCD also revealed an unexplained ongoing coral mortality from disease across a 9 square kilometer area. Clearly, further ecological, geological and oceanographic investigations are needed to fully understand the role that mesophotic coral reefs play within the interconnected reefs systems of the Caribbean and the world.

This project has benefited greatly from support of a generous VI-EPSCoR donor, the Lana Vento Charitable Trust. For example, funds from the Vento Charitable Trust were used to purchase two closed circuit rebreathers (CCR) that enable divers to stay on the reef for up to twice as long as they had previously been able to when using NITROX. The CCR units have increased the capability of researchers to document the largely unknown deep reef habitats of the USVI and to expand their cutting edge research on grouper and snapper spawning aggregations.



*A dense coral community of the Marine Conservation District surveyed by scientific divers from CMES using advanced technical NITROX and closed circuit rebreather diving systems.*

# Oceanographic Research Collaborations

## HISTORIC THERMAL GLIDER LAUNCH FROM ST. THOMAS

In December of 2007, researchers from the Woods Hole Oceanographic Institution Autonomous Systems Lab, led by scientist Dr. David Fratantoni, in collaboration with UVI scientists Prof. Roy Watlington, Dr. Nasseer Idrisi, Mr. Kevin Brown and Dr. Tyler Smith, launched and tested a new prototype autonomous vehicle off St. Thomas.

The Slocum Thermal Glider is designed to draw energy from the differences in ocean temperature arising from thermal stratification of layers of different density within the ocean. Wax-filled tubes inside the glider's engine expand in the warm surface waters, pushing engine pistons that decrease the vehicle's buoyancy, allowing the vehicle to sink. Since the glider has wings attached at the sides, this sinking is in the form of 'gliding' downwards. As the glider reaches deeper cooler waters, the wax in the engine tubes contracts, retracting the pistons, which in turn increases the buoyancy, causing the vehicle to 'glide' upwards. The thermal glider can move slowly through the water over long periods of time, propelled by the ocean's thermal energy, in contrast to older electrically propelled autonomous vehicles that could only remain in the field for very short periods of time. The longer periods allow for the collection of large data sets that were previously difficult to obtain.



David Fratantoni (left) and Benjamin Hodges (right) launching the Slocum Thermal Glider to the south of St. Thomas. Photo by Nasseer Idrisi.

## NOAA SHIP NANCY FOSTER CRUISES, MARCH-APRIL, 2007 AND MARCH-APRIL, 2008

For the past two years UVI researchers have joined scientists from National Oceanic and Atmospheric Administration's (NOAA) Atlantic Oceanographic and Meteorological Laboratory and from Southeast Fisheries Science Center aboard the research vessel *Nancy Foster*. The UVI researchers, Mr. Kevin Brown, Dr. Nasseer Idrisi, and Dr. Tyler Smith from CMES and undergraduate Ms. Ashly Bebe, and their colleagues have participated in an interdisciplinary field study of the Virgin Islands and northern Leeward islands, including collection of data on fish larvae and physical oceanographic conditions. The study's main goal is to provide scientific data to support the management of Marine Protected Areas.

The scientists use a variety of netting techniques to collect fish larvae and zooplankton food at different ocean depths. Prior to each net tow, standard physical samples are collected for chemical analyses and an Acoustic Doppler Current Profiler (ADCP) measures ocean currents. As the ship steams, data are continuously collected by a hull-mounted ADCP and a flow-through water system to measure surface water temperature, salinity, and chlorophyll fluorescence. During the cruise, Lagrangian drifters are deployed to track surface currents and communicate their position via satellite.

Collaborations such as those with Woods Hole and the NOAA vessel *Nancy Foster* are filling important gaps in knowledge of the coastal waters of the US Virgin Islands and the Caribbean region. For example, data collected since December 2007, as the WHOI thermal glider travelled between St. Thomas and St. Croix (see "Historic Thermal Glider"), has already revealed anomalies in the deep water structure, that have since been verified by NOAA *Nancy Foster* sampling in the deep basin between St. Thomas and St. Croix. The data are currently being analyzed to better understand the nature of these anomalies. These and other collaborations are enabling UVI researchers to more thoroughly explore and understand the complex nature of the waters and biota of the Virgin Islands.

## Research on Acoustics and Fish Movement

Nine miles south of St. Thomas, where the ocean shelf quickly drops from 140 feet to thousands of feet deep, large numbers of grouper gather annually to spawn. These spawning aggregations (SPAGs) leave them extremely vulnerable to fishing pressures. In the late 1970's, for instance, a Nassau grouper SPAG was fished to commercial extinction. As a result, fisheries managers in the Caribbean, and around the world, have implemented a number of management strategies such as seasonal and permanent closures to relieve the pressure on aggregating fish and increase their total number. Critical to determining the efficacy of closures is collection of data on fish migration to and from the aggregation site, as well as their daily movement patterns during spawning. With a



*Research on Acoustics and Fish Movement, cont. on page 4*

# Masters of Marine and Environmental Science Program

**T**he first cohort of students in the new VI-EPSCoR funded Masters of Marine and Environmental Science (MMES) program in the Division of Science and Mathematics at UVI matriculated in August 2007. The inaugural class of nine students includes several students already working in natural resource management within the VI. Department of Planning and Natural Resources (DPNR) and the National Park Service.

The program seeks to provide students with advanced scientific and management training in marine and environmental science to meet local, regional and global demand. MMES students have exceptional access to a diversity of island marine and terrestrial environments, and the graduate program focuses on experiential learning, with field-based courses and hands-on research emphasizing Caribbean ecology and resource management. For example, this year students organized a NOAA-led workshop on "Managing Visitor Use in Marine Protected Areas" that provided an overview of the human dimensions of protected area management. The workshop offered examples of visitor use to Marine Protected Areas and associated impacts, and



*Hannah Gray, MMES graduate student*

presented a range of strategies and tactics that managers can use to address these impacts. As a result of the workshop, MMES students wrote a set of recommendations for sustainable development of the new Lindqvist

Beach on St. Thomas. This year's students also created a draft management plan for UVI's Brewer's Bay water catchment area which will be discussed with university administrators in the coming year. They completed their first year by presenting plans for thesis research projects ranging from coral reef and native plant restoration, to environmental attitudes of Virgin Islanders, to watershed management, among other topics. For more information about the MMES program, go to <http://mmes.uvi.edu>.

## Sustainable Land Development Workshop

**V**I-EPSCoR sponsored a half-day St. Thomas-based workshop on sustainable land development in November 2007, led by Dr. Gaboury Benoit, Director of the Center for Coastal and Watershed Systems at Yale University. Participants including private developers, staff from the VI Department of Planning and Natural Resources, and Master of Marine and Environmental Science (MMES)

students discussed environmental impacts of different local land development practices. In a field exercise, workshop participants then used the LAND rating system from Dr. Benoit's book *Land and Natural Development (LAND) Code: Guidelines for Sustainable Land Development* to evaluate the environmental footprint of a building and surrounding land.

## Math Master's Program Graduating Its First Cohort

**S**even Virgin Islands mathematics teachers graduated in May 2008 from the new VI-EPSCoR-funded Master of Arts in Mathematics for Secondary Teachers program in the Division of Science and Mathematics at UVI. The Math Master's program is designed to meet the professional development needs of the territory's secondary school teachers. In addition to their studies at UVI, students in the program had the opportunity to attend a 2-week course at the University of Virginia-Charlottesville on technology-integration in the teaching of mathematics, as well as the 2008 annual conference of the National Council of Teachers of Mathematics in Salt Lake City, Utah. The Virgin Islands Department of Education is very supportive of the new program and has provided full scholarships for all participating public school teachers.

Graduates in the first cohort include Ms. Laverne Baker, Mr. Alex Ferguson, Ms. Cassandra King, Ms. Meria Marcel, and Mr. Jeffrey Whelan, all from St. Croix Educational Complex, Mr. Benjamin Avon from Ivanna Eudora Kean High School (STT), Ms. Karisma Bryan and Mr. Moordale Bryan from St. Croix Central High School, and Mr. Spencer Conrad from St. Joseph High School (STX) and UVI. Three of the teachers—Avon Benjamin, Moordale Bryan, and Jeffrey Whelan—are department chairs at their respective schools. Four of the seven graduates have expressed an interest in pursuing doctoral studies in mathematics.

## New Coral Systematics Group at UVI

**R**eef-building corals are a key player in coral reef ecosystems. Until recently, understanding relationships among corals has been a challenge because skeletal characteristics were the only basis for classifying different corals; yet, as anyone who has spent time on a coral reef will have noticed, corals take on a bewildering array of shapes and colors. This variability in coral morphology makes it difficult to determine whether different forms are actually different species or not, and how the different forms may have evolved. The new Coral Systematics Group at UVI, led by Dr. Sandra Romano (DSM), has been using molecular data to determine whether similar but different forms of corals are separate species or not, and to investigate how these different forms may have evolved.

In one project, the Coral Systematics group has been examining relationships between five coral species in the genus *Porites*, including finger corals (branching forms) and mustard hill corals (massive forms) that co-occur as common inhabitants of Caribbean reefs. UVI undergraduates Ms. Tryphena Cuffy and Ms. Semoya Phillips, along with Mr. Matt Lucas, a master's student at Southeastern Missouri State University, have participated in this work. Analyses of DNA

sequences support the hypothesis that these forms are all one species with high morphological variability. Ongoing analyses of the DNA data are being used to determine relationships among the different species in this group and their relationship to Indo-Pacific corals.

A second project has been led by Dr. Joel Stake, a postdoctoral research associate. Dr. Stake and undergraduates Ms. Cherissre Boateng and Mr. Elisha Jno-Baptiste are using DNA sequences to determine relationships between genera and families of scleractinian corals. They have been collecting DNA sequences from two nuclear gene regions and one mitochondrial gene region from both reef-building and non-reef-building scleractinian corals. Analysis of data collected in the lab, along with published data and data from other labs, will lead to a much better understanding of how corals have evolved globally.

Ms. Boateng and Mr. Jno-Baptiste presented their research in a poster titled "Molecular phylogenetic analysis of family level relationships among scleractinian corals Cnidaria: Anthozoa" at the 2008 Meeting of the Society for Integrative and Comparative Biology, January 2008.

## Undergraduate Researchers Study Natural Products Chemistry

**D**r. Omar Christian (DSM), VI-EPSCoR researcher in natural products chemistry, served this year as mentor for three student winners at the 6th annual UVI Spring Research Symposium in March 2008. First place went to Mr. Ali Kareem's poster on the "Antihypertensive metabolites from *Atrocarpus altilis* (Breadfruit)" (Ali Kareem, Ms. Keisha R. Christian, Ms. Andrita Griffin, Dr. Omar E. Christian). Ms. Ophelia Wadsworth shared second prize for her poster

titled "Antimicrotubule metabolites from *Ircinia strobilina* and other Virgin Islands Sponges" (Ms. Ophelia Wadsworth, Dr. Susan Mooberry, Dr. John Reed, Dr. Omar E. Christian), along with Ms. Digna M. Washington for her research poster "Cytotoxic metabolites from *Pseudoceratina crassa*" (Ms. Digna M. Washington, Dr. Omar E. Christian, Dr. John Reed, Dr. Susan Mooberry).

### *Research on Acoustics and Fish Movement, cont. from page 2*

NOAA Sea Grant award and VI-EPSCoR-funded equipment, CMES researchers are working to determine these movement patterns using hydro-acoustic telemetry, and to establish the minimum size of fishery closures for protecting grouper spawning aggregations in the U.S. Virgin Islands.

Three commercially important groupers, red hind, Nassau and yellowfin were internally tagged with acoustic transmitters within two existing fishery closures in the USVI: the Red Hind Bank Marine Conservation District (MCD) and the Grammanik Bank (map). Acoustic receivers, moored underwater, enabled researchers to track fish movement during aggregation events. Results revealed that the Nassau and yellowfin groupers – who spawn at the Grammanik Bank – have daily

movement patterns that extend well beyond the closure area of 1.5 km. Therefore, the threat of fishing pressure during spawning months would be reduced by as much as 3.5 times if the closure area were expanded to cover their average daily movements. The red hind, however, are afforded protection throughout their spawning because the closure boundaries encompass the actual spawning events as well as daily and weekly movements. Accordingly, since the MCD has been closed either seasonally or permanently since 1990, the red hind aggregation has seen dramatic increases in size, density and total abundance. These dramatic improvements have subsequently spilled over into local fisherman's traps, an ultimate goal of any fisheries management strategy.

# Volunteers Study Sea Turtle Populations in Brewer's Bay

**V**I-EPSCoR researchers Dr. Paul Jobsis (DSM) and Mr. Kemit Amon Lewis (DPNR) have been coordinating volunteers from UVI and the community to assess green and hawksbill sea turtle populations in Brewer's Bay on the UVI St. Thomas campus. Scientists and volunteers have conducted monthly swimming surveys of sea grass beds in the bay and along the rocky wall of the Cyril E. King airport runway. The surveys demonstrated a consistent green sea turtle density of 3.2 +/- 1.1 per hectare over the sea grass beds, with a density of hawksbill turtles along the rocky runway of 3.9 +/- 1.0 turtles per hectare. Nearly all the turtles observed appear to be juveniles, which suggests Brewer's Bay is an important habitat for juvenile green and hawksbill turtles.

With the help of Dr. William Coles (DPNR), scientists and volunteers conducted three sea turtle "capture, tag and release" efforts in 2008. Volunteers captured, weighed, measured and tagged (or photo identified, for smaller turtles) 26 sea turtles. So far, only a small number of the turtles have been recaptured, suggesting that the populations in Brewer's Bay are either larger than earlier estimates or more dynamic than expected (i.e. turtles moving in and out of the Bay).

This pilot research has confirmed Brewer's Bay as an excellent area to study green and hawksbill sea turtles. The project also exemplifies the important role volunteers can play in this type of research, with the additional benefit of educating the public about sea turtle conservation.



*UVI student Jan-Alexis Barry releases a Green Sea Turtle. Photo: Paul Jobsis*

## New UVI and NOAA Partnership to Protect Coral Reefs

**U**VI scientists have joined forces with scientists from the NOAA Biogeography Branch and DPNR to undertake a region-wide evaluation of coral reef monitoring activities. The purpose of this new 5-year cooperative agreement is to help coordinate and optimize monitoring efforts to ensure that resource managers receive accurate, timely, and cost-effective information on the status of the marine environment. Dr. Simon Pittman, a NOAA senior scientist and spatial ecologist, is now based at UVI as NOAA's Coral Reef Conservation Program Monitoring Coordinator. Dr. Pittman said, "With so many different monitoring activities underway, there is a real need to optimize the way we collect, integrate, analyze and communicate our monitoring data".

Dr. Pittman will also be working on several other joint research projects with UVI scientists that aim to assess ecosystem health, improve the understanding of fish movement patterns both inside and outside of marine protected areas (MPAs), and evaluate the effectiveness of MPAs in the region. NOAA has also funded a research assistant, Mr. Steven Hitt, who will be working on joint research projects while studying for the Master's degree in Marine and Environmental Science at UVI.





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**WHAT IS VI-EPSCOR?**

EPSCoR stands for **Experimental Program to Stimulate Competitive Research** (EPSCoR). EPSCoR, a program of the National Science Foundation, is designed to increase research and education capacity in science and engineering within a state or territory of the United States that has traditionally been under funded in these areas. The overarching idea is that individuals with training in the areas of science, math, and technology are better able to have a positive impact on a region's management and development. The Virgin Islands received its first EPSCoR grant in 2004 and is presently in its fourth year of funding. Virgin Islands-EPSCoR is hosted by the University of the Virgin Islands on behalf of the people of the Virgin Islands, and receives its guidance from a Governing Committee that includes representatives of both the public and the private sector.



*The Virgin Islands Experimental Program to Stimulate Competitive Research is supported by National Science Foundation Grant #0346483. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.*