

NOAA UNDERSEA RESEARCH CENTER
at the University of North Carolina Wilmington

2007 Annual Report



**Southeast and Gulf of Mexico Region
2007 Semi-Annual Progress Report
NOAA Award #NA03OAR4300088
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PREFACE

The Department of Commerce's "Financial Assistance Standard Terms and Conditions," requires all grant recipients to "submit performance (technical) reports in triplicate (one original and two copies) to the Federal Program Officer in the same frequency as the Financial Status Report (SF-269)...Unless otherwise specified in the award provisions, performance (technical) reports shall contain brief information as prescribed in the applicable uniform administrative requirements incorporated into the award [Special Award Conditions (SACs) in NURP grants]."

In 2007, the NOAA Undersea Research Center (NURC) at the University of North Carolina Wilmington (UNCW) was funded by Amendments 9 and 10 of NOAA grant #NA03OAR4300088. Supplemental funds from several sources besides core funding from the NOAA Undersea Research Program (NURP) completed the 2007 work plan, as described in the Scope of Work. The SACs require "semi-annual progress reports that include quick-looks, statistics, status of development projects, advisory committee reports, comparison of accomplishments with goals/objectives for the period, reasons why goals were not met, and emphasis on exceptional results." For twelve month awards, like NA03OAR4300088, the first progress report is due seven months after the start date and the second report is due thirteen months after the start date.

The first progress report highlighted scientific and operational activities that were completed by June 30, 2007. This semi-annual progress report emphasizes scientific and operational accomplishments that were completed during the second half of the 2007 award period; however, this document primarily serves as an annual report and includes significant events, accomplishments and center statistics. **Full project summaries and project-specific operational statistics for the entire calendar year are included in the National Management Information System located at <http://data.nurp.noaa.gov/nurp03/research.asp>.** Detailed information about the center's facilities, systems, personnel and research priorities are included in the center's phase I omnibus proposal to NOAA.

INTRODUCTION

In 2006 the east coast NURP regional centers underwent considerable restructuring resulting in a shift in priorities and a reduction in funding. The new directive, which extended into 2007, was to keep assets and personnel in a state of readiness to commence full operations in 2008 and to engage in partnership projects on a cost-reimbursable basis in 2006 and 2007.

As a result of this new directive, NURC and UNCW management worked to develop a new business model that would incorporate the center's core mission, for which it receives its NURP funding, with an income-generating, service-based concept. This enhanced and expanded 'service center' model sells asset time, at cost, to users according to a published day-rate. These day rates differ for NOAA, other federal partners, and non-federal users. NOAA current Special Award Conditions allows program income to be used for program expenses instead of requiring that they be returned to the agency;

In 2007 the center segmented its operations into discrete service centers: The Aquarius Reef Base (ARB), Advance Diving Technology program (ADT) and the Undersea Vehicles Program (UVP). Each service center is lead by a manager empowered to capitalize assets, foster intra-NOAA and extramural collaborations, and pursue technology to keep assets on the cutting-edge of in situ marine science. While each service center is a discrete entity, cooperation between programs is maintained in order to stay cost effective and to allow staff to remain proficient using all center assets.

SCOPE OF WORK

Work Plan Funding

As requested by NURP, the 2007 operations plan and corresponding budget allowed the center to remain in a state of readiness to commence full operations in 2008 and to engage in partnership projects on a cost-reimbursable basis in 2007. Total operating budget for 2007 was \$3,707,091. All funds received were subsequently spent on direct project support, including principal investigator subawards and variable project costs, and infrastructure and fixed operational costs. Funding sources included the following:

- Funds allocated in NURP grant: (\$2,973,721)
 - \$1,200,000: Phase I NURP center allocation for SEGM
 - \$3,354 deobligated and remained with the program office to support Iridium satellite service contract for the AUVs
 - \$977,860: Phase II NURP center allocation for SEGM
 - \$80,000: Coral Reef Conservation Program funds to fully support project 2007-02-09 (Miller)
 - \$500,000: Coral Reef Conservation Program funds to fund subawards and mission costs for projects 2007-08B (Lasker), 2007-09B (Pawlik), 2007-11A (Valentine), 2007-12 (Lindquist), 2007-13A (Coleman) and 2007-14 (Koenig)
 - \$209,261: NOAA Marine and Aviation Operations funds for vessel lease, shipping and crane services to support projects 2007-10B (Ross), 2007-13A (Coleman) and 2007-14 (Koenig)
 - \$6,600: NOAA NCCOS funds to support operations for project 2007-07B (Whitfield)
- Supplemental Funds: (\$733,370)
 - \$5,456: NOAA Center for Sponsored Coastal Ocean Research (CSCOR) funds for staff travel to support project 2007-04B (Appeldoorn) in Puerto Rico.
 - Funds transferred on Federal level; staff issued Federal invitational travel orders.
 - \$110,000: University of Cincinnati to cover NEEMO projects XII (2007-01-01).
 - \$96,346: NASA to cover NEEMO projects XII (2007-01-01).

- \$143,000: NASA to cover NEEMO projects XIII (2007-01-06).
- \$20,000: University of Pennsylvania – balance of 2006 NEEMO projects (2006-06-02)
- \$150,000: NIUST (University of Southern Mississippi) for AUV development (2007-02).
- \$65,000: Living Oceans Foundation for Project SeaCamel (2007-01-02)
- \$133,418: US Navy, SRDD, for projects 2007-01-07 and -08.
- \$10,150: Miscellaneous Aquarius Reef Base revenue generated via day rates.

Major Acquisitions

In October the Aquarius Reef Base took possession of operational support vessel to replace the *R/V Legacy* which burned and sank in 2006. The vessel, renamed the *R/V George Bond*, is a 1995 42-foot dive boat built by Newton that was purchased from Cristal Clear Vessel Leasing LLC for \$145,000. The funds for this acquisition came from the \$215,000 *R/V Legacy* insurance settlement. Insurance funds, less new boat cost, were used to significantly upgrade the vessel's electronics, safety gear and other items to make it ready to support field operations.



R/V George Bond at the ARB dock in Key Largo (left) and working offshore (right).

Key Staff Additions

One of the main components of the 2007 Aquarius Reef Base business plan (see 'Programmatic Planning') was to hire a chief scientist to develop new science programs, raise funds and work with clients. Dr. Ellen Prager was hired in September to fill this role. Dr. Prager has a Ph.D. in Marine Geology and Physical Oceanography from Louisiana State University. She has extensive experience developing innovative science and outreach partnerships, holds key membership and board positions, continues to be involved with high-level national ocean policy making and strategic planning, and is a polished public speaker and fund raiser. Dr. Prager's passion for the sea and Aquarius is evident in her new book, *Chasing Science at Sea: Tales of Adventure, Learning, and Near-disaster*.

Work Plan Deviations

Three projects tied directly to NOAA Coral Reef Conservation Program funding, which arrived with the center's Phase II award received in August, were deferred until 2008 due to other scheduled operational commitments. Valentine (2007-11A), Coleman (2007-13A) and Koenig (2007-14) will begin fieldwork in early 2008.

Mechanical problems with the NOAA Ship Nancy Foster resulted in the loss of operational days for two projects. Whitfield (2007-07B) lost two days and the Ross project (2007-10B) was terminated at-sea without any operations being conducted.

PROGRAMMATIC PLANNING

2007 served as a springboard to launch three major initiatives that will shape the center in 2008 and beyond. Two significant workshops relating to the Aquarius Reef Base were held in 2007 to assist managers chart and refine a new course for ARB. Both workshops were attended by preeminent scientist and managers from academia, government, NGOs, and industry. Center directors also proposed to formally transition management and oversight of the center's Advanced Diving Technology program to the NOAA Diving Program in Seattle.

Aquarius Reef Base (ARB) Summit

The 2006 funding crisis served as the catalyst for NURC and UNCW managers to review how the center conducted business in response to the rapidly changing climate of marine science management and policy. The service center concept was created to address this paradigm shift, with the Aquarius Reef Base serving as the focus for 2007. Early in the year, a new ARB business model was developed that outlined new directions in terms of research, partnerships, and public outreach, without compromising the science mission and national reputation.

The ARB Summit was developed as a forum to vet the new business model. A group of 19 panelists, nine ex-officio UNCW and NURC participants and three facilitators met for three days in Islamorada, Florida, to identify ways to increase, diversify, and stabilize funding for undersea operations and science. Summit participants represented potential partners and clients, various business sectors including industry, government, NGOs, and academia, and stakeholders with knowledge of saturation diving and a vested interest in the ARB's future.

Purpose of Summit

- Develop a plan to increase base of funding – stabilize and grow—for ARB
- Create/build a viable, collaborative entity that can attract sustainable funding – grow and diversify
- Begin a business plan – including mission and vision statement and outreach effort
- Review two new positions to enhance ARB marketing and outreach including: 1) public relations specialist to focus on outreach (cost-shared with UNCW Advancement); and 2) Aquarius Reef Base chief scientist to develop new science programs, raise funds and work with clients.

The meeting was ably facilitated by UNCW's Small Business Technology Development Center, led by Ms. Leslie Langer. They prepared a report from the meeting that summarized meeting deliberations and recommendations (<http://www.uncw.edu/aquarius/summit.pdf>), which served as guidance for the ARB Strategic and Business Plan.

Coral Restoration Workshop

Coral reefs around the world are declining, including in the Caribbean and Florida Keys where cover has decreased dramatically starting in the late 1970s. Marine Protected areas (MPAs) have been established within the Florida Keys to manage multiple uses and set aside specific sites for special use and enhanced protection. Restoration techniques utilizing coral culture and transplantation have been applied to a limited extent in the Florida Keys and elsewhere around the region to repair acute damage done by incidents such as vessel groundings. It is hoped that restoration practices can ameliorate site specific coral damage within the context of wider-scale ecosystem restoration and protection. The Aquarius Reef Base and NOAA Fisheries received funding to support a dedicated saturation mission (the Aquarius Coral Restoration and Resilience Experiments, or ACRRE) to address restoration management needs through scientific research.

Thirty-two scientists and managers from various agencies and institutions within the south Florida region with specific restoration responsibilities and/or on-going restoration projects in the Keys

were invited to a workshop held in August 2007 to address the following questions identified by the Florida Keys National Marine Sanctuary as priorities for managers:

- What are management needs and priorities related to coral restoration via culturing and transplantation?
- What are required studies and related technical needs required to address these management priorities?
- How can ACRREs mission best fulfill some of these study needs and complement existing programs?

Although Aquarius is situated at a deeper depth (20 m) than most traditional reef restoration projects, applicable results can be obtained by designing and executing the major, long-term experiments with ARB support (aquanaut excursions, shore support, dive access, real-time observing and monitoring) at depths of greater than 14 m, while running complementary experiments at adjacent shallower depths, where *Acropora* were once abundant and to 'calibrate' deeper results. ARB is also well suited to establish a long-term experimental testbed for restoration practices and related research projects, especially in terms of having ongoing ocean observations, year-round access to the site, and periodic intense operational access via saturation missions. A significant field effort will begin in 2008.

ADT Transition Plan

In October, the center submitted a plan to the NOAA Diving Program (NDP) in Seattle, Washington, to gauge their interest in assuming the center's lead on advanced diving technology efforts. The proposal outlines a way to better serve NOAA scientists, and then, ultimately, to promote a seamless way for marine scientists within academia to collaborate more effectively with NOAA scientists and agencies. Through a formal collaborative agreement with NDP, the center will continue to develop, test, and evaluate advanced diving training programs and equipment as requested by NOAA personnel as they address their agency's science mission. Then, through a series of integrated steps, the newly developed training and operation protocols and associated equipment will be transitioned into the mainstream NDP operating program.

The newly integrated Advanced Diving Program is designed to permit each entity, NURC/UNCW and NDP, to build upon its strength while serving in a collaborative manner with the other. This manufactured stronghold will allow the ADP to set the standard for advanced diving in NOAA and academia. It offers continuity and provides a platform for expansion. NDP is still reviewing the plan.

ACCOMPLISHMENTS

Projects in 2007

Projects supported in 2007 fall into one of three categories:

- **Peer reviewed research projects:** Projects accepted as part of the center's 2005 RFP. All project costs, including science subawards, were covered by non-NURP funds.
- **In-house staff technology development projects:** One-year projects that concentrate on staff training and proficiency and technology development activities.
- **Service Center projects:** Service Center projects use center assets and facilities and leverage center funding. Users either: 1) use center facilities and pay for all incidental expenses, or 2) pay a cost-reimbursable day-rate for the use of center assets. Decision as to charges is based on several factors including: UNCW and federal policies, relevance to the center's mission, type of partner (NOAA versus extramural), status as a previously peer-reviewed and accepted project, or status as a priority research development project.

Complete project summaries can be found in the NURP Management Information system (MIS) at http://data.nurp.noaa.gov/mis/NURP_research.asp. These summaries include project objectives, operational statistics, and project results.

The center supported 21 projects over the course of the year, with three being deferred until 2008 (Table 1):

- Seven (7) peer reviewed research projects (2007-05B, -06B, -07B, -08B, -09B, -10B, and 12A)
- Four (4), staff technology development projects (2007-01, -02, -03 and 04B),
- Ten (10) service center projects (2007-01-01, -01-02, -01-04, -01-05, -01-06, -01-07, -01-09A, 2007-02-01, -02-02, and 2007-04B)

Many of these projects were multi-disciplinary projects that address more than one research theme based on NOAA's strategic goals (<http://www.noaa.gov>) and Coral Reef Ecosystem Research Plan for FY 2007 to FY 2011 (http://www.coris.noaa.gov/activities/coral_research_plan/pdfs/jurisdiction_w_research.pdf). Also, only one PI is shown for convenience (see NURP MIS for other investigators).

The period of performance for NURC-supported projects is January 1, 2007 to December 31, 2008 to allow investigators time to complete analyses and prepare publications. All system lease and subaward costs are covered by other NOAA partners or through levied day rates covered by respective principal investigators.

Table 1. NURC/UNCW 2007-2008 projects. Systems: AQU = Aquarius, ROV = Remotely Operated Vehicle, AUV = Autonomous Underwater Vehicle, GLD = Webb Autonomous Glider, SCU= scuba, TEC = Technical diving scuba, SUB = submersible. Project summaries and budget details can be found in omnibus proposals.

Project #	PI	Title	Year	NURP Funds – Phase I	NURP Funds – Phase II	Ancillary Funds ^A / Day-Rate★	
2007-01	Rutten	<i>Aquarius</i> Reef Base Development	1 of 1	✓	✓		
2007-01-01	Todd	NEEMO-XII	1 of 1			★	
2007-01-02	Renaud	Project SeaCamel	1 of 1			★	
2007-01-03	Project not conducted						
2007-01-04	Thompson	If Reefs Could Talk	1 of 1			^A 7	
2007-01-05	Lirman	Coral Colony Retrieval	1 of 1			★	
2007-01-06	Todd	NEEMO-XIII	1 of 1			★	
2007-01-07 & 08	Knudson	U.S. Navy saturation development missions	1 Of 1			★	
2007-01-09A&B	Miller	Aquarius Coral Reef Restoration Experiments (ACREs)	1 of 2 2 of 2			^A 1	
2007-02	Potts, T.	Autonomous Undersea Vehicle Development	1 of 1		✓	^A 6	
2007-02-01	Horn, L.	<i>Eagle Ray</i> development cruise – Liberty Star	1 of 1		✓	^A 6	
2007-02-02	Horn, L.	<i>Eagle Ray</i> development cruise – R/V Foster	1 of 1		✓	^A 6	
2007-02-03	Project not conducted						
2007-02-04	Project not conducted						
2007-02-05	Rona, P	AUV mapping of Hudson Canyon	1 of 1		✓	^A 6	
2007-03	Potts, T.	Advanced Diving Technology Development	1 of 1		✓		
2007-04B	Appeldoorn	CRES 2006: Ecology, Integrity & Status of Deep Caribbean Coral Reefs	2 of 3			^A 2	
2007-05B	Warner, M.	Recruitment dynamics of gorgonian corals: Baseline recruitment and effects on macroalgal cover	2 of 2			^A 3	
2007-06B	Kim, K.	The Link Between Coral Hosts, Surface Microbiota, and Disease	2 of 2			^A 3	
2007-07B	Whitfield, P.	Assessment of the status and risk posed by the invasive lionfish in North Carolina hardbottom communities	2 of 2			^A 4	
2007-08B	Lasker, H.	Recruitment Dynamics of Gorgonian Corals: Baseline Recruitment and the Effects of Macroalgal Cover	2 of 2			^A 1	
2007-09B	Pawlik, J.	Ecology of Sponges on Florida Reefs: Demography and Bleaching	2 of 2			^A 1	
2007-10B	Ross, S.	Deep coral habitat mapping along the southeastern US continental slope using an autonomous underwater vehicle with multibeam.	2 of 2		✓	^A 5	
2007-11A&B	Valentine, J	Marine Reserve Effectiveness in Restoring Coastal food Webs: A Multitrophic Assessment Using Special Protection Areas in the FKNMS	1 of 2 2 of 2			^A 1	
2007-12A&B	Lindquist, N.	Role of sponges in N cycling and total respiration in coral reef ecosystems	1 of 2 2 of 2			^A 1	
2007-13A&B	Coleman, F.	Behavior of red grouper and other grouper species in marine reserves in the northeastern Gulf of Mexico	1 of 2 2 of 2			^A 1, ^A 5	
2007-14	Koenig, C.	Can human intervention increase recovery potential of destroyed deep-water coral (<i>Oculina varicosa</i>) habitat and fish populations?	1 of 1			^A 1, ^A 5	

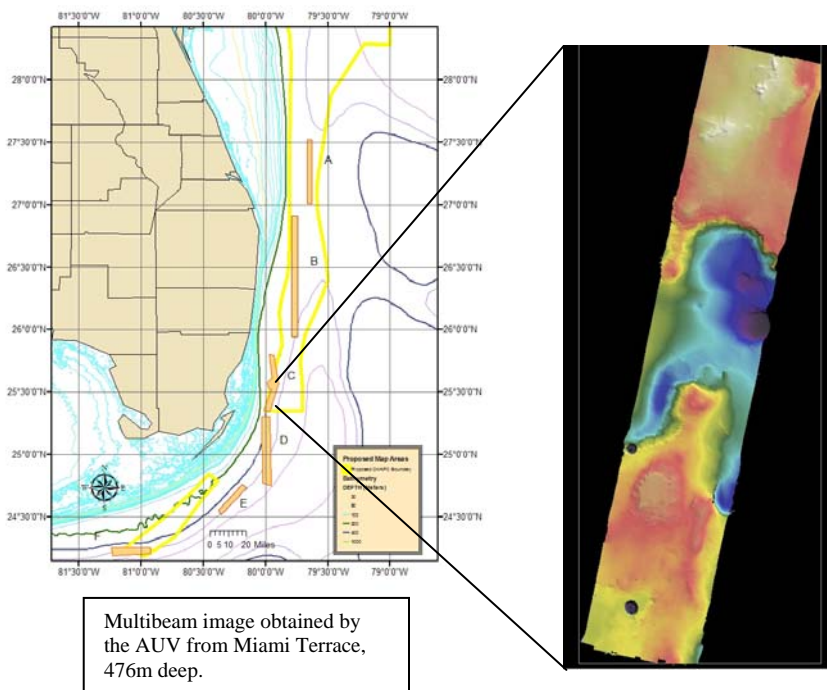
If a project number is not followed by a letter, the project is a one-year project.
 A = First year of two-year project; B = Second year of a two-year project; C = Third year of a three-year project
 Superscript = project funded by ancillary funding source
 1 Costs covered by NOAA Coral Reef Conservation Program.
 2 Costs covered by NOAA Center for Sponsored Coastal Ocean Research (CRES); funds encumbered in 2006.
 3 Costs covered by NOAA Coral Reef Conservation Program; funds encumbered in 2006.
 4 Costs covered by NOAA NCCOS.
 5 Shiptime costs covered by NOAA Marine and Aviation Operations
 6 Costs covered/shared by NIUST
 7 Costs covered by National Marine Sanctuary Program.
 ★ Costs covered by a user-levied day-rate
 Shaded rows indicate projects deferred until 2008.

Research and Technology Highlights

Eagle Ray Sea Trials Morph to Science

Two projects conducted in 2007 officially ushered in the science era of the *Eagle Ray* AUV. Although both cruises were categorized as 'test and evaluation' cruises, science objects formed the basis around which the staff scripted the evaluation missions.

In the first project (project # 2007-02-02), the center collaborated with NOAA's Gray's Reef National Marine Sanctuary, South Atlantic Fisheries Managements Council, Harbor Branch Oceanographic Institute and NIUST on a research expedition off the east coast of Florida to document deep-water, hard-bottom habitat areas of particular management concern. Deep Water Coral Ecosystems (DWCEs) occur along the southeastern coast of the United States from North Carolina to the southwestern Gulf of Mexico. Only a small percentage of known sites has been investigated beyond fathometer transects; each new exploratory expedition discovers new sites. Many more coral sites are likely, and the full extent of topographic features on the Blake Plateau remains unknown. Similarly, the distribution of possible DWCEs along the southern margin of the Florida peninsula south of Miami and along the Florida shelf margin in the Gulf of Mexico are largely uninvestigated.



Using state-of-the-art multibeam mapping capabilities, the *Eagle Ray* AUV ensounded over 14 km² of bottom habitat. Additionally, Fledermaus 3D representations of the multibeam data collected and 3D "flythroughs" have been prepared for outreach purposes and will enhance the Habitat and Ecosystem Web site.

The second project was lead by Dr. Peter Rona of Rutgers University (project # 2007-02-05). Using the NOAA Ship Ronald H. Brown as a support platform, the vehicle was employed to survey essential fish habitat at the head of the Hudson Canyon.

The canyon head appears to be a source for sustaining regional recreational and commercial fisheries. Although at the doorstep of New York City, Hudson Canyon is largely unexplored.

Due primarily to weather and minor technical problems, the scientists were able to only partially map four blocks each of a smaller area. However, the maps proved to be of high quality with a major increase in resolution from ~100 m for the Hudson Canyon Region map that we made in 2002 with NOAA/OE support using the Ron Brown's Seabeam multibeam sonar to about 3 m, revealing a world of features relevant to fish habitat.

This project also included a topside outreach effort to promote the science and technology. Five hours of footage was collected and covered *Eagle Ray* launch and recoveries, lab work, CTD sampling, and participant interviews. The majority of the footage was AUV-related, while up to ninety minutes was dedicated to interviews.

An overview film is expected to be finished by the end of February, highlighting the background of the cruise as well as the current science in relation to AUV mapping and CTD casting. Interviews with the Chief Scientist, Peter Rona, and other participants aid in telling the story. A promotional video for *Eagle Ray's* Launch-And-Recovery-System has already been created.

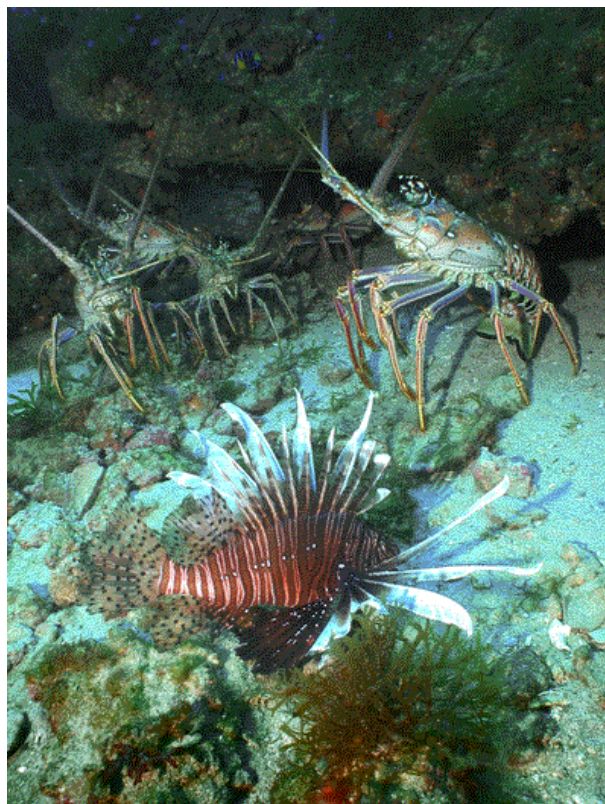
Invasive lionfish an ever-expanding threat to coastal North Carolina

The Indo-Pacific lionfish, *Pterois volitans*, is not a non-native venomous fish that is now established and reproducing along the continental shelf from Florida to North Carolina. Since 2000, lionfish have been primarily found in water depths greater than 40 m, due to the Gulf Stream moderated bottom water temperatures that occur year-round at these depths. Ms. Paula Whitfield and her team of NOAA researchers are continuing to expand on the previous research surveys to better understand the status of the lionfish invasion and to ultimately determine the impact (project # 2007-07B).

For four consecutive years lionfish were found to be widespread within Onslow Bay, North Carolina. A total of 22 sites were surveyed in 2004 and 27 sites in 2005 and 2006, and 11 sites thus far in 2007 from Cape Fear to Cape Lookout, North Carolina in water depths of 30 to 50 meters deep. By 2006 Lionfish were present at 99 percent of the sites, up from 86 percent in 2004. In 2007 lionfish were found at 100 percent of the sites. In addition, anecdotal and verified reports continue to confirm these findings as well as the increase in geographic spread of lionfish. Not only do Lionfish reports continue to increase along the east coast but more alarmingly are becoming quite common in the Bahamas as far south as the Turks and Caicos. These data suggest that lionfish have become rapidly established within the large southeast marine ecosystem and that the spread of lionfish into the Caribbean and Gulf of Mexico is imminent.

Lionfish density estimates from diver transects were obtained from 11 sites in 2007. These density estimates indicate that lionfish may be approaching densities similar to some native serranids. Furthermore lionfish density estimates have increased by 80 percent within the last year alone. Since 2004 a total of 276 specimens were collected for life history analyses and 57 were collected alive for use in reproductive studies and early life history studies. The lionfish ranged in size from 5 to 45 cm in length and weighed from 25 to 1380 grams. Several lionfish collected throughout the course of this study were larger (45 cm) than the reported maximum length from their native range (38 cm), suggesting that lionfish growth along the southeast U.S. is not resource limited. The growth rate of lionfish in the Atlantic or in their native habitat remains unknown.

More data is needed from winter, but it appears there is spawning seasonality within the Atlantic lionfish population. Results also



Lionfish mingles with spiny lobster off the coast of North Carolina.

suggest that Lionfish reproduce early in their life history sometime between 15 and 20 cm total length. In 2007 it was confirmed that lionfish spawning year-round in the Bahamas and off North Carolina are spawning in most months with the exception of winter. Although preliminary, analyses of annual zones on sagittal otoliths suggest that the lionfish population off North Carolina is relatively young, (max. age 7 years old; 43 cm specimen). If confirmed, these results would support our general timeline of the invasion which we believe began around the year 2000, off North Carolina. However, age validation is still required to confirm this result.

The Atlantic lionfish diet is comprised mainly of prey from a variety of fish families including members of the Serranidae, Pomacentridae, Labridae, Scaridae, Blenniidae, Bothidae, Carangidae, and Monacanthidae. Since lionfish are opportunistic predators feeding primarily on smaller fishes, there is potential for trophic overlap with native fishes such as groupers in the genus *Mycteroperca*. Groupers comprising this genus feed almost exclusively on fishes. In particular, gag (*M. microlepis*) and scamp (*M. phenax*) groupers are present in significant numbers off the North Carolina coast and scamp occur at size classes that appear to overlap size classes of lionfish. Serranids form one of the most important food items in the scamp diet so similarly sized scamp and lionfish may be targeting similar prey. In addition, lionfish have been confirmed to prey upon scad (Carangidae), one of the dominant fish species in the diet of gag.

Aquarius: An underwater marine education classroom



Aquanauts swim outside Aquarius.

In November 2007, the Living Oceans Foundation conducted six live “underwater classrooms” from Aquarius during Project SeaCamel (project # 2007-01-02). The objective of this project was to create an underwater marine education classroom environment through live Web-broadcasts from inside Aquarius and from the surrounding reef. The classrooms and associated materials were targeted for university students although high school and middle school science and technology courses were also able to utilize many of the materials. Topics covered included corals, sponges, physical oceanography and Aquarius as an artificial reef.

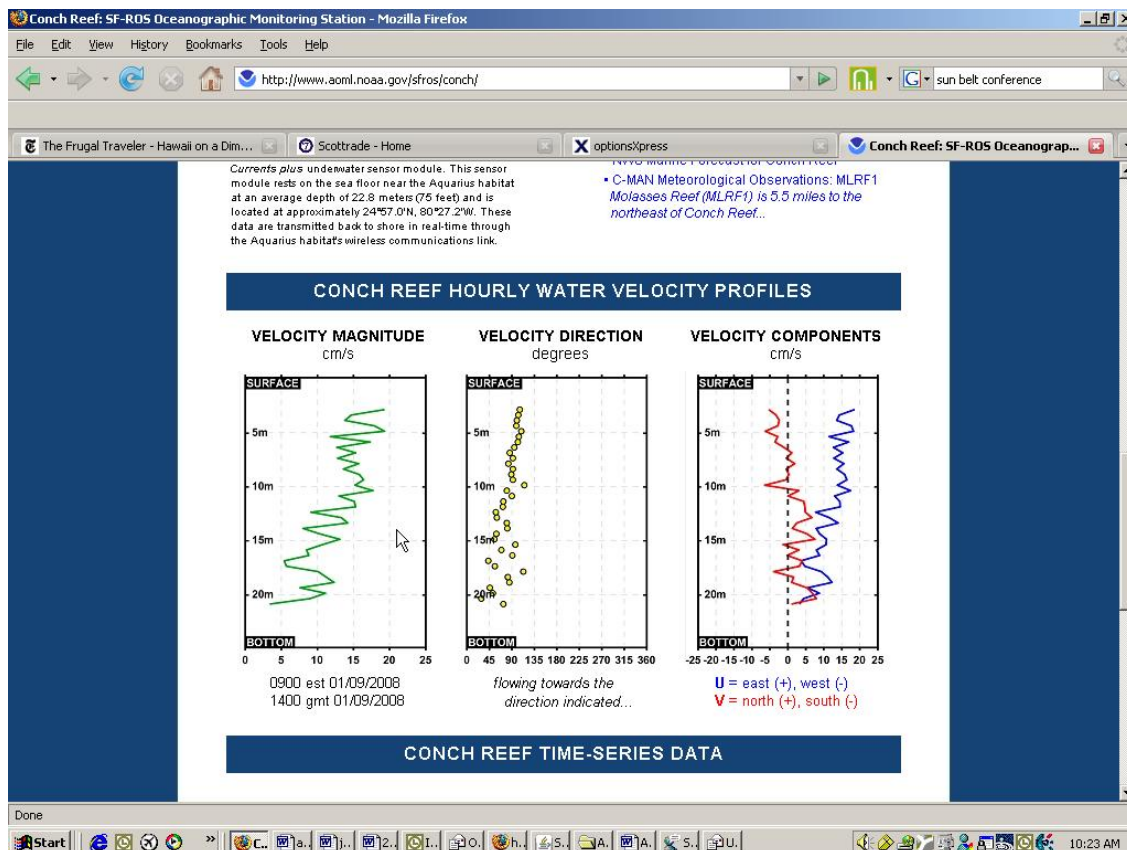
The objective was accomplished by creating six live shows that were broadcasts over the Internet (<http://seacamel.livingoceansfoundation.org>). Additionally, course notes for each of the modules, with related questions and further reading, were posted on the Project SeaCAMEL website in advance of the project. During the mission, images and video clips were posted on the SeaCAMEL website and YouTube.

Real-Time Collaboration...

As part of NOAA's South Florida Program, the Aquarius Reef Base is collaborating with the Atlantic Oceanographic and Meteorological Laboratory and the Rosenstiel School of Marine and Atmospheric Science to provide real-time data gathered from Conch Reef Oceanographic Monitoring Station to all interested parties. The Conch Reef Oceanographic Monitoring Station is located at the Aquarius undersea laboratory. Presently, Conch Reef hourly measurements include water velocity and directional wave data, along with water temperature, salinity, chlorophyll fluorescence, light transmittance (turbidity), and dissolved oxygen.

The time-series data collected at Conch Reef, along with other mooring and ship track data, contribute to the South Florida Regional Observing System (SF-ROS) being implemented by NOAA/AOML in support of South Florida Everglades Restoration and NOAA legislative regional mandates with regard to living marine resource protection and the FKNMS. The integrated SF-ROS system consists of these observations and a regional hydrodynamic model (SoFla HYCOM) which will assimilate these data.

<http://www.aoml.noaa.gov/sfros/conch/>



Screen shot of the Conch Reef Web page.

Operational Statistics

Operational statistics for 2007 are misleading when the numbers are examined in a vacuum or compared against prior years. Non-saturation and technical diving, programs that have historically relied upon discrete, center-support research activities, declined in the wake of budget restrictions and a redirection of manpower towards saturation diving and the AUV. There were no ROV dives in 2007 as both UVP staff members were fully integrated into *Eagle Ray* AUV operations in order to make the vehicle ready for full science operations in 2008. Demand for non-saturation diving, technical diving and the ROV from the science community remain high and the managers of the respective programs have turned down numerous opportunities to sell asset time in 2007. ROV dives should increase to 2004 levels as operations resume after the relocation of *Eagle Ray* to Mississippi. Saturation diving from Aquarius continues to increase and is at its highest level since 2003 (Table 2).

Table 2. NURC/UNCW dive statistics for the last 10 years: 1998-2006. Note: Totals are cumulative since 1988.

	Non-saturation SCUBA (Air & Nitrox)		Saturation (Aquarius) SCUBA and Umbilical		Technical (Air & Mixed Gas)		ROV		AUV (in-water operational days only)		Total		# Part.	# Inst.
	Days	Dives	Days	Dives	Days	Dives	Days	Dives	Glider	Eagle Ray	Days	Dives		
1998	480	3773	9	92	46	345	30	41			251	3906	433	95
1999	431	5948	55	400	37	201	5	52			509	6348	260	64
2000	294	7433	74	906	28	185	21	70			406	8423	291	68
2001	703	5672	138	806	40	240	52	130			933	6663	247	33
2002	496	6384	70	673	25	176	37	80			650	7210	322	88
2003	419	5301	70	532	39	353	50	153			582	6052	279	64
2004	518	7139	48	364	34	315	41	120			607	7623	333	98
2005	472	5655	31	319	64	424	38	144			605	6542	304	63
2006	353	4921	48	294	29	276	1	4	83	10	514	5495	268	43
2007	325	4117	50	416	27	155	0	0	0	16	418	4704	297	47
Total	10324	73553	713	6203	193	1523	422	1160	83	26	7856	82179	4867	1138

Publications

An important metric of center productivity is peer-reviewed publications authored by center-funded scientists. Ten (10) new peer reviewed publications and non-reviewed articles have been received by the center since January 2007 (see first progress report for publications received during the first half of 2007). Since 1995, over 560 papers have been published or are currently in press in peer-reviewed journals. The full publications list can be viewed on the center's Web site (<http://www.uncw.edu/nurc>).

Publications received in 2007:

Hornbach, M.J., C. Ruppel and C.L. Van Dover. 2007. Three-dimensional structure of fluid conduits sustaining an active deep marine cold seep. *Geophysical Res. Lett.*: 34.

Lindholm, J., L. Kaufman, S. Miller, A. Wagschal & M. Newville. 2005. Movement of yellowtail snapper (*Ocyurus chrysurus* Block 1790) and black grouper (*Mycteroperca bonaci* Poey 1860) in the northern Florida Keys National Marine Sanctuary as determined by acoustic telemetry. Marine Sanctuaries Conservation Series MSD-05-4. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Marine Sanctuaries Division, Silver Spring, MD. 17 pp.

Lindholm, J., A. Knight, L. Kaufman, and S. Miller. 2006. A pilot study of hogfish (*Lachnolaimus maximus* Walbaum 1792) movement at the Conch Reef Research Only Area (northern Florida Keys). National Marine Sanctuary Program NMSP-06-06. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, Silver Spring, MD. 14 pp.

Lindholm, J., A. Knight, L. Kaufman, and S. Miller. 2006. Site Fidelity and Movement of the Parrotfishes *Scarus coeruleus* and *Scarus taeniopterus* at Conch Reef (northern Florida Keys). *Caribbean Journal of Science*, Vol. 42, No. 1, 138-144.

Shepard, A., M. Miller. 2007. Planning for Coral Reef Restoration Research, Best Practices, and Implementation of Aquarius Coral Restoration/Resilience Experiments (ACRRE). RESTORATION WORKSHOP REPORT, August 2007, Homestead, FL. 20 pp.

Morris J.J and D.W. Freshwater. 2007. Phenotypic variation of lionfish supraocular tentacles. *Environ Biol Fish.*

Burkpile, D.E. and M.E. Hay. 2007. Predator release of the gastropod *Cyphoma gibbosum* increases predation on gorgonian corals. *Oecologia*

Weisz, J.B., N. Lindquist, C.S. Martens. In Press. Do associated microbial abundances impact marine demosponge pumping rates and tissue densities? *Oecologia*

Reed, J. K., C. C. Koenig, and A. N. Shepard, 2007. Impact of bottom trawling on a deep-water *Oculina* coral ecosystem off Florida. *Bulletin of Marine Science* 81: 481–496.

Lumsden, S.E., T.F. Hourigan, A.W. Bruckner, and G. Dorr (eds). 2007. *The State of Deep Coral Ecosystems of the United States*. NOAA Tech Mem CRCP-3. Silver Spring, MD.

Outreach

Several activities related to public outreach were completed in this period, including:

- Press Releases (accessible at http://www.uncw.edu/aquarius/press/press_releases.html)
- Print and online resources
 - Earth's Final Frontiers - Deep Oceans. Harcourt Education. Sparks, Amy. In press. (archived images provided)
 - Medical Clinics of North America, November 2005, volume 89, number 6. ed: Holstege, C.P. and Rusyniak, D.E. (Kesling, Douglas photo credits [pp1201-1202])
 - Photos Document Coral Forest Annihilation by John Nielsen. December 26, 2007. NPR Online: <http://www.npr.org/templates/story/story.php?storyId=17102434>
 - Physical Science, 3rd ed., BJU Press. June 2007 (archived images provided)
 - America's Choice Literacy Program, Washington, DC (lesson plans and Web site text used for home school curricula).
 - 2007 South Atlantic NOAA Deep Water Coral Teachers' Workshop (<http://www.uncw.edu/nurc/workshop.doc>)
 - 'Ask an Aquanaut' blog launched (<http://www.nurc.net/blog/archives/category/ask-an-aquanaut/>)
 - NOAA's Teacher at Sea: Miriam Hlawatsch (blog during Whitfield project) (<http://teacheratsea.noaa.gov/2007/hlawatsch/index.html>)

VISION TO 2008

In 2008, NIUST will take possession of *Eagle Ray* and operate it out of Mississippi. NURC/UNCW will continue to provide considerable at-sea support and technical oversight during the year-long transition, but will also look to other opportunities to expand its expertise and knowledge beyond *Eagle Ray*. The center's potential merger with Ocean Exploration and role as the nucleus of a new NOAA Cooperative Institute provides the center with an opportunity for it to take a considerable leadership role within NOAA to provide AUV technology and meet future research goals.

The center will also enter into a more formal collaboration with NURC at the University of Connecticut to make their dual body 1000 meter ROV system operational and available to support science in 2008. This system is a hybrid of NURC/UCAP's existing Deep Sea Systems International ROV (formerly known as *Kraken*) and the Deep Ocean Engineering's P3S2 ROV. The main ROV (beta name *Proteus*) will utilize the medium sized frame of the Hela ROV connected to the depressor with a light, near neutrally-buoyant tether, but with new thrusters to accommodate the sampling and operational requirements. The depressor sled, beta name *Poseidon*, will be connected directly to the surface ship and will carry a 3-chip video camera, three HMI lights and a turning thruster to position the camera and lighting.

The center's efforts in testing and evaluating rebreathers as a viable science tool will continue. The CRES project (2008-04B) enters into its second full year of trials, four center staff recently participated in rebreather training program and collaborative efforts with East Carolina University are planned for spring 2008.