

Cooperative Institute for Ocean Exploration, Research and Technology (CIOERT)

Annual Progress Report: 01 April 2010 to 31 March 2011



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INTRODUCTION

GENERAL DESCRIPTION

The Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT) is led by the Harbor Branch Oceanographic Institute at Florida Atlantic University in Fort Pierce, Florida. The University of North Carolina Wilmington is the co-managing partner, and limited partners are SRI International in St. Petersburg, FL, and the University of Miami, Miami, FL. The CIOERT is aligned with the NOAA/OAR Office of Ocean Exploration and Research (OER).

The CIOERT serves OER priorities in the following theme areas:

- I. *Develop advanced underwater technologies.* CIOERT will expand the scope and efficiency of exploration and research by developing, testing, and applying new and/or innovative uses of existing technologies to ocean exploration and research activities.
- II. *Explore and research the frontier regions of the eastern U.S. Continental Shelf and beyond.* CIOERT will focus on the exploration and research of ecosystems and habitats of economic, hazardous, scientific or cultural importance within and beyond the eastern U.S. Continental Shelf as defined by OER.
- III. *Improve understanding of vulnerable deep and shallow coral ecosystems.* Priority activities will include supporting ocean exploration and research using advanced underwater technologies and techniques to improve the understanding of coral and sponge ecosystems.
- IV. *Improve ocean literacy and build NOAA's technical and scientific work force.* Education activities will emphasize delivery of education and outreach experiences and products to a world-wide audience and classroom. University students, the work force of tomorrow, will be exposed to ocean exploration and advanced technologies through hands-on experiences, mentors, and world-class training programs.

THE CIOERT VISION is to transform the way we explore the ocean and transition our results to breakthrough products and technology.

THE CIOERT MISSION is to apply disciplined innovation to continually improve, extend, and fortify NOAA's exploration, research, and operational capabilities.

AWARD DETAILS

In July 2009, CIOERT received \$150,000 (NOAA award # NA09OAR4320073) to support Task I Administration and Education/Outreach activities and submitted an annual Science Plan for Task II and III activities. FAU received the latter funding of \$1.15M (Amendment 1 to NOAA Award # NA09OAR4320073) in October 2009. In April 2010, a request for supplemental funding for the Year 2 Science Plan for Tasks I-III was submitted; the request was approved and awarded in July 2010. This progress report covers the period of April 1, 2010 to March 31, 2011 and includes all Task I, II, and III activities.

CIOERT MANAGEMENT

The Cooperative Institute (CI) is led by Harbor Branch Oceanographic Institute at Florida Atlantic University (HBOI/FAU), with co-managing partner University of North Carolina-Wilmington (UNCW). Together, the managing partners are responsible for program administration and management of all Task I (Administration and Education) activities, for which significant cost-sharing is being provided.

Fiscal and human resources management adhere to the guidelines set out in the handbook for cooperative institutes and relevant federal regulations for contracts and grants. The CI staffs its research and support functions with employees from the managing member institutions. The CI leadership and science teams work closely with NOAA management, scientists and mentors to develop effective cross-organizational teams and foster innovation.

Key management staff and responsibilities for program management are:

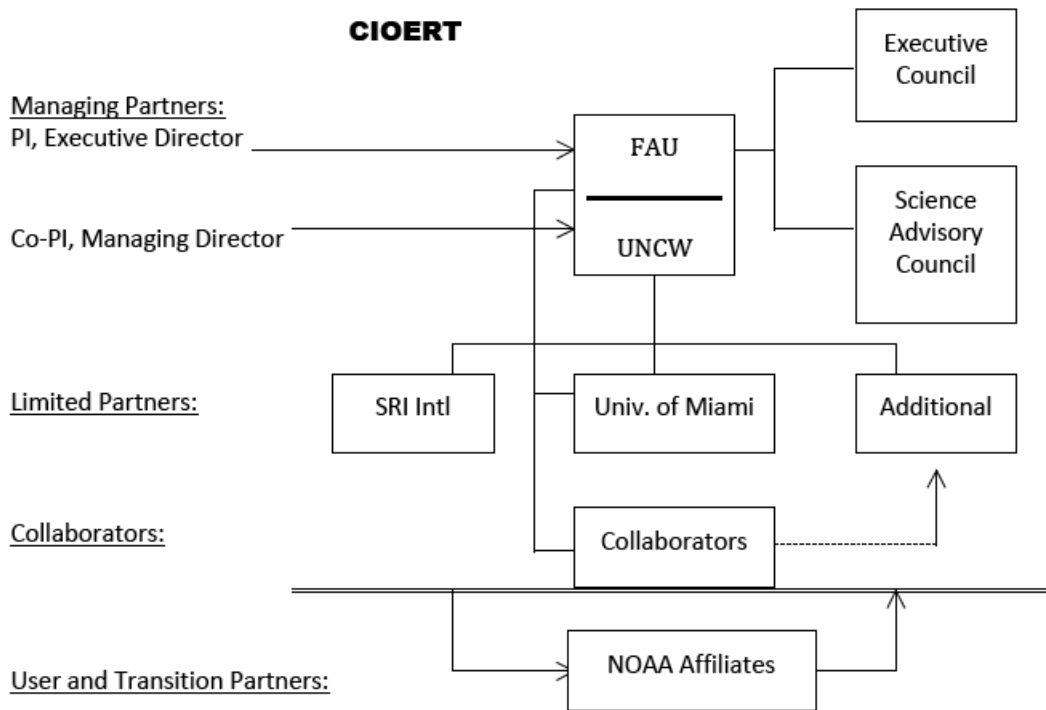
- **Executive Director:** Dr. Shirley A. Pomponi (HBOI/FAU) serves as the Executive Director. The Executive Director determines the strategic direction for the CI, in consultation with the other members of the Executive Council, and is responsible for building a team that focuses on continuous and rapid creation of value for NOAA through both incremental and transformational innovations. In addition to leading the CI, other responsibilities include: Executive Council chair; Science Advisory Council vice-chair; liaison between the CI and FAU senior management; primary point of contact with NOAA leadership; and advocacy, program development and research support. Dr. Pomponi is located at FAU's Harbor Branch site.
- **Managing Director:** Dr. Daniel G. Baden (UNCW) shares management responsibilities with the Executive Director. Other responsibilities include: Executive Council vice-chair; Science Advisory Council chair; oversight of UNCW contract obligations; and guidance and direction of CIOERT programs.
- **Associate Director:** Appointed jointly by the Executive and Managing Directors, Andrew Shepard (UNCW) provides oversight of daily CI activities, including supervision of staff; coordinates advisory board meetings (Executive Council, Science Advisory Council, and *ad hoc* boards as needed); is accountable for CI progress (progress reports, data management); serves as a regular interface between the stakeholders and users of CIOERT innovations.
- **Director of Education:** Dr. M. Dennis Hanisak (FAU) provides leadership and oversight of all educational programs.
- **Financial Accounting:** Dr. Edwin P. Bommel, CPA, Director of Research Accounting at FAU, is responsible for compliance with all federal regulations regarding spending and contracts; preparing and reconciling budgets; and creation of mandated fiscal reports.
- **Other CI staff:** The CI managing partners hire other staff as required to support Task I, II or III activities. Each managing partner will be responsible for supervising its CI-affiliated faculty, students and staff.

CIOERT ORGANIZATIONAL STRUCTURE

HBOI/FAU is the lead institution for the CI and, together with UNCW, provides administrative and managerial support (Task I activities), delivery of educational programs and products (Task I activities), and has formal responsibility to NOAA for all Task II and III research activities, including research and technology planning, logistics, deliverables, and administration (Figure 1). The CIOERT operates consistent with the NOAA Interim Cooperative Institute Handbook, and includes Executive

and Managing Directors, an Executive Council, a Science Advisory Council, and appropriate staff. CIOERT engages several types of partners:

- **Managing partners** (FAU and UNCW) are responsible for and cost-share Task I administration activities; they provide leadership and support for innovation, exploration, research, technology development, and transition to applications under Tasks II and III;
- **Limited partners** (University of Miami and SRI International) provide key capacities and leverage for the life of the CI;
- **Collaborators** are project-based partners or investigators for technology development, operations, and science;
- **NOAA partners** are NOAA program directors and laboratories with which we will collaborate to identify, prioritize, and address NOAA needs.



CIOERT 2010 organization structure.

Figure 1. CIOERT Y2 organizational structure.

CIOERT ADVISORY COUNCILS

CIOERT has created advisory councils as a means of engaging partners from inside and outside NOAA in providing planning and guidance regarding Task I, II, and III activities. These advisory groups include an Executive Council, a Science Advisory Council (formerly Council of Fellows), and Theme Teams.

Following are descriptions of these group’s objectives, members and meeting schedule (Table 1). All advisory group meetings are posted on the CIOERT Web site (cioert.org/calendar), and notes are shared via with group members for edits and corrections.

Table 1. Advisory group meetings convened during reporting period: April 2010 through March 2011.

Date	Group	Purpose	Minutes
4/5/10	TIMO	Development of Advanced Diving Technology Program plan	
4/29/10	TIMO	Development of Advanced Diving Technology Program plan	X
4/19/10	EC	NOAA CI Directors meeting	
4/29/10	EC	Y2 Science Plan development	X
4/14/10	EOIM	Ocean Literacy strategy and IMS development	X
5/18/10	EC	CIOERT oil spill response activities, NOPP proposal	X
5/27-28/10	All	CIOERT oil spill response activities	X
6/28/10	All	FLoSEE expedition planning	
8/18/10	All	OER update; Strategic Planning for Y3-5; FLoSEE report	X
9/17/10	EC	Annual meeting planning, outreach, DWH opportunities	X
11/3/10	OER Dirs.	CI managers attend OER Directors meeting at NOAA	
11/23/10	EC	Annual meeting invitees; Y3-5 strategy	X
12/16/10	FAU PIs	Y3 Science Plan	X
12/20/10	UNCW PIs	Y3 Science Plan	X
1/3/11	UNCW PIs	Annual workshop planning; C4 assets	
2/7/11	All	Annual meeting—SAC, EC, and PIs attending	X
2/18/11	TIMO	Deep ROV for science—FGBNMS partnership	
3/1/11	EOIM	Information Management System requirements—IMS Plan	X
3/11/11	UNCW PIs	UNCW Site visit by Nathalie Valette-Silver	X
3/22/11	EC	NOAA CI Directors meeting	

Executive Council

The Executive Council consists of senior NOAA program officials (from OER and OAR), the CI Executive Director (chair) and Managing Director (vice-chair), the directors of CIOERT Limited Partners (SRI International and the University of Miami), and other Limited Partners as they become part of the CI (Table 2). The Executive Council has the following responsibilities:

- Set strategic directions for the CI, including preparation of the CIOERT Concept of Operations;
- Ensure linkages and relevance to NOAA programs;
- Approve appointments to the Science Advisory Council;
- Review and recommend improvements regarding CIOERT policies and business plan, including administrative and budget policies;
- Review annual Science Plan and budget;
- Review and implement agreements or addenda to the CI's cooperative agreement and make related recommendations to the Executive Director;
- Review CI programs, projects and progress;
- Communicate NOAA strategic plans and priorities to the CI planning teams to ensure program alignment with these priorities; and
- Provide information regarding CI successes to the NOAA Administrator to justify inclusion of CI funding in the NOAA core budget.

The monthly meeting agenda is flexible and prepared in advance by the CIOERT Directors.

Table 2. CIOERT Executive Council Members

Name	Term	Affiliation
Shirley Pomponi, Chair	Y1-3	HBOI/FAU, CIOERT Exec. Director
Dan Baden, Vice Chair	Y1-3	UNCW, CIOERT Managing Director
Peter Ortner	Y1-3	U Miami, RSMAS
Larry Langebrake	Y1-3	SRI International
Karen Kohanowich	Y1-2	NOAA/OER
John Cortinas, Jr.*	Y1-2	NOAA/OAR CI Program Director
Nathalie Valette-Silver	Y2-3	NOAA/OER
Gene Smith	Y2-3	NOAA/OER Program Officer

*John Cortinas has been replaced on the Executive Council by Philip Hoffman.

Science Advisory Council

The Science Advisory Council is composed of scientists who have national or international reputations for outstanding research and includes: the Managing Director (chair); senior scientific/technical representatives from each CI Managing Partner and Limited Partner institution; regional ecosystem representatives (representing Great Lakes, Northeast, Southeast, Gulf of Mexico); and CI theme representatives (undersea technology, ocean exploration, coral ecosystems, education) (Table 3). Membership will be balanced among NOAA senior scientists from NOAA programs such as NOAA regional assessment teams, other NOAA Cooperative Institutes, NOAA Environmental Research Labs, Sea Grant, Sanctuary Regional Program offices, and/or other *CIOERT* stakeholders, e.g., Ocean Observing Regional Associations, Regional Fishery Management Councils, state agencies. These positions will rotate every two years. The Science Advisory Council will meet at least twice each year, and will have the following responsibilities:

- Advise the Executive Council on regional and function-specific activities and priorities related to the CIOERT theme areas;
- Leverage NOAA national and regional efforts in CIOERT theme areas;
- Provide guidance to the Executive Director in maintaining high standards of science and technology development;
- Provide annual guidance to the Executive Council on programs and approaches to meet NOAA and OER priorities, goals, and milestones;
- Review CIOERT exploration/research/technology/education program outputs annually;
- Provide advice on balance of resources invested into programs by theme area and ecosystem region;
- Advise the Executive Council on selection of new Science Advisory Council members and reappointment of current members;
- Make recommendations to the Executive Director on the establishment of *ad hoc* advisory groups; and
- Serve as an expert resource to the Executive Director for advice on innovations in science and technology related to the CIOERT theme areas.

The SAC's semi-annual meeting agenda includes:

- Review of CIOERT progress reports (annual)
- Development and input for upcoming annual Science Plan
- New directions and opportunities
- Other business

Table 3. CIOERT Science Advisory Council Members.
Constituency—MP = managing partner, LP = Limited Partner.

Name	Affiliation	Constituency	Theme	Region
Dan Baden, Chair	UNCW, CIOERT Managing Director	CI MP		
Shirley Pomponi, Vice Chair	HBOI/FAU, CIOERT Executive Director	CI MP		
Dennis Hanisak	HBOI/FAU	CI MP	Education Corals	SE
Amy Wright	HBOI/FAU	CI MP	Expl	SE
John Morrison	UNCW	CI MP	Tech, Expl	SE
Alina Szmant	UNCW	CI MP	Corals	SE
Bob Cowen	U Miami	CI LP	Expl, Corals	SE
Lori Adornato	SRI	CI LP	Tech	SE
Kacky Andrews *	NOAA/CRCP	NOAA/CRCP	Corals	All
Zdenka Willis	NOAA/IOOS	NOAA/IOOS	Tech	All
Lesley Stokes	NOAA NMFS SEFSC	NOAA/NMFS	Expl, Corals	SE
Marie Colton	NOAA/GLERL, CILER	NOAA	Expl	GL
Steven Lohrenz	Univ. of S. Mississippi, NGI CI	Stakeholder	Expl	GM
Ann Bucklin	U Conn	Stakeholder	Expl	NE
Sharon Walker	U S. Mississippi	Stakeholder	Education	All

*Kacky Andrews is no longer at NOAA; although she has been invited to remain on the SAC, she has not accepted the invitation. Cisco Werner was an original SAC member; he has changed jobs, and although he now works for NOAA, he has opted to withdraw from the SAC.

Theme Teams

In addition to the Executive Council and Science Advisory Council, CIOERT utilizes theme teams for innovation and to sustain communication with partners. The teams serve several functions, including:

- Develop and implement CIOERT procedures and functions, e.g., information management, proposal planning, project review and selection;
- Report on progress of projects and activities; update operations/projects calendar;
- Advise Executive Council on deviations from the annual work plan;
- Advise Executive Council on new directions and innovations within their theme;
- Identify new opportunities for partnerships and funding; and
- Team-specific milestones.

Team meetings are chaired by Andrew Shepard, CIOERT Associate Director, UNCW. Except for an annual CIOERT-wide workshop, meetings will be held at least every quarter using Gotomeeting and teleconference. A meeting calendar is kept at www.cioert.org; meetings are set in this calendar on a fixed monthly schedule, however, only need to occur each quarter. Additional dates will be used to schedule, handle, and update ad hoc tasks. The Executive Director may also call for other meetings as needed. Meetings will normally last one hour and include:

- Review of team milestones
- Review/updates of Project milestones (included with each project summary template) and operations calendar update
- New directions and opportunities.

For 2009-2011, the team membership included: investigators who led the writing of the CIOERT proposal and years 1 & 2 Science Plans; one collaborator from outside the Managing and Limited Partners; and at least one representative from the NOAA Office of Ocean Exploration and Research (Table 4).

Table 4. CIOERT Theme Team advisory groups.

Theme teams	Name	Affiliation	Partner
Technology Innovation & Marine Ops (TIMO)	Steve Schock	FAU	MP
	Lee Frey	HBOI/FAU	MP
	Dan Baden	UNCW	MP
	Lori Adornato	SRI	LP
	Sam Walker	SECOORA	Collaborator
	Felipe Arzayus	OER	NOAA
	Kelley Elliot	OER	NOAA
	Don Liberatore	HBOI/FAU	MP
	John Kloske	SRI	LP
	Lance Horn	UNCW	MP
	Doug Kesling	UNCW	MP
Exploration	Tammy Frank	HBOI/FAU	MP
	Amy Wright	HBOI/FAU	MP
	Jeff Wright	UNCW	MP
	Carm Tomas	UNCW	MP
	Nancy Grindlay	UNCW	MP
	Gregor Eberli	UM	LP
	Dave Eggleston	NCSU	Collaborator
	Reggie Beach	OER	NOAA
Coral	Joshua Voss	HBOI/FAU	MP
	Sara Edge	HBOI/FAU	MP
	Alina Szmant	UNCW	MP
	Rob Whitehead	UNCW	MP
	Dennis Hanisak	HBOI/FAU	MP
	John Reed	HBOI/FAU	MP
	Richard Appeldoorn	UPR	Collaborator
	Steve Ross	UNCW	MP
	Sandra Brooke	MCBI	Collaborator
	John Tomczuk	OER	NOAA
Education, Outreach & Info Management (EOIM)	Aaron Alexander	UNCW	MP
	Tom Potts	UNCW	MP
	Felipe Arzayus	OER	NOAA
	Nelson Beaman	HBOI/FAU	MP
	Jim Masterson	HBOI/FAU	MP
	Jennifer Dorton	UNCW	MP
	Sharon Mesick	NCDDC	NOAA
	Dennis Hanisak	HBOI/FAU	MP
	Leslie Sautter	College of Charleston	Collaborator
	Paula Keener Sue Kezios Christine Patrick	OER UNCW OER	NOAA MP NOAA

COMPLIANCE WITH SPECIAL AWARD CONDITIONS

SAC 1: Safety- general: compliance with applicable state and federal laws and regulations governing health and safety for all employees at the worksite associated with operations conducted pursuant to the cooperative agreement, including training and safety equipment, safety investigations in response to incidents, and corrective actions to mitigate recurrence of similar incidents.

Compliance Affirmation: All regulations and laws related to safety, including Appendix A to part 215 of OMB Circular A-110, were adhered to during year 2 field programs. One non-diving incident occurred during year 2 dive operations supported by UNCW, a minor elbow strain due to lifting equipment. An incident report was filed with UNCW in accordance with state policies, and is available upon request.

SAC 2: Diving procedures: conduct diving operations in accordance with guidance that meets or exceeds applicable state and federal regulations and industry standards.

Compliance affirmation: All dives conducted during year 2 were scientific diving as defined by OSHA regulations 29 CFR, part 1910, subpart T, standard 1910.402. All diving was done in accordance with AAUS regulations for UNCW and HBOI-supported scientific diving. Copies of AAUS-approved diving manuals for nitrox/air and technical diving are available upon request.

SAC 3: NOAA Diver Reciprocity: NOAA divers dive under NOAA standards in accordance with NOAA established dive planning and reciprocity procedures while diving under activities sponsored by this award.

Compliance Affirmation: All NOAA divers participating during field projects overseen or sponsored by CIOERT followed NOAA standards. CIOERT's UNCW Advanced Diving Technology Program has a reciprocity agreement with the NOAA Dive Program, available upon request.

PROJECT PROGRESS REPORTS

EXECUTIVE SUMMARY OF IMPORTANT RESEARCH ACTIVITIES

The Task II/III Science Plan was developed based on peer review and prioritization of projects proposed in response to FFO No. OAR-CIPO-2008-2001403. Projects address all theme areas of CIOERT (Table 5). Project numbers refer directly to sections in which they were described in the original proposal.

Table 5. CIOERT projects and activities covered by this progress report.

Task	Theme	Project #	Lead	Title	Primary NOAA Technical Contact
I	Admin Education	1.0	Pomponi, FAU	CIOERT Task I Activities	Smith, OAR/OER
III	1	3.3.2.1	Baden, UNCW	New Technology Development to Measure <i>In Situ</i> Metabolism and Bioenergetics in Corals	Smith, OAR/OER
III	1	3.3.2.3	Adornato, SRI	Transition of Homeland Security Information Technology for Assessing Ecosystem Change from Baselines	Smith, OAR/OER
III	2	4.2.1	Frank, HBOI/FAU	The Linkage between Pelagic and Benthic Ecosystems	Smith, OAR/OER
II	2	4.2.5	Eggleston, NCSU	Connectivity between Deep and Shallow Ecosystems: Ecosystem Approach to Management of New Shelf Edge MPAs	Kellison NCCOS/CCFHR – Beaufort, NC
III	2	4.3.1	Wright, HBOI/FAU	Discovery of Novel Therapeutic Agents from Marine Frontier Habitats	Smith, OAR/OER
II	2	4.5.1	Shepard, UNCW	Submerged Cultural Resources (SCR) in NOAA’s Sanctuaries	Cantelas, OAR/OER
II	3	5.2.4	Szmant, UNCW	New Technology Development in Support of Ocean Acidification Research	Smith, OAR/OER
II	3	5.3.1	Reed, HBOI/FAU	Mesophotic Reef Ecosystems	Puglise, NOS/CSCOR
II	3	5.5.1	Ross, UNCW	Exploration and Characterization of Deep Sea Coral Ecosystems off the Southeast US	David, NMFS – Pascagoula Lab
III	4	6.3.1	Hanisak, HBOI/FAU	At-Sea Research Opportunities for the Next Generation of Scientists: The CIOERT Transect Program	Smith, OAR/OER

DISTRIBUTION OF NOAA FUNDING BY TASK AND THEME: YEAR 2

Year 2 funding supported Task I, II and III projects in all CIOERT theme areas (Figure 2). This breakdown assumes C4 field operations support is split between Task II, theme 2 and 3.

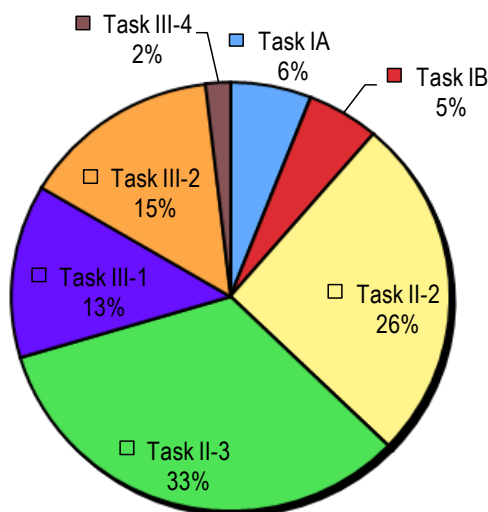


Figure 2. Breakdown of Year 2 budget by task (Roman numerals) and CIOERT theme (1 = technology innovation, 2 = shelf frontiers, 3 = coral ecosystems, 4 = education project).

EXECUTIVE SUMMARY—HIGHLIGHTED ACCOMPLISHMENTS:

Following are highlights from the Y2 projects (see progress reports below for more details):

- Project # 1.0 (Task I): 20 advisory group meetings, including annual strategic planning workshop; Web site maintained (cioert.org); Innovation training for CI collaborators; Strategic Plan drafted; Annual Progress reports and Science Plans prepared; service on nine national and regional ocean panels; set requirements for Information Management System.
- Project # 2.0 (C4): Undersea operational support provided for 12 missions and 100 dive days during this report period, including 4 CIOERT missions, 7 partnership projects with NOAA PIs and one with the U.S. Navy.
- 3.3.2.1: Instrument requirements and design complete; CISME prototype built with O₂ probe and tested in lab; pH probe identified; began construction of field unit with new pH probe.
- 3.3.2.3: Although contract was stalled, SRI investigators identified CIOERT data sets for input and testing of Marine Domain Awareness System.
- 4.2.1: Plankton and coral samples collected in collaboration with project 5.3.1 (Florida Shelf Edge Expedition, FLOSEE) for reproductive analysis.

- 4.2.5: Similar modeling project included in collaborative proposal to NSF to study connectivity of chemosynthetic communities in the North Atlantic.
- 4.3.1: Samples were collected during two CI-related expeditions. The Florida Shelf Ocean Exploration Expedition (FLOSEE) and a NOAA expedition to deep-water coral reefs in the Gulf of Mexico and SE Atlantic Coast. Source materials evaluated and microbes selected for isolation, resulting in 102 cultures being added to the Harbor Branch Marine Microbial Culture Collection. Microorganisms have been fermented using varied growth conditions, resulting in production of 175 extracts, which have been evaluated using LC-MS. All samples collected on the FLOSEE expedition were extracted for HPLC analysis. Sponges collected from specific marine frontier habitats were shipped under cold conditions to UNC Wilmington Center for Marine Science for the isolation and culture of bacteria associated with these sponges, with focus on order Actinomycetales, as this group of microbes has a long and successful history of producing antibiotics, anticancer, and immunosuppressive agents.
- 4.5.1: 2010 missions mapped and surveyed 8 new deep water wreck sites in and near the Thunder Bay and Monitor Sanctuaries.
- 5.3.1: August FLoSEE expedition (cioert.org/flosee) explored mesophotic and deep coral reefs from the FL Keys to panhandle, including several newly designated shelf edge marine protected areas; coordinated with DHW Incident Command Center during expedition, including provision of samples to NRDA labs.
- 5.5.1: Collaborative Deep Coral Expedition on NOAA ship Ron Brown, with Woods Hole Oceanographic Institution's Jason ROV explored deep coral ecosystems off the east coast of Florida in areas targeted by the regional fishery management council for baseline characterization.
- 6.3.1: One 7-day leg of 21-day FLoSEE expedition dedicated to university student education; student team carried out same research objectives as FLoSEE science teams.

DETAILED PROJECT PROGRESS REPORTS

PROJECT #: Y2-1.0
TITLE: *CIOERT Task I Activities*

PRINCIPAL INVESTIGATORS:

Dr. Shirley A. Pomponi, Executive Director, FAU
Dr. Daniel G. Baden, Managing Director, UNCW
Andrew Shepard, Associate Director, UNCW
Dr. M. Dennis Hanisak, Director of Education, FAU

PROJECT DURATION: Year 2 of 5 (FY09-14).

BUDGET: Total request \$189,121; see budget spreadsheet and narrative for details.

NOAA GOALS: __ Protect, restore, and manage the use of coastal and ocean ecosystem based management; __ Understand climate variability and change to enhance society's ability to plan and respond; __ Serve society's needs for weather and water information; __ Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation; x
Mission support.

PROJECT OVERVIEW

Task I CIOERT activities include administrative support services (Task IA) and education and outreach activities (Task IB). Both Managing Partners, UNCW and FAU, are responsible for program administration and management of all Task I (Administration and Education) activities, for which significant cost-sharing is being provided.

TASKS, TIMELINES, & MILESTONES

Year 2 Activities:

1. Continue support for CI management elements; establish Web-based "cloud" services for promoting sustained interaction;
2. Engage CI staff, project leads, managing and limited partners in formal training in the discipline of Innovation (led by SRI International);
3. Strategic planning outputs: CIOERT Science Strategic Plan, Annual Work Plan, Information Management Action Plan, Education/Outreach Action Plan, Technology and Operations Plan (including Role of Human Intervention in Undersea Research and Exploration);
4. Implement educational activities: hire specialists, initiate postdoctoral program and visiting fellows program (the latter contingent on additional funding);
5. Support outreach and NOAA "in-reach" activities: develop and sustain promotional materials for CIOERT including Web site (cioert.org) and brochure; conduct briefings on CIOERT for regional partners and stakeholders (e.g., NMFS, NOS and Fishery Management Councils);
6. Implement Project Information Management System and sustain input;
7. Progress reporting: develop and submit NOAA annual progress report.

	2010-11 Timeline											
Activity	J	A	S	O	N	D	J	F	M	A	M	J
1	X	X	X	X	X	X	X	X	X	X	X	X
2			X									
3	B											C
4	X	X	X	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X	X	X	X	X	X
6	X	X	X	X	X	X	X	X	X	X	X	X
7												X

PROGRESS REPORT

Following are the Task I milestones and related progress for this report period:

1. Develop MOA with NOAA to refine proposed work plan (in progress): negotiations initiated with OER in November 2009, meeting CIOERT grant terms and conditions; draft in review by FAU and UNCW.
2. Establish CI management elements (complete): Advisory groups include Executive Council (EC), Science Advisory Council (SAC) and 4 theme teams (Education/Outreach/Info Management, Technology Innovation/Marine Operations, Shelf Exploration, Coral Ecosystems). The EC meets monthly by conference call, and theme teams meet at least once/quarter. Meeting notes are posted on Google Docs site and shared with OER. Science Advisory Council selected and met in Feb. 2010. Advisory group meetings convened (as reported in Y1 Annual Report). Established Gotomeeting as on-line meeting venue.
3. Engage CIOERT partners in discipline of Innovation (partially complete): due to budget limitations, no funding was allotted for this activity in the 2009 Science Plan; texts for Carlson and Wilmot (2006), Discipline of Innovation, were distributed to project leads and Executive Council; planning underway to include training resources in 2010 Science Plan. A one-day Innovation workshop, led by Langdon Morris (author of Permanent Innovation, 2006) was hosted by UNCW on April 28 and attended by the Executive Director, Managing Director, Associate Director, CIOERT administrative support staff at UNCW, and most of the UNCW CI PI's.
4. Strategic planning outputs (in progress): CIOERT Handbook under review includes Concept of Operations, Communications Plan, Performance Evaluation Plan and more; Theme Teams working on theme-related Strategic Action Plans (also to be posted on Google docs site).
5. Implement educational activities (partially complete): hired outreach specialist at UNCW; need to initiate postdoctoral program and visiting fellows program next report period.
6. Support outreach activities (in progress): promotional materials include Web site (cioert.org) and one-page overview; conducted several briefings on CIOERT for regional partners and stakeholders (e.g., NMFS, NOS and Fishery Management Councils)
7. Progress reporting (complete): develop and submit NOAA progress reports.
8. Implement Project Information Management System (in progress): CIOERT staff initiated IMS development; outline of requirements and outputs under review by EOIM theme team.

Outcomes/Outputs:

Several presentations including an overview of CIOERT are available at cioert.org. Targeted presentations by CIOERT managers include:

- S. Atlantic Fishery Management Council, Charleston, SC, Aug.—CIOERT Overview for SAFMC Habitat Advisory Panel (by AD)
- NMFS Advanced Sampling Technology Working Group, Miami, FL, Nov.—CIOERT fisheries and habitat innovations (by AD)
- S. Florida Coral Reef Initiative, Miami, FL, Nov.—CIOERT Coral Program (by AD)

Other outputs/products: CIOERT Web site (cioert.org).

Task I Funding Allocations

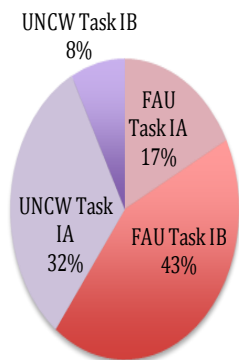


Figure 1. Budget of \$189,121 was split between Task IA administrative activities and Task IB education activities, shared by managing partners FAU and UNCW.

The total Y2 Task I project budget of \$189,121 covered CIOERT administrative and education activities, shared by managing partners FAU and UNCW (Figure 1).

Following are the Task I milestones as specified in the Y2 Science Plan scope of work and related progress for this report period:

- Continue support for CI management elements:
 - Advisory group meetings— 7 in Y1, 13 in Y2 (Table 1).
 - Utilize Web-based “cloud” services for promoting sustained interaction:
 - DOCUMENT SHARING:
 - *Google Docs*-- shared editing of group meeting notes and reports
 - *MS Office Live Workspace*-- shared editing of complex documents
 - *YouSendIt*-- free service for sending large (<100 MB) documents
 - MEETING/DISCUSSION:

- *Gotomeeting/Webinar*-- on-line meeting service including chat, phone, video conferencing, and real-time sharing of computer displays
- Innovation Training:
 - SRI gave overview of discipline of innovation at annual meeting, Feb 2011
 - Dedicated workshop led by SRI not accomplished due to scheduling problems of with SRI trainers and contract delays. Scheduling is in progress; the training will occur at the SRI St Petersburg facility before October 31, 2011.
- Strategic planning:
 - NOAA Needs Assessment (Dec 2010)—met with 22 NOAA stakeholders in Silver Spring to discuss their program needs related to CIOERT capabilities
 - CIOERT Annual Meeting (Feb 2011)—met with 42 NOAA and CI partners to present progress and help define Y3-5 work plans
 - MOA draft in review
 - Completed drafts of 2011-2014 Science Plan, Information Management Plan, Education/Outreach Action Plan, and Technology and Operations Plan (including Role of Human Intervention in Undersea Research and Exploration)
 - Directors participate in NOAA, national, and regional ocean strategy associations, committees, and panels:
 - Consortium for Ocean Leadership (Pomponi, Bd of Trustees through 3/11)
 - National Association of Marine Labs (Pomponi, Bd of Directors)
 - Southern Association of Marine Laboratories (Pomponi, President)
 - NOAA Deep Sea Coral Research and Technology Program- Southeast Regional Planning Team, Data Management Team (Shepard)
 - NOAA Oceans and Human Health Science Advisory Panel (Baden)
 - Florida Oceans and Coastal Council (Pomponi, appointed by FL FWC)
 - Florida Institute of Oceanography (Pomponi, Council Chair)
 - Southeast Coastal Ocean Observing Regional Association (SECOORA) (Pomponi, Bd of Directors)
 - NOAA CI Directors Executive Committee (Pomponi)
- Implement education and outreach activities:
 - Hire communication and outreach specialist; not yet hired; position description under review by FAU HR; will be posted ASAP; expect to hire before June 15, 2011.
 - Initiate postdoctoral program and visiting fellows program (not implemented; insufficient funds);
 - Developed promotional materials for CIOERT including Web site (cioert.org), CIOERT poster and brochure;
 - Conducted briefings on CIOERT for partners and stakeholders; Jan. briefings in Silver Spring included OAR, NMFS, NOS, NOAA Education, and NESDIS/IOOS representatives
 - Participated in “*Why Do We Explore?*” - NOAA Ship *Okeanos Explorer* Online Teacher Professional Development Series, Offering #2, June 21 – July 2, 2010
 - Participated in “**Lessons from the Deep: Exploring the Gulf of Mexico’s Deep-Sea Ecosystems**” October 11-29, 2010
 - Participated in monthly OER Communications team conference calls; report on CIOERT news and support related team activities such as calendar and program posters
- Implement Project Information Management System:
 - Requirements document drafted

- Data Manager resigned in Feb. 2011, funding reprogrammed in April, plan to implement via contract by August 2011
- Progress reporting:
 - Developed and submitted Y1 and Y2 annual progress reports.
 - Handled ad hoc requests for information requested by NOAA/OER (e.g., ship time requests, DWH Spill compensation funds, review/edits to OER Strategic Plan).

Table 1. Advisory group meetings convened during reporting period: April 2010 through March 2011.

Date	Group	Purpose	Minutes
4/5/10	TIMO	Development of Advanced Diving Technology Program plan	
4/29/10	TIMO	Development of Advanced Diving Technology Program plan	X
4/19/10	EC	NOAA CI Directors meeting	
4/29/10	EC	Y2 Science Plan development	X
4/14/10	EOIM	Ocean Literacy strategy and IMS development	X
5/18/10	EC	CIOERT oil spill response activities, NOPP proposal	X
5/27-28/10	All	CIOERT oil spill response activities	X
6/28/10	All	FLoSEE expedition planning	
8/18/10	All	OER update; Strategic Planning for Y3-5; FLoSEE report	X
9/17/10	EC	Annual meeting planning, outreach, DWH opportunities	X
11/3/10	OER Dirs.	CI managers attend OER Directors meeting at NOAA	
11/23/10	EC	Annual meeting invitees; Y3-5 strategy	X
12/16/10	FAU PIs	Y3 Science Plan	X
12/20/10	UNCW PIs	Y3 Science Plan	X
1/3/11	UNCW PIs	Annual workshop planning; C4 assets	
2/7/11	All	Annual meeting—SAC, EC, and PIs attending	X
2/18/11	TIMO	Deep ROV for science—FGBNMS partnership	
3/1/11	EOIM	Information Management System requirements—IMS Plan	X
3/11/11	UNCW PIs	UNCW Site visit by Nathalie Valette-Silver	X
3/22/11	EC	NOAA CI Directors meeting	

Outcomes/Outputs:

- Y1 Annual Progress Report
- Y1 and Y2 Science Plans
- Workshop report: *New Instrumentation for Assessment of Ocean Acidification in Coral Ecosystems, and Modeling of Coral Calcification*. SRI International-Marine Technology Division, St. Petersburg, FL; March 2010
- Expedition reports:
 - *Florida Shelf Edge Expedition (FloSEE)*, J. Reed, Chief Scientist
 - *Extreme Corals 2010*, S. Ross, Chief Scientist
- Web site (cioert.org)
- News releases, e.g., Battle of the Atlantic 2009, FLoSEE 2010, Extreme Corals 2010
- Marketing materials (poster, brochure, thematic one-pagers)

PROJECT #: Y2-2.0 (C4)

TITLE: C4 Operations Support for Year 2 CIOERT and Partnership Projects

PRINCIPAL INVESTIGATORS:

Shirley Pomponi, HBOI; Andy Shepard, UNCW

NOAA Collaborators (list names, affiliations):

See Table 3 under Progress Report section below.

PROJECT DURATION: Year 1 of 1

BUDGET: Total = \$846,540 for FAU award, plus \$33,000 for use of NOAA vessel

GOALS:

- CIOERT Research Themes: x Technology Innovation, x Exploring Shelf Frontiers, x Vulnerable Coral Ecosystems, x Education/Outreach
- NOAA Goals: x Protect, restore, and manage the use of coastal and ocean ecosystem based management; Understand climate variability and change to enhance society's ability to plan and respond; Serve society's needs for weather and water information; Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation; x Mission support.
- OER Strategic Goals/Actions (ref. OER SP): x Interdisciplinary exploration, x Development and utilization of advanced underwater technology, x Systematic research, x Education and outreach

PROJECT OVERVIEW

The CIOERT Core Capabilities Center (C4) supports operations for CIOERT and partnership projects. NOAA and CIOERT partners benefit from world-class CIOERT field operations capabilities at day rates subsidized by CIOERT's investment. Per CIOERT's original proposal, "this CI is uniquely qualified to provide access to, and expertise associated with specialized ocean exploration and research vehicles, systems, and sensors to conduct ocean exploration, research, and technology development." C4 capabilities: enable deep shelf and slope exploration (beyond 40 m); provide flexible, affordable operations, e.g., modular, ready-to-go and rapidly deployed from vessels of opportunity; manage risk by providing safe, tested, reliable support for undersea operations, including expertise and systems; and support a multi-system/platform approach to increase capabilities and safety of undersea operations. This project summary provides an overview (partners, objectives, outcomes, co-funding) of the C4 partnership projects conducted during the Year 2 (2010-2011) award period.

TASKS, TIMELINES AND MILESTONES:

This project summary includes all costs associated with the rest of the CIOERT 2010 Science Plan, supported by a subsidy for technical diving and vehicle operations, as well as day rates (minus subsidy) and other costs required to support at-sea operations. Technical diving done this year will utilize mixed gas scuba, not rebreathers, except for participation in training and testing activities.

Proposed 2010-2011 Activities (Table 2):

1. 2010-11 operations calendar posted and sustained (ID all missions and customers)
2. Cruise plans for 2010-11 missions on file and integrated with Information Management System
3. Develop CIOERT Marine Operations Action Plan, including clear definition of Dive Program Policies and Procedures
4. Support for CIOERT field operations (see 2010 Science Plan, task II/III projects)
5. Support for other NOAA field operations.

Table 2. 2010-11 activity milestones for C4 project.

Task	J	F	M	A	M	J	J	A	S	O	N	D
1	X	X	X	X	X	X	X	X	X	X	X	X
2		X										
3				X								
4	X	X	X	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X	X	X	X	X	X

Out-Year Activities (contingent upon new funding):

1. Annual operations calendar developed (ID all missions and customers)
2. Cruise plans for all missions on file (integrated with PIMS)
3. Support for CIOERT field operations (as detailed in Annual Science Plan)
4. Support for other NOAA field operations via C4 cost center.

Broader Impacts:

C4 is an integral part of every CIOERT project and related outreach and education efforts. Advanced technologies provide opportunities for STEM education and hands-on learning. In Year 1, Project # 6.3.1 (Transects Program) included ROV operations, and more advanced technologies will be added in future years. PI feedback from this mission provides testimony to the impact this exposure can have on undergraduate education:

One dedicated effort to begin in 2010 is development of a new *Ocean Innovator* Web site to complement OER's Ocean Explorer with focus on technology innovation. OER's Ocean Explorer Web site (www.oceanexplorer.noaa.gov) focuses on OE signature expeditions (not NURP) and the variety of related science, technology, and education activities associated with these expeditions. One of the most popular sites within NOAA (second only to weather.gov), its most successful (by hit/user rate) pages are tapped for imagery and education products. Its most common users are educators and students. During the first planning call of the CIOERT Outreach/Education/Info Management advisory team, OER's representative asked CIOERT to devise a Web presence focused on **technology innovation** to rival Ocean Explorer. C4 will work with the EOIM team during the 2010-2011 award period to develop the vision, requirements, content, and partnerships to leverage costs.

Innovation and Transition:

Innovation derives from creativity and experience. C4 experts are innovators with over 150 years of at-sea experience between them. Successful technology transition requires working closely with customers to design, construct, test and evaluate, refine, and apply technologies. Related roles include:

- **Professionals** work closely with the scientific community to get their jobs done safely and effectively.
- **Technologists** fix problems during a mission, not uncommon when using advanced undersea technologies and seeking to develop high risk-high reward innovations.
- **Innovators** integrate new sensors/instrumentation packages onto a variety of mobile or moored platforms for new data acquisition capabilities.
- **Mentors** provide training, risk management, technology transition, and next generation of operational expertise.
- **Operators** provide safe, affordable, effective access to advanced undersea systems.
- **Science team members** allow scientists to concentrate on the science and not have to worry about the operational aspects. C4 operational staff facilitate, for example, cruise planning, bid specs, equipment acquisition, dive supervision, training, equipment maintenance and upgrades, and handling of mission logistics.
- **Managers** grow CIOERT resources, with an established “following” of customers in the scientific community who know the experts, who’s the best, who can get the job done, and seek C4 support for their research.

A key task for the 2010 Science Plan will be to work with NOAA and AAUS partners to develop a technical diving plan. This strategic plan will minimally include: justification for the continued NOAA and national need for technical diving (mandates and science requirements by various agency partners); outline of the required elements in terms of people, equipment and regulations; and outline of an implementation plan. The first step will be to work with NOAA’s Dive Program and NOAA Dive Safety Officers to get their feedback on their existing or intended needs and plans.

CIOERT/NOAA Collaboration:

NOAA partners are the most common C4 customers, both for support of applied research missions (e.g., **Table 3**) and transition of undersea technologies. In addition to revenue-generating projects in Table 3 (all with NOAA partners), other NOAA collaborations in 2010-11 include:

- New 1000-m ROV: At request of Flower Garden Banks National Marine Sanctuaries, C4 operations personnel have developed proposal to purchase 1000 meter ROV, to be owned by FGBNMS but operated by C4. The Sanctuary approached the C4 team based on our track record, operational capabilities, expertise, and their lack of all these capabilities. HBOI has been contacted about fabrication of sampling equipment (biobox, small scale suction sample device, and spring loaded push cores). Requests for use are in hand for in 2010, including support for multiple NOAA Sanctuaries, NOAA Fisheries, and NOAA’s Deep Sea Coral program.
- Technical diving: As highlighted at 2008 DAN Tech Diving Conference (<http://www.diversalertnetwork.org/FastAccess/2008TechnicalDiving.aspx>), technical diving is increasingly popular, especially for the scientific diving community. The NOAA Dive Program does not currently support technical diving and utilizes C4 to support NOAA dive missions. C4 involves minimal infrastructure, which includes advanced and specialized equipment, and the experience to facilitate safe, deep diving technology. CIOERT will also continue to work with NOAA on application of rebreathers for scientific diving.

An important task for C4 is to develop a business model that facilitates NOAA access to all CIOERT capabilities. Finding ways to provide affordable, safe and effective access to C4 operations resources

will also provide models for improving access to other CIOERT assets, such as people, labs, planning, and training activities (e.g., strategic planning workshops, Innovation training).

PROGRESS REPORT

ACCOMPLISHMENTS:

CIOERT’s Year 1 Annual Report did not include a C4 project summary, although the team supported both CIOERT and partnership projects. The C4 team supported:

- 10 field expeditions in Year 1, including 4 CIOERT and 6 partnership projects; and
- 12 field expeditions in Year 2, including 5 CIOERT and 7 partnership projects (**Table 3**).

C4 partnership projects (numbered with 2.0.xx, shaded rows in Table 3) are approved for support based on feasibility (availability, budgetary) and relevance (science, approach) to CIOERT’s mission. These projects provided *over \$2,000,000 in program income and co-funding* from outside partners in Years 1 and 2.

Partnership Project Descriptions:

Full project summaries for CIOERT projects are included elsewhere in this Annual Report. Following are summaries for *partnership projects* in Table 3:

YEAR 1 (JUL 2009-JUN 2010):

Y1	Jul-09	Y1-2.0.01	J. DeBose, FGBNMS	<i>Marine Debris Assessment Expedition- FGBNMS</i>
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The Gulf of Mexico Marine Debris Project (GOMMDP) was launched in August 2006 in response to the coastal impacts of Hurricanes Katrina and Rita. In 2008-2009, CIOERT supported undersea operations on offshore banks in support of GOMMDP objectives. The missions explored protected areas in partnership with the NOAA Office of Response and Restoration and the Flower Garden Banks National Marine Sanctuary to document debris and continue the Sanctuary’s ongoing efforts to explore and map the shelf edge banks in the northern Gulf. Project benefits include:

- Assessment of the impacts and sources of marine debris in the Flower Garden Banks National Marine Sanctuary.
- Decreased vulnerability and increased protection of sanctuary resources, including the substrate and fauna of Stetson Bank.
- Increased safety of divers, fishermen and sanctuary personnel.
- Increased public awareness of the cause and effects of marine debris in deepwater habitats.
- Development of a marine debris prevention, monitoring, and response plan (<http://marinedebris.noaa.gov/projects/flowergdnfdg.htm>).

Table 3. Y1-2 projects supported by C4: Full Project Summaries for the CIOERT projects are included with Annual Progress Reports; *short descriptions of the partnership projects* (shaded rows; project numbers 2.0.xx) follow in the text of this C4 Project Summary. Funding: (a) Support from CIOERT for project operations; (b) UNCW Revenue Account support for operations; (c) Other Program Income paid to UNCW/C4 by partners; and (d) estimated project co-funding (not paid to UNCW/C4) based on ship time and science support from partner. Dive days do not include cancelled days or move/demove.

YR	MO.	Prj #	Partner PIs (not including CI leads)	Title	Asset	(a) CIOERT \$	(b) UNCW Revenue Acct. \$	(c) Other Prog. Inc- \$	(d) Est. Co- funding	Dive Days
1	Jul-09	Y1-2.0.01	J. DeBose, Flower Garden Banks NMS	<i>Marine Debris Assessment Expedition- FGBNMS</i>	Tech			0	35000	5
1	Sep-09	Y1-2.0.02	S. Donahue, Florida Keys NMS; P. Whitfield, NCCOS-Beaufort	<i>Assessment of the lionfish population in deep water habitats within the FKNMS</i>	Tech			3000	21000	3
1	Jan-10	Y1-5.3.1a	R. Appeldoorn, UPR	<i>Mesophotic Reef Ecosystems</i>	Tech	36856	8061	0	98000	14
1	Mar-10	Y1-2.0.03	D. Conlin, National Park Service;	<i>Rebreather Training/Evaluation with NPS</i>	Tech			0	25000	5
1	Apr-10	Y1-2.0.04	T. Battista, NOS	<i>Characterization of seafloor habitats of the U.S. Caribbean</i>	ROV			68499	260000	16
1	May-10	Y1-4.5.1a	R. Green, Thunder Bay NMS	<i>Technical Diving Operations to support high resolution image acquisition in TBNMS</i>	Tech	21000	930	26800	98000	14
1	Jun-10	Y1-4.5.1b	J. Hoyt, Monitor NMS	<i>Technical Diving Operations to support high resolution image acquisition in the Graveyard</i>	Tech	18388		20400	84000	12
1	May-10	Y1-5.3.1b	GP Schmahl, FGBNMS	<i>Mesophotic Reef/Marine Debris Removal</i>	ROV	12031	12927	0	30000	5

1	May-10	Y1-2.0.05	A. David, NMFS	<i>Survey of Habitat and Fish Assemblages in South Atlantic Marine Protected Areas (MPAs)</i>	ROV			20297	65000	4
1	Jun-10	Y1-2.0.06	M. Yoklavich, NMFS	<i>Deep Sea Coral and Benthic Habitat Surveys in and around Channel Islands National Marine Sanctuary</i>	ROV			8678	42000	5
2	Aug-10	Y2-5.3.1	T. Kellison, NCCOS-Beaufort	<i>Fishery-independent sampling to assess spatial variability in red snapper populations off the SEUS</i>	ROV	23044		0	120000	10
2	Sep-10	Y2-2.0.02	P. Whitfield, NCCOS-Beaufort	<i>Lionfish distribution and ecology off the SEUS</i>	Tech			10640	35000	10
2	Sep-10	Y2-2.0.03	R. Schwemmer, Channel Islands NMS	<i>Archaeological Survey to Inventory Submerged Shipwreck Sites in and near Pacific Coast Sanctuaries</i>	Tech			3600	35000	5
2	Oct-10	Y2-2.0.04	D. Howard, Cordell Bank NMS	<i>Cordell Bank National Marine Sanctuary Reef Crest Dive Project</i>	Tech			8640	42000	6
2	Jan-11	Y2-2.0.05	J. Campo, Parsons Inc.; C. Watterson/USN	<i>Ground truth of MBES, Jacksonville, FL</i>	ROV			31458	39859	4
2	Mar-11	Y2-2.0.06	T. Battista, NOS	<i>Characterization of seafloor habitats of the U.S. Caribbean</i>	ROV			70000	234000	18
2	Apr-11	Y2-2.0.07	R. Appeldoorn, UPR	<i>Mesophotic Reef Ecosystems</i>	Tech			17920	112000	16
2	May-11	Y2-5.3.1	M. Hickerson, FGBNMS/NOS	<i>Research Area Pre-Closure Surveys for Flower Garden Banks NMS</i>	ROV	15000		0	35000	5
2	Jun-11	Y2-4.5.1	R. Green – TBNMS	<i>Submerged Cultural Resources in NOAA's</i>	Tech	7840		0	49000	7

				<i>Sanctuaries</i>						
2	Jun-11	Y2-2.0.09	GP Schmahl, FGBNMS; P. Sammarco, LUMCON	<i>Deep-water Reconnaissance of Potentially Sensitive Biological Features (PSBFs) Surrounding Shelf-Edge Topographic Banks in the Northern Gulf of Mexico</i>	ROV			77920	140000	20
2	Aug-11	Y2-4.5.1	J. Hoyt – Monitor NMS	<i>Submerged Cultural Resources in NOAA’s Sanctuaries</i>	Tech	9600		0	12000	6
2	Jun-11	Y2-5.3.1	G. Piniak, NCCOS; E. Hickerson, FGBNMS	<i>Mesophotic Reef Ecosystems – FGBNMS</i>	Tech	15900		0	60000	10
							TOTALS	367852	1671859	200

Y1	Sep-09	Y1-2.0.02	S. Donahue, FKNMS; P. Whitfield, NCCOS- Beaufort	<i>Assessment of the lionfish population in deep water habitats within the FKNMS</i>
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The Indo-Pacific lionfish, *Pterois volitans*, is 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 found primarily in water depths greater than 130fsw, due to year-round Gulf Stream moderated bottom water temperatures at these depths. However, lionfish are now dispersing and surviving closer to shore on temperate and sub-tropical reefs throughout the southeast US, Caribbean, and Gulf of Mexico. In addition to lionfish, there are other stressors currently to hard-bottom habitats including climate change and overfishing. In September 2009, NOAA Fisheries researchers continued their research to examine the ecosystem and fisheries impacts of lionfish and other stressors on Florida Keys coral communities, including mesophotic reefs below 40 m depth. Led by Florida Keys National Marine Sanctuary and NCCOS scientists, quantitative lionfish, native fish and habitat surveys were conducted at 10 different locations in water depths from 25-50 m, utilizing decompression diving operations led by CIOERT's Advanced Dive Program manager, Doug Kesling. This information will allow researchers to assess the potential impact of the lionfish to native communities and add to the baseline community dataset established in 2006.

Y1	Mar-10	Y1-2.0.03	D. Conlin, National Park Service;	<i>Rebreather Training/Evaluation with NPS</i>
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The NPS Submerged Resources Center sponsored Closed Circuit Rebreather (CCR) training March 2011 in Key Largo, FL, including participation by the NOAA Dive Program and training leadership by CIOERT's Advanced Diving Program lead, Doug Kesling. This is part of an on-going interagency effort to evaluate various units and explore the move to closed-circuit scuba for use in archaeological studies down to 100 m depth. NPS covered all instructor and course costs. Per NPS lead, chief archaeologist Doug Conlin, "we had amazing training session with what I regard to be the best, most advanced and most well thought out rebreather [Sentinel, <http://www.tech-ccr.com/technicaldiving/sentinel-rebreather.shtml>] currently on the market. Phil Short (<http://www.philshorttechnical.co.uk>) was a great instructor and we, as well as Doug Kesling, learned a lot about rebreathers in general and this unit in particular."

Y1	May-10	Y1-2.0.05	A. David, NMFS	<i>Survey of Habitat and Fish Assemblages in South Atlantic Marine Protected Areas (MPAs)</i>
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In February 2009, the South Atlantic Fishery Management Council (SAFMC) closed eight areas along the outer continental shelf from Cape Hatteras, NC to the Florida Keys for protection of seven deep reef fish species including five species of grouper and two species of tilefish. NOAA Fisheries is conducting a robust study of habitat and fish assemblages within and adjacent to these Type II (i.e. trolling for pelagics is still allowed, but the areas are closed to all bottom fishing) deep-reef marine protected areas (MPAs), which will provide an efficacy test of this management tool. Thus far, four years of pre-closure data have been collected, which is crucial for establishing baseline estimates of fish assemblages as well as two years of post-closure data. Post-closure data will continue to be collected and will be compared to data prior to the implementation of fishing restrictions to look for recovery among targeted reef fish populations and, therefore, examine the success of these MPAs.

Y1	Apr-10	Y1-2.0.04	T. Battista, NOS	<i>Characterization of seafloor habitats of the U.S. Caribbean</i>
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In March and April 2010, the NOAA Center for Coastal Monitoring and Assessment (CCMA) conducted the seventh year of an ongoing scientific research mission onboard the NOAA Ship *Nancy Foster* funded by NOAA's Coral Reef Conservation Program. The purpose of the cruise will be to collect swath bathymetry and acoustical backscatter, as well as fishery acoustics data in high priority areas in the U.S. Caribbean in mid-water depths of approximately 10 to 150 meters in order to characterize seafloor habitats within all U.S. States, Territories, and Commonwealths. CIOERT's Phantom SII ROV, operated by Lance Horn and Glenn Taylor, UNCW, supported delineation and identification of seafloor habitats and video assessment of fish. Resulting data products are available to a wide variety of end-users, including project partners, NPS resource managers, the CFMC, Biogeography Branch research scientists, and researchers involved in testing and development of the new acoustics technology. There is also the potential for selective use of the data products in updating NOAA nautical charts and NOAA Tsunami Inundation Modeling projects. In addition, the mission will help NOAA meet its U.S. Coral Reef Task Force commitment to map U.S. coral reef ecosystems. Web site: http://ccma.nos.noaa.gov/ecosystems/coralreef/usvi_nps.html.

Y1	Jun-10	Y1-2.0.06	M. Yoklavich, NMFS	<i>Deep Sea Coral and Benthic Habitat Surveys in and around Channel Islands National Marine Sanctuary</i>
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Underwater surveys of corals, sponges, and associated habitats, invertebrates, and fishes were conducted on a deep rocky bank off southern California using non-extractive transect methodologies and direct observations from University of Connecticut's Kraken II remotely operated vehicle (ROV) and the NWFSC/PIFSC Seabed autonomous underwater vehicle (AUV) onboard the NOAA ship McArthur II. Our survey area was in and adjacent to the Channel Islands National Marine Sanctuary, in the Southern California Bight. CIOERT ROV pilot, Lance Horn, UNCW, served as part of the ROV team. This research directly supports the goals of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the National Marine Sanctuaries Act (NMSA), and is a contribution to NOAA's Deep-Sea Coral Research and Technology Program. The results represent a baseline for future monitoring of change to the deep sea coral community on the Piggy Bank and evaluation of the effectiveness of Marine Protected Areas (MPA) to conserve biodiversity of habitats and assemblages with increased time of protection inside the relatively new Footprint MPA and EFH Conservation Area.

YEAR 2 (JUL 2010-JUN 2011):

Y2	Aug-10	Y2-5.3.1	T. Kellison, NCCOS-Beaufort	<i>Fishery-independent sampling to assess spatial variability in red snapper populations off the SEUS</i>
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The following description is for a Y2 CIOERT core project. It is described here and not with the 5.3.1 Project Summary (Reed and Voss) as it was an opportunity to partner with NCCOS on their R/V *Nancy Foster* expedition using ROV support days provided by CIOERT. These days became available when the Florida Shelf Edge Expedition (FLoSEE), the primary Project # 5.3.1 field expedition, was able to leverage use of Harbor Branch-FAU's R/V *Seward Johnson* and *Johnson Sea-Link* research submersible to respond to critical needs in the Gulf of Mexico.

The NOAA Ship *Nancy Foster* sailed August 28, 2010, for two weeks to conduct fishery-independent sampling of deep-water snapper and grouper populations on the continental shelf from northern Florida

to the Carolinas. Research objectives include: (1) assess spatial variability in red snapper habitat distribution and abundance, (2) comparative analysis of fish traps, video cameras, and acoustics for fishery-independent data collection, and (3) acoustic and visual mapping of hard-bottom reef habitats. Dr. Todd Kellison, NOAA’s Southeast Fisheries Science Center lab in Beaufort, NC, led the expedition, which utilized CIOERT’s remotely operated vehicle (ROV) support, led by the team of Lance Horn and Glenn Taylor, UNCW. Expected outcomes include information required by the South Atlantic Fisheries Management Council as it deals with restoring depleted and overfished snapper and grouper populations.

Y2	Sep-10	Y2-2.0.02	P. Whitfield, NCCOS-Beaufort	<i>Lionfish distribution and ecology off the SEUS</i>
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The Indo-Pacific lionfish, *Pterois volitans*, is 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 found primarily in water depths greater than 130fsw, due to year-round Gulf Stream moderated bottom water temperatures at these depths. However, lionfish are now dispersing and potentially surviving closer to shore. In addition to lionfish, there are other stressors currently to hard-bottom habitats including climate change and overfishing. In September 2010, NOAA Fisheries researchers continued their research to examine the ecosystem and fisheries impacts of lionfish and other stressors on North Carolina hard-bottom communities within Onslow Bay. Specifically, researchers conducted quantitative lionfish, native fish and habitat surveys at 10 different locations in water depths from 75 – 150 fsw, utilizing decompression diving operations led by CIOERT’s Advanced Dive Program manager, Doug Kesling. This information will allow researchers to assess the potential impact of the lionfish to native communities and add to the baseline community dataset established in 2006.

Y2	Sep-10	Y2-2.0.03	B. Schwemmer, Monterey Bay NMS	<i>Monterey Bay NMS Archaeological Survey to Inventory Submerged Shipwreck Sites</i>
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In support of NOAA’s Monterey Bay NMS and other Sanctuary partners, CIOERT technical divers, D. Kesling and T. Dunmire, surveyed two shipwrecks and one site with two submerged WWII era Amtracks (amphibious tracked vehicles). One of the shipwrecks was the British 3-masted bark Harlech Castle lost near Point Piedras Blancas in 1869. As described by Sanctuary lead, B. Schwemmer, “We all work in various parts of the nation, but this expedition along with Cordell Bank NMS successful mission exposed many of you to not only the challenges we face along California’s Central Coast, but what wonderful opportunities and resources that are waiting to be discovered in future missions. It was a memorable experience to take the maritime heritage team out to the site of the USS Macon to put into context where we conducted the 5-day expedition in 1500 feet of water in 2006, and commemorate the 75th anniversary of the sinking together. I was truly impressed with the professionalism and level of skill you all brought to the mission.”

Y2	Oct-10	Y2-2.0.04	D. Howard, CBNMS	<i>Cordell Bank National Marine Sanctuary Reef Crest Dive Project</i>
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For the first time since the designation of the Cordell Bank National Marine Sanctuary (CBNMS) in 1989, technical scientific SCUBA divers revisited the shallowest parts of Cordell Bank's reef crest (115-200ft) from October 6-11th, 2010 off of the research vessel *Fulmar* (<http://sanctuaries.noaa.gov/missions/2010reefcrest/welcome.html>). CIOERT supported the technical diving operations, invited to participate and joined by divers from CIOERT east coast partner Sanctuaries at Thunder Bay, the USS Monitor and Grays Reef. The central goal of the Cordell Bank

Reef Crest mission was to test the feasibility of using technical divers for accomplishing hands-on tasks at depths of 115-200ft over Cordell Bank, and compare reef community composition to the last dives conducted three decades ago.

Y2	Jan-11	Y2-2.0.05	J. Campo, Parsons Inc.; C. Watterson/USN	<i>Ground truth of MBES, Jacksonville, FL</i>
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In partnership with the US Navy, CIOERT's Undersea Vehicles team supported ROV operations to survey a trunk telecommunications and power cable line that connects a proposed Undersea Warfare Training Range (USWTR) off Mayport, FL to the land-based facility. Video footage and sediment samples of the area will aid planning and executing the submarine cable installation, providing critical data for identifying a suitable location to lay the cable from shore out to the range 50 nm offshore, and best location to bring the trunk cable to shore. Suitable location includes minimizing potential impacts to areas of live-bottom substrate, other sensitive habitats, especially those designated as essential fish habitat (EFH), and submerged cultural resources.

Y2	Mar-11	Y2-2.0.06	T. Battista, NOS	<i>Characterization of seafloor habitats of the U.S. Caribbean</i>
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In March and April 2010, the NOAA Center for Coastal Monitoring and Assessment (CCMA) conducted the seventh year of an ongoing scientific research mission onboard the NOAA Ship *Nancy Foster* funded by NOAA's Coral Reef Conservation Program. The purpose of the cruise will be to collect swath bathymetry and acoustical backscatter, as well as fishery acoustics data in high priority areas in the U.S. Caribbean in mid-water depths of approximately 10 to 150 meters in order to characterize seafloor habitats within all U.S. States, Territories, and Commonwealths. CIOERT's Phantom SII ROV, operated by Lance Horn and Glenn Taylor, UNCW, supported delineation and identification of seafloor habitats and video assessment of fish. Resulting data products are available to a wide variety of end-users, including project partners, NPS resource managers, the CFMC, Biogeography Branch research scientists, and researchers involved in testing and development of the new acoustics technology. There is also the potential for selective use of the data products in updating NOAA nautical charts and NOAA Tsunami Inundation Modeling projects. In addition, the mission will help NOAA meet its U.S. Coral Reef Task Force commitment to map U.S. coral reef ecosystems. Web site: http://ccma.nos.noaa.gov/products/biogeography/usvi_nps/details.html

Y2	Apr-11	Y2-2.0.07	R. Appeldoorn, UPR	<i>Mesophotic Reef Ecosystems</i>
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CIOERT Advanced Diving Technology Program will again participate in the NOAA-funded Deep Coral Reef Ecosystems Studies program, led by the University of Puerto Rico. As described at the Center for Sponsored Coastal Ocean Research (CSCOR), the goal of the Deep-CRES program is to provide sound science to enable effective ecosystem-based management of mesophotic coral ecosystems (<http://www.cop.noaa.gov/ecosystems/coralreefs/current/mce.aspx>). The 2011 mission will build on CIOERT's mesophotic reef project (#5.3.1) to explore Caribbean mesophotic reef ecosystems off Puerto Rico and the US Virgin Islands. Research is driven by 24 specific hypotheses within 3 primary objectives:

- Characterization – species compositions and changes in space and time, disease prevalence and dynamics, genetic variability, reproduction and recruitment, plus the current and historical environment affecting reef distribution and function. Work includes still/video photography, specimen collection, repeat sampling and experimental manipulations.
- Connectivity – the relationship and ecological flow between deep and shallow reefs using taxonomic, genetic, reproductive and recruitment studies, and simulation modeling. Can deep reefs

seed threatened shallow species, or are deep reefs dependent upon larval import from shallow reefs?

- Vulnerability – new/different species, small populations, slow growth and close proximity to land potentially make Caribbean deep reefs unique yet vulnerable to anthropogenic stress. A scientific management committee ensures proper scheduling and completion of all activities.

Y2	Jun-11	Y2-2.0.09	GP Schmahl, FGBNMS/BOEMRE	<i>Deep-water Reconnaissance of Potentially Sensitive Biological Features (PSBFs) Surrounding Shelf-Edge Topographic Banks in the Northern Gulf of Mexico</i>
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As energy demands continue to increase, US oil and gas reserves are steadily declining with time. This is occurring at a time when political stability has been compromised in many of the countries that serve as US sources of oil and gas. It has been predicted that the oil and gas reserves of the northern Gulf of Mexico will be depleted by 2020. Because of this, there is an increasing amount of pressure placed on government and our oil and gas industries to tap reserves further offshore and in deeper water, at the edge and off the continental shelf. Juxtaposed to this are recent studies indicating that there are abundant and species-rich benthic communities associated with macro- and micro- geological features in these deeper waters of the GOM. It therefore becomes important to determine whether areas identified as potential drilling sites possess Potentially Sensitive Biological Features (PSBFs), which could serve as habitat for a rich community of sessile and vagile epibiota, and demersal and pelagic fish. The project is a partnership between CIOERT, Minerals Management Service, NOAA’s Flower Garden Banks National Marine Sanctuary, and the Louisiana University Marine Consortium, sponsored primarily by MMS. Goals are to survey the benthos on up to 13 deep-water banks and reefs in the northern Gulf of Mexico and obtain quantitative estimates of the biological communities associated with them, using a Remotely Operated Vehicle (ROV) operated by the CIOERT team at UNCW. The ROV will collect video and still photographic data; temperature and depth data; and topographic relief data. The quantitative surveys will follow a mixed model, three-level, nested orthogonal design. There will be 5-10 drop-sites per bank, and 25 transects (random) per drop-site. Video will be recorded continuously, and there will be 8 still photos taken per transect at uniform intervals of 10 sec. Topography will be recorded via a multi-beam sensor standardized by depth of the unit. Hard-bottom will serve as the primary target substratum, and all epibiota will be analyzed in the laboratory via image processing software. Some samples will be collected by the ROV, returned to the vessel, and identified by taxonomic experts. Data will be quantified to produce an in-depth understanding of the distribution, abundance, and diversity of organisms on these features. We will also investigate the potential of correlations between biotic diversity and topography to determine whether similar features should be investigated for their biotic communities prior to drilling.

Broader Impacts:

Many of the above projects included outreach activities (see product outputs below). In addition, many engaged students through formal and informal education, and inclusion of university students in research (Table 4).

Table 4. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist				
Visiting Scientist				
Postdoctoral Fellow				

Res. Support Staff	3	3		
Administrative				
OTHER:				
Employees with <50% CI funding (not including students)				
Employees Co-located at NOAA Lab				
Undergrad students	4	4		
Graduate students	8		8	
Obtained NOAA employment within last year				

OUTPUTS AND OUTCOMES:

Data Sets:

C4 personnel support field operations and are not responsible for data management. ROV products including dive tracks, imagery, and sensor files are delivered to the chief scientist. All datasets for CIOERT projects are responsibility of project PI and reported on in their project summaries.

Technology developments:

- Rebreathers: As stated in the Project Summary, the C4 Advanced Diving Technology Program at UNCW continues to engage with NOAA and other federal partners in the testing and evaluation of Closed-Circuit Rebreathers for scientific diving (e.g., projects Y1-2.0.03 and Y2-2.0.07). With significant contributions from the ADTP, NOAA is poised to approve the first CCR unit for use during NOAA dive operations.
- Deep Science ROV: Flower Garden Banks NMS is preparing the bid specification, led by the C4 Undersea Vehicles Program team, for purchase of a 1000-m ROV. The system will promote the pace, scope and efficiency of deep diving over currently available systems. Cost-per day will be reduced over leased systems by working from vessels of opportunity down to 25 m length. Payloads designed for scientific diving (e.g., HD video, downward looking still camera, sampling articulators and bins). Plans are to purchase in 2011 and commence field operations in early 2012.

Publications

Shepard, A.N. 2011. Gliders—cost-effective monitoring and vanguard technologies for ocean management. *Ocean Technology News*. In press.

Y2-2.0.02:

Whitfield PE, Muñoz RC, Buckel CA, Degan BP and Freshwater DW (in prep) Bottom water temperature influence on invasive lionfish and native fish distribution and abundance in Onslow Bay NC USA. for submission to *Marine Ecology Progress Series*.

Paula Whitfield, Roldan Muñoz, Christine Addison, Lauren Heeseman (in review) Biological community assessments of World War II shipwrecks: Report to the Monitor National Marine Sanctuary 2010 Battle of the Atlantic Mission. (in review as a *Marine Sanctuary Conservation Series Report*)

Ricardo Betancur-R., Andrew Hines, Arturo Acero P. Guillermo Orti', Ami E. Wilbur and D. Wilson Freshwater. 2011. Reconstructing the lionfish invasion: insights into Greater Caribbean biogeography. *Journal of Biogeography*. doi:10.1111/j.1365-2699.2011.02496.x

Muñoz, R. C., Currin, C. A., and P. E. Whitfield. 2011. Diet of the invasive lionfish on hard bottom reefs of the Southeast United States: insights from stomach contents and stable isotopes. In press, *Marine Ecology Progress Series*. DOI 10.3354/meps09154.

Presentations:

Y1-2.0.06:

- Information Report on NOAAs Deep Sea Coral Program-West Coast to Pacific Fisheries Management Council Meeting; November 2010; Costa Mesa, CA.
- NOAAs Deep Sea Coral Program - West Coast Activities; NOAA Deep Sea Coral Coordinators Meeting; July 29, 2010; Nationwide Webinar (archived presentation available on DSC Intranet site).

Y2-2.0.04:

- Poster -- McGann, M. and C. Powell. 2011. Cordell Bank National Marine Sanctuary sediment yields a diverse micro- and macrofauna. Sanctuary Currents Symposium, Seaside, CA: study element of ongoing collaboration between CAS and CBNMS to professionally catalog the flora and fauna of Cordell Bank. The collection's current holdings are available through the CAS website at <http://research.calacademy.org/izg>. Planned uses of this collection include temporal comparison of the Cordell Bank reef crest biota using the recent photos taken by CIOERT divers and historic photos taken by the divers of Cordell Expeditions over 25 years ago.

Web Sites/News:

Y1-2.0.06:

- Deepsea Coral and Sponge Image Database from 2010 surveys of deepsea corals and sponges off Southern California-- <http://swfsc.noaa.gov/DeepseaCoralImageDatabase/>
- News article in the Ventura County Star newspaper immediately following our cruise (July 2, 2010)-- <http://www.vcstar.com/news/2010/jul/02/scientists-peer-at-sea-life-near-anacapa-island/>
- PI website with research activities and more information on deep sea coral communities off US west coast-- <http://swfsc.noaa.gov/HabitatEcology/>.

Y2-2.0.04:

- Cruise Report: Re-Discovering Cordell Bank: Dive Expedition 30 years later (<http://cordellbank.noaa.gov/science/characterization.html#30years>)
- National Marine Sanctuaries Expedition Outreach Website (documenting objectives and daily results of cruise) (<http://sanctuaries.noaa.gov/missions/2010reefcrest/welcome.html>)
- Outreach podcast (focusing on deep sea corals and highlighting images from dive expedition) (<http://cordellbank.noaa.gov/science/characterization.html#deepseacoral>) (http://cordellbank.noaa.gov/video/deepwater_corals.mov)
- News story on ABC KGO-TV San Francisco focused on the dive mission (http://abclocal.go.com/kgo/story?section=news%2Fassignment_7&id=7728043)
- Photos and posts on Facebook outreach site (posting of photos dramatically increased number of people that this site reached; number of 'friends' increased from ~50 to almost 300 (<https://www.facebook.com/pages/Cordell-Bank-National-Marine-Sanctuary/355147797782#!/pages/Cordell-Bank-National-Marine-Sanctuary/355147797782?sk=photos>).

Y2-2.0.06:

- Coverage by National Geographic of Caribbean deep reef studies-- <http://video.nationalgeographic.com/video/player/news/environment-news/us-ocean-floor-mapping-vin.html>

FIELD OPERATIONS SUPPORT:

The C4 team supported 200 dive days and an estimated 800 science dives during year 1-2 (Table 5).

Table 5. Operational information for Y1-2 projects supported by C4 team. Shaded rows are partnership projects.

Y R	MO.	Prj #	Partner PIs (not including CI leads)	Site	Vessel	Asset	Dive Days
1	Jul-09	Y1-2.0.01	J. DeBose, FGBNMS	GOM, Shelf Edge	Manta	Tech	5
1	Sep-09	Y1-2.0.02	S. Donahue, FKNMS; P. Whitfield, NCCOS-Beaufort	SEUS, FL Keys	Foster	Tech	3
1	Jan-10	Y1-5.3.1a	R. Appeldoorn, UPR	CAR, USVI, PR	Nekton	Tech	14
1	Mar-10	Y1-2.0.03	D. Conlin, National Park Service;	SEUS, FL Keys		Tech	5
1	Apr-10	Y1-2.0.04	T. Battista, NOS	CAR, USVI	Foster	ROV	16
1	May-10	Y1-4.5.1a	R. Green, TBNMS -NOAA	GL, Lake Huron	Storm	Tech	14
1	Jun-10	Y1-4.5.1b	J. Hoyt/ Monitor NMS	SEUS, Hatteras, NC	SRVx	Tech	12
1	May-10	Y1-5.3.1b	GP Schmahl, FGBNMS	GOM, Shelf Edge	Manta	ROV	5
1	May-10	Y1- 2.0.05	A. David, NMFS	SEUS, Shelf Edge	Foster	ROV	4
1	Jun-10	Y1-2.0.06	M. Yoklavich, NMFS	PAC, Channel Islands	MacArthur	ROV	5
2	Aug-10	Y2-5.3.1	T. Kellison, NCCOS-Beaufort	SEUS, Onslow Bay, NC	Foster	ROV	10
2	Sep-10	Y2-2.0.02	P. Whitfield, NCCOS-Beaufort	SEUS, NC-GA	Foster	Tech	10
2	Sep-10	Y2-2.0.03	B. Schwemmer, Monterey Bay NMS	PAC, Monterey Bay		Tech	5
2	Oct-10	Y2-2.0.04	D. Howard, CBNMS	PAC, Cordell Bank	Fulmar	Tech	6
2	Jan-11	Y2-2.0.05	J. Campo, Parsons Inc.; C. Watterson/USN	SEUS, Jacksonville, FL		ROV	4
2	Mar-11	Y2-2.0.06	T. Battista, NOS	CAR, USVI	Foster	ROV	18
2	Apr-11	Y2-2.0.07	R. Appeldoorn	CAR, PR, USVI	Spree	Tech	16
2	May-11	Y2-5.3.1	M. Hickerson, FGBNMS/NOS	GOM, Shelf Edge	Manta	ROV	5
2	Jun-11	Y2-4.5.1	R. Green – TBNMS	GL, Lake Huron	Storm	Tech	7
2	Jun-11	Y2-2.0.09	GP Schmahl,	GOM, Shelf	Manta	RO	20

			FGBNMS/BOEMRE	Edge		V	
2	Aug-11	Y2-4.5.1	J. Hoyt – Monitor NMS	SEUS, Hatteras, NC	SRVx	Tech	6
2	Jun-11	Y2-5.3.1	G. Piniak, NCCOS; E. Hickerson, FGBNMS	GOM, Shelf Edge	Manta	Tech	10
							200

MILESTONES:

In year 1, there was no C4 project and no milestones set, except for field missions reported on in CIOERT core project summaries. The Year 2 Project Summary for C4 listed the following milestones and schedule:

Progress on Y2 Activities (Table 6):

1. 2010-11 operations calendar posted and sustained (ID all missions and customers); pdf calendar posted to <ftp://bowline.uncw.edu> (CIOERT C4 folder) and updated with C4 monthly report
2. Cruise plans/reports for 2010-11 missions on file and integrated with Information Management System; IMS not deployed as of this progress report; Y2 Cruise Reports will be posted to <ftp://bowline.uncw.edu> (CIOERT C4 folder) by April 30
3. Develop CIOERT Marine Operations Action Plan, including clear definition of Dive Program Policies and Procedures; CIOERT C4 team dives under auspices of UNCW dive program using existing Scuba and Technical Diving Manuals
4. Support for CIOERT field operations (2010 Science Plan, task II/III projects); see Table 2.
5. Support for partnership field operations; see Table 2.

Table 6. 2010-11 activity milestones for C4 project. B = begin, X = continuing, C = complete.

Task	J	A	S	O	N	D	J	F	M	A	M	J
1						B	X	X	X	X	X	X
2		X							X			
3	C											
4	X	X	X	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X	X	X	X	X	X

PROJECT #: 2009-3.3.2.1

TITLE: *New Technology Development to Measure In Situ Metabolism and Bioenergetics in Corals*

PRINCIPAL INVESTIGATORS:

Alina Szmant, Robert Whitehead, Daniel Baden, (UNCW); Charles Mazel, PSI, Inc.

NOAA GOALS:

- CIOERT Research Themes: Technology Innovation, Vulnerable Coral Ecosystems
- NOAA Goals: Protect, restore, and manage the use of coastal and ocean ecosystem based management; Understand climate variability and change to enhance society's ability to plan and respond; Serve society's needs for weather and water information; Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation; Mission support.
- OER Strategic Outcomes: Development and utilization of advanced underwater technology, systematic research
 - Technology Outcomes: Identify, prioritize, develop, and apply physical, chemical, and biological oceanographic technologies to increase the pace, efficiency and scope of undersea discovery and understanding; stimulate and support creative development of new technologies and improvement of existing technologies; test and evaluate new technologies; transition new technologies to appropriate users within NOAA and the broader scientific community; provide leadership and coordination throughout NOAA for development and deployment of undersea technology.
 - Research Outcomes: Discover and understand ecosystems in the ocean and especially, the eastern U.S. Continental Shelf.

PROJECT OVERVIEW

Tools for non-destructively measuring coral metabolism and bioenergetics *in situ* are needed to promote rapid assessment and monitoring of metabolic health of corals and other key coral reef species, including their response to ocean acidification. A non-destructive sampling approach is especially desirable because cover of live coral is greatly reduced. We are in the process of developing such an *in situ* instrument for measuring metabolic rates (delta pH and oxygen; pCO₂ will be a desirable future enhancement) for corals and other marine organisms. The new instrument is being named CISME (Coral In Situ Metabolism and Energetics; pronounced KISME to reflect the expected gentle interactions between the instrument and the coral). The resulting technology may change how we assess coral reef ecosystem health, increase the accuracy and reliability of assessments, and greatly reduce costs over traditional visual surveys, field samples, and lab work. The technology may be adapted for use on deep coral and other shelf ecosystems.

Year 2 Technical Objectives

- Identify a pH sensor that can be incorporated into CISME.
- Refine the bench-top prototype sensor system used for laboratory experiments at UNCW, with the sensing elements submerged in seawater aquaria and the supporting electronics and controller on the laboratory bench.

- Design and build an underwater housing, power supply and associated self-contained electronic control and data handling to transition the bench-top instrument into a diver-operated instrument package.

PROGRESS REPORT

Project Status: In year 1, PSI (Dr. Charles Mazel and assistant Dr. Brian Murphy) in collaboration and consultation with UNCW CIOERT investigators (Whitehead, Szmant, Baden) began the process of developing such an instrument. We are collaborating to adapt and integrate probes and electronic components manufactured by the German biotech company, PreSens GmbH (<http://www.presens.de/>) and other off-the-shelf OEM components, plus new components and software being developed by PSI Inc and UNCW investigators into a laboratory bench-top demonstration system for testing with corals in aquaria. We purchased and have extensively tested the PreSens oxygen system at CMS, and found it have a equilibrate quickly and have high sensitivity. However, after much testing and discussions with PreSens, we abandoned trying to use the PreSens pH electrode in CISME because it does not stabilize in natural seawater solutions.

In early year 2, PSI built the first prototype of CISME as a bench-top instrument (see Figures 1, 2 at end of the report) which is capable of measuring oxygen flux by corals, but without the pH measurement system installed. The prototype has a built in light source that can be adjusted so that we can measure P-I curves in situ, as well as a pump to produce circulation within the experimental chamber and the tubing leading to the chemical sensors. The instrument base is submersible but at this time connects to an interface box containing the PreSens O₂ electronics and a laptop. The prototype was tested with live corals in early March, 2011, and minor technical problems were identified to be modified. We learned that we can get good measurements of respiration and photosynthesis rates over short timeframes of 10-15 minutes each (Figure 3).

We have resolved the pH problem by adopting a Honeywell ISFET pH electrode. We tested a unit at CMS and found this electrode to equilibrate within seconds, and to have sufficient sensitivity and stability for our needs. A second prototype of CISME is being built that will include the ISFET electrode. We are negotiating with Dr. Todd Martz at Scripps Institution of Oceanography and the commercial company SatAtlantic to purchase a small electronic control module they have developed for this electrode, since this would save time and money over PSI having to develop a comparable product.

In the remainder of Year 2, the first diving prototype of CISME will be built and tested in the Florida Keys in June 2011. This test will determine the reproducibility of the instrument as well as the variability in metabolic rates of a set of experimental corals, both in the field and in a field laboratory for comparison. We will also be able to compare *in situ* field metabolic rates with those measured after the corals are moved into a laboratory setting for experiments with oil and dispersants (Voss and Edge). This will serve as a basis for refining the design, and a path forward for demonstrating the data-collecting, research and monitoring value of the instrument in year 3.

Year 1 and 2 Milestones Accomplished:

1. Implement a GUI driver for the PreSens O₂ OEM board and sensor. Implement a temperature measurement capability that works in parallel with the O₂ sensor.

2. Implement a chamber and pump design that provides 10 – 20 cm/sec flow over the coral surface. (Figures 1 and 2).
3. Implement a means of inserting/removing a loop of tubing into the flow path. This loop could be used for multiple purposes, including: introducing a known quantity of dye to be used for post-measurement volume determination; drawing off a water sample for volume, alkalinity, or other measurement; and introducing additives such as photosynthesis inhibitors in order to perform controlled experiments.
4. Implement a means of making the measurement volume dark for respiration measurements and of illuminating the measurement volume for photosynthesis and calcification measurements, with variable illumination of approximately 250 – 400 $\mu\text{Einsteins (PAR)}/\text{m}^2/\text{sec}$.
5. Implement a means of attaching or otherwise positioning the sensor volume against an artificial test surface with topography and roughness comparable to a colony of *Montastraea annularis*. The combination of the chamber edge design and the mounting method provides a watertight seal on a living coral in the laboratory to isolate the measurement volume over the surface of a live coral. However, performance at this level while diving cannot be guaranteed.
6. Testing of a benchtop prototype at CMS with live corals (Figure 3, March 2011).

Milestones Remaining:

7. Delivery of submersible instrument equipped with both O₂ and pH sensors to UNCW (estimated date late May 2011).
8. Completion of UNCW and PSI qualification tests (estimated June 2011).

Outcomes:

None to date.

Outputs:

Poster presented at February 2011 ASLO Ocean Sciences Meeting, San Juan PR.

Whitehead, R. F.; Hagenson, N. L.; Oliver, J. A.; Szmant, A. M. **Calcification, photosynthetic, and respiration rates of the reef coral *Eusymilia fastigiata* in response to changes in seawater chemistry.**

Abstract: Ocean acidification (OA), by reducing aragonite saturation state, is expected to reduce coral calcification. However, most coral calcification occurs during daylight hours when photosynthesis elevates internal coral tissue pH and O₂ and presumably also saturation state. This effect, known as light stimulated calcification, has the potential to counteract the effects of external seawater chemistry. In our experiments with *Eusymilia fastigiata*, we manipulated seawater chemistries (pH, O₂, HCO₃ and CO₃ concentrations) during both dark and light incubations in order to discern whether pH or pO₂ is the driver for light enhanced calcification and to test the hypothesis that under high light levels and with intact symbiont populations, corals will demonstrate little response to seawater acidification. Calcification rates in the light were 50-100 % higher than in the dark. High pH but not high O₂ doubled dark calcification to values similar to those in the light. Further manipulations of pH with TRIS buffer

and of DIC show that *Eusmylia* calcification rates are consistently elevated at high pH even when DIC is low. Experiments with reduced pH are in progress.

FIGURES:

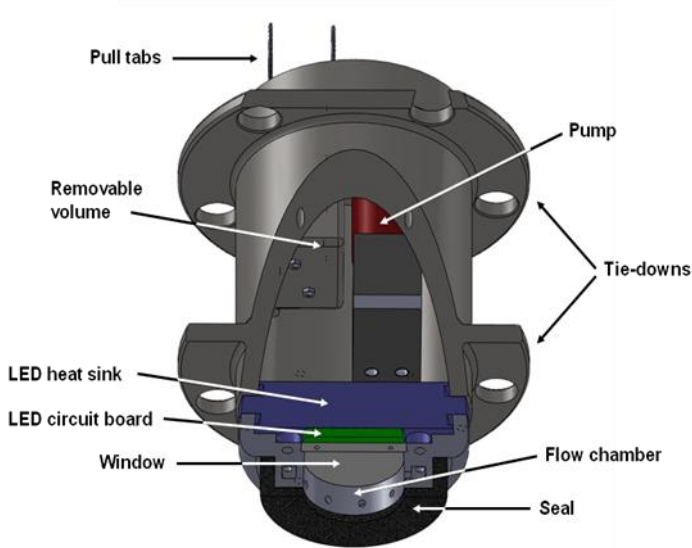
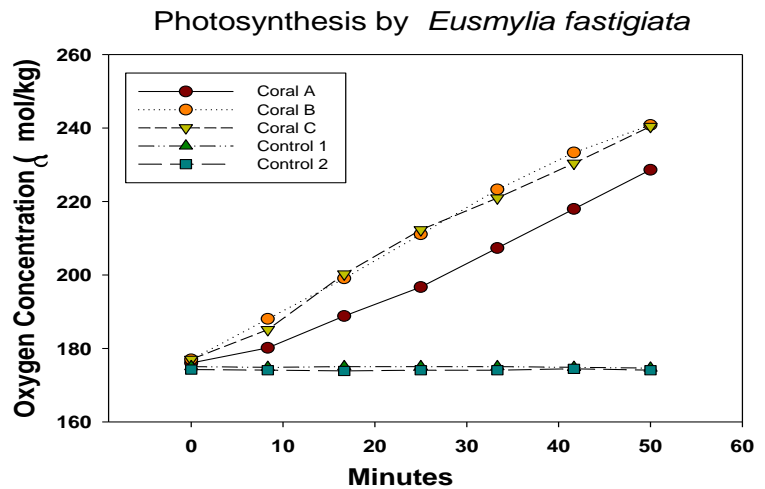


Figure 1. Cutaway Solidworks view of the CISME Ver. 1 instrument design. The LED board is mounted to a custom designed aluminum heat sink that is in communication with the surrounding water.



Figure 2. View into the flow chamber showing the six LEDs mounted on the custom circuit board

Figure 3. Laboratory test of CISME Ver. 1 with the coral *Eusmylia fastigiata* showing the photosynthesis response of the coral to light produced by the CISME light source.



PROJECT #: Y2-3.3.2.3
**TITLE: *Transition of Homeland Security Information Technology
for Assessing Ecosystem Change from Baselines***

PRINCIPAL INVESTIGATORS: Lori Adornato (SRI)

PROJECT DURATION: Year 1 of 1

BUDGET: Total request \$31,670 (an additional \$44,800 will be reprogrammed from Year 1 funds); see budget spreadsheet and narrative for details.

GOALS:

CIOERT Research Themes: Technology Innovation, Exploring Shelf Frontiers, Vulnerable Coral Ecosystems, Education/Outreach

NOAA Goals: Protect, restore, and manage the use of coastal and ocean ecosystem based management; Understand climate variability and change to enhance society's ability to plan and respond; Serve society's needs for weather and water information; Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation; Mission support.

OER Strategic Outcomes: Interdisciplinary exploration, Development and utilization of advanced underwater technology, Systematic research, Education and outreach

Technology Outcomes: Identify, prioritize, develop, and apply physical, chemical, and biological oceanographic technologies to increase the pace, efficiency and scope of undersea discovery and understanding; Stimulate and support creative development of new technologies and improvement of existing technologies; Test and evaluate new technologies; Transition new technologies to appropriate users within NOAA and the broader scientific community; Provide leadership and coordination throughout NOAA for development and deployment of undersea technology.

PROJECT OVERVIEW: As multi-platform land and sea-based mobile and fixed observing systems generate huge amounts and new types of data, the challenge of making sense and useful products out of the number and varying types of data increases. The envisioned project will provide a service oriented architecture (SOA) application to support ecosystem-based management with a specific focus on ocean acidification. Adoption of the SOA approach will ultimately allow for very cost-effective implementation of the information management platform for the broader environmental science community. As such, the work proposed will ultimately support all CIOERT projects by offering a unified approach to integrating, analyzing, and publishing data.

The proposed pilot project will demonstrate the feasibility of the SOA application for ecosystem-based management. In its final form, should funds become available for follow-on work, the data management platform will provide marine scientists, resource managers, and decision makers the ability to "establish dedicated mechanisms to translate research results into readily used products" as called for by the NSTC Joint Subcommittee on Ocean Science and Technology (Jan. 2007). It will also address the overarching NOAA need "to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources."

PROGRESS REPORT

No substantial progress has been made on this project due to lengthy contract negotiations between FAU and SRI (note: contract has been executed as of submission of this report). At least two meetings were held with CIOERT managers to target highest priority tasks once the contract is finally awarded. Collaboration will be enhanced through use of Web-based portal for communicating, progress tracking, and sharing documents.

New proposed timeline based on assumption that contract is in place by May 1, 2011 (X = original, R = revised):

Activity/Milestone	Y2 Q1	Y2 Q2	Y2 Q3	Y2 Q4	Y3 Q1	Y3 Q2	Y3 Q2	Y3 Q2
Requirements definition to determine specific data integrity services that will improve data collection process in situ			X		R			
Install and configure platform and client application.				X		R		
Implement data integrity service					X		R	
Visualize data integrity results to plan for next day sampling locations						X		R

PRODUCTS:

Outcomes: None

Outputs:

Technology developments: None

Publications (list): None

Presentations (list):

- Project overview presentation at CIOERT Annual Meeting, Feb. 2011

Other outputs (e.g., outreach products, models, curriculum/lesson plans): None

FIELD OPERATIONS: None.

PROJECT #: Y2-4.2.1

TITLE: *The Linkage between Pelagic and Benthic Ecosystems*

PRINCIPAL INVESTIGATORS:

Tamara Frank (HBOI/FAU), Andrew Remsen (University of South Florida), Sandra Brooke (Marine Conservation Biology Institute), Tracey Sutton (Virginia Institute of Marine Science)

RELATED NOAA GOALS:

- CIOERT Research Themes: Technology Innovation, Exploring Shelf Frontiers, Vulnerable Coral Ecosystems, Education/Outreach
- NOAA Goal: Protect, restore, and manage the use of coastal and ocean ecosystem based management
 - Objectives: Advance understanding and characterization of coastal, marine, and Great Lakes ecosystem health and associated socioeconomic benefits, and develop forecasting capabilities to meet management needs; provide tools, technologies, and information services that are effectively used by NOAA partners and customers to improve ecosystem-based management
- OER Strategic Outcomes: Interdisciplinary exploration, Development and utilization of advanced underwater technology, Systematic research, Education and outreach
 - Exploration Outcomes: Discover and characterize new resources in the ocean; map and characterize key features and habitats.
 - Technology Outcomes: Identify, prioritize, develop, and apply physical, chemical, and biological oceanographic technologies to increase the pace, efficiency and scope of undersea discovery and understanding; stimulate and support creative development of new technologies and improvement of existing technologies; test and evaluate new technologies; transition new technologies to appropriate users within NOAA and the broader scientific community; provide leadership and coordination throughout NOAA for development and deployment of undersea technology.
 - Research Outcomes: Discover and understand ecosystems in the ocean and especially, the eastern U.S. Continental Shelf; study and understand extreme and unique environments in the oceans.
 - Education/Outreach Outcomes: Enhance ocean science literacy as it relates to discovery and understanding of new resources and ecosystem processes, mapping and characterizing key features and habitats, and, identifying, developing and applying science tools to increase the pace, efficiency and scope of discovery and understanding of the ocean; use the Program's Web site to reach out to diverse audiences effectively and efficiently to communicate key ocean messages in ways that inform and educate individuals and organizations in general and targeted audiences; communicate with media representatives and others in ways that encourage and result in media coverage, and increase understanding of expedition, projects, and programs supported by OER and partners; foster external and internal partnerships to support ocean exploration and research objectives.

PROJECT OVERVIEW:

Integrated ecosystem approaches are required for assessment and management of marine resources. The aim of this project is to utilize a combination of new and traditional technologies to provide a rapid assessment of plankton biodiversity, and the chemical/physical parameters affecting their abundance and distribution. These data will be used to identify the linkages between pelagic and benthic ecosystems in areas where mesophotic and deep reef communities exist, as well as develop a comprehensive database of baseline information that can be used to assess the consequences of anthropogenic pressures.

PROGRESS REPORT

Year 1 Activities:

1. Collect live coral on Steve Ross's NOAA- funded cruise (Brooke)
2. Culture coral larvae (Brooke)
3. Prepare SIPPER for deployment on vessels of opportunity (Remsen)
4. Cruise preparation (Frank)
5. Pelagic and benthic sampling (Frank, Remsen, Sutton, Brooke and students)
6. Taxonomic analysis and quantification of zooplankton, ichthyoplankton, coral larvae – students will be trained in this by the PIs
7. Hold monthly calls to discuss progress
8. Work on Year 1 progress report

Year 2 Activities: : July 2010- Mar 2011

197 zooplankton samples were collected on the FloSEE cruise, between 27 July 2010 and 8-Aug 2010 from the following locations:

NW Florida Shelf, Madison Swanson (~29 11.2N, 85 42.2W), bottom depth 85 m

- 27 July 10 12:00 EST – 6 samples - 10 to 50 meters
- 28 July 10 12:20 EST – 5 samples - 10 to 70 m
- 28 July 10 22:10 EST - 7 samples - 0 to 70 m

NW Florida Shelf, Madison Swanson Site 5 (~29 07.6N, 85 47.1W), bottom depth 175 m

- 29 July 10 12:00 EST – 7 samples - 20 to 150 m
- 29 July 10 21:50 EST – 7 samples – 10 – 150 m

Florida Shelf, Twin Peaks Ridge (~28 57.6 N, 85 21.7'W), bottom depth 70 m

- 30 July 10 13:18 EST – 7 samples – 10-60 m
- 30 July 10 21:30 EST – 7 samples, 10-60 m

Florida Shelf, Snyder's Ridge (~28 20.0.5 N, 85 21.705 W), bottom depth 75 m

- 31 July 10 12:20 EST – 6 samples, 10-60 m
- 31 July 10 21:40 EST – 7 samples, 10-60 m

Florida Shelf, SW Florida Lithoherms (~28 20.97 N, 84 48.05 W), bottom depth 500 m

- 3 Aug 10 13:30 – 3 samples (20-290 m)

Florida Shelf, S Pulley Ridge (~24 42.7 N, 83 46.9 W), bottom depth 100 m

- 4 Aug 10 13:30- 6 samples, 20-80 m)

Florida Shelf, S Pulley Ridge (~24 41.8 N, 83 50.9 W), bottom depth 280 m

- 4 Aug 10 21:30 – 7 samples, 20 – 110 m

Outside Tortugas Reserve (~24 24.7 N, 83 15.2 W), bottom depth 215 m

- 5 Aug 10 13:00 – 5 samples, 40-200 m
 - 5 Aug 10 21:30 – 5 samples, 40-200 m
- Pourtales Terrace (~24 14.6 N, 81 50.8 W), bottom depth 330 m
- 6 Aug 10 13:00 – 6 samples, 10-120 m depth
 - 6 Aug 10 21:00 – 5 samples, 10-120 m
- Pourtales Terrace, Alligator Bioherm (24 36.6N 80 37.1W), bottom depth 200 m
- 7 Aug 10 13:30 7 samples, 10-150 m
- Miami Terrace, BU6 (25 53.4 N, 79 53.4W), bottom depth 300 m
- 8 July 10 14:30 7 samples, 50 – 250 m

22 benthic crustaceans were collected on FloSEE with the JSL to determine if this was the spawning season of the predominant species of benthic crabs at deep reefs:

26 July 10 – 28 12.273 N 84 43.022 W West Florida Shelf, Steamboat Lumps

- 5 tiny Chirostylids – look like juvenile Eumunida
- Decorator crab covered with sponge
- Brachyuran – not gravid – tiny, probably juvenile
- Scyllaridae – slipper lobster – small and probably juvenile
- One small decorator
- Small Gastroptychus
- Arrow crab – Majidae - striped – small but adult size
- Small brachyuran

3 Aug 10 - 26 20.161N 84 45.371W SW Florida Lithoherms

- Brachyuran *Bathynectes longispina*
- Anomuran *Eumunida picta*
 - Sent to Dr. Keith Crandall for Decapod Tree of Life Project

4 August 2010 24°42.30N, 83°45.13W South Pulley Ridge,

- 3 small brachyuran crabs
 - Sent to Dr. Keith Crandall for Decapod Tree of Life Project

6 August 10 24°15.063 N, 81°47.823 W Key West Sinkhole B – Pourtales Terrace

- Anomuran *Eumunida picta*
- Brachyuran *Bathynectes longispina*
 - Sent to Dr. Keith Crandall for Decapod Tree of Life Project

7 August 10 24°42.168 N, 80°30.856 W Alligator Bioherm – Pourtales Terrace,

- brachyuran crab
 - Sent to Dr. Keith Crandall for Decapod Tree of Life Project

8 Aug 10 26 05.74N 75 50.51W Miami Terrace, BU-4 Wreckfish Site

- Anomuran *Eumunida picta* – adult

8 Aug 10 26 00.86N 79 49.46W Miami Terrace, BU-6

- 2 Caridean shrimp - *Parapandalus richardi*

Coral samples collect by Sandra Brooke on cruises of opportunity to analyze for reproductive status

2010 – North Carolina – May/June

- 7 *Lophelia pertusa*

2010 – Florida - Gulf of Mexico – July

- 6 *Lophelia pertusa*
- 4 *Madaracis*

2010 – Florida – Gulf of Mexico – September

- 58 *Lophelia pertusa*
- 12 *Madrepora oculata*
- 2 *Enallopsammia profunda*
- 8 *Leiopathes*

2010 – Florida – Gulf of Mexico – October

- *Lophelia pertusa*

2010 – Florida – November

- 36 *Lophelia pertusa*
- 7 *Enallopsammia profunda*
- 4 *Keratoisis*
- 20 Zoanthids

Zooplankton samples

Some of these samples were analyzed by graduate students for their projects as part of the *Immersion in Ocean Science* course, but time constraints allowed analysis of only the dominant groups at each location, divided into Recognizable Parataxonomic Units (PUs), in which individuals are categorized based on appearance (Oliver and Beattie, 1993, 1996; Krell 2004). This methodology was developed to allow for some evaluation of biodiversity data in regions where high biodiversity and time constraints do not allow initial assessments to be to the species level of identification. With this methodology, as long as the categories are the same for each site, the PU classifications can be used as a first step in comparing the biodiversity and abundances at the different sites.

Samples were analyzed from the Madison Swanson sites in the north, and the Dry Tortugas Ecological Reserve, South Pulley Ridge and Key West sites in the south. In terms of invertebrate zooplankton, all of the sites were dominated by copepods. However, at the northern sites, the copepods were not as numerically dominant as at the southern sites, composing 71% of the total biomass in the north (Figure 1A) vs. 86% (Figure 1 B) in the south. This may have been a function of the higher percentage of chaetognaths (predatory worms that are known predators of copepods – Kehayias 1996) at the northern site. The overall diversity at the north sites was higher (data analyzed by Gabby Barbarite and Lorin

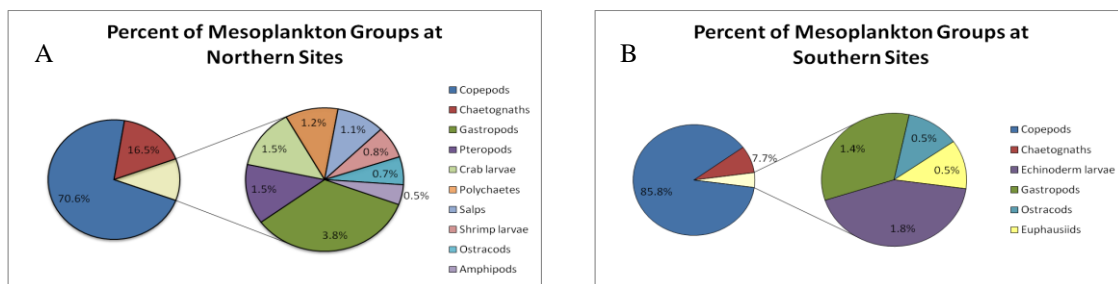


Figure 1: Percent abundance of parataxonomic groups at northern (A) and southern sites (B). Data compiled and graphed by Lorin West.

West), which may be a function of the lower impact by copepods, allowing for the utilization of limiting resources by other taxonomic groups. The overall density of total organisms at the northern

sites was also higher (2547 vs. 2077 individuals m^{-3} – Lorin West data comparing Madison Swanson sites vs. South Pulley Ridge, Tortugas Ecological Reserve and Key West sites; 3735 vs. 2438 individuals m^{-3} – Gabby Barbarite data comparing northernmost Madison Swanson site vs. Tortugas Ecological Reserve site). The northern sites had much lower surface salinities (20 PSU at 20 m at Madison Swanson sites vs. 30 PSU 20 m for all southern sites), as well as higher relatively CDOM fluorescence (uncalibrated values so relative observations only are possible – calibrated values will be provided by Dr. Michelle Wood and Regina Easley), suggesting greater freshwater runoff with higher nutrients, and higher nutrients may be a possible explanation for the abundance differences. These data are supported by CTD data indicating that that beam transmittance, an indication of water clarity, is $\sim 86\%$ in surface waters at Madison Swanson, and $\sim 92\%$ in surface waters at in surface waters at Tortugas.

Further indication of more turbid water at Madison Swanson comes from the analysis of day vs. night distributions of organisms at Madison Swanson vs. Tortugas Ecological Reserve by Gabby Barbarite (Fig. 2). The daytime depths for many of the organisms at Madison Swanson were

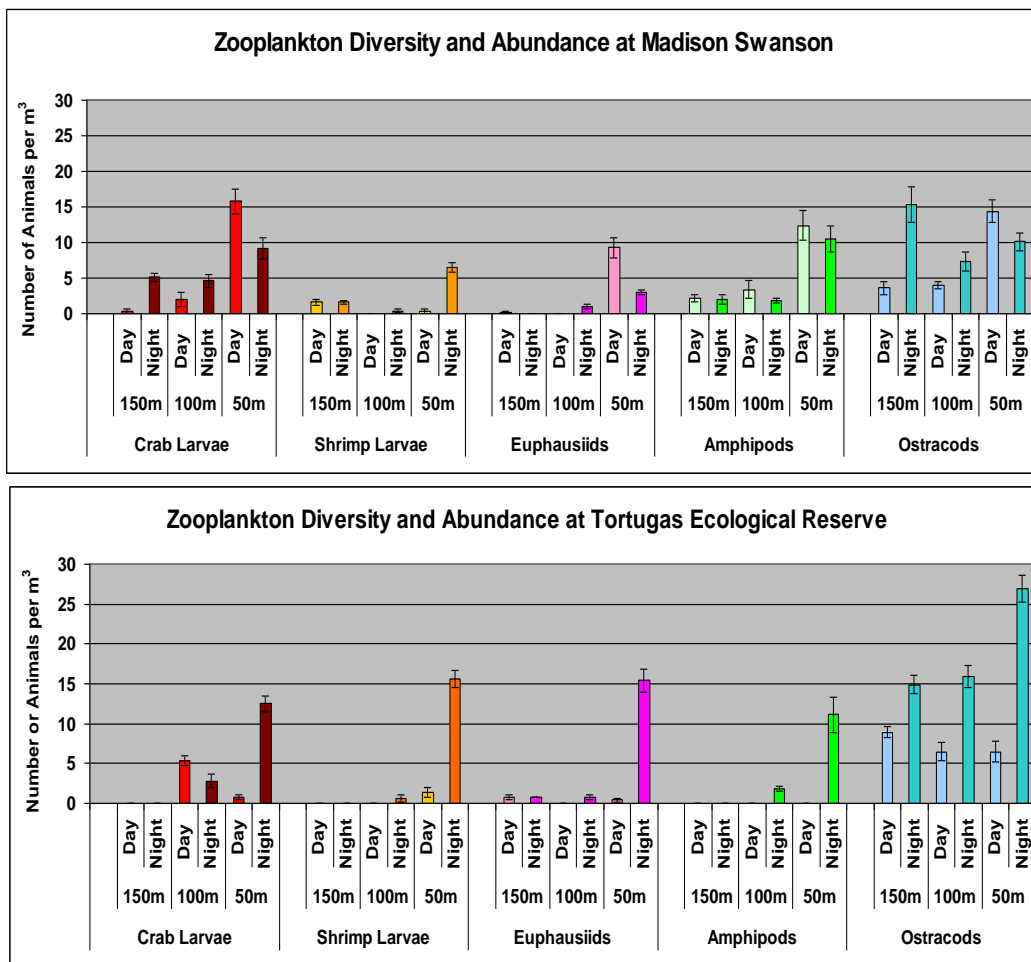


Figure 2. Day vs night abundance of crab larvae, shrimp larvae, euphausiids, amphipods and ostracods at Madison Swanson (top) and Tortugas Ecological Reserve (bottom). All of these groups, with the exception of shrimp larvae, have equal or higher abundances at 50 m during the day vs. at night at Madison Swanson. At Tortugas, the abundances are all substantially higher at night at 50 m than during the day. Data compiled by Gabby Barbarite.

shallower than for the same organisms at the Tortugas site. Specifically, more crab larvae, euphausiids, amphipods and ostracods are present at 50 m during the day than at night at Madison

Swanson, while at Tortugas, these groups were virtually non-existent in surface waters, and undertook a substantial vertical migration at night, along with copepods, shrimp larvae, gastropod larvae and chaetognaths at both locations. It is well known that animals that undertake diel vertical migrations do so to avoid visual predators by hiding in deeper darker waters during the day, and ascend into surface waters at night to feed under the cover of darkness (rev. Cohen and Forward 2009). In turbid waters, the threat of visual predators is diminished for smaller or more transparent organisms, enabling some of them to remain in more turbid waters during the day. Further analyses of the other samples should provide more data to support or refute this correlation.

Interestingly, the one group found in higher abundance at the southern site was the echinoderm larvae. They were virtually non-existent at the northern sites, but were found in abundances as high as 40 larvae m³ in shallow depths at the southern sites (Figure 3). This could be a function of the lower salinities at the northern sites, as echinoderm larvae survival decreases with decreasing salinity (Roller and Stickle, 1993).

Fish larvae

A separate analysis of fish larvae was conducted from samples collected at Madison Swanson in the north and Pulley Ridge in the south. Initial taxonomic analysis down to order and family level was done by Dr. Tracey Sutton (VIMS), an expert in fish taxonomy. Thus far, 25 families have been identified in the samples. In addition, families in the order Gadiformes, Ophidiiformes, Perciformes, Pleuronectiformes, Stomiiformes and Tetraodontiformes will be identified in the future. Of these 25 families, 13 were common to both sites, 9 unique families were present in Madison Swanson and 3 unique families were present in Pulley Ridge. Each region has distinctly different dominant larval groups. Larvae from the family Myctophidae (32.2% of identified larvae), Carangidae (8.1%), Synodontidae (7.6%) and Clupeidae (6.4%) made up over 50% of the identified larvae at Madison Swanson, while larvae from the order Tetraodontiformes (30.5%) and family Bregmacerotidae (23.2%) made up over 50% of the larvae at Pulley Ridge (Table 1). It will be interesting to compare how the dominant larvae from benthopelagic species correlate to the abundance of adults identified from the benthic transects.

Table 1. Total number of identified larval fish families or orders by site. Families in bold are found in both locations. Analysis by Tracey Sutton.

FAMILY	TOTAL NUMBER		REL ABUNDANCE	
	PR	MS	PR	MS
Antennariidae	1		0.001	
Balistidae	1	1	0.001	0.002
Blenniidae	32		0.040	
Bothidae	16	6	0.020	0.010
Bregmacerotidae	10	133	0.013	0.232
Carangidae	64		0.081	
Carapidae	1	5	0.001	0.009
Clupeidae	51		0.064	
Cottidae		1		0.002
Cynoglassidae	2		0.003	
Gadiformes		5		0.009
Gobidae	15	8	0.019	0.014

Monacanthidae	3	1	0.004	0.002
Myctophidae	256	39	0.322	0.068
Ogcocephalidae	5	9	0.006	0.016
Ophidiidae	4	2	0.005	0.003
Ophidiiformes	6	57	0.008	0.099
Paralichthyidae		30		0.052
Paralepididae	21		0.026	
Perciformes	33	16	0.042	0.028
Phosichthyidae	11		0.014	
Pleuronectiformes	59	28	0.074	0.049
Priacanthidae	6	1	0.008	0.002
Scombridae	37		0.047	
Scorpaenidae	19	5	0.024	0.009
Serranidae	16	6	0.020	0.010
Sphyraenidae	1		0.001	
Stomiiformes	38	25	0.048	0.044
Syngnathidae		2		0.003
Synodontidae	61	6	0.077	0.010
Tetraodontiformes	2	175	0.003	0.305
Leptocephali	23	13	0.029	0.023
Unidentified	60	8		

As seen in Figure 4, the trend in ichthyoplankton density mirrors that for zooplankton density – substantially more fish larvae at the northern site than at the southern site. This precludes the hypothesis that the higher density of zooplankton at the northern site is due to fewer

As seen in Figure 4, the trend in ichthyoplankton density mirrors that for zooplankton density – substantially more fish larvae at the northern site than at the southern site. This precludes the hypothesis that the higher density of zooplankton at the northern site is due to fewer

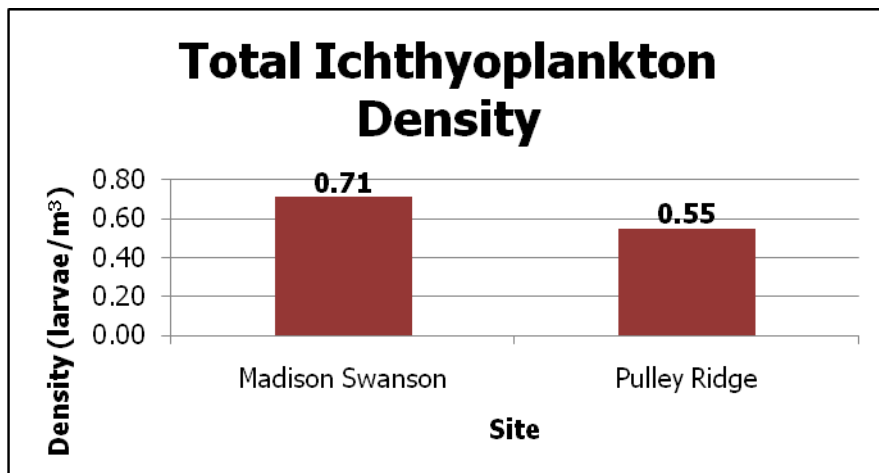


Figure 4. Abundance of ichthyoplankton at northern (Madison Swanson) and southern (Pulley Ridge) sites. Data compiled by Lindsay Harris and Chris Malinowski

ichthyoplankton predators. Rather, ichthyoplankton abundance may be higher in the north because there are more available prey in the north, which may be related to higher nutrient levels in the north

due to proximity to hydrodynamic features like the Mississippi River plume bringing in more nutrients. In addition, the Loop Current, which is in closer proximity to Pulley Ridge than Madison Swanson, may influence the dispersion of larval organisms by continuously flushing the area with lower nutrient seawater from the Caribbean. The Madison Swanson site showed a prominent halocline and low salinity surface waters (Figure 5A), as well as higher turbidity, characteristic of calm waters some distance away from the Loop Current, but fed by nutrient rich freshwater terrestrial runoff. The Pulley Ridge site had substantially higher surface salinity and no halocline.

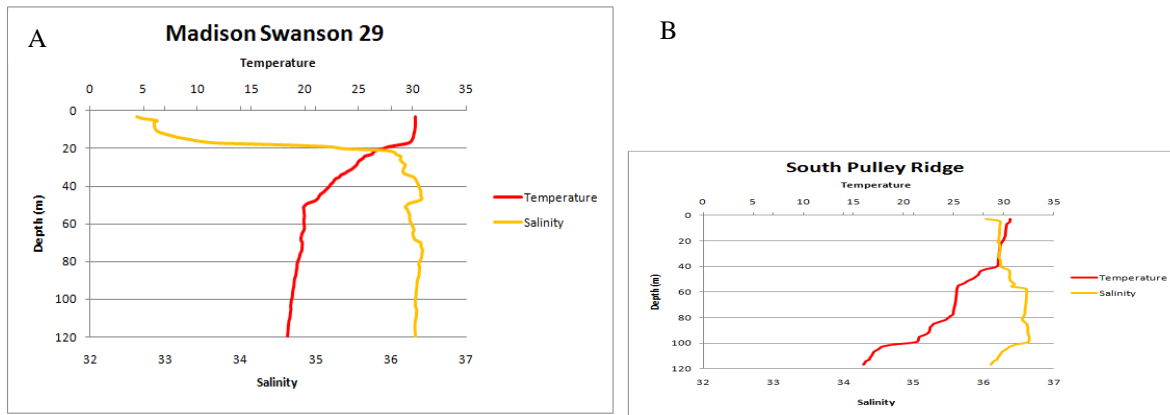


Figure 5. Temperature/salinity profiles vs. depth for Madison Swanson (A) and South Pulley Ridge (B).

Benthic crustacean samples

9 juveniles

- 7 anomurans (5 *E. picta*, 2 *G. spinifer*)
- 1 brachyuran
- 1 slipper lobster (Scyllaridae)

14 adults

- 5 anomurans - 3 *E. picta*, 2 *G. spinifer* – none gravid
- 4 brachyurans – 1 *Bathynectes longispina*, 3 unidentified brachyurans – none gravid
- 1 Scyllarid (slipper lobster) – not gravid
 - 1 Majidae – striped arrow crab – gravid
 - 2 *Parapandalus richardi* (shrimp) – one gravid

It appears that early August is not the spawning season; the presence of so many juveniles suggests that it may be in spring. Frank will be going through benthic crustacean samples collected during 3 years of Ocean Exploration cruises and Brooke will be going through museum samples to look for periodicity of gravid females

Deep-sea corals

Dr. Sandra Brooke, an expert in coral larvae, has processed all tissue, and will be cutting the blocks and analyzing sections for presence of oocytes/stage of maturity in *Keratoisis*, *Madrepora*, *Madaracis*, *Leiopathes*. Observations on *Lophelia* and *Enallopsammia* from 2009 indicated that mature oocytes were present in August, and spawning in these two species was observed Sept. and October *Lophelia* and *Enallopsammia*. Tissue for these two species was also collected in 2009, and will be sectioned to verify these observations.

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- Roller, R.A. and W.B. Stickle. 1993. Effects of temperature and salinity acclimation of adults on larval survival, physiology, and early development of *Lytechinus variegatus* (Echinodermata, Echinoidea). *Mar. Biol.* 116:583-591.

Presentations:

Delray Alliance, Delray Beach, Sept. 1, 2010

Oil Out of Sight – How Do We Monitor the Effects of an Oil Spill of a Deep-sea Oil Spill?

Ocean Science Lecture Series, HBOI, September 22, 2010

A Quick Look Beneath the Surface: The Florida Shelf Edge Exploration (FloSEE Expedition)

FAU Frontiers of Science Series, Boca Raton, January 7, 2011

The Gulf Oil Spill: FAU’s Science at Work

PROJECT #: Y2-2009-4.2.5

TITLE: *Connectivity between Deep and Shallow Ecosystems: Ecosystem-based Management of New Shelf Edge MPAs*

PRINCIPAL INVESTIGATORS:

David Eggleston, Roy He, Jeff Buckel (North Carolina State University)

NOAA Collaborators: A. David (NMFS); A. Hohn, C. Taylor, T. Kellison, Erik Williams (NMFS/NCCOS-Beaufort)

PROJECT DURATION: Year 1 of 5 (FY09-13).

BUDGET (next year): Total request \$10,000; see budget spreadsheet and justification for details.

GOALS:

- CIOERT Research Themes: Technology Innovation, Exploring Shelf Frontiers, Vulnerable Coral Ecosystems, Education/Outreach
- NOAA Strategic Plan Goals: Protect, restore, and manage the use of coastal and ocean ecosystem based management; Understand climate variability and change to enhance society's ability to plan and respond; Serve society's needs for weather and water information; Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation; Mission support.
 - Climate Objective: Describe and understand the state of the climate system through integrated observations, monitoring, and data management
 - Ecosystems Objectives: Improve ecosystem health through conservation and restoration of habitat; Provide tools, technologies, and information services that are effectively used by NOAA partners and customers to improve ecosystem-based management
 - Mission support: Ensure a strategic, integrated, and balanced observing system investment portfolio for NOAA through the use of quantitative analysis
- OER Strategic Outcomes: Interdisciplinary exploration, Development and utilization of advanced underwater technology, Systematic research, Education and outreach
 - Exploration Outcome: Map and characterize key features and habitats.
 - Technology Outcome: Identify, prioritize, develop, and apply physical, chemical, and biological oceanographic technologies to increase the pace, efficiency and scope of undersea discovery and understanding; Stimulate and support creative development of new technologies and improvement of existing technologies; Transition new technologies to appropriate users within NOAA and the broader scientific community.
 - Research Outcome: Discover and understand ecosystems in the ocean and especially, the eastern U.S. Continental Shelf.

PROJECT OVERVIEW:

This CIOERT project addresses NOAA's OER mission to explore and research living marine resources of the eastern U.S. continental shelf from 40-300m. The overall goal is to support Ecosystem-Based Management (EBM) by developing and applying conceptual and mathematical models to data collected during CIOERT and NOAA partner expeditions, to describe and predict impacts of EBM approaches. Our approach will use metapopulation and EBM conceptual

frameworks, and predictions from coupled bio-physical and ecosystem numerical models as guides for hypothesis testing. Sampling will use current and emerging undersea survey technologies that are integrated with habitat-mapping, both seafloor and pelagic sampling, and bio-physical modeling efforts that rely on data collected by the CIOERT mesophotic coral team, collected by our team as necessary, and collected by other NOAA field programs (e.g., NMFS/Beaufort, spawning aggregation cruises).

PROGRESS REPORT

Project Status: Funding was not received by the PI until February 2010. Nevertheless, we have met one-on-one or as small groups to discuss data needs and availability for Year 1 modeling efforts, and have begun to parameterize the models. For example, we have added Dr. David Kimmel (Asst. professor, East Carolina University) to our science team because of his expertise in working with zooplankton in the US South Atlantic. Dr. Kimmel will obtain the “small- and large- zooplankton” data required to parameterize our ecosystem model (see above). We plan our first workshop during March 2010 to refine hypotheses, modeling and data integration aspects of this project.

Outcomes: NA

Outputs: NA

Technology developments:

- Proposed-- ROMS, LTRANS and Metapopulation model development and parameterization.

Publications (list): None

Presentations (list): None

Other outputs/products (list, e.g., models, curriculum/lesson plans): None

Project Status: The overarching goals of this project are to (1) quantify population connectivity within and among deep water MPAs and habitat areas of concerns, as well as shallow water settlement and nursery habitats, and (2) Compare and contrast marine ecosystem organization and functions across habitats and space/time scales. During this reporting period, we accomplished the following tasks for “Population Connectivity”: (i) configured hydrodynamic and particle-tracking models and coupled these between U.S. South Atlantic Bight (SAB) and Gulf of Mexico (GoM), (ii) assessed proof-of-concept connectivity between deep water MPAs and shallow water settlement and nursery habitats using in the SAB using red snapper as the focal species, and (iii) identified data needs and gaps. If funded in years 3-5, we will expand our target species and systems to include black sea bass and deep-water corals. Regarding “Marine Ecosystem Organization,” we accomplished the following tasks: (i) configured a NEMURO ecosystem model and coupled it between SAB and GoM, (ii) assessed the ability of NEMURO to predict chlorophyll a concentrations in the SAB and GoM using satellite observations, and (iii) identified data needs and gaps. This modeling component of CIOERT is key to data integration and synthesis, and guiding field programs in an iterative, cost-effective manner.

Technology developments:

- Proposed-- ROMS, LTRANS and Metapopulation model development and parameterization.

Publications (list): None

Presentations (list):

- Project overview and preliminary results were presented by Eggleston at the CIOERT PI workshop in February 2011 at HBOI.

Other outputs/products (list, e.g., models, curriculum/lesson plans):

- Similar modeling project used for collaborative proposal to NSF to study connectivity of chemosynthetic communities in the North Atlantic.

PROJECT #: Y2-4.3.1

TITLE: *Discovery of Novel Therapeutic Agents from Marine Frontier Habitats*

PRINCIPAL INVESTIGATORS:

Amy Wright, FAU, and Daniel Baden, UNCW

Co-Investigators: UNCW: Andrea Bourdelais, Jennifer McCall, Carmelo Tomas, Wendy Strangman, Jeffrey Wright; HBOI: Esther Guzmán, Peter McCarthy

NOAA GOALS:

- CIOERT Research Theme: Exploring Shelf Frontiers
- NOAA Goal: Protect, restore, and manage the use of coastal and ocean ecosystem based management
- OER Strategic Outcomes: Interdisciplinary exploration, Systematic research, Education and outreach
 - Exploration Outcome: Discover and characterize new resources in the ocean.
 - Research Outcome: Discover and understand ecosystems in the ocean and especially, the eastern U.S. Continental Shelf; increase knowledge focused on new resources from the sea.
 - Outreach Outcome: through expedition and Web products, including the Program's Web site, to reach out to diverse audiences effectively and efficiently to communicate key ocean messages in ways that inform and educate individuals and organizations in general and targeted audiences; communicate with media representatives and others in ways that encourage and result in media coverage, and increase understanding of expedition, projects, and programs supported by OER and partners; foster external and internal partnerships to support ocean exploration and research objectives.

PROJECT OVERVIEW:

The goal of this project is to add socioeconomic value to the CI expeditions through the discovery of new therapeutic agents from pelagic, midwater and benthic habitats explored by the CI. A special emphasis will be placed on missions to lesser studied mesophotic and deep-water reefs and shelf frontiers. These frontier habitats represent a rich repository of unstudied biodiversity including marine actinomycetes, fungi, microalgae, sponges, ascidians and cnidarians. The results of studies on the bioactivity and chemistry of novel compounds isolated from these organisms will be applied in the long term to the development of compounds used to study, diagnose or treat human heritable diseases, cancer, infectious diseases, diseases of the immune system, cardiovascular disease, and central nervous system disorders. The project will also provide training opportunities for students in the fields of cell biology, molecular biology, microbiology and natural products chemistry.

The overall work plan encompasses participation of staff from the CIOERT Natural Products Drug Discovery Project Team (NPDDT) on CI expeditions (particularly in Year 1 with Project 5.3.1 Mesophotic Reef Ecosystems). During the expeditions the researchers will preserve invertebrate specimens and begin culturing microorganisms for later chemical and biomedical follow-up in the UNCW and HBOI laboratories. After the expedition, materials will be evaluated in a broad range of biological assays related to human disease. The active components will be purified and the structures defined through spectroscopic methods. Analogs and derivatives will be produced as necessary to optimize pharmacological properties. Patent applications will be filed to protect new discoveries and private sector or government partners sought for development. It is anticipated that the project will yield a total of 25-75 novel compounds over the 5-year period, representing a diverse range of chemical classes including peptides, polyketides, alkaloids, terpenes, and molecules of mixed biosynthesis. At least one of the compounds will be licensed for clinical development.

Tasks, Timelines and Milestones:

The overall work plan involves collection of materials, fermentation/culture of microorganisms; extraction; biological screening; chemical purification; structure elucidation; additional biological characterization to define mechanism of action of the materials. Details follow:

Aim 1. To participate in CI expeditions and collect specimens for biomedical research.

Aim 2: To culture marine bacteria, fungi, cyanobacteria and microalgae from macro-organisms, seawater and environmental samples.

Aim 3. To evaluate extracts, enriched fractions and pure compounds derived from the organisms (macro and micro) in a broad range of biological assays.

Aim 4: To purify and define the structures of the active compounds.

Aim 5: To protect the intellectual property and seek partners for development of the compounds as pharmaceutical agents.

Aim 6: To actively involve undergraduate, graduate and post-graduate students in all aspects of the research.

PROGRESS REPORT

Progress has been made on all Aims listed above. Details follow:

I. Project Status: Harbor Branch Oceanographic Institute (A. Wright, P. McCarthy, E. Guzmán)

A. Collections at HBOI: (Reed, Wright, Pomponi, Guzmán)

Samples were collected during two CI-related expeditions. The Florida Shelf Ocean Exploration Expedition (FLOSEE) and a NOAA expedition to deep-water coral reefs in the Gulf of Mexico and SE Atlantic Coast. During the FLOSEE expedition, 231 macro organism samples and 48 water samples were collected for the Drugs from Frontier Habitats Project. During the 2010 Deep coral expedition 9 samples were collected for the Drugs from Frontier Habitats Project.

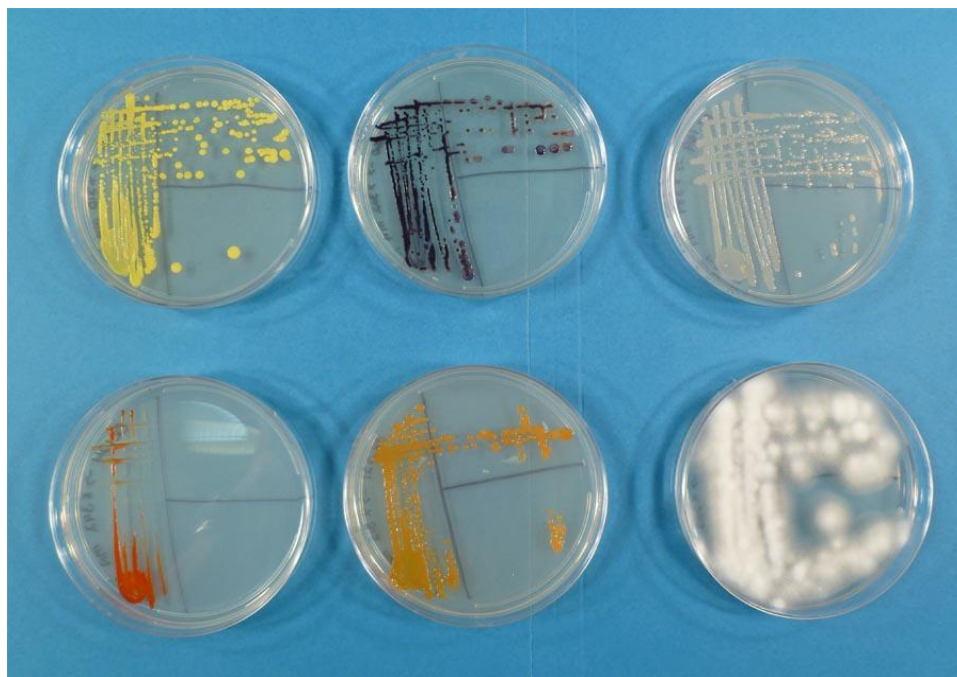
B. Microbiology and Fermentation of Microbes from Frontier habitats (McCarthy)

Isolation of novel microbes at HBOI-

Microbial isolations were initiated from a total of 43 sources collected during the FLOSEE expedition (Figure 4.3.1.A). Each of these was prepared as a suspension in sterile seawater, diluted to 10⁻³ and 10⁻⁵, and plated onto a series of media designed to allow cultivation of a range of heterotrophic microorganisms. The media used were Marine Agar 2216 and 60:40 (60% filtered seawater: 40% deionized water solidified with 1.5% (w/v) agar) each of which was supplemented with cycloheximide and either polymixin B or nalidixic acid. The final medium used was R2A, a medium commonly employed in environmental microbiology. In this case the R2A was prepared at 1/10th of the normal nutrient composition and with a seawater base.

All plates were incubated at 25°C until the growth of distinct colonies was observed (3-6 months). Distinct colony types were selected from each source and growth medium. Individual isolates were purified by quadrant inoculation of the original isolation medium to a single colony type. Individual colonies were then grown on either Marine Agar 2216 (bacteria) or YpSs (fungi and actinomycetes) and entered into the Harbor Branch Marine Microbial Culture Collection.

Figure 4.3.1.A Examples of five bacteria and a fungus isolated from source materials collected during the CIOERT expedition.



To date, the plates for 23 of the 43 source materials have been evaluated and microbes selected for isolation. This has resulted in 102 cultures being added to the Harbor Branch Marine Microbial Culture Collection (HBMMCC, Table 4.3.1-1)

Table 4.3.1-1: Microbial isolates added to the HBMMCC from source materials collected during the CIOERT expedition, July 2010.

Type	Number of Isolates
Fungi	4
Actinomycetes	5
Gram negative bacteria	79
Gram positive bacteria	14
TOTAL	102

All new isolates are fermented in a single medium and tested for their ability to produce antibiotic activities using a test panel of pathogenic microbes. Hit rates for this batch of isolates have been typical for the screens. Results are shown in Table 4.3.1-2.

Table 4.3.1-2: Antimicrobial activity of HBOI isolates derived from the FLOSEE expedition July 2010.

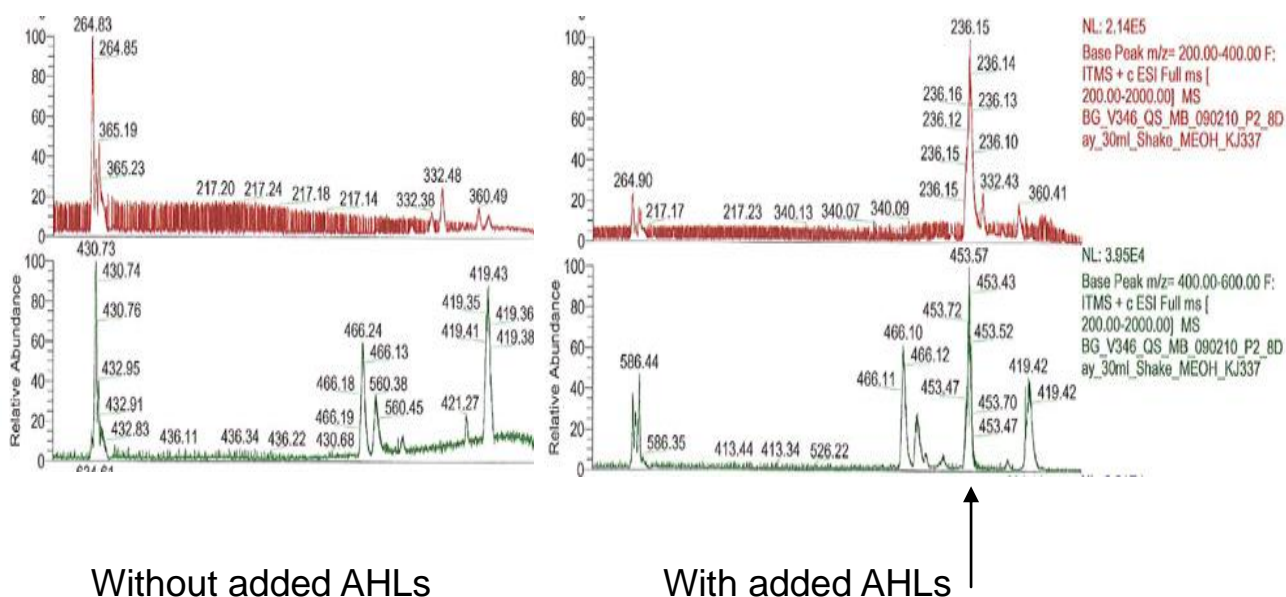
Isolate Number	Zone of Growth Inhibition (mm)			
	<i>Candida albicans</i>	<i>Pseudomonas aeruginosa</i>	<i>Staphyococcus aureus</i>	MRSA
X302	ND	7	13	12
X345	ND	10	15	17
X388	15	ND	ND	ND

Hit Rate 2% 2% 4% 3%

Fermentation for natural products studies- HBOI

The microbial studies for CIOERT in the current performance period have focused on microbes cultured from specimens collected in the deep water environments of coastal Florida. A total of 27 microorganisms have been fermented using varied growth conditions. This has resulted in the production of 175 extracts which have been evaluated using LC-MS. For this work we have focused on two groups of organisms: the fungi and Gram-negative bacteria. For the fungi, each isolate has been grown on liquid (SYZ, PDBS) media and a solid medium comprised of moistened rice. For the Gram-negative bacteria we have evaluated the effect of added quorum-sensing molecules (acyl homoserine lactones, AHLs) on the production of secondary metabolites. Two of the bacteria tested in the Quorum Sensing system showed differences in the metabolite spectrum revealed by LC-MS (Figure 4.3.1-B). Studies are continuing to learn more about the types of bacteria affected by these AHLs and the types of secondary metabolites which are induced. Fungal extracts have been selected for further study: chromatography and purification of the LC-MS peaks to generate additional materials for biological evaluation.

Figure 4.3.1-B. LC-MS traces of extracts from a microbe grown in the presence and absence of acylhomoesrine lactone (AHL) quorum sensing molecules. Presence of AHLs modifies the production of compounds in culture.



C. Natural Products Chemistry at HBOI

All samples collected on the FLOSEE expedition were extracted for HPLC analysis. Selected chemically rich species for which sufficient weight exists have been put into the HBOI Peak fractionation process and these enriched materials are being assayed in target directed assays.

Sponge *Aphrocallistes beatrix* (Wright, Guzmán)

One focus of the collections in Year 1 was on the sponge *Aphrocallistes beatrix* which occurs in the area where the first Deep-coral expedition took place. Our interest in *Aphrocallistes* stems from earlier work in which the HBOI research group had tested extracts from this sponge species in the sea urchin embryo assay with the goal of discovering novel antimetabolic agents. One specimen of *A. beatrix* collected on a previous expedition near the current expedition cruise track was found to have activity in the PANC-1 tumor cell line and inhibited sea urchin embryo cell division. The fraction contained two major compounds, one of which had been identified as a bromotyrosine derived metabolite called aphrocallistin that displays significant activity against cancer cells bearing mutations in the p53 tumor suppressor gene (JNP 2009). In earlier studies Aphrocallistin was not found to inhibit sea urchin embryo cell division. The second major compound was unstable and only a small amount of impure material from the original collection remained. As part of the CIOERT project, this impure material was subjected to fractionation and yielded five fractions. The fractions were assayed by flow cytometry to determine if they induce cell cycle arrest with the result that none of the fractions showed this activity. The structure of the second major compound in the sponge extracts was defined using 1 and 2D NMR methods coupled with high resolution mass spectroscopy. It is a novel 2-aminoimidazole-containing compound. The isolation of additional compound is currently being conducted to allow for publication of the structures as well as further biological testing.

Unfortunately insufficient material from the first collection of *Aphrocallistes* remained to pursue identification of the compound that induces cell cycle arrest. This was solved when during the first deep-coral expedition, 11 specimens of *Aphrocallistes* were collected. HPLC analysis of crude extracts from the specimens determined that 4 of the specimens contain aphrocallistin, the new aminoimidazole compounds and possibly the trace compound which we originally thought might be the compound which induces cell cycle arrest (“Compound 3”). Over the summer (2010), an undergraduate intern worked with the newly collected sponge material and determined that in fact aphrocallistin is the compound that induces cell cycle arrest. “Compound 3” was apparently a contaminant introduced by an earlier intern into the extract. The 2010 student also determined that the initiating event in blocking cell cycle progression is a very early event, as delayed addition of the compound to fertilized sea urchin embryos has no effect on cell division. This confirms our earlier work that aphrocallistin induces G1 cell cycle arrest rather than G2/M arrest. This work may help define the mode of action of aphrocallistin. Collaborators at the Sanford Burnham Medical Research Institute (SBMRI) in Orlando Florida synthesized a library of analogs of aphrocallistin with the goal of improving potency of the compounds. As part of this CIOERT project we tested the new compounds for activity in a drug-resistant breast cancer cell line. One compound displayed 5 fold greater activity than the parent compound and has sufficient to be a strong lead for further drug development. We continue to collaborate with the SBMRI researchers on testing of new analogs synthesized in their laboratory with the goals of defining structure activity relationships and obtaining a derivative useful in pulling down the molecular target.

Paraclochirus mysticus

This unusual deep-water holothurian was found to be active in two assays downstream of Ras signaling under other grants active in the PI and Co-Investigator’s laboratories. Activating mutations in Ras can lead to a number of aggressive cancers including pancreatic, melanoma and colon cancers. Three small specimens (approximately 2 cm x 1 cm < 75 g of biomass) had been collected on an

earlier State of Florida funded expedition to deep water benthic habitats off the Florida Keys and there was a substantial need to isolate additional compound for chemical and biological analysis. The FLOSEE mission was working near the site of collection (Alligator lithoherm) and PI Wright had the opportunity to dive in the JSL-II and collect more material. Testing confirms the original activity and we are actively pursuing the isolation of the active compounds under an NIH funded project. This demonstrates how CIOERT funds used for expeditions can be leveraged with other Agency funds to achieve the goals of discovering new bio products from the sea and adding socio-economic value to CIOERT expeditions.

D. Biological testing of Specimens Collected over the Performance Period –HBOI (Guzmán/McCarthy)

Extracts were prepared from each of the macro-organisms collected for project 4.3.1 during the 2010 FLOSEE and Deep Coral expeditions. These extracts have been tested against a panel of tumor cell lines and for their antimicrobial activity. Screening for inhibition of proliferation of the PANC-1 tumor cell line was completed and 14 extracts showed significant activity at concentrations of 5 µg/mL. Screening for inhibition of proliferation of the NCI-ADR-RES breast cancer cell line was completed and 10 extracts showed significant activity at concentrations of 5 µg/mL. All extracts were tested for their ability to inhibit the growth of *Staphylococcus aureus*, methicillin resistant *S. aureus* (MRSA), *Candida albicans* and *Pseudomonas aeruginosa*. Twenty-five extracts showed some level of antimicrobial activity against one or more of the microbes in this panel. Additional assays are on-going.

II. Project Status: University of North Carolina Wilmington, (D. Baden, J. Wright)

A. Microbiology at the UNCW Center for Marine Science (J. Wright)

A total of 31 sponges collected from specific marine frontier habitats were shipped under cold conditions to UNC Wilmington Center for Marine Science for the isolation and culture of bacteria associated with these sponges. We are specifically interested in examining the bacteria associated with these deep-water sponges belonging to the order Actinomycetales, since this group of microbes has a long and successful history of producing antibiotics, anticancer, and immunosuppressive agents.

A cubic centimeter of each of the 31 sponges was excised using a sterile razor blade and treated using protocols developed at CMS to isolate actinomycete bacteria. Each treated sample was plated in duplicate on 3 different types of low nutrient agar plates containing carbon and nitrogen sources mimicking those found in the marine environment. These plates were grown at 28°C for 8 weeks, after which potential actinomycete colonies were identified by their morphology and transferred to fresh agar plates. These colonies were continually transferred until pure clones were obtained at which point they were transferred to agar slants and stored at 2°C. A total of 77 actinomycete strains have been isolated from these frontier habitat sponge samples.

Small scale culture and processing of each of these organisms is underway in order to determine the metabolic profile of each strain. For this preliminary analysis, each isolate is cultured in 100 ml scale and harvested using resins thus providing a crude cell and media extract that is free of salts. This extract is then processed using methods developed at CMS to generate 40 fractions per organism that are collected in 96-well plates. This high throughput screening (HTS) format allows us to perform a variety of biological and chemical assays and rapidly identify lead compounds.

Fractions collected in 96-well plates are screened in-house for biological activity, using antibacterial and anticancer assays. Our previous biological screening methods involved disc-diffusion assay techniques, which are both costly and labor intensive when used in the scale this project requires (77 organisms yielding 40 fractions each means 3000 fractions to screen). We therefore designed and implemented protocols for 96-well plate antimicrobial screening, using a luciferase assay monitored by luminescence. We also have an in house assay for cytotoxicity screening using a myosarcoma cell line monitored by fluorescence.

In addition to our biological screens, these fractions are screened for chemical novelty using LC-DAD-ESIMS. This data, in conjunction with commercial databases, allows us not only to identify common metabolites and media components minimizing time spent pursuing false leads but also to identify potential new chemistry and develop a chemical fingerprint of any bioactive compounds captured in a well.

To date, these preliminary studies have been performed on 42 of the 77 isolated organisms, while the remaining 35 organisms are in line to be cultured and processed. In the meantime, screening of the plates that have already been generated has allowed us to identify several interesting leads which are being followed up in parallel to the remaining preliminary analyses.

Full data analysis has been completed for the antimicrobial and chemical screening of 4 organisms to date. The data sets for the remaining processed organisms as well as cytotoxicity screening data are still being analyzed in order to identify hits. Of the 4 organisms with completed antimicrobial and chemical screening data, strain CMS K3-1 obtained from one sponge contains two separate leads and the details are described below which nicely illustrate the process utilized at CMS. All 40 fractions from CMS K3-1 collected in a 96-well plate were screened in our chemical and biological assays. Fractions 7 and 8 displayed potential chemical novelty (molecular weight range of 550-600Da and an isotopic ratio indicating the presence of halogens), while fractions 14-16 displayed antimicrobial activity. The compounds of interest identified in the chemical screening are two related metabolites and a search of commercial databases (AntiBase, MarinLit, SciFinder) using the molecular weights, UV absorbance, and presence of halogens indicate these compounds represent novel chemistry and thus warrant further investigation. The LC-DAD-ESIMS data of the fractions displaying antimicrobial activity have been dereplicated using commercial databases and do not correspond to any known antimicrobial secondary metabolites. Based on these results CMS K3-1 was cultured in larger scale (2.4 L) and processed using scaled-up methods similar to the preliminary analytical methods. The presence of both the chemical and biological leads produced by this strain has been confirmed in the large scale material by LCMS and antimicrobial testing. Assay guided fractionation is underway to determine the structures of these lead compounds. The crude material from large scale culture of CMS K3-1 was first fractionated using a C18 SepPak eluted with a step gradient of methanol-water. Antimicrobial screening of these fractions revealed activity in the 60% aqueous methanol fraction which has been further fractionated using size exclusion chromatography. The resulting fractions were also subjected to antimicrobial screening and activity was retained in a sub-set of fractions which have been combined in preparation for HPLC. The lead compounds identified by LC-DAD-ESIMS chemical screening were identified in the 40% aqueous methanol SepPak fraction, which was subsequently fractionated, again using size exclusion chromatography. This material has been purified by HPLC and is ready for NMR analysis and full structure determination.

Finally, a further development is the recent funding received by CMS for a Roche 454 Jr. DNA sequencer. This instrument is ideal for *de novo* DNA sequencing experiments, and we plan to sequence the complete genome of several of the interesting bacteria we have isolated from frontier

habitat sponges. The small genomes of these bacteria lend themselves to this approach and the genetic information obtained will add considerably to our knowledge of the chemical biodiversity of these bacteria and greatly facilitate the discovery of cryptic or orphan genes encoding new bioactive molecules.

B. Chemical and Biological Testing at UNCW Center for Marine Science (D. Baden)

The team has set out to utilize individual species to isolate new and novel potential bioactive molecules. Over the first two years, we sought to understand the breadth of molecules produced by *Karenia brevis*, isolated from the Gulf of Mexico, as well as from waters off Delaware and the eastern seaboard.

The concept is that, at least for this species, a number of bioactive polyketides are known, and many have been identified already as brevetoxins, and other shorter and smaller polyketides known as brevesin, brevisamide, and brevenal. Even within this cadre of molecules, there are ion channel activators, ion channel inhibitors, and molecular modulators of membrane function. The question are, “How many different types of bioactive molecules does this single species produce?”, and “Can we isolate and characterize physiological function to permit future development as potential pharmaceutical leads?”

The first step is in isolating new compounds and characterizing by NMR and LC MS. In the figure below, we illustrate three classes of materials identified this period not previously identified from *Karenia*. In all cases, Chromatrons, Combiflash and RP-LC have been utilized to achieve purity. With scale up from these cultured organisms, it will be of utility to have technologies that are readily scaled-up, which each of these is amenable to. Figure 1 illustrates the 3 classes identified, sterols, phytoindenes, and polyketide non-toxins.

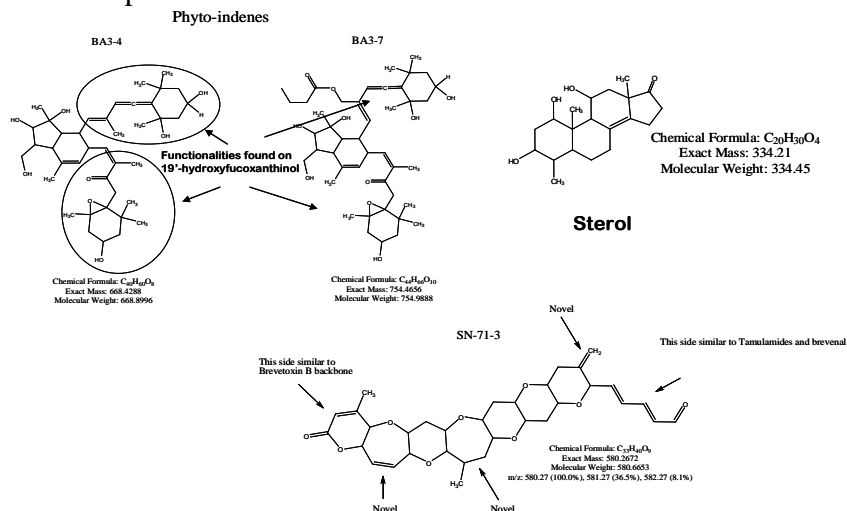
Post-isolation, we sought to complete development of the Annexin V apoptosis assay, to reveal specific cell deaths events induced for these and future compounds. The Annexin assay is of specific interest as a special type of cytotoxicity assay that will accurately portray isolated chemicals as either “necrotic” or “apoptotic”, the latter being of specific utility in the identification of potential chemotherapeutic agents. Chemicals that test positive for necrosis, but not for apoptosis, are likely non-specific cytotoxic agents that will possess significant toxic side-effects in animal or human trials. It is our goal this year to completely sort out the utility of this assay for routine use and to begin employment of other bioassays in our arsenal to come to some understanding of the MoA (mechanism of action).

New collections of epibenthic organisms from the waters of Curacao have led to the cloning of numerous *Gambierdiscus* clones, multiple species of *Protocentrum*, numerous *Ostreopsis*, and several *Amphidinium* species.

Over the next 12 months, these will be cultured to 1 liter flask size for biological testing along with the 5 co-existing *Karenia* species that occur along with *K. brevis* during Florida red tides.

Brevenal has completed the pre-chorus phase with Big Pharma and is entering the funding phase prior to licensing. Clinical testing is anticipated to begin in 2012. Brevisin as a drug carrier is being evaluated with several cancer chemotherapeutic agents as well as with materials supplied by HBOI from their active agents collection. Especially we are interested in testing discodermolide.

Figure 1. New Natural Compounds from *Karenia brevis*



C. Communication between HBOI and UNCW researchers

The PIs and Co-Investigators have held quarterly conference calls to discuss the project. The PIs met during the Strategic Planning Session to discuss results. E-mail has also been important in facilitating communication between the groups.

OUTCOMES:

Expected outcomes, including discovery of new drugs, take many years to develop from initial sampling to FDA testing. Organisms worked on over the course of the project are yielding new discoveries many of which have associated intellectual property which we will seek to protect with appropriate patent coverage through our Universities. Investigators on the project have participated in outreach to the public regarding the chemical and biological diversity of marine organisms and marine drug discovery through one public lecture held at HBOI; through teaching students at the Marine and Oceanographic Academy of St. Lucie County, a science based public High School located at the FAU campus; through providing tours of the laboratories for 85 visitors to the HBOI Marine Biomedical laboratories and through the public media (newspapers, TV).

OUTPUTS:

Technology developments: The project has discovered novel chemical compounds with biological activities. At this time it is premature to make decisions regarding their future development as therapeutic agents or as biological probes. Additional testing is required to better define their utility. This testing will continue over the remainder of the performance period.

Publications: None in press at this time; one publication in preparation.

Presentations:

- “Project 4.3.1 Discovery of Novel Therapeutic Agents from Marine Frontier Habitats” Cooperative Institute for Ocean Exploration and Technology Strategic Planning Meeting. Amy E. Wright, Daniel Baden, Harbor Branch Oceanographic Inst., Fort Pierce, FL. February 7, 2011.
- “A Quick Look Beneath the Surface: The Florida Shelf Edge Exploration (FLoSEE) Expedition” Tammy Frank, Dennis Hanisak, John Reed & Amy Wright, HBOI Ocean Science Lecture Series, Wednesday, September 22, 2010.

Public Outreach:

- Interview and article in the Orlando Sentinel on Drug Discovery from Deep Florida Reefs off South Florida
- Interview for WESH Channel 2 Orlando on “Drugs from the Sea”
 - <http://www.wesh.com/health/26734039/detail.html?taf=orl>
- Public Broadcasting Segment filmed that highlights Marine Drug Discovery and Ocean Exploration. It is in the final editing phase and is expected to air later in 2011.

Other outputs/products (list, e.g., models, curriculum/lesson plans): None at this time

PROJECT #: Y2-4.5.1

TITLE: *Submerged Cultural Resources in NOAA's Sanctuaries*

PRINCIPAL INVESTIGATORS:

Andy Shepard (UNCW); NOAA Collaborators: Russ Green (Thunder Bay NMS); Dave Alberg and Joe Hoyt (Monitor NMS); John Kloske (SRI International); Anni Dalglish (HBOI/FAU)

PROJECT DURATION: Year 2 of 2

BUDGET: Total request = **\$15,008**, NOT including tech diving team support (subsidized day rate) included in C4 project; budget narrative and tables.

GOALS:

- CIOERT Research Themes: Technology Innovation, Exploring Shelf Frontiers, Vulnerable Coral Ecosystems, Education/Outreach
- NOAA Goals: Protect, restore, and manage the use of coastal and ocean ecosystem based management; Understand climate variability and change to enhance society's ability to plan and respond; Serve society's needs for weather and water information; Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation; Mission support.
- OER Strategic Outcomes (from 1/25/10 Guidance Memo, Att. A): Interdisciplinary exploration, Development and utilization of advanced underwater technology, Systematic research, Education and outreach
 - Exploration Outcomes: Explore, locate and identify submerged cultural resources in the oceans.
 - Technology Outcomes: Make platforms available to academia, non-government organizations, industry, and government agencies as a means to inspire new technology development and innovation. Identify NOAA and broader scientific community users that can benefit from new technology development. Engage NOAA users to provide input on how the technology is developed, what sensors are incorporated, and what is required to operate the technology.

PROJECT OVERVIEW:

CIOERT will partner with National Marine Sanctuaries (ONMS) off the U.S. east coast from the Great Lakes to Gulf of Mexico to explore and characterize submerged cultural resources (SCR) in and close to the Sanctuaries. OER is the only NOAA program with the specific mission of exploring and documenting SCR. OER collaborates with the NMS through its NOAA Maritime Heritage Program, which mandates the Sanctuaries to manage SCR and requires CIOERT assistance in accessing deep (>40 m) resources. Year 1 and 2 activities target areas for high resolution mapping, ground-truthing, and archaeological surveys of known and newly discovered cultural resources within the Graveyard of the Atlantic off Cape Hatteras in partnership with Monitor NMS, and in Thunder Bay NMS; both Sanctuaries are now reviewing plans to expand their areas of responsibility, including more deepwater SCR. We will partner with SRI International to deploy an AUV with high resolution mapping sonar to map new deep wrecks located during previous shipboard multibeam surveys. One of these wrecks, the *Empire Gem* off Cape Hatteras, is known to be leaking its gasoline cargo. Technical divers will characterize sites, including deployment of new sensors for detection and mapping of detect trace chemicals (hydrocarbons).

PROGRESS REPORT

Progress: Funding for project was received in Dec 2009. Initial planning call was immediately held with Sanctuary staff from Monitor NMS and Thunder Bay NMS. In order to accommodate weather and planning time, cruises were planned for May-Jun 2010. Cruise plans were submitted and approved by UNCW's Dive Safety Board in April 2010; both plans are on file at CIOERT.

Schedules for the two legs:

- 1) Lake Huron: All operations will be conducted on Lake Huron on a daily basis. Mission dates are as follows:
 - May 6th – mobilize gear in Alpena, Michigan
 - May 7th-20th dive ops
 - May 21th – demobilize gear in Alpena, Michigan

- 2) Cape Hatteras: All operations will be conducted in the Atlantic Ocean off the coast of North Carolina in the vicinity of Ocracoke Inlet. The team may conduct no more than 4 consecutive days at sea. Mission dates are as follows:
 - June 8th – mobilize gear in Ocracoke, North Carolina
 - June 9th – 20th Technical dive ops.
 - June 21st – 30th Continued dive-ops within recreational limits.
 - July 1st – demobilize gear in Ocracoke, North Carolina

Deviations: Both cruises will be conducted prior to the end of this award period (ends June 30, 2010). Dive targets changed from the original proposal at the request of Sanctuary managers.

Outcomes:

- New information will contribute to TBNMS support for a bill to expand the sanctuary to 4,085 square miles is now before the U.S. Congress. Expansion will dramatically increase the sanctuary's resource management obligations.

Outputs:

Data:

- hard point archeological data and video and still imagery to create photo mosaics, site plans and a detailed assessments.

Technology developments:

- C4 tech dive team continues to work with Sanctuary managers and divers to evaluate development and application of new closed-circuit rebreathers for archaeological science.

Publications (list):

- Cruise Plans for each cruise.

Other outputs/products (list, e.g., models, curriculum/lesson plans):

- Cruise results will be featured on the Sanctuaries' Web sites

Field Operations:

Support Vessel	Undersea Asset	# Dive Days	# Dives	Max Depth (m)
Leg 1- R/V <i>Storm</i>	Trimix scuba	14*	TBD	75
Leg 2- R/V <i>SRVx</i>	Trimix scuba	12*	TBD	85
Leg 2- R/V <i>SRVx</i>	Nitrox scuba	10	TBD	40

* - planned dive days

PROJECT STATUS:

Thunder Bay:

All 2010 operations were conducted on Lake Huron on a daily basis:

- May 6th – mobilize gear in Alpena, Michigan
- May 7th-20th dive ops
- May 21th – demobilize gear in Alpena, Michigan

The dive team including Russ Green (TBNMS), Tane Casserley and Joe Hoyt (Monitor NMS), Wayne Lusardi, Pat Labadie, Doug Kesling (CIOERT), Scott Fowler (CIOERT), Mike Abbott (NOAA, Woods Hole), and Joe Mangiafico (University of Connecticut), successfully assessed the wrecks of the schooner *Defiance* (1848-1854; 185 foot depth), brig *Audubon* (1854-1854; 170 foot depth), steamer *Messenger* (1866-1890; 190 foot depth), and steamer *Norman* (1890-1895; 210 foot depth). All are in the potential expanded sanctuary boundaries and possess a significant degree of archeological, historical and/or recreational significance. Each site has inherent elements of interest: *Defiance* is an early schooner for this region; *Audubon* is a brig and collided with *Defiance* under somewhat mysterious circumstances; the *Messenger* is a new target found in 2008 during a side scan sonar cruise; the 300-foot long steamer *Norman* is a sistership to the *Grecian* (within the sanctuary) and the *Northern Light* (down in the FL Keys). A bulk freighter, the *Norman* represents a type of vessel that made possible the explosive industrial growth of the United States just before the turn of the twentieth century. Her east-bound cargoes of iron ore made possible the fortune of J.P. Morgan, and made his U.S. Steel Corp. America's first billion dollar company. Given its early date of build, we focused a bit more on schooner *Defiance*, created profile and plan view site maps and mosaics, and took comprehensive video and stills. We also confirmed the identify of the *Messenger* and produced a mosaic. With less time to spend at the other sites, we produced mosaics, stills, and video of the *Audubon* and *Norman*. In short, we attempted to assess these sites through a common "resource management" lens.

Prior to this expedition, Sanctuary managers had limited or fragmented data on each of the sites. Given their remarkable states of preservation, popularity among the tech diving community, historical and archeological significance, and the potential for sanctuary expansion, the timing was excellent to start getting a handle on these amazing and complex resources that NOAA may soon be responsible for managing. The results, methodologies, recommendations will be covered in a full technical report due by July 2011.

Cape Hatteras:

The cruise report for the June 2010 *Battle of the Atlantic* technical diving mission off Cape Hatteras is on file at CIOERT. Logs and images from the expedition can be seen at

<http://sanctuaries.noaa.gov/missions/2010battleoftheatlantic/welcome.html>. Dive operations were conducted in the Atlantic Ocean off the coast of North Carolina in the vicinity of Ocracoke Inlet.

Mission dates are as follows:

- June 8 – mobilize gear in Ocracoke, North Carolina
- June 9th – 20th Technical dive ops.
- June 21st – 30th Continued dive-ops within recreational limits.
- June 30 – demobilize gear in Ocracoke, North Carolina

During the course of the 21 scheduled days for the project, the team was completely operational for 15 days at sea. The remaining 6 days were consumed with mobilization/demobilization (3 days) and weather (3 days). Given the unpredictable nature of the environment (inclement weather, sea-state, wind), this figure is considered excellent. This amount of time allowed researchers to conduct a total of 139 dives (87 of which were technical mixed gas dives), and investigate in detail 8 different wreck sites. In addition to the 8 sites that were actually visited, several additional sites were positively located and had their positions and depth profiles recorded. Most of these sites were recorded with a combination of high-definition video and still photography, as well as site sketches from diver observations. The intention on each site was to develop a catalog of imagery that could later be used to make management assessments or aid in the development of more in-depth study. Highlights of sites investigated by divers include:

- ***City of Atlanta-- merchant vessel sunk by U-123:*** First site investigated on this expedition due to its northerly position. The site rests in approximately 80fsw due east of Buxton, NC. The site has been wire dragged as a navigation hazard and consists predominantly of a large debris field. The engine and boilers are extant amidships with the prop shaft running aft to the propellers. A large circular structure is the most characteristic feature at the stern. The location of this site and the cooler water temperatures results in infrequent visitation by the local diving community. It is believed that this site would benefit from greater archaeological inquiry and more holistic background research. Due to the depth and complex nature of the site, the site would most economically be modeled acoustically or photographically.
- ***Ciltvaira-- merchant vessel sunk by U-123:*** site was located during the project but due to time constraints was not visited. However, position information and depth profiles were recorded. If future research efforts are directed at this site it is recommended that they are done in concert with *City of Atlanta* due to their proximity.
- ***Dixie Arrow-- merchant vessel sunk by U-71:*** This large tanker laden with 86,136 barrels of crude oil is very representative of the typical merchant loss off the Carolinas, as well as a heavily visited dive site. Wreck site in approximately 90fsw Southeast of Ocracoke, NC, was most intensively documented of the shallow sites save *Keshena*. Extensive mud mapping, photo and video documentation, and feature specific-detailed mapping was completed. Due to the size of the site and time allotted, a full scale site plan was not a practical approach. Uncharacteristically poor visibility prevented the acquisition of a photomosaic, which otherwise is believed to be a valuable data product for this site. It is recommended that this site receive further documentation as it is a good candidate for NRHP nominations as a representative site.
- ***Empire Gem – merchant vessel sunk by U-66:*** Wreck site rests in 160fsw off Cape Hatteras. The dive team visited this site; however, combination of strong currents and near zero visibility prevented archaeological data acquisition. The vessel itself has large sections still intact. It rests almost completely upside down. It is recommended that this site receive a full scale archaeological assessment in the future. It is known to still contain large pockets of trapped bunker fuel, which have reportedly been leaking over the years since its loss. A detailed archaeological survey is

needed to assess corrosion potential and site integrity in order to ascertain any possible environmental impact that may exist on site. In the event mitigation efforts are attempted, the requisite Section 106 survey would be complete.

- ***E.M. Clark*—merchant tanker sunk by U-124:** 9,647 gross-ton tanker carrying 118,000 barrels of heating oil destined for New York. *E.M. Clark* was the main focus of the technical diving portion of the research cruise, selected due to the fact that the site is completely intact from stem to stern. This level of preservation is adequate for the NRHP due both to its integrity and its representativeness of the BOA engagement. The wreck rests on its port side in 260fsw. Due to low visibility and high currents, coupled with the extreme depth and limited bottom time, dives were not able to complete a traditional survey or acquire a photomosaic. Site documentation focused on diver observations and notes, and extensive photo and video documentation. Due to the level of integrity and the complexity of the site, this is a good candidate for further investigation. In particular, a detailed 3D acoustic survey should be conducted and further attempts made at acquiring a complete photomosaic.
- ***Keshena* – tug sunk by mine in attempt to recover torpedoed cargo vessel:** *Keshena* was documented with this highest level of detail on this survey for several reasons. As a military vessel the *Keshena* is protected under the Sunken Military Craft Act, and detailed baseline data needed to be collected on site. Equally important is the significant historical role that *Keshena* played in the Battle of Convoy KS-520. KS-520 has been chosen as a particularly representative engagement and will be the focus of future study. In particular, the KOCOIA rubric of battlefield archaeology interpretation; and as such the *Keshena* must be documented as an avenue of retreat in that framework. Furthermore, the accessibility and size of this site made it an ideal choice to further develop open ocean intermediate water depth archaeological survey methods. This also means, the site is frequented by the diving community and it is known that in the past artifacts and material has been recovered from the site. Detailed site plans and photomosaics were recorded during the survey of this site.
- ***Manuela* – cargo ship sunk by unidentified U-boat:** Wreck site rests in 160fsw southeast of Ocracoke, NC. The wreck has some intact sections with high relief, but the majority is disarticulated. Documentation at this site consisted exclusively of photo/video documentation.

In addition to dive sites, new targets for future surveys were identified, including:

- ***Australia*—oil tanker sunk by U-332:** The 11,728 gross-ton *Australia* was laden with 110,000 barrels of fuel oil destined for New York. Wreck site was not dived during this survey but the location was positively identified. The wreck mark and the location were recorded and will be targeted for future survey work.
- ***Kassandra Louloudis*-- cargo ship sunk by unidentified U-124:** Greek merchant vessel was not dived during this survey but the location was positively identified. The wreck mark and the location were recorded and will be targeted for future survey work.

Biological assessments were also conducted at each site visited, including fish counts and video acquisition, and placement of CTD data-loggers on each site. The data loggers will acquire data for up to two years and will be recovered in a future expedition. This information will be used to begin development of wreck site ecosystem assessments.

YEAR 2 PROGRESS:

Proposed Y2 expeditions did not take place by the time of this report. The Thunder Bay mission is planned for May 17-28, 2011. The Cape Hatteras AUV mission is planned for June 11-18, 2011. The Cape Hatteras technical diving mission is planned for Aug 15-26, 2011. The Hatteras missions were delayed from original planned 2010 dates due to availability of ship-time (using Sanctuary's SRVx). These expedition results will be reported on in the Y3 Progress Report.

Dr, Anni Dalglish, HB/FAU, joined the project in March 2011 to oversee choice of the hydrocarbon sensors to be deployed from the SRI AUV and manage resulting data. Targeted sensors for oil and Poly-aromatic Hydrocarbons (PAH) have been chosen based on spectral properties (ability to detect oil and gasoline). HBOI's Turner Cyclops C6 data platform that will be used to interface the sensors with the AUV was delivered to SRI engineers in April 2011. Integration has been delayed by approval of the final SRI sub-award (still not finalized as of April 12, 2011).

PRODUCTS:

OUTCOMES:

New information will contribute to TBNMS support for a bill to expand the sanctuary to 4,085 square miles is now before the U.S. Congress. Expansion will dramatically increase the sanctuary's resource management obligations.

OUTPUTS:

Data:

- Hard point archeological data and video and still imagery to create photo mosaics, site plans and detailed assessments archived with Sanctuary partners.
- Images posted at cioert.org/images.

Technology developments:

- C4 tech dive team continues to work with Sanctuary managers and divers to evaluate development and application of closed-circuit rebreathers for archaeological science.
- Integration of high resolution bottom mapping sonar, and hydrocarbon sensors on AUV will enable first synoptic oil/gas leak detection and high resolution bottom mapping in east coast Sanctuaries (to be done on June 2011 mission).

Publications:

- Cruise Plans and Reports for each cruise on file.

Presentations:

Other outputs/products (list, e.g., models, curriculum/lesson plans):

- 2010 Battle of the Atlantic Expedition web site--
<http://sanctuaries.noaa.gov/missions/2010battleoftheatlantic/welcome.html>

FIELD OPERATIONS:**Year 1:**

Location	Support Vessel	Undersea Asset	# Dive Days	# Dives	Max Depth (m)
Thunder Bay	R/V <i>Storm</i>	Tech diving	14	79	75
Cape Hatteras	R/V <i>SRVx</i>	Tech diving	15	139	85

Year 2:

Location	Date	Support Vessel	Undersea Asset	# Dive Days	# Dives	Max Depth (m)
Thunder Bay	May 2011	R/V <i>Storm</i>	Tech diving	14*	Tbd	75
Cape Hatteras	June 2011	R/V <i>SRVx</i>	AUV	10*	Tbd	200
Cape Hatteras	Aug 2011	R/V <i>SRVx</i>	Tech diving	10*	Tbd	85

* - planned dive days

PROJECT #: Y2-5.3.1
TITLE: *Mesophotic Reef Ecosystems*

PRINCIPAL INVESTIGATORS: John Reed, Joshua Voss, Sara Edge, M. Dennis Hanisak – HBOI at FAU

COLLABORATORS:

Emma Hickerson- NOAA, Flower Garden Banks NMS
Kimberly Puglise- NOAA/CSCOR Coral Reef Ecosystem Studies Program
Mark Monaco- NOAA/CCMA
Chris Caldow – NOAA/CCMA
Andy David- NOAA National Marine Fisheries Service
Greg Piniak- NOAA Center for Coastal Fisheries and Habitat Research
Scott Donahue- NOAA Florida Keys NMS
Dan Dorfman, NOS/NCCOS Biogeography Branch

PROJECT DURATION: Year 2 of 2

BUDGET: Total request \$138,963 (total budget includes additional \$51,370 reprogrammed from Year 1); see budget spreadsheet and narrative for details.

GOALS:

- CIOERT Research Themes: Technology Innovation, Exploring Shelf Frontiers, Vulnerable Coral Ecosystems, Education/Outreach
- OER Strategic Outcomes (see 1/25/10 Guidance Memo, Att. A): Interdisciplinary exploration, Development and utilization of advanced underwater technology, Systematic research, Education and outreach
 - Exploration Outcomes:
Discover ecosystem processes in the oceans.
Map and characterize key features and habitats.
 - Technology Outcomes:
Transition new technologies to appropriate users within NOAA and the broader scientific community.
 - Research Outcomes:
Discover and understand ecosystems in the ocean and, especially, the southeastern U.S..
Florida Keys Marine Sanctuary and the Flower Gardens Banks Marine Sanctuary.
Study and understand extreme and unique environments in the oceans.
 - Education/Outreach Outcomes:
Work closely with NOAA partners and the education component of the CIOERT project for at-sea web sites, and educator and student programs.
- NOAA Strategic Plan Goals: Advance understanding of ecosystems to improve resource management. Milestone: 0-2y: Meet annual targets for the number of Coastal, Marine, and Great Lakes Ecological Characterizations that meet management needs.

PROJECT OVERVIEW:

Year 2 activities will focus on continuing Year 1 work and additions to mapping and habitat characterizations of mesophotic reef sites in the southeastern U.S. We will collaborate with the NOAA Sanctuaries Program to select and characterize mesophotic reefs and shelf-edge MPA sites in the Gulf of Mexico and the southeastern U.S. region. Using ROVs, we will ground-truth priority areas by conducting photographic/video surveys according to the protocols developed below for detailed habitat characterizations. In conjunction with the ROV dives, we will utilize the C4 technical dive team at UNCW to conduct detailed site specific surveys, video transects, and collections of select marine organisms (algae, corals, sponges, gorgonians, fish, etc.). A critical component will be to conduct molecular-based comparisons of corals from various regions and depths to investigate connectivity, relative levels of coral stress, and bacterial symbionts associated with coral mucus. In addition, we will continue restoration and preservation of historic videotape and photographic archives, and develop protocols to ensure comparable collection of data, samples, and documentation of sites. We will ensure the availability of all data to the scientific community and resource managers. This integrative CIOERT approach will enable comparison of the status of mesophotic reefs and shallow coral reefs across the southeastern U.S.

PROGRESS REPORT

Y1 ACCOMPLISHMENTS:

FAU received notice of award for Task II/III funding for the CIOERT Mesophotic Reef Ecosystem Project (2009-5.3.1) on October 22, 2009, and the subcontract to UNCW was completed by November 11, 2009. As a result of the 5 month delay in funding, the timeline milestones were shifted and some planned cruises were delayed from 2009 to 2010. In the short time available in 2009, the Mesophotic project completed some major milestones. Specifically we completed the following objectives for the major elements and goals of the project:

1. Map and Characterize Mesophotic Reef Ecosystems- One mesophotic ecosystem cruise by UPRM was completed in January 2010 with Year 1 funding and two planned cruises had to be delayed. The UPRM principal investigator (Richard Appeldoorn) initiated this goal at several sites in the Caribbean, including Mona Island, Seco, Vieques Island, St. Thomas, and St. Croix (see Project 2009-5.3.1 Progress Report, July-December 2009).
2. Develop Standard Collection and Documentation Protocols- Protocols from various sources have been acquired including Etnoyer et al. (2007) which will be used as a template for cnidarian (coral, gorgonian) sampling. A questionnaire has been sent for input from agencies and research specialists in their respective fields with regards to photo/video documentation, biomedical samples, genetic samples, reproductive samples, document archives and distribution. For sponge collections and genetic samples we have contacted the PIs of the NSF PORTOL Tree of Life Project. A standard protocol for deep sea habitat surveys is in development by the PI which will be reviewed and approved by various agencies including DOE, MMS, FDEP, and NOAA. This may be applied to our mesophotic ecosystem surveys.
3. Year 1 Field Studies- Mission planning including funding sources, personnel, cruise plans, and dive plans were initiated for the three major cruises for Year 1. Due to delayed funding some cruises were shifted from 2009 to 2010 and some were merged to reduce costs. The following describes the status of each of Year 1 field studies:

a. Year 1 Field Studies: U.S. Caribbean- This cruise was a collaboration of UPRM, HBOI and NOAA scientists, and the UNCW and UPRM Technical Dive Team, from January 9 to 23, 2010

on the R/V *Nekton Rorqual*. The cruise plan and research objectives were developed by Richard Appeldoorn (UPRM; see Project 2009-5.3.1 Progress Report, July-December 2009, Appendix 1). The primary objective was to collect quantitative information of fish and invertebrate communities through visual census and photo-transects at each site which included Mona Island, Seco, Vieques Island, St. Thomas, and St. Croix. Two teams of rebreather divers conducted transects at target depths of 70 and 50 m, and where possible teams using standard scuba surveyed the top of the slope <30 m. Phototransects consisted of high-resolution still photography along a 10 x 0.4 m portion of the bottom. Visual census fish transects covered a 10 x 4m area. A second dive at each site was used for general, larger scale characterization and specimen collection for species identification and genetic analyses. ROV dives at each site were used to screen each area in preparation for diver deployment. The Dive Plan and Dive Emergency Plan was developed by Doug Kesling (UNCW) who acted as chief Dive Safety Officer for the cruise including the Technical Dive Team and shallow water scuba divers (see Project 2009-5.3.1 Progress Report, July-December 2009, Appendix 2). Unfortunately one of the UPRM technical divers suffered decompression illness, but was treated successfully on site by the Kesling dive team with an inflatable recompression chamber (see D. Kesling, UNCW Dive Incident Report, January 16, 2010).

b. Year 1 Field Studies: Gulf of Mexico – This project is a collaboration FGNMS, NOAA, and HBOI scientists, UNCW ROV support with the NOAA NURC SuperPhantom ROV (Lance Horne, chief pilot), and the UNCW Technical Dive Team. The first ROV cruise was originally scheduled for October 19-23, 2009, but was postponed due to the delays in CIOERT funding, and re-scheduled for May 17-21, 2010 on the FGNMS vessel R/V *Manta*. Results are reported below with the Y2 report period.

c. Year 1 Field Studies: SE U.S.A. MPAs- This cruise to the new mesophotic MPAs that are at the shelf edge from North Carolina to Florida is a collaboration of Andy David (NOAA NMFS), HBOI scientists (John Reed, Tammy Frank, and HBOI technicians), USF scientist (Andrew Remsen), and UNCW ROV Support (Lance Horn), The cruise was originally scheduled on the new NMFS vessel, *Pisces*, May 7-31, 2010, using the NOAA NURC SuperPhantom ROV. NOAA, however, had to re-schedule the *Pisces* to the Pacific Ocean to replace another vessel and as a result the cruise was considerably reduced in time and scope. The cruise is now scheduled for May 4-10, 2010 on a much smaller live-aboard dive boat. Results are reported below with the Y2 report period.

Revised Schedule: Year 1 Tasks, Timelines and Milestones:

Year 1 Activities:

1. UNCW and FAU receive funding for Year 1 Tasks, November 2009.
2. Development of coordinated survey and sampling protocols to facilitate cross regional and multi-depth data comparisons.
3. Develop cruise and dive plans with PIs and collaborators for the three Year 1 cruises.
4. Advertise and hire technicians for HBOI (Voss, Edge, Reed).
5. Train technicians: initiate video archives; coral analyses.
6. Fieldwork- UPR cruise (Jan. 9-23, 2010): ROV and Tech diving video transects, habitat characterization, sampling. J. Voss will participate.
7. Process and analyze coral samples from UPR cruise (Voss and Edge).
8. Fieldwork- Southeastern U.S. MPA cruise (May 4-10, 2010): ROV video transects, habitat characterization, sampling. J. Reed and technician will participate.
9. Process and analyze coral samples, benthic videotapes from SE USA cruise (Reed, Voss, Edge).

10. Fieldwork- Gulf of Mexico cruise (May 17-21, 2010): ROV video transects, habitat characterization and sampling. J. Voss and J. Reed will participate.
11. Process and analyze coral samples, videotapes from GOM cruise (Voss, Edge, Reed).
12. Year 1 progress report (July 2009-March 2010), April 30, 2010.
13. Complete Year 1 data analysis, evaluate standardized protocols.
14. End Year 1 funding, September 30, 2010.

Activity	N 2009	D	J 2010	F	M	A	M	J	J	A	S
1	X										
2		X	X	X	X	X	X				
3		X	X	X	X						
4			X	X							
5				X	X	X	X	X	X		
6			X								
7						X	X				
8							X				
9								X	X	X	
10							X				
11								X	X	X	
12						X					
13										X	X
14											X

The primary changes to the original schedule due to funding reductions and delay in the start date include:

1. The start date for hiring technicians, cruise planning, and developing collection protocols delayed.
2. Due to NCCOS budget cuts the pending cruise for Dry Tortugas was cut for Year 1.
3. UPR Cruise- In discussions with Dr. Emma Hickerson (FGNMS), UNCW and HBOI, it was decided to move the Tech Diving support from the GOM cruise and add to the time on the UPR cruise. This allowed for a total of 12 tech dive days for the UPR cruise. Dr. Voss (HBOI) will participate on the cruise for the coral health analysis project. UNCW Tech Dive Team (D. Kesling, DSO) will lead the diving support.
4. GOM Cruise- The October 2009 GOM cruise was moved to May 2010. This in part was due to delayed funding to the FGNMS program for this and other mapping projects. Four days of UNCW ROV support will be provided along with time and travel for J. Voss and J. Reed to participate for habitat mapping, characterization, and coral health assessment.
5. SE U.S.A. MPA cruise- The cruise dates were shifted to May 4-10, 2010. Due to rescheduling of the NOAA vessel, we had to use a smaller vessel and are unable to test the SIPPER technology at this time, but this is planned for Year 2.
6. Final report- Due to the delay in initial funding and the resulting delay in field work, it is difficult to complete a full analysis of the cruise data in time for the deadline of the Year 1 Annual Report. This progress report was submitted on April 30, 2010.
7. Year 2 Plans- Although funding has not been approved for Year 2, the FGNMS program plans to provide UNCW ROV and Tech Diving support for FGNMS cruises scheduled in the summer of 2010. We have submitted plans for our 2010 CIOERT Year 2 projects.

Year 1 Outcomes/Outputs:

Fieldwork and Data Analyses:

Due to the delays in funding as outlined above none of the field work was initiated in 2009 and only one cruise was completed at this time in 2010. The primary goals of mission planning were completed. Conference calls were completed for each of the cruise missions to develop the following: mission goals and objectives, mission teams, dive teams, dive safety and emergency plans, and cruise plans.

New Technician Support:

Two research biologists were hired in support of this project in March 2010. Both have begun work on the molecular analysis and video analysis respectively. In addition, they are currently undergoing scientific diver training.

Field Operations:

As of April 30, 2010, the following cruise was completed during Year 1.

Support Vessel	Undersea Asset	# Dive Days	# Dives	Max Depth (m)
R/V <i>Nekton Rorqual</i>	UNCW Technical Dive Support	14	8	70

YEAR 2 PROJECT OVERVIEW:

The following report includes activities funded by: 1) CIOERT's Year 1 funding which occurred after the Year 1 Annual Report was submitted (March 30, 2010), and 2) CIOERT's Year 2 funding up through March 30, 2011. Year 2 results from April 1, 2011 to the end of Yr 2 (June 30, 2011) will be reported in the Year 3 report.

ACCOMPLISHMENTS:

Task- Field Studies:

a) Northern Gulf of Mexico: Flower Garden Banks National Marine Sanctuary Experimental Fishing Pre-Closure Assessments (FGNMS; PI- Emma Hickerson)

This project is a collaboration of FGNMS, NOAA, and HBOI scientists, UNCW ROV support with the NOAA NURC *SuperPhantom* ROV (Lance Horne, chief pilot), and the UNCW Technical Dive Team. For Year 1 the first ROV cruise was originally scheduled for October 19-23, 2009, but was postponed due to the delays in CIOERT funding. The second cruise originally scheduled for May 1-6, 2010 with the UNCW Technical Dive Team was also postponed. In Year 1 the cruise was conducted May 16-21, 2010 with the FGNMS vessel R/V *Manta* and the UNCW *SuperPhantom* ROV. HBOI scientists John Reed and Joshua Voss participated as co-PIs. Habitat characterization continued in areas of the Sanctuary not previously surveyed with quantitative methods. Sample collections of corals for investigations of genetic connectivity are planned to determine the relative health of deep coral populations and to provide material to the New Biomedical Resources Project (CIOERT 4.3.1). However, the *SuperPhantom* ROV only has a single-function manipulator and collections were limited to five opportunistic samples. The FGNMS team in collaboration with CIOERT will quantify fish and

benthic components in the Sanctuary in conjunction with a proposed experimental fishing closure, i.e., setting up long-term, deep-water transects.

The May 2010 cruise resulted in 100 nm of ROV photo and video transects on the the East and West Banks of the Sanctuary covering both coral caps on each bank and a variety of habitats over a range of depths (to 150 m). A total of fifteen 100 m transects were randomly plotted in each habitat zone: the Soft Bottom Community, the Deep Coral Zone, the Coralline Algae Zone, and the Algal Nodule Zone. The surveys along the coral cap will be used to compare ROV transects to SCUBA diver surveys. Hydroacoustic data were collected to map the abundance and distribution of fish in the Sanctuary and compare these patterns across habitats and over time. Preliminary processing and data acquisition from the ROV video data collected in May, 2010 and SCUBA data collected in Sept 2010 are complete. Coral mucus samples collected during the Sept, 2010 cruise have been extracted and processed, with data analysis nearing completion for comparison with corals in other areas in the Tropical Western Atlantic. Analyses of the benthic still photographs from each 2010 cruise are underway.

A second cruise in Year 2 is planned for May 2011 to the Flower Garden Banks National Marine Sanctuary and the science objectives will include further characterization of essential fish habitat within the existing sanctuary boundaries in areas not previously surveyed as well as areas that are proposed for sanctuary expansion. Quantification of fish and benthic components within the Sanctuary will be conducted to assess the role of essential fish habitat in fisheries production. These data will provide critical information leading to a proposed experimental fishing closure within FGBNMS. Corals and other species will be collected to study genetic connectivity, to determine the relative health of deep coral populations (see below). The cruise is again supported by a combination of funding and support from CIOERT, FGBNMS, NOAA CRCP funding, and NOAA NCCOS. In Year 3, a cruise aboard the *Nancy Foster* is scheduled for Aug 2011 to continue coral cap surveys and collections related to this project. The length of this cruise will be increased to 16 days (likely split into two legs) due to reallocation of shiptime within the Sanctuaries program from FKNMS to FGBNMS.

b) SE U.S.A. MPAs: Fish and Benthic Habitat Characterization of New Shelf-Edge Marine Protected Areas off Southeastern U.S. (NOAA NMFS- PI, Andy David; Co-PI, John Reed, HBOI)

This cruise surveyed several of the new mesophotic MPAs that are snapper/grouper breeding grounds at the shelf edge from North Carolina to Florida. This is a long term effort in collaboration with Andy David (NOAA NMFS) and John Reed (HBOI-FAU). The cruise was originally scheduled on the new NMFS vessel, *Pisces*, May 7-31, 2010, however, it had to rescheduled when the *Pisces* was sent to the Pacific Ocean to replace another vessel. This cruise was conducted with Year 1 funding, May 4-10, 2010, on a much smaller live-aboard dive boat, M/V *Spree*, with the UNCW *SuperPhantom* ROV (UNCW Pilot- Lance Horn). As a result the cruise was considerably reduced in time and scope; berthing was limited to only two HBOI scientists, and the SIPPER (plankton analyzer) could not be used because of space limitations which cut the Benthic-Pelagic Coupling Project, headed by Tammy Frank (HBOI) and Andrew Remsen (USF). However, the revised objectives still enabled CIOERT to collaborate with NMFS to conduct quantitative photographic/video transects at the new MPA sites; NMFS personnel assessed fish communities and CIOERT personnel assisted with benthic habitat characterization. Dive sites consisted of the North Florida MPA, South Carolina MPA, and South Carolina Edisto MPA. The objectives are to: 1) survey sites within newly designated mesophotic, shelf-edge MPAs and compare to adjacent outside sites. 2) conduct quantitative photographic/video transects to 152 m depth, 3) assess fish communities, and 4) assess and characterize benthic habitats.

The cruise resulted in 17 ROV dives, 21 hours of videotape transects, and 873 digital still images documenting habitat and fauna. These data are in the process of being analyzed. A second cruise in Year 2, May 30- June 11, 2011, is planned on the R/V *Pisces* with a NOAA ROV to survey additional shelf-edge MPA sites off eastern Florida. These will include the St. Lucie MPA, and the Florida Keys “The Humps” MPA. Video and photographic transects will be made at these sites to document for the first time the benthic fish and sessile fauna of these deepwater sites. Surveys will also be made on the Miami Terrace within the newly designated Deep Coral Habitats Area of Particular Concern to assess habitat, fish populations, and potential impact of bottom fisheries (crab trap and shrimp trawling).

c) Gulf of Mexico: CIOERT Rapid Response Cruise for the Oil Spill

Summary

As proposed in the Year 2 Science Plan (above), a main objective of the Mesophotic Project is to characterize mesophotic reef ecosystems off southern and western Florida (Florida Keys NMS [FKNMS], Tortugas Ecological Reserve [TER], and west Florida shelf- Pulley Ridge to Madison Swanson MPA). The original Y2 cruise plan was scheduled for May 2011 to use the UNCW technical diving and ROV operations aboard the R/V *Walton Smith*. However, this had to be rescheduled due to the British Petroleum’s Deepwater Horizon oil spill in the Gulf of Mexico, April 20, 2010. With approval of NOAA and CIOERT we rescheduled and redefined our Mesophotic GOM cruise originally planned for May 2011 in rapid response to the oil spill. Our original CIOERT cruise plan was expanded to enable CIOERT scientists to assess the potential impact of the oil spill on shelf-edge (mesophotic) and deepwater reefs along the west Florida shelf and to provide data to assist NOAA in background ecosystem assessment, damage assessment, and restoration if necessary. The diverse expertise of our CIOERT Project Teams was critical in our capability to respond rapidly to the spill. Within 3 weeks of notice of the cruise, we implemented a cruise plan with the collaboration of a total of 43 scientists, technicians and students from CIOERT (HBOI-FAU, University of North Carolina at Wilmington, University of Miami, and SRI International), NOAA Fisheries, NOAA NCDDC, NOAA OER, NOAA AOML, and Florida State University. The Florida Shelf-Edge Expedition (FLoSEE; cioert.org/flosee) was conducted July 9-August 9, 2010, as part of the Year 2 science plan. This 32-day expedition used HBOI’s R/V *Seward Johnson* and *Johnson-Sea-Link II* submersible and focused on deepwater coral reefs and shelf-edge mesophotic reefs along the west Florida shelf, Florida Keys, and southeastern Florida.

Objectives

The CIOERT scientific themes for this research cruise addressed the following: 1) assessment and documentation of deep-water coral reefs, shelf-edge mesophotic reefs, and essential fish habitat; 2) stress responses of corals and other marine invertebrates exposed to oil and chemical dispersants; 3) assessment of zooplankton and linkages between pelagic and benthic ecosystems; 4) chemical analysis of sessile benthic taxa and biomedical resources; and 5) education and outreach.

Assessment of Deepwater Coral Reefs and Mesophotic Reefs (CIOERT 2010-5.3.1, Mesophotic Reef Ecosystems:

PIs: John Reed, (Lead PI), M. Dennis Hanisak, Ph.D.; Joshua Voss, Ph.D., Shirley Pomponi, Ph.D., Amy Wright, Ph.D., Tammy Frank, Ph.D.

- Assessment and documentation of deep-water coral and shelf-edge mesophotic reefs, and hard-bottom essential fish habitat.

- Baseline assessment of non-impacted areas and documentation and quantification of oil impacted areas.
- Locate, characterize, and determine the distribution of benthic deepwater and shelf-edge (mesophotic zone) hardbottom and coral communities in the selected study areas,
- The selected areas were ground-truthed using the *Johnson-Sea-Link* submersible with video and digital still cameras.
- These data are being analyzed and interpreted in GIS showing benthic habitat polygons and areas of possible oil impact.

Stress Responses of Corals and Other Marine Invertebrates Exposed to Oil and Chemical Dispersants (CIOERT 2010-5.3.1, Mesophotic Reef Ecosystems):

PIs: Sara Edge, Ph.D., Joshua Voss, Ph.D.

Baseline assessment of non-impacted taxa and analyses of impacted taxa.

Quantitative Assessment of Zooplankton (CIOERT 2010-4.2.1, Linkage between Pelagic and Benthic Ecosystems):

P.I. Tamara Frank, Ph.D.

Baseline assessment of non-impacted areas and documentation of impacted areas.

Chemical Analysis of Sessile Benthic Taxa and Biomedical Resources (CIOERT 2010-4.3.1, Discovery of Novel Therapeutic Agents from Marine Frontier Habitats):

P.I. Amy Wright, Ph.D.

Baseline assessment of non-impacted taxa and documentation of impacted taxa.

Education and Outreach (CIOERT 2010-6-3-1):

PIs: M. D. Hanisak, Ph.D., T. Frank, Ph.D.

On site videographer, HBOI-FAU website, daily logs, one leg of cruise with students and educators.

Results

A total of 121 collection sites (stations) were sampled using the *Johnson-Sea-Link* II submersible (50 dives), scuba (8 dives), snorkel (1), CTD rosette (40), MOCNESS net (19), plankton net (1), dipnet (1), and hook and line (1). A total of 165 (1-hr) submersible videotapes were recorded which provides documentation of benthic habitats, sample collections, and quantitative video transects. A total of 6,622 digital photographs were taken during submersible dives and in the laboratory documenting each collected specimen and benthic habitats. A total of 698 samples were collected during the expedition and included the following: Cnidaria (coral, gorgonians, zoanthids)- 199, Porifera (sponges)- 181, Chordata (tunicates, fish)- 35, Echinodermata (sea urchins, starfish, crinoids, sea cucumbers)- 35, Arthropoda (crabs, shrimp)- 20, Bryozoa (moss animals)- 13, Mollusca (bivalves, snails)- 12, Algae- 59, rock and sediment- 75. Each specimen was thoroughly documented and all data and samples are archived at HBOI-FAU.

ArcGIS and Databases

An Access database of the site and sample data was compiled with links to all the additional datasets. For example, in this database, the site data are linked to each sample specimen, which are linked to submersible track data, submersible CTD data, fathometer transect data, submersible logs, and specimen photographs. These data are archived at HBOI's DBMR Museum (CDs) and backed up on

HBOI's computer server. These data are also compiled in ArcGIS (version 9.3) which shows details maps of all the collection sites, and hot links to each sample, photograph, and other data.

We have provided NOAA NCDDC with open access to all metadata records, all physical data sets (e.g., CTD, fluorometry), dive logs, and lab specimen images. Some data are restricted as various researchers are analyzing and publishing the results.

Web Sites

CIOERT's FLoSEE Expedition Web site (cioert.org/flosee): Dedicated to the FLoSEE expedition featuring links to news events and articles, image gallery, daily logs from sea, and links to other resources relevant to mesophotic reefs and the DWH oil spill event.

NOAA Research has just posted a web page for the anniversary of the Deepwater Horizon disaster. See <http://researchmatters.noaa.gov/news/Pages/dwh.aspx>. NOAA has highlighted contributions from the CIs that played a role in the response -- see the "Cooperative Institutes Contribute" section. Be sure to look at the Meet Our DWH Scientists section too -- click on the blue bar to get a list of scientists featured in this section. CIOERT director Shirley Pomponi is among them.

Task- Molecular Analyses of Coral Samples:

Tissue samples from Scleractinia, Alcyonacea, Ascidiacea and Porifera were collected from sites in the Gulf of Mexico during the FLoSEE cruise. Samples are being stored at Harbor Branch at -80°C in an organic tissue preservative for further analysis and long-term storage. Phenol-chloroform extractions of total RNA have been performed on several of the samples and the quality, quantity and purity has been analyzed using a spectrophotometer. The purified RNA will be fluorescently labeled and hybridized to a custom-designed Anthozoan microarray. Subsets of the collected samples are anticipated to be labeled, hybridized and analyzed for gene expression by July 2011. Statistical analysis will be performed on the resulting expression data using JMP® Genomics (SAS Institute, Inc.). In addition, we are exploring funding options in order to analyze a subset of these samples for hydrocarbon concentrations.

Task- Develop Standard Collection and Documentation Protocols:

CIOERT and NOAA collaborators developed standardized protocols in Years 1 and 2 that can be used for future CIOERT funded collections and surveys in Years 3-5. We are testing and revising these protocols in Year 2 and continue to gather input from outside users.

Protocols from various sources have been acquired including:

- Collection and preservation of samples: protocols will be standardized for priority taxa (primarily cnidaria [e.g., Etnoyer et al., 2006], sponges, and macroalgae) to enable further research in systematics, reproduction and genetics, coral diseases, and marine natural products.
- A questionnaire was sent for input from agencies and research specialists in their respective fields with regards to photo/video documentation, biomedical samples, genetic samples, reproductive samples, document archives and distribution.
- For sponge collections and genetic samples we have contacted the PIs of the NSF PORTOL Tree of Life Project.

- A standard protocol for deep sea habitat surveys is in development by the PI which will be reviewed and approved by various agencies including DOE, MMS, FDEP, and NOAA. This may be applied to our mesophotic ecosystem surveys.
- Quantitative photographic/video transects (Submersible/ROV Surveys):
The overall intent will be to meet the current guidelines for conducting offshore benthic surveys as accepted by Bureau of Ocean Energy Management (formerly BLM), and as applied by Reed 2006, Messing *et al.* (2006a and b), and Reed, Duncan, and Furman (2008). Regulatory engagement will be needed to reach consensus on the protocol to be adopted for collecting baseline benthic habitat data that is acceptable to USGS, MMS, NOAA, and FDEP.

Task- Videotape/Photographic Archives- Restoration, Preservation, and Data Mining:

Source Material

Harbor Branch Oceanographic Institution’s Biomedical Marine Research Division (BMR) has an archive of over 600 underwater videotapes taken from the *Johnson-Sea-Link* submersibles, *Clelia* submersible, and Harbor Branch ROV. In addition are insitu 35-mm photographs from submersible and scuba dives of habitat and fauna. These are from nearly 80 worldwide collection expeditions by conducted by HBOI scientists from 1976 to present and ranging throughout the Caribbean, Bahamas, Gulf of Mexico, southeastern US, Pacific Ocean (Galapagos, Cocos Island, Pearl Islands), and eastern Atlantic (Canary Islands, Madeira, Salvage Islands), and at depths up to 3000 ft, including mesophotic and deep-water reefs.

<u>Source Videotapes</u>	<u>Type of Tape</u>	<u>Number of Tapes</u>	<u>Hours (approx.)</u>	<u>GB/Tape</u>	<u>Drives</u>
Dec. 1984 to 1989	3/4 inch	267 (20 min)	89	22 Gb/tape	12
Nov. 1990 to 2001	Hi-8 mm	75 (1-2 hr)	75	120 Gb/tape	18
Aug. 2001 to 2007	Mini DV	275 (60 min)	275	12 Gb/tape	7
Total		617	439		

Total Hard Drive File Size: 18,500 GB.

Objectives

- To copy and preserve a set of >600 submersible videotapes that are irreplaceable and invaluable. These resources (museum specimens, achived photographs and submersible videotapes) must be saved for future generations for scientific studies, biomedical research, and conservation efforts.
- The primary archives which are the original tapes are stored in a humidity and temperature controlled room. This project will make a copy of each tape in a raw, uncompressed format (highest quality possible) to external computer hard drives for the secondary archive.
- Secondary Archive- Each Mini DV tape (60 min) saved in raw, uncompressed format will result in ~12.4 GB avi file. The analog tapes (3/4” and Hi-8 mm) result in 60 GB per hour files (1.08 GB/min).
- Tertiary Archive- As tapes are copied to the computer, a compressed DVD videotape will be made for each tape.
- Digitize original 35-mm insitu photographs as high resolution files (600 dpi, 15 mB images).

Results- Preservation

- Submersible/Scuba 35-mm Photos Digitized- 9050
1987-2000
- Submersible Videotapes digitized- 68 tapes, 2 Terabytes
1989-2000
Grenada, Barbados, Guadeloupe, St. Lucia, Martinique, Curacao, Bonaire, Aruba, Jamaica, Bahamas
- Submersible Videotapes Restored (originals soaked/baked and copied to master Betatape)- 71 tapes, 171 dives, 1975-1981

Mining the Data

An MS Access database was developed to compile metadata from HBOI photo/video archives for each submersible dive (i.e., source tape, location, depth, dive objectives). As the original videotapes are copied, we review the data sources regarding the metadata for dives within the mesophotic zone (30-150 m) in Florida, Bahamas and Caribbean. As personnel become trained and available, the database will be expanded to transcribe annotations from the dives, characterizing the benthic habitats and benthic fauna. This relatively unknown region of the shallow-water reef ecosystem may be the safety net for many shallow-water reef corals and other species that are showing signs of serious damage by the effects of global climate change and increasingly warmer temperatures on our shallow water reefs. In the relatively cooler climates of these mesophotic reefs, many of the species dying off in shallow water may survive. This repository of historical and recent data from our previous expeditions may be useful in developing management plans for the MCEs.

YEARS 1 AND 2- REVISED TASKS, TIMELINES AND MILESTONES:

During the 15 months since funding for this project became available, the Mesophotic Project completed some major milestones. Specifically we completed the following objectives for the major elements and goals of the project:

The primary changes to the original schedule due to funding reductions and delay in the start date are the following:

1. The start date for hiring technicians, cruise planning, and developing collection protocols delayed.
2. Due to NCCOS budget cuts the pending cruise for Dry Tortugas was cut for Year 1.
3. UPR Cruise- In discussions with Dr. Emma Hickerson (FGBNMS), UNCW and HBOI, it was decided to move the Tech Diving support from the GOM cruise and add to the time on the UPR cruise. This allowed for a total of 12 tech dive days for the UPR cruise. Dr. Voss (HBOI) participated on the cruise for the coral health analysis project. UNCW Tech Dive Team (D. Kesling, DSO) lead the diving support.
4. FGBNMS Cruise- The October 2009 GOM cruise was moved to May 2010. This in part was due to delayed funding to the FGNMS program for this and other mapping projects. Four days of UNCW ROV support and provided time and travel for J. Voss and J. Reed to participate for habitat mapping, characterization, and coral health assessment.
5. FGBNMS Cruise – In September 2010 in partnership with the FGBNMS, NCCOS, and CIOERT, a 4 day cruise was completed to characterize coral habitat and fish communities on East and West Bank. In total, 75 100 m² surveys were completed and fisheries acoustic surveys

were conducted over shallow dive sites and ROV sites completed in May 2010. J. Voss participated.

6. SE U.S.A. MPA cruise- The cruise dates were shifted to May 4-10, 2010. Due to rescheduling of the NOAA vessel, we had to use a smaller vessel and are unable to test the SIPPER technology at this time, but this is planned for Year 2.
7. GOM Oil Response Cruise: May 2010, we were told to plan for this mission beginning July 9-Aug. 9, 2010. With approval of NOAA and CIOERT we moved and redefined our Mesophotic GOM cruise originally planned for May 2011.

REVISED SCHEDULE: YEAR 1-2 TASKS, TIMELINES AND MILESTONES:

Activity	N-2009	D	J-2010	F	M	A	M	J	J	A	S	O	N	D
Funding Starts	X													
Protocol Plans		X	X											
Archives			X	X	X	X	X						X	X
Yr Cruise Plans		X	X	X	X									
Hire 2 Techs			X	X										
Train Techs				X	X	X	X	X	X					
UPR Cruise			X											
Data Analysis						X	X					X		
SE MPA Cruise							X							
Data Analysis								X	X	X				
FGNMS Cruises							X				X			
GOM Oil Cruise								X	X	X				
Yr Prog Rpt						X								
End Yr 1											X			
Oil Cruise- data entry												X	X	X
Oil Cruise- Report														X

YEAR 2: ACTIVITIES AND DELIVERABLES:

1. UNCW and FAU receive funding for Year 2 Tasks, June 1, 2010.
2. Implement and test coordinated survey and sampling protocols to facilitate cross regional and multi-depth data comparisons.
3. Develop cruise and dive plans with PIs and collaborators for the Year 2 cruises.
4. Continue archive and analysis of historical videotapes.
5. Fieldwork- Southeastern U.S. MPA cruise (June-July, 2010, 14 days, tbd): ROV video transects, habitat characterization, sampling (J. Reed, T. Frank, 2 Research Assistants). Followed by cruise report.

6. Fieldwork- FGNMS, Gulf of Mexico cruise (July, 2010, 10-day cruise): R/V *Nancy Foster*, UNCW Tech Divers and scuba diving, habitat characterization and sampling (J. Voss, S. Edge, J. Reed and Research Assistants). Followed by cruise report.
7. Fieldwork- Tortugas and Pulley Ridge, Southwest Florida (May 2011, leg 1, 2 weeks, tbd): R/V *Walton Smith*, ROV video transects and collections, habitat characterization, sampling (J. Reed, J. Voss, S. Edge, T. Frank, A. Wright, D. Hanisak, S. Pomponi, RAs).
8. Fieldwork- Tortugas and Pulley Ridge, Southwest Florida (May, 2011, leg 2, 1 week, tbd): R/V *Walton Smith*, UNCW Tech Divers, video transects and collections, habitat characterization, sampling (J. Reed, J. Voss, S. Edge, T. Frank, A. Wright, D. Hanisak, S. Pomponi, RAs). Followed by cruise report.
9. Process and analyze coral samples, benthic videotapes from cruises (J. Reed, J. Voss, S. Edge, RAs). Draft manuscript focused on the relative differences in gene expression and microbial community composition among corals from shallow and mesophotic depths.
10. Complete Year 1 data analysis, evaluate standardized protocols, draft annual progress report for Year 1, September 30, 2010.
11. End Year 1 funding, September 30, 2010.
12. Year 2 progress report (June- December, 2010), December 31, 2010.
13. Complete and submit Year 1 and 2 Annual Report, April 30, 2011.
14. End Year 2 funding, June 30, 2011.

Activity	Timeline											
	J 2010	A	S	O	N	D	J 2011	F	M	A	M	J
1	X											
2	X	X	X								X	X
3	X	X					X	X		X	X	
4	X	X	X	X	X	X	X	X	X	X	X	X
5	X											
6	X											
7											X	
8											X	
9		X	X	X	X				X	X	X	X
10	X	X	X									
11			X									
12						X						
13										X		
14												X

YEARS 1 AND 2- OUTCOMES/OUTPUTS:

Grants Pending and Funded

The competitive edge of our CIOERT Team has allowed newly funded grants and competitive proposals that provide added value to our CIOERT objectives, including:

Funded: BP funded FIO Oil Spill Response Grant-“Molecular Diagnostics of Coral Exposed to Oil and Dispersants”; FKNMS “Annual Coral Health Cruise”.

Pending: 2011 NOAA REPP- “Understanding Coral Ecosystem Connectivity in the Gulf of Mexico-Pulley Ridge to the Florida Keys”; Mote Protect our Reef Grant Program- “Determining the Molecular Basis of Susceptibility to Disease in Floridian Corals”; Naval Surface Warfare Center- NSWCCD, Ft.

Lauderdale; Project Title- “Deep-Water Benthic Habitat Characterization”; South Atlantic Fishery Management Council (SAFMC) for NOAA CRCP request; Project Title- “South Atlantic MPAs and Deepwater Coral HAPCs: Characterization of Benthic Habitat and Fauna”.

Technician Support

Two research biologists were hired in support of the Mesophotic Reef Project in March 2010. They have begun work on the molecular analysis, database management, ArcGIS, and video/photo archives respectively. In addition, they have completed HBOI’s scientific diver training certification course, CPR, first aid, and dive accident management.

Symposia and Presentations

2011. Eckerd College Sigma Xi Keynote Lecture. April 14, 2011. “Corals on the Edge- Charting a future for coral reef ecosystems.” J. Voss

2011. HBOI Ocean Science Lecture Series, Harbor Branch Oceanographic Institution, Florida Atlantic University, March 2, 2011. Presentation- “Deep Sea Coral Reefs - Oases of the Ocean Recent Discoveries and Conservation”. J. Reed.

2011. Cooperative Institute for Ocean Research and Technology (CIOERT), Workshop, Harbor Branch Oceanographic Institute, February 7-8, 2011. Presentation- “CIOERT mesophotic reef project- results of years 1 and 2 and plans for years 3-5”. J. Reed, J. Voss.

2011. American Society of Limnology and Oceanography, 2011 International Aquatic Sciences Meeting, February 13-18, 2011, San Juan, Puerto Rico. Poster Presentation- “Distribution and habitat characterization of deep-sea coral ecosystem habitat off Florida, southeastern United States.” J. Reed, S. Farrington, C. Messing, B. Walker, S. Brooke, M. Brouwer, T. Correa.

2010. Renewable Ocean Energy and the Marine Environment: Responsible Stewardship for a Sustainable Future, Nov. 3-5, 2010, Florida Atlantic University. Presentation- “Distribution and characterization of deep-water reef and hard-bottom habitats off eastern Florida.” J. Reed, C. Messing, B. Walker, S. Brooke, M. Brouwer, T. Correa, and S. Farrington.

2010. HBOI Ocean Science Lecture Series, Harbor Branch Oceanographic Institution, Florida Atlantic University, September 22, 2010. Presentation- “A Quick Look Beneath the Surface: The Florida Shelf Edge Exploration (FLoSEE).” D. Hanisak, J. Reed, T. Frank, A. Wright.

2010. Florida Keys Linking Science to Management Conference. Oct 21, 2010. “Black band disease pathogenesis and impacts in the Florida Keys.” J. Voss.

2009. HBOI Ocean Research Colloquium, Harbor Branch Oceanographic Institute, Fort Pierce, Florida, December 3, 2009. Presentation- “Mesophotic Reefs (30-150 m) The Frontier of Exploration and Research.” J. Reed.

2009. St. Augustine Colloquium, St. Augustine, Florida, November 18, 2009. Presentation- ““Discovery and Conservation of Florida’s Deep Water Coral Reefs.” J. Reed.

2009. South Atlantic Fishery Management Council, Joint Meeting of full Council and the Habitat and Ecosystem Advisory Panel, Charleston, S.C., September 16-18, 2009. Reed, J.K., Presentation-“Results of Florida’s Deep-sea Coral Cruise, R/V Seward Johnson and Johnson-Sea-Link Submersible, August 5-17, 2009”. J. Reed.

Publications

Reed, J.K., C. Messing, B. Walker, S. Brooke, T. Correa, M. Brouwer and T. Udouj. 2011 (in press). Habitat characterization, distribution, and areal extent of deep-sea coral ecosystem habitat off Florida, southeastern United States. *Journal of Caribbean Science*.

Paterson I., J. C. Roberts, S. M. Dalby, G. J. Naylor, E. A. Guzmán, R. Isbrucker, T. P. Pitts, P. Linley, D. Divlianska, J. K. Reed, and A. E. Wright. 2011 (in press).. Leiodermatolide, a potent antimetabolic macrolide from the marine sponge *Leiodermatium* sp. *Natural Products*. DOI: 10.1002/anie.200., *Angew. Chem. Int. Ed.*, 5 pp.

Reed, J.K., J. Seitz, and T. Jordan-Sellers. 2011. Miami ocean dredged material disposal site: tilefish (*Malacanthidae*) habitat identification and characterization study. U. S. Army Corps of Engineers. 43 pp.

J. Reed, and S. Farrington. 2010. Distribution of deep-water commercial fisheries species-golden crab, tilefish, royal red shrimp- in deep-water habitats off eastern Florida from submersible and ROV dives. South Atlantic Fishery Management Council and NOAA National Marine Fisheries Service. 163 pp., HBOI Contribution Number 1815.

Thiago Correa, G. Eberli, M. Grasmuecka; J.K. Reed, K. Verwer, S. Purkis. 2010 (submitted). Quantitative habitat characterization of cold-water coral ridges at the Straits of Florida. *Nature Geoscience*.

Baumberger, R.E., N. J. Brown-Peterson, J.K. Reed, and R. Grant Gilmore. 2010. Spawning aggregation of beardfish, *Polymixia lowei*, in a deep-water sinkhole off the Florida Keys. *Copeia* 1: 41-46. HBOI Contribution Number 1789.

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Messing, Charles G., Maria Cristina Diaz, Kevin Kohler, John K. Reed, Klaus Ruetzler, Rob van Soest, Janie Wulff, and Sven Zea. 2009. South Florida sponges, a guide to identification. http://www.nova.edu/ncri/sofla_sponge_guide/index.html#guide. National Coral Reef Institute, Oceanographic Center, Nova Southeastern University. HBOI Contribution Number 1797.

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Kemani Wangun, H, A. Wood, C. Fiorella, J. Reed, P. McCarthy, A. Wright. 2010. Gymnochromes E and F: cytotoxic Phenanthroperylenequinones from a deep-water crinoid, *Holopus rangii*. *Journal of Natural Products*. HBOI Contribution Number 1799.

Wright A.E., G.P. Roth, J.K. Hoffman, D. B. Divlianska, D. Pechter, S.H. Sennett, E.A. Guzmán, P. Linley, P.J. McCarthy, T.P. Pitts, S.A. Pomponi, and J.K. Reed. 2009. Isolation, synthesis, and biological activity of aphrocallistin, an adenine-substituted bromotyramine metabolite from the Hexactinellida sponge Aphrocallistes beatrix. J Nat Prod. 72(6):1178-1183. HBOI Contribution Number 1733.

Reaka, M.L., S.Altman, D. Ballantine, M. Dowgiallo, D. Felder, R. Pyle, J. Reed, H. Spalding, E. Theil, E. Weil. 2009. (in press). Biodiversity of mesophotic coral ecosystems. Coral Reefs.

HBOI Technical/Miscellaneous Reports

Reed, J.K. and S. Farrington. 2011. Final Cruise Report. Florida shelf-edge expedition (FLoSEE), deepwater Horizon oil spill response: Survey of deepwater and mesophotic reef ecosystems in the eastern Gulf of Mexico and southeastern Florida. R/V Seward Johnson, Johnson-Sea-Link II Submersible, July 9-August 9, 2010. 82 pages. HBOI Technical Report Number 127.

Reed, J.K., C. Messing, B. Walker, S. Brooke, M. Brouwer, T. Correa, and S. Farrington. 2011. Distribution and habitat characterization of deep-sea coral ecosystem habitat off Florida, southeastern United States. American Society of Limnology and Oceanography, 2011 International Aquatic Sciences Meeting, February 13-18, 2011, San Juan Puerto Rico. HBOI Miscellaneous Contribution Number 689.

Messing, C., B. Walker, J. Reed, and S. Farrington. 2011. South Florida Ocean Measurement Facility: deep-water benthic habitat characterization. R/V Freedom Star and Navy TONGS ROV. Navy Surface Warfare Group, Ft. Lauderdale, FL. HBOI Technical Report No. 128.

Reed, J.K., C. Messing, B. Walker, S. Brooke, M. Brouwer, T. Correa, and S. Farrington. 2010. Distribution and characterization of deep-water reef and hard-bottom habitats off eastern Florida. Renewable Ocean Energy and the Marine Environment: Responsible Stewardship for a Sustainable Future, Nov. 2010, Florida Atlantic University. Abstract, p. 42. HBOI Miscellaneous Contribution Number 687.

J. Reed, and S. Farrington. 2010. Distribution of deep-water commercial fisheries species-golden crab, tilefish, royal red shrimp- in deep-water habitats off eastern Florida from submersible and ROV dives. South Atlantic Fishery Management Council and NOAA National Marine Fisheries Service. 163 pp., HBOI Contribution Number 1815.

Pomponi, S., A. Shepard, J. Reed, D. Hanisak, T. Frank, A. Wright. 2010. Florida shelf edge expedition (FLoSEE) summary report: R/V *Seward Johnson* and *Johnson-Sea-Link* Submersible, July 9-August 9, 2010. The Cooperative Institute for Ocean Exploration, Research, and Technology: Deepwater Horizon Oil Spill Response. HBOI Miscellaneous Contribution Number 683.

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Reed, J.K.. 2010. Final report. Florida’s Deep-water oases: exploration and characterization of deep reef ecosystems. Report to NOAA Office of Ocean Exploration, Grant Number NA07OAR4600290, July 2007- June 2009. HBOI Miscellaneous Contribution Number 682.

Reed, J.K. and S. Ross. 2010. Cruise report. Florida’s deep water oases- exploration of deep reef ecosystems; submersible survey of the deep-water *Lophelia* coral ecosystems off central eastern Florida. R/V *Seward Johnson* and *Johnson-Sea-Link II* Submersible, August 5-17, 2009. HBOI Miscellaneous Contribution Number 651.

CIOERT Website

FLoSEE Expedition Web site (cioert.org/flosee): Dedicated to the FLoSEE expedition featuring links to news events and articles, image gallery, daily logs from sea, and links to other resources relevant to mesophotic reefs and the DWH oil spill event.

Field Operations:

Year 1: Nov 2009-June 30, 2010

Support Vessel	Undersea Asset	# Dive Days	# Dives	Max Depth (m)
R/V <i>Nekton Rorqual</i>	UNCW Technical Dive Support	14	8	70
M/V <i>Spre</i>	UNCW <i>SuperPhantom</i> ROV	7	17	152
R/V <i>Manta</i>	UNCW <i>SuperPhantom</i> ROV	7	19	150

Year 2: July 1, 2010 – March 31, 2011

Support Vessel	Undersea Asset	# Dive Days	# Dives	Max Depth (m)
R/V <i>Seward Johnson</i>	<i>Johnson-Sea-Link</i> submersible	32	50	500

PROJECT #: Y2-5.5.1

TITLE: *Exploration and characterization of Deep Sea Coral Ecosystems off the Southeast US*

PRINCIPAL INVESTIGATORS:

Steve W. Ross (UNCW, Chief Scientist, Lead PI) - Overall organization and science, fish studies
Sandra Brooke (MCBI-OIMB, Co-Chief Sci, Co-PI) – Coral biology, site selection
John Reed (FAU) – natural products, sponges, site selection, golden crab distributions
Liz Baird (NC Museum Nat. Sci.) - education/PR activities, web/email
Brendan Rourke (TAMU) Coral age, growth, paleoecology
Scott France (LSU) Octocoral genetics
Katherine Coykendall (USGS) Scleractinian genetics

Other NOAA Collaborators:

Martha Nizinski (NMFS- Systematics Lab)
Andy David (NMFS- Pascagoula Lab)
John Tomczuk (DSCRTP – Silver Spring)
Steve Matthews (NMFS- Pascagoula Lab)

PROJECT DURATION: Year 1 of 1 (FY09-10).

GOALS:

CIOERT Research Themes: _xx_ Technology Innovation, __Exploring Shelf Frontiers, _xx_ Vulnerable Coral Ecosystems, _xx_ Education/Outreach

NOAA Goals: _x_ Protect, restore, and manage the use of coastal and ocean ecosystem based management; __ Understand climate variability and change to enhance society's ability to plan and respond; __ Serve society's needs for weather and water information; __ Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation; __ Mission support.

OER Strategic Goals:

- **ACTIVITY 1:** Interdisciplinary exploration of the oceans in both space and time.
 - Exploration Goal 1.1 Discover and characterize new resources in the oceans.
 - Exploration Goal 1.2 Discover ecosystem processes in the oceans.
 - Exploration Goal 1.3 Map and characterize key features and habitats.
- **ACTIVITY 2:** Systematic research focused on transformation of discoveries into useful knowledge.
 - Research Goal 2.1 Discover and understand ecosystems in the ocean, including the U.S. Continental Shelf and beyond.
 - Research Goal 2.4: Ocean Dynamics: Episodic Events to Long Term Changes.
- **ACTIVITY 3:** Development and utilization of advanced underwater technology to expand the pace and scope of exploration and research.
 - Technology Goal 3.2 Stimulate and support creative development of new technologies and improvement of existing technologies.
 - Technology Goal 3.4 Transition new technologies to appropriate users within NOAA and the broader scientific community.
- **ACTIVITY 4:** Through education and outreach, engage a wide variety of audiences by innovative means.

- Education Goal 4.1 Enhance ocean science literacy as it relates to discovery and understanding of new resources and ecosystem processes; mapping and characterizing key features and habitats; and, identifying, developing and applying science tools to increase the pace, efficiency and scope of discovery and understanding of the ocean.
- Outreach Goal 4.1 Use the Web to reach out to diverse audiences effectively and efficiently to communicate key ocean messages in ways that inform and educate individuals and organizations in general and targeted audiences.

PROJECT OVERVIEW

During a 2009 expedition co-sponsored by CIOERT and the NOAA Coral Reef Conservation Program, a human-occupied submersible was deployed on deep sea coral ecosystems off the east-central coast of Florida, to characterize high relief mounds discovered during recent multibeam echosounder surveys. Target sites included areas in the newly designated Habitat Areas of Particular Concern, which may be affected by existing deep water bottom fisheries. The NOAA Deep Sea Coral Team for the Southeast Region (NC to South Florida) asked CIOERT to oversee a 2010 expedition using the NOAA ship Ronald H Brown and Woods Hole Oceanographic Institution's Jason ROV. Goals and objectives of the cruise respond to NOAA's Coral Reef Conservation Program 2009 Science Plan for DSCE off the southeast US (in prep.). Like the 2009 expedition, the 2010 cruise was a partnership between NOAA (CIOERT and other partners), USGS, and a variety of other academic collaborators. The public in the expedition through Web products and video production. Outcomes will include: new imagery and mapping products available to the South Atlantic Fisheries Management Council (SAFMC) and NOAA CRCP; characterization of the target sites to be conveyed in presentations and publications; new data from benthic landers developed especially for this mission; and outreach and education products that promote ocean literacy.

PROGRESS REPORT

The following progress information was excerpted from the post-cruise report prepared by co-PIs, Dr. S. Ross, UNCW, and Dr. S. Brooke, MCBI-OIMB. NOAA's Coral Reef Conservation Program, through its Deep Sea Coral Research and Technology Program (DSCRTP) sponsored this research expedition, which was part of the second year of a three-year research effort in the SEUS region. This expedition maintains continuity with the DSCRTP 2009 cruise (see http://fl.biology.usgs.gov/DISCOVER/cruise_plan_2009.html). Like the 2009 expedition, the 2010 cruise was a partnership between NOAA, the University of NC at Wilmington, USGS, and a variety of collaborators. The multi-disciplinary team of investigators addressed: 1) program needs of the NOAA DSCRTP, 2) management needs of the South Atlantic Fishery Management Council (SAFMC), and 3) ongoing participant research priorities. Scientists from NOAA's Cooperative Institute for Ocean Exploration Research and Technology (CIOERT) participated in the mission and collaborated on multiple science objectives.

The research cruise utilized the NOAA ship Ronald H. Brown and the Jason II ROV (Woods Hole Oceanographic Institute). The research objectives emphasized the use of the ROV, but allowed for other sampling activities to generate data for complementary objectives. This expedition occurred immediately after a similar deep coral cruise (Lophelia II project funded by BOEMRE) in the GOM using the same ship and ROV. While impacts from the Deepwater Horizon oil spill seemed unlikely in this part of the Atlantic, cruise participants were aware of potential impacts, but no oil-related phenomena were observed.

All target study sites for this project were on the continental slope (> 200 m) off the East coast of Florida, except for one station on the West Florida slope that was visited during transit to the Atlantic (Figs. 1). Multibeam sonar data from past surveys (as well as new data collected during the cruise) were used to help identify dive and sampling sites as well as to improve ROV navigation. Target sites were prioritized according to several criteria: 1) areas that were poorly explored and had a high probability of having well developed coral ecosystems, 2) areas that were high priority for the South Atlantic Fishery Management Council, 3) areas that represented data gaps in long term studies, 4) new areas that had not been explored previously. Similar methodologies were applied at all sites to facilitate large area comparisons.

The cruise mobilized in Pensacola, FL (08-09 Nov 2010) and demobilized in Cape Canaveral, FL (23 Nov). The ROV Jason II was used to conduct video transects and other photographic documentation, deploy equipment and make collections to meet the cruise objectives. When weather permitted, a single ROV dive was completed per day, and generally one to two days were spent at each site. In addition to ROV operations, several multibeam sonar surveys, CTD/Niskin rosette casts, and otter trawls were conducted.

Although weather was marginal for much of the cruise, the cruise was generally considered successful. Twenty-nine non-ROV stations were sampled or surveyed during this cruise, and nine ROV dives were successfully accomplished (Figs. 1). Most of the scheduled ROV dives were accomplished, although many were of shorter duration than planned due to weather, equipment issues and challenges of working in the Gulfstream. While ROV dives were assigned one station number, all dives accomplished multiple objectives.. The non-ROV stations included 22 CTD casts and 7 otter trawl tows. Several small colonies of *Lophelia* were collected and maintained alive in a chilled re-circulating system on the ship, and respiration experiments were conducted on board ship with these samples. Summary of all samples collected is included in Table 1.

Table 1. Summary subsamples collected on eastern and western Florida slopes during 9-22 November 2010 Ronald H. Brown cruise. Number of taxa is based on tentative identifications conducted in the field and is subject to change as data are analyzed.

Sample Type	No. Taxa
Isotope (Trophic study)	10
Genetic	38
Photo	n/a
Water Samples	16
ROV macrofauna collection	62
Paleoecology – Corals	5
Reproduction & Biology – Corals	8
Reproduction - Other Invertebrates	2
Taxonomy – Crinoids & Forams	2
Biomedical & Taxonomy - Sponges	14

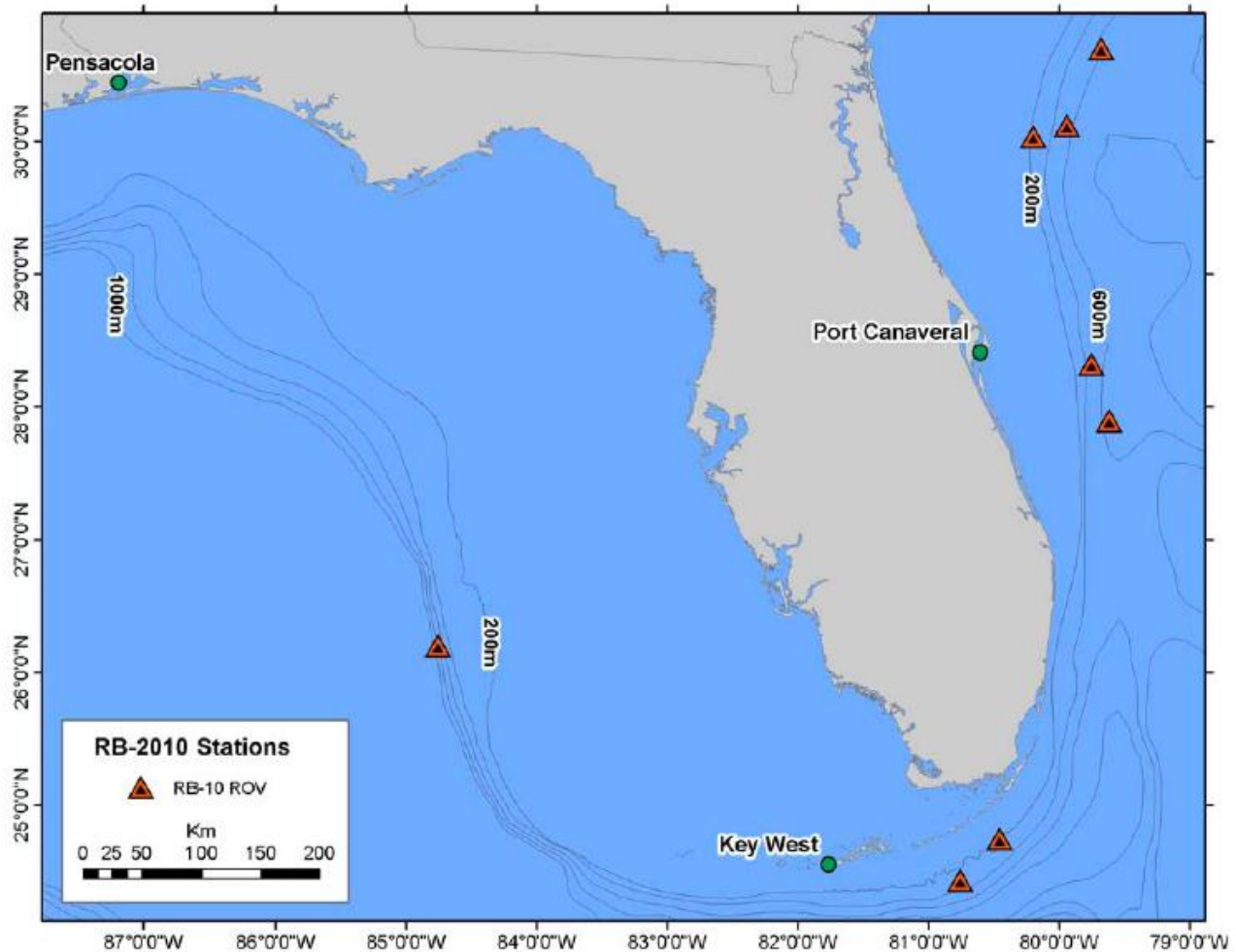


Figure 1. Overall area sampled during 9-22 November 2010 cruise of NOAA ship *Ronald H. Brown* (RB). Cruise originated in Pensacola, FL and ended in Cape Canaveral, FL. See Figs. 2 and 3 for details of selected areas.

Education and outreach activities included:

- North Carolina Museum of Natural Sciences (NCMNS) provided outreach and education support before, during and after the 14 day Extreme Corals Expedition. Participants included museum educator, Mike Dunn (Senior Manager of Outreach), and living collections specialist, Peyton Hale.
- Cleveland County 8th grade science teacher, Beverly Owens, assisted with research operations and web site outreach and education. Cleveland County School System posted daily pictures from Ms. Owens, keeping the entire county linked to the mission.
- NCMNS website (<http://deepcoral.wordpress.com>) included a daily blog, biographies of the research team, links to partners, related sites, and websites for previous missions. Blog provided information about the daily activities on the ship and interviews with the science team and ship and ROV crew. Over the course of the cruise there were 41 posts and 62 comments. The blog page received 4,160 views as of January 2011.
- CIOERT website (<http://cioert.org/xcorals>) covered press releases, an expedition overview, and an explanation of NOAA's DSCRTP program objectives, and linked to the Museum site so that visitors to either location could read the daily updates and see the images.

- Emmy-award winning photographer, Art Howard, provided topside imagery and assisted with imagery-related products. Twenty-five still images were provided for the press kit, and a DVD with 5 minutes of edited underwater footage was prepared for press distribution.
- On 26 Nov 2010, NOAA and partners distributed a press release to the media describing this cruise. Articles appeared in several publications, including: Daytona Beach News Journal (<http://www.news-journalonline.com/news/local/east-volusia/2010/11/27/aquatic-showcase-nearby.html>), TCPalm (<http://www.tcpalm.com/news/2010/nov/24/noaa-news-expedition-explores-previously-uncharted/>), Cleveland County Schools site (<http://www.clevelandcountyschools.org/index.php/news/41-district-news/396-follow-cms-science-teacher-on-15-day-deep-sea-coral-expedition>).
- Cleveland County cable TV station interviewed Beverly Owens about the cruise.

PRODUCTS:

Outcomes (one-page, emphasize major outcomes such as new discoveries, economic benefits, capabilities transitioned to NOAA operations, or ocean management decisions impacted by your project):

The shallowest known *Lophelia* ecosystem in the US was discovered at ~200m off Jacksonville Florida. This site was of unusually low temperature (8°C) for such depths, and considering the suite of deep coral fauna, must represent some kind of permanent oceanography anomaly. Dives on deep sites in the Jacksonville area revealed extensive deep coral ecosystems. This area certainly warrants further exploration. We also discovered deep corals on a new site off Vero Beach, and on the previously explored mounds of Triceratops.

Outputs:

Technology developments (short paragraphs including name and transition plans):

Publications (list): Pending

Presentations (list): Pending

Other outputs (list, e.g., outreach products, models, curriculum/lesson plans):

‘Extreme Corals 2010’ was featured on two internet sites (<http://deepcoral.wordpress.com> and <http://cioert.org/xcorals>) that documented cruise progress and facilitated public awareness of deep coral ecosystems and cruise objectives. These sites were linked to and supplemented by other sites, which also had information about past missions (<http://naturalsciences.org/microsites/education/deepsea/index.html>) or about deep-sea corals in general (www.lophelia.org).

FIELD OPERATIONS:

Dive Areas (please attach map products if available):

Geographic Name	Lat/Long	Depth Range	Port Used
Florida west coast	26-12/84-45	200-800	Pensacola, FL
Florida east coast	30-41/79-41	200-800	Cape Canaveral, FL

Support:

Ship (Name)	At-sea days	Cruise Dates	Work Plan Deviations
NOAA Ship Ron Brown	13	9-23 Nov 2010	

Undersea Assets:

Asset (name)	Dive Days	Dates	Max. Depth	Work Plan Deviations
Jason ROV	9	9-23 Nov 2010	800 m	Weather cancelled 4 dives and shortened two others. Difficulties deploying JASON in the Gulfstream also resulted in much shorter bottom time than expected.

PROJECT #: 2010-6.3.1

TITLE: “Ocean Discovery”: At-Sea Research Opportunities for the Next Generation of Ocean Scientists

PRINCIPAL INVESTIGATORS:

Dennis Hanisak (HBOI/FAU), Tamara Frank (HBOI/FAU), Gorka Sancho (College of Charleston), Leslie Sautter (College of Charleston),

RELATED NOAA GOALS:

- CIOERT Research Themes: X Technology Innovation, X Exploring Shelf Frontiers, X Vulnerable Coral Ecosystems, X Education/Outreach
- NOAA Goals: x Protect, restore, and manage the use of coastal and ocean ecosystem based management; __ Understand climate variability and change to enhance society’s ability to plan and respond; __ Serve society’s needs for weather and water information; __ Support the Nation’s commerce with information for safe, efficient, and environmentally sound transportation; x Mission support.
- NOAA Research (OAR) Plan: Explore the oceans - Milestone: 0-2y: Raise student, teacher, and public awareness and stewardship of the oceans through a significant web presence, curriculum development, and signature expeditions.
- OER Strategic Outcomes (see 1/25/10 Guidance Memo, Att. A): X Interdisciplinary exploration, X Development and utilization of advanced underwater technology, X Systematic research, X Education and outreach
 - Exploration Outcomes: Goal 2.1 - Discover and understand ecosystems in the ocean and especially the eastern U.S. Continental Shelf.
 - Technology Outcomes: Goal 3.4 - Transition new technologies to appropriate users within NOAA and the broader scientific community.
 - Research Outcomes: Goal 1.2 - Discover ecosystem processes in the oceans. (i.e., enable understanding of linkages between pelagic and deep-sea ecosystems, particularly for coral communities).
 - Education/Outreach Outcomes: Goal 4.1. - Enhance ocean science literacy as it relates to discovery and understanding of new resources and ecosystem processes; mapping and characterizing key features and habitats; and identifying, developing and applying science tools to increase the pace, efficiency and scope of discovery and understanding of the ocean.

PROJECT OVERVIEW:

“Ocean Discovery” is CIOERT’s project to provide at-sea research opportunities for the next generation of scientists. This project builds on (1) FAU’s *Oceanographic Experience for Undergraduates* course, piloted in 2009 and continued each year thereafter at FAU, by Drs. Tammy Frank, Ned Smith, and Dennis Hanisak, as part of the HBOI/FAU Semester By The Sea Program and (2) the successful Year 1 CIOERT cruise in support of the Transect Program, developed by Drs. Leslie Sautter and Gorka Sancho (College of Charleston). These cruises and courses have successfully demonstrated that actual research experience is a highly effective tool for training university students in ocean sciences. Based on those experiences and the overall mission of CIOERT, in Year 2, we began the first of a series of CIOERT “Ocean Discovery” cruises that increase “hands-on”, at-sea, multi-disciplinary opportunities for advanced undergraduate and graduate students in the CIOERT region, with each cruise focused on one or more of CIOERT’s themes. The critical goal of this

program is to facilitate students to become successful scientists through active participation and immersion in a multi-disciplinary ocean sciences research and monitoring cruise, followed by a rigorous, laboratory-based oceanographic research course. In Year 2, this goal was successfully accomplished during Leg 4 of CIOERT's Florida Shelf Edge Exploration (FLoSEE) cruise that explored the shelf edge ecosystems of Florida. Students were fully integrated into each day of FLoSEE's operations and worked with PIs involved with all 3 CIOERT research projects on the expedition, who continued to fully conduct their research activities during that same leg. Students then completed a full semester course during the fall which led to each student developing a project, collecting appropriate data, and producing both a written research paper and scientific poster. Continued implementation of CIOERT's "Ocean Discovery" cruises will provide a high-quality research experience for university students each year at a critical junction in their academic training. Their student presentations will also impact their peers and younger students who may then also aspire to ocean-related careers.

PROGRESS REPORT

Completion of Year 1 Work Plan: College of Charleston TRCH-05, Cruise November 13-17, 2009, Spring Semester Class 2010 (PI's: Leslie Sautter, Gorka Sancho)

In addition to what was proposed in our Year 2 work plan, three remaining tasks from the Year 1 project were completed by the College of Charleston (PI's: Leslie Sautter, Gorka Sancho):

- (1) Completion of program surveys/evaluations from Year 1
- (2) Finalization of web site student research results from Year 1
- (3) Completion of graduate thesis work on phytoplankton/domoic acid research from Year 1

The 5-day research cruise portion of the inaugural CIOERT Transect Program was initiated on November 13, 2009 and completed on November 17, 2009, aboard the *R/V Savannah*, a UNOLS vessel owned/operated by Skidaway Institute of Oceanography. This leg was the fifth Transect Program conducted at the College of Charleston. Led by co-PIs Gorka Sancho and Leslie Sautter (Biology Department and Department of Geology and Environmental Geosciences respectively, College of Charleston), 12 undergraduate students were selected from both Geology and Marine Biology applicants. Six students from each major were selected. In addition, two Masters of Environmental Studies graduate students, Liz Symon and Tom Smith, participated as assistant scientists.

Completion of program surveys/evaluations from Year 1

In order to assess the program's impact on undergraduate students, several evaluation methods were used including: pre-cruise, post-cruise, and post-program email questionnaires. 100% of the participants completed the pre-cruise and post-cruise surveys. 50% of the participants completed the post-program email questionnaire. The surveys consisted of essay questions and choices from a five-point Likert-type scale ranging from "highly agree" to "highly disagree." The post-program email questionnaire consisted of asking for updates on career routes/ internships, future plans and/or further schooling opportunities. The responses from the surveys were used to provide evidence whether or not the program met its objectives and served as a positive impact for participating students as an influential factor in student decisions concerning future jobs, internships and further schooling. Table 1 lists the student research project titles with associated research area.

Program evaluations/surveys from the year 1 cruise have been completed. The surveys revealed an overwhelmingly positive response on the program's success rates in enhancing the undergraduate research experience. Some of the results included:

- 100% of the students agreed (92% highly agree; 8% agree) they wish to pursue a career in a science-related field, 100% agreeing (75% highly agree; 25% agree) specifically an ocean science career
- 92% of the students agreed (50% highly agree; 42% agree) the research cruise enhanced their understanding of the way scientific knowledge is constructed
- 100% of the students agreed (75% highly agree; 25% agree) that they learned what specific equipment is appropriate for specific data collection, felt comfortable operating the equipment, and felt comfortable working aboard a ship for an extended period of time
- 100% of the students agreed (67% highly agree; 33% agree) that they plan to seek other research opportunities aboard research vessels
- 75% of the students felt their level of biology was highly impacted
- 58% of the students felt their level of geology was highly impacted

Finalization of web site student research results from Year 1

Student abstracts, student poster presentations, and selected student Powerpoint presentations have been published on the website (www.oceanica.cofc.edu). Student survey results were cleaned up and edited for web publication.

Completion of graduate thesis work on phytoplankton/domoic acid research from Year 1

Few studies have been done on phytoplankton off shelf waters in the southeast coast of the U.S. To provide evidence of the program's ability to enable undergraduate oceanographic research, phytoplankton composition and distribution results from Legs 03 (November 2004) and 05 (November 2009) were used. An interannual marine phytoplankton community dynamics survey in continental shelf waters off of Charleston, SC was conducted. The results from both cruise legs in which undergraduates participated in were used in order to provide an example of how undergraduate research can contribute to the scientific community and future scientific endeavors. Using the successful monitoring protocols of the Transects Program along with an undergraduate workforce and the outreach and research objectives of NOAA's Phytoplankton Monitoring Network (PMN), the phytoplankton data from Legs 03 and 05 are currently being used to design procedures for a future offshore HAB monitoring plan for coastal waters off the coast of Charleston, SC collaborating the Transects Program with NOAA's PMN. Final completion of the graduate thesis associated with this work by Elizabeth Minor is expected to occur in fall 2011. In addition, a manuscript is being prepared for submission to a peer-reviewed journal utilizing the survey results and student phytoplankton results of the Transects Program in the coming months of fall 2011 as well.

Table 1. Student Research Areas and Research Project Titles

Research Area	Research Project Title
Continental Shelf Sediments	<ul style="list-style-type: none"> • Changes in Cross-shelf Sand Size Distribution off the Coast of Charleston, SC from 2003-2009 • Sediment Grain Size Distribution and Mineral Composition across the Continental Shelf off Charleston, SC
Benthic Habitats and Organisms	<ul style="list-style-type: none"> • Habitat Characterization of Continental Shelf Seafloor off Charleston, SC • Relationship of Coarse-grained Sediment Distribution and Composition with Echinoderm Species' Habitat Preferences • Distribution of Decapod Crustaceans along the South Atlantic Bight off the Coast of Folly Beach, SC • Seasonal Variation in Demersal Fish Diversity and Abundance in the South Atlantic Bight
Benthic Foraminifera	<ul style="list-style-type: none"> • Comparison of Benthic Foraminifera between Two Cross-Shelf Transects off Charleston, SC • Cross-shelf Benthic Foraminifera Distribution off the Charleston SC Coast
Phytoplankton	<ul style="list-style-type: none"> • Interannual marine phytoplankton community dynamics in continental shelf waters off Charleston, SC
Zooplankton	<ul style="list-style-type: none"> • Distribution and Diel Vertical Migration of Zooplankton in the South Atlantic Bight • Diversity and Distribution of Pteropods across the Continental Shelf of South Carolina • Diel Vertical Migration and Cross-shelf Distribution of Ichthyoplankton off Charleston, SC

Progress of Year 2 Work Plan: HBOI-FAU, FLoSEE Cruise, Leg 4, August 2-9, 2010, Fall Semester Class 2011 (PI's: Dennis Hanisak, Tammy Frank)

The Year 2 CIOERT Ocean Discovery Program was originally planned as a cruise in May 2011, followed by a summer course, to collect samples and data during a 7-day research cruise aboard the *R/V Walton Smith* (owned/operated by the University of Miami), analyze the data in the laboratory classroom, and prepare documentation and professional-style presentations of their results and interpretations. Due to CIOERT's rapid response to the *Deepwater Horizon*, we were able to do the cruise aboard the *R/V Seward Johnson*, with HBOI/ FAU's *Johnson-Sea-Link II* submersible, July 9 - August 9, 2010. This change provided much greater capacity and capability for the CIOERT cruise than proposed, but meant that we had very little time to prepare for the course. Even with the shortened timeline, we were able to recruit 7 graduate students, 6 of whom who had never been at sea, for Leg 4 of the FLoSEE cruise (<http://cioert.org/flosee/>)

Year 2 Tasks, Timelines and Milestones

The original proposed time line for Year 2, with brief statements of progress follows:

Activity	Year 2 Timeline											
	J	A	S	O	N	D	J	F	M	A	M	J
1		X	X	X								
2					X	X	X	X				
3										X		
4											X	
5											X	X
6												X

- (1) Develop cruise plan for *RV Walton Smith* cruise and syllabus for *Oceanographic Exploration of Florida's Continental Shelf*. The cruise plan for the *R/V Seward Johnson* cruise was developed in June 2010; the syllabus was developed for the course *Immersion in Ocean Sciences* in July 2010.
- (2) Recruit students for *Oceanographic Exploration of Florida's Continental Shelf*. 7 graduate students were recruited in July 2010 (see photograph above).
- (3) Pre-cruise meetings with participants. Due to the major change in cruise plans, preparation for the cruise was done by pre-cruise e-mails and orientation in port immediately prior to the cruise
- (4) 7-day oceanographic research cruise. The cruise was conducted as Leg 4 (August 2-9, 2010) of the FLoSEE cruise. Students worked in two teams, alternating each day between a benthic team (emphasis on submersible collections and their processing) and a pelagic team (emphasis on CTD and zooplankton sampling) with each student rotating to all roles within each team.
- (5) A 4-credit hour *Oceanographic Exploration of Florida's Continental Shelf* laboratory course taught by the PI's and other FAU CIOERT researchers. Due to the actual cruise unexpectedly occurring in the summer after course listings were already in place, the course was offered in the Fall 2010 term as a 3-credit course, entitled *Immersion in Ocean Sciences*. Instructors were all CIOERT researchers who were on the FLoSEE expedition: Tammy Frank, Dennis Hanisak, and John Reed.
- (6) Research Poster Presentations (end of course). Students presented their research both as written research papers and scientific posters. Posters were presented at a CIOERT Ocean Discovery Student Research Symposium on December 8, 2010, with CIOERT and other FAU scientists participating
- (7) Posting of web resources on the CIOERT website (within 1 month of the course). Materials were posted (blogs and images) on the FLoSEE website (<http://cioert.org/flosee/>).
- (8) Submission of select manuscripts (within 6 months of the course). After final edits are made, selected student manuscripts will be submitted for publication on the CIOERT *Ocean Discovery* cruise website by June 30, 2011.

Outcomes/Outputs:

The National Academy of Science (2007) in its landmark report, *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, reported on the crisis in U.S. science and technology, and recommended key actions for restoring U.S. world leadership largely through improving STEM (Science, Technology, Engineering and Math) efforts. Consistent with solutions to this crisis is NOAA's Education Mission: "to advance environmental literacy and promote a diverse workforce in ocean, coastal, Great Lakes, weather, and climate sciences to encourage stewardship and increase informed decision making for the Nation" (NOAA Education 2008).

"Ocean Discovery" is CIOERT's project to provide at-sea research opportunities for the next generation of scientists. This project builds on (1) FAU's *Oceanographic Experience for Undergraduates* course, piloted in 2009 and continued each year thereafter at FAU, by Drs. Tammy Frank, Ned Smith, and Dennis Hanisak, as part of the HBOI/FAU Semester By The Sea Program and (2) the successful Year 1 CIOERT cruise in support of the Transect Program, developed by Drs. Leslie Sautter and Gorka Sancho (College of Charleston). These cruises and courses have successfully demonstrated that actual research experience is a highly effective tool for training university students in ocean sciences.

Based on those experiences and the overall mission of CIOERT, in Year 2, we began the first of a series of CIOERT "Ocean Discovery" cruises that increase "hands-on", at-sea, multi-disciplinary opportunities for advanced undergraduate and graduate students in the CIOERT region, with each cruise focused on one or more of CIOERT's themes. The critical goal of this program is to facilitate students to become successful scientists through active participation and immersion in a multi-disciplinary ocean sciences research and monitoring cruise, followed by a rigorous, laboratory-based oceanographic research course.

In Year 2, this goal was successfully accomplished during Leg 4 of CIOERT's Florida Shelf Edge Exploration (FLoSEE) cruise that explored the shelf edge ecosystems of Florida from July 9-August 9, 2011. Students were fully integrated into each day of FLoSEE's operations and worked with PIs involved with all 3 FLoSEE projects on the expedition (Project 2010-5.3.1, *Mesophotic Reef Ecosystems*; Project 2010-4.2.1, *The Linkage between Pelagic and Benthic Ecosystems*; and Project 2010-4.3.1, *Discovery of Novel Therapeutic Agents from Marine Frontier Habitats*), who continued to fully conduct their research activities during that same leg. Students then completed a full-semester course, *Immersion in Ocean Sciences*, during the fall which led to each student developing a project, collecting and processing appropriate samples and data, and producing both a written research paper and scientific poster. Continued implementation of CIOERT's "Ocean Discovery" cruises will provide a high-quality research experience for university students each year at a critical junction in their academic training. Their student presentations will also impact their peers and younger students who may then also aspire to ocean-related careers.

The Ocean Discovery cruises train the next generation of scientists and NOAA employees in both traditional and novel research methodologies by providing a wide range of expertise for university students: increasing "hands-on" at-sea, multi-disciplinary opportunities; providing accredited courses taught by CIOERT scientists, engineers, and educators; and integrating these student scientists into cutting-edge CI research projects. Students have the opportunity to work alongside faculty researchers from partnering research institutions, while being trained in both traditional and novel research methodologies.

CIOERT’s “Ocean Discovery” cruises communicate the excitement of research and discovery to university students at a critical stage of their career decision-making. “Ocean Discovery” provides a high-quality research experience for students by engagement in actual ocean monitoring and research through shipboard data collections and analyses. Such training opportunities for aspiring marine scientists, with active participation and immersion in multi-disciplinary ocean sciences research, are rare. Student research questions are created in association with CIOERT research projects. Student presentations impact their peers and younger students who may then also aspire to ocean-related careers. Student experiences and knowledge are transferred to the general public, college students, pre-college teachers, and their students via presentations and web-based resources.

CIOERT is committed to bringing “science at sea” experiences to university students, in the context of a complete research project—from data collection to presentation. In addition to significant student learning and training in ocean sciences, scientific knowledge will be impacted, due to the numerous multi-disciplinary studies that will be conducted with CIOERT researchers. As has been shown by FAU/HBOI’s Semester By The Sea Program and the College of Charleston’s Transect Program, the CIOERT Ocean Discovery Program is expected to increase the post-college involvement of students in ocean sciences and technology by immersing them directly into multidisciplinary marine science research. Through active engagement in the entire process of research, students will not only increase their understanding of the scientific process, but also they will observe, study and characterize ocean conditions and selected benthic and pelagic habitats across the continental shelf. Student participation in Ocean Discovery cruises will utilize new technologies developed by CIOERT research projects and incorporated in these student training cruises, exposing the students to new innovations, such as the *Kraken* (or *Mohawk*) ROV proposed in Year 3. There is a high probability the Ocean Discovery students will become tomorrow’s marine scientists, educators, and managers, all working, directly or indirectly, in support of NOAA’s mission.

Field Operations (FLoSEE Cruise, students specifically worked on Leg 4)

Support Vessel	Undersea Asset	# Ops Days	# Dives	Max Depth (m)
<i>R/V Seward Johnson</i>	<i>Johnson-Sea-Link II</i>	32	50	500

APPENDIX: NOAA CI TABLES FOR PUBLICATIONS AND PERSONNEL

SUMMARY TABLES:

Table A-1. Publications resulting from project.

Type	Inst. Lead Author	NOAA Lead Author	Other Lead Author
Peer reviewed	2	3	7
Non-peer reviewed	8	0	2

Table A-2. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist	3	3		
Visiting Scientist				
Postdoctoral Fellow				
Res. Support Staff	1	1		
Administrative	1	1		
OTHER:				
Employees with <50% CI funding (not including students)	13.90	0.75	4	9.15
Employees Co-located at NOAA Lab				
Undergrad students	5	5		
Graduate students	16		15	1
Obtained NOAA employment within last year				

PROJECT TABLES—Data reported above, detailed by projects below:

PI: Pomponi
Proj: 1.0 (Task I)

Table A-2. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist				
Visiting Scientist				
Postdoctoral Fellow				
Res. Support Staff				
Administrative	1	1		
OTHER:				
Employees with <50% CI funding (not including students)				
Employees Co-located at NOAA Lab				
Undergrad students				
Graduate students				
Obtained NOAA employment within last year				

PI: Pomponi
Proj #2.0

Table A-1. Publications resulting from project—please forward pdf copies of publications when available.

Type	Inst. Lead Author	NOAA Lead Author	Other Lead Author
Peer reviewed		3	1
Non-peer reviewed	1		

Table A-2. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist				
Visiting Scientist				
Postdoctoral Fellow				
Res. Support Staff	3	3		
Administrative				
OTHER:				
Employees with <50% CI funding (not including students)				
Employees Co-located at NOAA Lab				
Undergrad students	4	4		
Graduate students	8		8	
Obtained NOAA employment within last year				

PI: Szmant, Whitehead, Baden, Mazel
Proj. #: 3.3.2.1

Table A-1. Publications resulting from project—please forward pdf copies of publications when available.

Type	Inst. Lead Author	NOAA Lead Author	Other Lead Author
Peer reviewed			
Non-peer reviewed	1		

Table A-2. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist				
Visiting Scientist				
Postdoctoral Fellow				
Res. Support Staff				
Administrative				
OTHER:				
Employees with <50% CI funding (not including students)				

Employees Co-located at NOAA Lab				
Undergrad students	1	1		
Graduate students				
Obtained NOAA employment within last year				

PI: Tamara Frank
Proj. #: 4.2.1

Table A-1. Publications resulting from project—please forward pdf copies of publications when available.

Type	Inst. Lead Author	NOAA Lead Author	Other Lead Author
Peer reviewed	0		
Non-peer reviewed	0		

Table A-2. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist	0			
Visiting Scientist	0			
Postdoctoral Fellow	0			
Res. Support Staff	0			
Administrative	0			
OTHER:				
Employees with <50% CI funding (not including students)	3			3
Employees Co-located at NOAA Lab	0			
Undergrad students	0			
Graduate students	0			
Obtained NOAA employment within last year	0			

PI: A. Wright, D. Baden
Proj. #:4.3.1

Table A-1. Publications resulting from project—please forward pdf copies of publications when available.

Type	Inst. Lead Author	NOAA Lead Author	Other Lead Author
Peer reviewed	0	0	0
Non-peer reviewed	0	0	0

Table A-2. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist				
Visiting Scientist				
Postdoctoral Fellow				

Res. Support Staff	1	1.0		
Administrative				
OTHER:				
Employees with <50% CI funding (not including students)	0.90	0.75		.15
Employees Co-located at NOAA Lab				
Undergrad students				
Graduate students				
Obtained NOAA employment within last year				

PI: A. Shepard
Proj #: 4.5.1

Table A-1. Publications resulting from project—please forward pdf copies of publications when available.

Type	Inst. Lead Author	NOAA Lead Author	Other Lead Author
Peer reviewed			
Non-peer reviewed			

Table A-2. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist				
Visiting Scientist				
Postdoctoral Fellow				
Res. Support Staff				
Administrative				
OTHER:				
Employees with <50% CI funding (not including students)	1		1	
Employees Co-located at NOAA Lab				
Undergrad students				
Graduate students				
Obtained NOAA employment within last year				

PI: John Reed
Proj. #: Y2-5.3.1; Mesophotic Reef Ecosystems

Table A-1. Publications resulting from project—please forward pdf copies of publications when available.

Type	Inst. Lead Author	NOAA Lead Author	Other Lead Author
Peer reviewed	2		6
Non-peer reviewed	6		2

Table A-2. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist				
Visiting Scientist				
Postdoctoral Fellow				
Res. Support Staff				
Administrative				
OTHER:				
Employees with <50% CI funding (not including students)	5		3	2
Employees Co-located at NOAA Lab				
Undergrad students				
Graduate students				
Obtained NOAA employment within last year				

PI: M. Dennis Hanisak
PROJ. #:2010-6.3.1

Table A-1. Publications resulting from project—please forward pdf copies of publications when available.

Type	Inst. Lead Author	NOAA Lead Author	Other Lead Author
Peer reviewed	0	0	0
Non-peer reviewed	0	0	0

Table A-2. CI supported personnel associated with project, including staff, collaborators and students.

Category	Total #	B.S.	M.S.	Ph.D.
≥ 50% SUPPORT FROM CI:				
Res. Scientist	0	0	0	0
Visiting Scientist	0	0	0	0
Postdoctoral Fellow	0	0	0	0
Res. Support Staff	0	0	0	0
Administrative	0	0	0	0
OTHER:				
Employees with <50% CI funding (not including students)	4	0	0	4
Employees Co-located at NOAA Lab	0	0	0	0
Undergrad students	0	0	0	0
Graduate students	8	0	7	1
Obtained NOAA employment within last year	0	0	0	0