



**Performance Report for Cooperative Agreement No: NA11SEC4810002  
for the Period from January 1 to June 30, 2012**

**University of Maryland Eastern Shore**

## **Living Marine Resources Cooperative Science Center**

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## **Executive Summary**

The mission of the Center is “*To develop exemplary academic and research collaborations that prepare a diverse student body for careers in marine and fisheries sciences*”. Established in October, 2001, the LMRCS was created as a cooperative agreement between NOAA Educational Partnership Program (NOAA EPP), the University of Maryland Eastern Shore (UMES), Delaware State University (DSU), Hampton University (HU), Savannah State University (SSU), the University of Miami (UM/RSMAS) and the University of Maryland Center of Marine Biotechnology now known as University of Maryland Center for Environmental Science Institute of Marine and Environmental Technology (UMCES-IMET). Oregon State University (OSU) was added to the consortium in 2011. UMES is the lead institution of the consortium.

The mission of the LMRCS is accomplished by addressing the following goals:

***Goal 1: Prepare the future workforce for marine and fisheries sciences***

***Goal 2: Strengthen collaborations across universities to enhance academic programs in marine and fisheries sciences***

***Goal 3: Develop an exemplary capacity for scientific collaborations among partner institutions in the fields of marine and fisheries sciences***

The Center continues to be guided by two management tracks, A) Administrative and B) Programmatic. The Administrative component includes the Center Director, Program Manager, Executive Committee, Center Core Administration and the Board of Visitors, whereas the Programmatic component includes the Technical Advisory Board that reviews proposals submitted annually to the Center for funding.

To accomplish Goal 1, the Center recruited 30 new students, and provided direct financial support to 72 students (16 Ph.D., 24 M.S., 32 B.S.) who received training in NOAA core science disciplines during this reporting period. Besides, more than 40 students who did not receive direct support from the Center benefited from center programs and infrastructure. Twelve (12) students graduated (7 BS, 4 MS, 1 Ph.D.) from the Center during this reporting period, whereas twelve (12) students interned at NOAA labs or labs of LMRCS partner institutions. Furthermore, the Center linked students to professional networks and employment opportunities in marine and fisheries science by providing support for them to attend scientific meetings such as the 2012 Ocean Sciences meeting in Salt Lake City, Utah where seven center students presented results of their research work, and NOAA EPP Education and Research Forum where 46 students presented their research results.

In order to maintain a pipeline of students into the marine sciences, the Center conducted summer 2012 activities for grades K-12 which impacted more than 200 students, including the Coast Camp for Youth at Savannah State University (#=100), CREST-CISCEP SEEL program at UMES (#=7), and the SciTech program at IMET in which >100 Baltimore area high school students participate annually, the Upward Bound Marine and Estuarine Science Program at UMES that reaches 25 high school students, and activities in marine science conducted at local schools by LMRCS faculty and graduate students.

To accomplish Goal 2, the Center used the Virtual Campus for curriculum development and seminars and expanded it to include courses which were offered online between Center partners and to students including a NOAA NEFSC contractor and a NOAA employee located in Woods Hole, MA enrolled in the Professional Science Master's (PSM) degree program at UMES. Seminars and several courses offered through the University of Maryland interactive video network (IVN) were made available to Center students during this reporting period. More than 29 NOAA scientific and administrative personnel were engaged in LMRCS education and outreach, scientific research and administrative functions. Three courses (Fish Ecology, Bayesian Statistics, Marine Population Dynamics) that are part of the “essential curriculum” recommended by NOAA Fisheries for training fisheries scientists were offered to students at the Center during spring 2012 semester. The Articulation Agreement document signed by six LMRCS partners has led to cross registration between partners for these courses.

Sixteen (16) students interned at NOAA Science labs during the reporting period. Additionally, six students took part in the 10 day NOAA LMRCS Winter Cruise held in January 2012. The purpose of the cruise was to provide at-sea experience to scientific personnel, graduate and undergraduate students of the LMRCS, conduct research related to impacts of climate change on distribution of megafauna, and assess abundance of monkfish and red crabs in deep waters of the north Atlantic.

The LMRCSC continued its Seminar Series during this reporting period by featuring presentations by two LMRCSC scientists from UMCES. These seminars were made available to students and scientists at the Center using the Virtual Campus technology.

In support of Goal 3, twelve (12) collaborative projects were funded by the LMRCSC for 2011-2012 following the review of 18 proposals by the TAB, and are currently underway. These collaborative projects address various aspects of NOAA's Next Generation Strategic Plan Goal (NGSG): "*Healthy Oceans - Marine fisheries, habitats, and biodiversity sustained within healthy and productive ecosystems*", and objectives: (1) Improved understanding of ecosystems to inform resource management decisions, (2) Recovered and sustained marine and coastal species, (3) Healthy habitats that sustain resilient and thriving marine resources and communities, and (4) Sustainable fisheries and safe seafood for healthy populations and vibrant communities. They also address some of the goals, objectives and priorities listed in NMFS 2007 Strategic Plan for Fisheries, such as Seafood safety (e.g. Organic contaminants in monkfish, *Lophius americanus*), research on Abundance and Life History of fish stocks (e.g. Development of *in-situ* assessment and observation methods for black sea bass, *Centropristis striata*), sustainable and environmentally sound aquaculture through the development of alternative feeds such as plant-based proteins (e.g. Taurine – the missing ingredient for development of fish free diets for aquaculture), and impacts of anthropogenic factors and environmental change on species (e.g. Temperature preference of Atlantic Croaker under normoxic and hypoxic conditions). The on-going and future research projects at the Center are intended to meet the mission of NOAA Fisheries: "*Stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems*". The TAB and NOAA scientists' involvement also ensures that the LMRCSC has a strong linkage with the mission of NOAA: "*To understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social and environmental needs*".

The following are highlights of the results obtained for some of the TAB projects. The development of *in-situ* assessment and observation methods for black sea bass, a commercially important species, will allow for better understanding of the meaning of trap CPUE and how it relates to fish abundance, which will allow managers to interpret CPUE and landings data with greater accuracy. A major objective of NMFS is to develop alternate feeds for aquaculture. The study dealing with taurine as an ingredient in the development of fish free diets is helping to establish the minimum taurine requirement and its effects at different inclusion levels for many commercially important fish species. Taurine plays a major role in allowing the reduction and elimination of fishmeal from fish diets. Thus results from this study are useful for greatly enhancing the ability of the aquaculture industry to increase global fish production. Finally, the study on temperature preferences of Atlantic croaker under normoxic and hypoxic conditions has yielded some preliminary data that are useful for evaluating the effects of anthropogenic stressors and habitat degradation on habitat use and residency of scianids.

In the current reporting period, LMRCSC students and faculty made 81 presentations (oral and poster) at scientific meetings (62 of which were made by students), and published 12 articles in refereed journals, two of which were authored or co-authored by students or graduates of LMRCSC. An additional two articles were accepted for publication or are in press. Through its research activities in living marine resources the Center is addressing NOAA Fisheries mission goal, to: "*protect, restore, and manage the use of coastal and ocean resources through an Ecosystem Approach to Management*".

A total of \$1,556,478 was collectively awarded in grants to the LMRCSC institutions during this reporting period, which has directly impacted and will continue to have positive impacts on Center activities. These funds enhanced LMRCSC research through support of its faculty and students and by development/enhancement of infrastructure. Four grant proposals totaling \$1.7 million were submitted to funding agencies during the current reporting period.

The foregoing indicate that the LMRCSC educational, research and outreach activities are addressing three of the five essential activities NOAA has identified as being important for the success of its mission: (i) "*developing, valuing, and sustaining a world-class workforce*", (ii) "*ensuring sound, state-of-the-art research*", and (iii) "*promoting environmental literacy*". Thus, the Center is making significant contributions to the training of a diverse body of students in NOAA related STEM disciplines that will help increase the competitiveness of the U.S. in global economy. The tables below summarize some of the LMRCSC accomplishments during this reporting period.

**NOAA EPP Cooperative Science Centers (CSCs) Program’s standardized Performance Measures:**

- Number of students from underrepresented communities who were trained (# = 57; 14 Ph.D., 15 M.S., 28 B.S.) and graduated (# = 7; 1 Ph.D., 1 M.S., 5 B.S.) in NOAA-mission sciences in the past six months.
- Number of students who were trained (# =72; 16 Ph.D., 24 M.S., 32 B.S) and graduated (# =12; 1 Ph.D., 4 M.S/PSM, 7 B.S.) in NOAA-mission sciences in the past six months;
- Number of students who completed experiential opportunities at NOAA facilities (# = 7);
- Number of EPP funded students who were hired by NOAA (# = 1), NOAA contractors (# = 0) and other environmental, natural resource, and science agencies at the Federal, State (# = 1), local and tribal levels, in academia and the private sector;
- Number of NOAA science and administrative personnel engaged in CSC Education and Outreach, Scientific Research, and Administrative functions (# > 33)
- Number of collaborative research projects undertaken between NOAA and MSI partners in support of NOAA operations (# = 12);
- Number of students (# = 1) and faculty (# = 15) who participated in and completed postdoctoral level research programs in support of the NOAA mission;
- Number of peer reviewed papers published in NOAA-mission sciences by scientists (faculty, postdoctoral fellows, and students) sponsored by NOAA EPP (# = 12);
- Funds leveraged with NOAA EPP funds (including student support) (# = \$1,556,478 ); and,
- Number of outreach participants engaged in NOAA mission relevant learning opportunities (# > 500).

**Summary of LMRCS Performance Measures of Success (Education and Outreach Programs) for 2011 - 2012**

Activities/Programs	Proposed in the Implementation Plan	Accomplished (Jan. 1 – Jun.. 30 2012) 6 months
	2011 - 2012	2011 - 2012
# K-12 Students participating in NOAA related science activities	1000	>300
# of students trained in NOAA related Sciences	84	>72
# B.S. Students who graduate in NOAA core Sciences	24	7
# M.S. Students who graduate in NOAA core Sciences	9	4
# Ph.D. Students graduating in NOAA core Sciences	4	1
# of internships at NOAA/other labs.	33	16
# of Courses to be offered via Virtual Campus or online	5	8
# of expected enrollments in each course	5–10	Average = 5
# of short courses to be offered at the Center during the summer	2	0
# of expected enrollments in each short course	5–10	N/A
Establish a B.S. degree concentration in Environmental & Resource Economics		Planning has begun
# participants in the UMES AFS Student Subunit Symposium	30	N/A, symposium was not held in April 2012 because of the UMES symposium that was held in spring 2012
Amount of leveraged funds (\$) for education and outreach	500K	>600K
# of student presentations at conferences	80	81
# of NOAA/LMRCS Fisheries Cruises	1	1
# of proposals submitted for educational/outreach programs	5	2
# of student co-authored publications	15	2
# of public outreach activities	8	5
# of individuals impacted by outreach activities	>1000	>500

**Summary of LMRCSC Performance Measures of Success (Research Programs)**

	<b>Proposed in the Implementation Plan</b>	<b>Accomplished (July. 1 – Dec. 31, 2011) 6 months</b>
<b>Activities</b>	<b>2011/2012</b>	<b>2011 - 2012</b>
1. Science Meeting date	March	Held in March 2012
2. # of TAB Proposals funded	10 to 16	12
3. # of proposals submitted to other programs	16	4
4. # of proposals funded (leveraged funding)	10	27
5. # of scientific presentations at conferences	120 (80*)	81(62*)
6. # of theses & dissertations produced	10	3
7. # of peer-reviewed publications	15*-30	12(2*)
8. Amount of leveraged funds (\$)	\$3 million	~\$1.7 million

*\*Number presented or co-authored by students (minimum)*

## INTRODUCTION

The Living Marine Resources Cooperative Science Center (LMRCSC) was established in October 2001 as a cooperative agreement between NOAA Educational Partnership Program, the University of Maryland Eastern Shore (UMES), lead institution, Delaware State University (DSU), Hampton University (HU), Savannah State University (SSU), the University of Miami, Rosenstiel School of Marine and Atmospheric Sciences (UM/RSMAS) and the University of Maryland Biotechnology Institute Center of Marine Biotechnology (UMBI-COMB), now known as the University of Maryland Center for Environmental Science Institute of Marine and Environmental Technology (UMCES-IMET). With the addition of Oregon State University in 2011, the LMRCSC now has seven partner institutions. The mission of the Center is ***“To develop exemplary academic and research collaborations that prepare a diverse student body for careers in marine and fisheries sciences”***.

The following are the goals and objectives of the LMRCSC:

### **Education Goal 1. Prepare the future workforce for marine and fisheries sciences**

**Objective 1.1:** Recruit students from under-represented groups into marine and fisheries science disciplines

**Objective 1.2:** Increase retention and degree completion rates for students in marine and fisheries sciences programs

**Objective 1.3:** Assess the value-added outcomes of degree programs in marine and fisheries sciences at the partner institutions

**Objective 1.4:** Link students to professional networks and employment opportunities in marine and fisheries sciences

### **Education Goal 2. Strengthen collaborations across universities to enhance academic programs in marine and fisheries sciences**

**Objective 2.1:** Use state-of-the-art, research-based curricula to provide students with the highest quality education in marine and fisheries sciences

**Objective 2.2:** Use Virtual Campus technology to provide students with the opportunity to learn from some of the nation's leading scholars in marine and fisheries sciences

**Objective 2.3:** Ensure that curricula of degree programs at partner institutions address current challenges and emergent needs within the profession

### **Research Goal 3. Develop an exemplary capacity for scientific collaborations among partner institutions in the fields of marine and fisheries sciences**

**Objective 3.1:** Integrate the Center's research agenda with NOAA Fisheries research priorities in four key thematic areas: quantitative fisheries, essential fish habitat, fisheries socioeconomics, and aquaculture.

**Objective 3.2:** Foster collaborative research programs to strengthen the research capacities of partner institutions by leveraging the significant strengths and resources of research universities as infrastructure for capacity building

**Objective 3.3:** Develop faculty recruitment and retention practices that ensure that the collective capacity of scholars affiliated with the Center represents significant concentrations of strength in the four key research thematic areas

## **SECTION I – STATUS OF AWARD TASKS (Goals and Objectives)**

### **Summary**

#### **1. Status of Goals/Objectives Accomplished As Defined in the Cooperative Science Center's Proposal**

This is provided below from pages 9 to 32.

**2. Status of Benchmarks due during the performance period:** The Center met or exceeded the benchmarks for the present 6 month semi-annual report. This is summarized on pages 6 and 7 above.



- 3. Status of Special Award Conditions (if applicable) Due During the Performance Period:** The following special award conditions were met during this reporting period and the documents were submitted to NOAA EPP as required.  
 (a) LMRCS C Strategic Plan (b) Implementation Plan (c) Science Plan (d) Student Development Plan (e) Post-doctoral Program Plan (f) CSC-CSC Joint Project, and (g) Quarterly Budget Spending Plan
- 4. Identification of the NOAA-mission Research and Report on the Impact of the Research on NOAA's Mission. In addition, provide the planned and actual duration and status of the research activity that is in support of NOAA's mission.** This is provided below under TAB funded projects, pages 18 to 31.
- 5. Identification of All Collaborative Research Activities Undertaken During the Award Period:** This is provided below under TAB funded projects, pages 18 to 31.
- 6. Report on the Administrative and Research Meetings Conducted in Support of Activities Under this Award**  
 (a) Meetings conducted during this reporting period include, monthly meetings of the Executive Committee, Science Meeting, conference calls by CSC Directors, and Distinguished Scientists.
- 7. Status of Recruitment (including students, staff and post-doctorates):** Thirty (30) students were recruited during this reporting period (please see Table 1); Dr. Patricia Goslee was recruited as Education Leader of the LMRCS C. The Center is currently in the process of filling the positions of Deputy Center Director, and Postdoctoral Research Associate.
- 8. Status of Faculty/NOAA Staff Exchanges:** Dr. Andrea Johnson (UMES) made several short visits to NOAA NMFS Woods Hole Lab to conduct research. She also spent two months (May and June, 2012) conducting research at NOAA NOS, Charleston, SC.
- 9. Status of Budget to Date (Expended and Remaining Funds):** Of the \$2,625,000 awarded to the LMRCS C in 2011-2012, \$1,383,653.95 has been spent, \$656,298.68 is remaining, and \$585,047.37 is open commitment.

## 1. Status of Goals/Objectives Accomplished as Defined in the LMRCS C's Proposal

For the period **Jan. 1 to Jun. 30, 2012**, the following tasks were accomplished in support of the goals and objectives of the LMRCS C:

### Education Goal 1: Prepare the future workforce for marine and fisheries sciences

The **NOAA Education Strategic Plan (2009-2029)** assigns a high level of importance to the goal of developing a future workforce that reflects the diversity of the U.S. Collectively, the LMRCS C partner institutions offer a full range of degrees (bachelors, masters, and Ph.D.) in marine and fisheries sciences.

**Objective 1.1: Recruit students from under-represented groups into marine and fisheries science disciplines** - Our recruitment efforts advance specific workforce development outcomes identified in the NOAA Education Strategic Plan:

- "A diverse and qualified pool of applicants, particularly from underrepresented groups, pursues student and professional opportunities for career development in NOAA mission-critical disciplines."
- "A diverse pool of students with degrees in science, technology, engineering, mathematics, and other fields critical to NOAA's mission connect to career paths at NOAA and in related organizations."

### Activities and Accomplishments: - *Recruitment into Marine Science Programs:*

- During this reporting period, Todd Christenson, Andrea Johnson, and P. Chigbu attended the ASLO Ocean Sciences Meeting in Salt Lake City (Feb 20-24, 2012) to recruit students. As a result of interactions with students, Nivette Perez (B.S., University of Puerto Rico) plans to apply to the PhD program at UMES and participated in the summer 2012 UMES REU program. Elizabeth Seagroves (B.S., HU) is also considering UMES graduate programs.
- The addition of Oregon State University to the Center has yielded significant dividends for the Center's training efforts in Stock Assessment and Resource Economics:
  - LaTree Denson began graduate studies in January 2012 at OSU and is progressing towards her M.S. Degree in Fisheries Science. Her primary research interest is stock assessment, and she is developing a simulation model to explore the effects of spatial variation on stock assessments under the guidance of David Sampson.
  - Smit Vasquez Caballero (graduate student, OSU) is continuing his dissertation research on a bioeconomic analysis of Pacific salmon stocks under the guidance of Dr. Gil Sylvia.

- Marisa Litz recently joined the Center as a PhD student in Fisheries at OSU and is, examining biochemical linkages within coastal food webs in the NE Pacific. Her research will determine whether variation in the growth or survival of early life stages of common forage fish species, such as northern anchovy, and juvenile salmon is directly related to the species' composition, quantity (numerical abundance), or quality (lipid abundance, class, and fatty acid composition) of their potential prey. She is working under the guidance of Dr. Jessica Miller.
- Chante Davis, a PhD student in Fisheries at OSU is developing a research project focused on assessing the potential effects of hydropower development on Siletz River salmon populations in coastal Oregon. She is working with state, federal, and tribal scientists to develop a comprehensive research effort for her PhD studies. Chante is advised by Dr. Jessica Miller.

**IMET Internships:** The UMCES IMET hosted 7 undergraduate interns in summer 2012. These students conducted guided research on LMRCS projects alongside Center researchers in IMET's aquaculture and biotechnology facilities.

The LMRCS currently supports 72 students through NOAA funding and through funds leveraged from other agencies via the efforts of Center researchers. Forty (40) of the students are graduate students, including 16 Ph.Ds. Thirty (30) of the students were recruited during this reporting period (Table 1).

**Table 1. Students recruited into LMRCS from January 1 to June 30, 2012**

First Name	Last Name	Academic Institution	Degree
Michline	Brice	UMES	Ph.D
Hector	Malagon	UMES	Ph.D
Marisa	Litz	OSU	Ph.D
Chante	Davis	OSU	Ph.D
Cedric	Shamley	HU	M.S.
Ashley	Silver	HU	M.S.
Aicha	Toure	DSU	M.S.
Nivette	Perez	UPR	B.S.
Nikkia	King	UMES	B.S.
Miera	Armstead	UMCP	B.S.
Terry	Anderson	SSU	B.S.
Robert	Dumas	SSU	B.S.
Robert	Kiser	SSU	B.S.
Shaneese	Mackey	SSU	B.S.
Rasheeda	Murray	SSU	B.S.
Eric	Parks	SSU	B.S.
Ana	Reyes	SSU	B.S.
Shakela	Roland	SSU	B.S.
Britni	Seider	SSU	B.S.
Laporsha	Sturdivant	SSU	B.S.
Erica	Igwacho	Morgan St.	B.S.
SaQuaia	Weaver	Morgan St.	B.S.
Matthew	Dill	HU	B.S.
Jonathan	Garring	HU	B.S.
Symone	Gyles	HU	B.S.
Hermosillo	Xana	Evergreen State	B.S.
Hillary	Dean	DSU	B.S.
Abosedede	Adeyiga	Cheyney Univ.	B.S.
Travonya	Kenly	Cheyney Univ.	B.S.
Christopher	Stewart	Cheyney Univ.	B.S.

**Objective 1.2: Increase retention and degree completion rates for students in marine and fisheries sciences programs:** Direct financial support is one key element in retaining students. But the LMRCSC also engages in instructional and student support practices that have been shown to increase retention rates. LMRCSC students are also highly involved in peer networks, on campus and across the nation, including regular involvement in national meetings of the American Fisheries Society.

**Activities and Accomplishments:** Students who received financial support from January 1 to June 30, 2012 are listed in Table 2, whereas those that graduated are presented in Table 3.

**Table 2. Students who received direct support during the funding period (January 1 to June 30, 2012).**

First Name	Last Name	Academic Institution	Degree	Type	Amount
Jan	Vicente Raczkowski	UMCP	Ph.D.	Stipend/Tuition/Travel	\$17,208.95
Aaron	Watson	UMCP	Ph.D.	Stipend/Tuition/Travel	\$5,634.94
Erica	Dasi	UMBC	Ph.D.	Stipend/Tuition/Travel	\$5,647.83
Tedra	Booker	UMES	Ph.D	Travel	\$1,267.16
Daniel	Cullen	UMES	Ph.D	Stipend	\$14,704.62
Rehab	El Fadul	UMES	Ph.D	Travel	\$1,001.29
Eric	Evans	UMES	Ph.D	Travel	\$1,106.29
William	Gardner	UMES	Ph.D	Travel	\$3,141.15
Jhamyllia	Rice	UMES	Ph.D	Stipend, Tuition, Travel	\$11,408.54
Adam	Tulu	UMES	Ph.D	Stipend	\$15,280.85
Dwight	Ebanks	RSMAS	Ph.D	Travel	\$2,333.00
Dominique	Lazarre	RSMAS	Ph.D	Stipend, travel	4506.03
Rolando	Santos	RSMAS	Ph.D	Stipend, travel	7297.65
Xaymara	Serrano	RSMAS	Ph.D	Stipend, travel	12160.21
Marisa	Litz	OSU	Ph.D	Stipend	\$6,600.00
Smit	Vazques Caballero	OSU	Ph.D	Stipend/Tuition/Travel	\$21,779.00
Whitney	Dyson	UMES	M.S.	Travel	\$1,207.29
Evan	Lindsay	UMES	M.S.	Travel	\$126.00
Courtney	McGeachy	UMES	M.S.	Stipend, Tuition, Travel	\$11,943.18
Belita	Nguluwe	UMES	M.S.	Stipend, Travel	\$8,699.99
Candace	Rodgers	UMES	M.S.	Stipend, Tuition	\$9,841.89
Cy'Anna	Scott	UMES	M.S.	Scholarship, Travel	\$4,322.29
Emily	Tewes	UMES	M.S.	Stipend	\$11,116.89
Heather	Wolfer	UMES	M.S.	Travel	\$1,081.29
Jeanette	Davis	UMCP	M.S.	Stipend/Tuition/Travel	\$17,070.71
Kathleen	Gillespie	UMCP	M.S.	Stipend/Tuition/Travel	\$15,725.38
Ammar	Hanif	UMCP	M.S.	Stipend/Tuition/Travel	\$ 21,259.25
Noelle	Hawthorne	SSU	M.S.	Stipend	\$5,000.00
Benjamin	Maher	SSU	M.S.	Stipend	\$1,500.00
Courtney	Pegus	SSU	M.S.	Stipend	\$12,500.00
Michele	Sherman	SSU	M.S.	Tuition/Travel	\$2,972.00
Crystal Jackson	Smith	SSU	M.S.	Stipend/Travel	\$12,552.79
Dontrece	Smith	SSU	M.S.	Stipend/Travel	\$5637.62
Denson	Latreese	OSU	M.S.	Stipend/Tuition/Travel	\$20,959.00
Cedric	Shamley	HU	M.S.	Stipend/Travel	\$2,900.00
Ashley	Silver	HU	M.S.	Travel	\$625.00
Ashley	Silver	HU	M.S.	Stipend/Travel	\$3,100.00
Hillary	Dean	DSU	M.S.	Stipend/Travel	\$543.09

Cory	Janiak	DSU	M.S.	Stipend/Tuition/Travel	\$15,076.72
Andrea	Stoneman	DSU	M.S.	Stipend/Tuition/Travel	\$18,838.44
Miera	Armstead	UMCP	B.S.	Travel	\$32.00
Terry	Anderson	SSU	B.S.	Stipend	\$960.00
Robert	Dumas	SSU	B.S.	Stipend	\$960.00
Robert	Kiser	SSU	B.S.	Stipend	\$650.00
Shaneese	Mackey	SSU	B.S.	Stipend	\$2,188.00
Monet	Murphy	SSU	B.S.	Stipend	\$1,800.00
Eric	Parks	SSU	B.S.	Stipend	\$4,000.00
Ana	Reyes	SSU	B.S.	Stipend/Travel	\$960.37
Laporsha	Sturdivant	SSU	B.S.	Stipend/Travel	\$4,085.43
Tiffany	Ward	SSU	B.S.	Stipend/Travel	\$2,537.09
Erica	Igwacho	Morgan St.	B.S.	Travel	\$1,835.90
SaQuaia	Weaver	Morgan St.	B.S.	Travel	\$1,494.01
Brittany	Carmon	HU	B.S.	Stipend	\$3,000.00
Kendyl	Crawford	HU	B.S.	Travel	\$935.00
Matthew	Dill	HU	B.S.	Stipend/Travel	\$2,670.00
Jonathan	Garing	HU	B.S.	Stipend	\$2,000.00
Camile	Gaynus	HU	B.S.	Stipend	\$3,935.00
Shadaesha	Green	HU	B.S.	Stipend/Travel	\$3,250.00
Symone	Gyles	HU	B.S.	Stipend	\$2,000.00
Keya	Jackson	HU	B.S.	Stipend	\$3,935.00
Symone	Johnson	HU	B.S.	Stipend/Travel	\$3,935.00
Xana	Hermosillo	Evergreen State	B.S.	Stipend/Tuition/Travel	\$7,325.00
Amy	Cannon	DSU	B.S.	Stipend/Travel	\$5,134.75
Aicha	Toure	DSU	B.S.	Stipend	\$300.75
Abosede	Adeyiga	Cheyney Univ.	B.S.	Travel	\$980.45
Travonya	Kenly	Cheyney Univ.	B.S.	Travel	\$1,742.90
Briana	Jones	UMES	B.S.	Scholarship, Travel	\$4,354.29
Tiana	Jones	UMES	B.S.	Scholarship, Travel	\$4,322.29
Nikkia	King	UMES	B.S.	Stipend	\$1,380.00
Nivette	Perez-Perez	UMES	B.S.	Stipend	\$1,000.00
Kristen	Rybyzyske	UMES	B.S.	Scholarship	\$3,241.00
Chris	Stewart	UMES	B.S.	Stipend	\$1,000.00
Nivette	Perez	UMES; Univ. PR	B.S.	Stipend	\$1,000.00
<b>TOTAL</b>					<b>\$414,620.50</b>

**Table 3. Students who graduated from January 1 to June 30, 2012.**

First Name	Last Name	Academic Institution	Degree	Date
Adam	Tulu	UMES	Ph.D.	May, 2012
Kelli	Edwards	SSU	M.S.	May, 2012
Jeremy	Mitchler	SSU	M.S.	May, 2012
Cy'Anna	Scott	UMES	B.S.	May, 2012
Kristen	Rybyzyske	UMES	B.S.	May, 2012
Symone	Johnson	HU	B.S.	May, 2012
Kendyl	Crawford	HU	B.S.	May, 2012
Elizabeth	Seagroves	HU	B.S.	May, 2012

Keya	Jackson	HU	B.S.	May, 2012
Rebecca	Lynch	DSU	B.S.	May, 2012
Jeffrey	Kipp	UMES	PSM	May, 2012
Andrew	Turner	UMES	PSM	May, 2012

Retention and degree completion rates are higher in academic programs that engage students in collaborative research with faculty members. Projects funded by LMRCSO involve both undergraduate and graduate students as active research participants. Students work as research collaborators with faculty and scientists at NOAA facilities. During the academic year, students participate in research projects at their home institutions. During the summer, students are involved in research at their home institutions, at other LMRCSO campuses, or at NOAA laboratories. Table 4 shows students who worked at NOAA labs or LMRCSO partner institution labs, whereas students who took part in the LMRCSO winter research cruise are presented in Table 5.

**Table 4. Students who worked at NOAA labs or LMRCSO partner institution labs (Jan. 1 to June 30, 2012)**

First Name	Last Name	Institution	Degree	Facility	Time Period
Kate	Fleming	DSU	M.S.	NMFS lab-Panama City, FL	Jan 2010 to May 2012
Briana	Jones	UMES	B.S.	NOAA	June to August, 2012
Miera	Armstead	UMCP	B.S.	UMCES-IMET	June to August, 2012
Travonya	Kenly	Cheyney Univ.	B.S.	UMCES-IMET	June to August, 2012
Erica	Igwacho	Morgan St.	B.S.	UMCES-IMET	June to August, 2012
Abosede	Adeyiga	Cheyney Univ.	B.S.	UMCES-IMET	June to August, 2012
SaQuaia	Weaver	Morgan St.	B.S.	UMCES-IMET	June to August, 2012
Ihuoma	Njoku	UMBC	B.S.	UMCES-IMET	June to August, 2012
Coleman	Ewell	HU	B.S.	Scripps Inst of Oceanography	June to August, 2012
Noelle	Hawthorne	SSU	M.S.	Gray's Reef NMFS	June to August, 2012
Erica	Parks	SSU	B.S.	Smithsonian Env. Res. Center	June to August, 2012
Robert	Kiser	SSU	B.S.	Woods Hole Ocean. Inst	June to August, 2012
Roy	Kennard	UMES	B.S.	NOAA COL	June to August, 2012
Courtnee	DePass	UMES	B.S.	NOAA Woods Hole Lab	June to August, 2012
Kihoto	Kitonga	UMES	B.S.	NOAA Woods Hole Lab	June to August, 2012
William	Gardner	UMES	Ph.D.	NOAA Sandy Hook Lab	Jan. to Jun, 2012

**Table 5. Students who participated in the 2012 LMRCSO Research Cruise.**

First Name	Last Name	Degree	Institution	Vessel	Date
Evan	Lindsay	PSM	UMES	Delaware II	Jan 17 - 27, 2012
Courtney	McGeachy	M.S.	UMES	Delaware II	Jan 17 - 27, 2012
Candace	Rodgers	M.S.	UMES	Delaware II	Jan 17 - 27, 2012
Whitney	Dyson	M.S.	UMES	Delaware II	Jan 17 - 27, 2012
Emily	Tewes	M.S.	UMES	Delaware II	Jan 17 - 27, 2012
Andrea	Stoneman	M.S.	DSU	Delaware II	Jan 17 - 27, 2012

More than 30 students who did not receive direct support from the LMRCSO, benefited from the programs offered by the Center and/or infrastructure established by the LMRCSO during this reporting period. Names of some of them at UMES are listed in Table 6.

**Table 6. Students who did not receive direct support but benefited from the program offered or infrastructure established by the LMRCSO at UMES**

First Name	Last Name	Classification/Institution
Efeturi	Oghenekaro	M.S. student, UMES

Ejiroghene	Mayor	M.S. student, UMES
Fred	Oseji	M.S. student, UMES
Baruch	Volkis	Ph.D. student, UMES
Michele	Traver	PSM student, UMES
Joseph	Drummond	PSM student, UMES
Cornelius	Chilaka	PSM student, UMES
Jessica	Blaylock	PSM student, UMES
Andrew	Turner	PSM student, UMES
Jeffrey	Kipp	PSM student, UMES
David	Gurung	Ph.D student, UMES
Chinwe	Otuya	M.S. student, UMES
Sylvia	Ossai	B.S. student, UMES
William	Bolley	B.S. student, UMES
Kingsley	Nkeng	B.S. student, UMES
Antoine	McKnight	B.S. student, UMES
Yannick	Nkeng	B.S. student, UMES
Kevin	Lawrence	B.S. student, UMES
Kiara	Campbell	B.S. student, Tuskegee University
Kandace	Griffin	B.S. student, Converse College, SC
Claresa	Youngblood	B.S. student, Tougaloo College, MS
CaSaundra	Bush	B.S. student, Syracuse University
Carleanna	Jordan	B.S. student,
Omorose	Aighewi	Rising freshman, College of Charleston

**Career Development Assistance:** Five LMRCSC students were assisted to identify and apply for NOAA scholarships and fellowships during this reporting period. In addition, LMRCSC faculty and staff reviewed application materials for several graduating students applying for professional positions.

**Build strong peer networks through student collaboration:** The Center has a Facebook web page, where potential students and those interested in the LMRCSC participate in discussions on a range of topics, including research projects, employment opportunities, and postdoctoral fellowships. About 40 students participated in the NOAA Education and Science Forum at FAMU, March 26-28, 2012, allowing them to network with their peers and professionals from NOAA and other agencies.

**Continually assess student performance and progress toward degree completion:** LMRCSC has developed an extensive assessment system, which informs decisions regarding academic program improvement and future curriculum development.

- **LMRCSC Exit Evaluation:** Two exit evaluations were submitted during this reporting period.
- **LMRCSC Cruise Evaluation:** Three cruise surveys were submitted during the current reporting period.
- **Evaluation Forms for interns and mentors:** No forms were submitted during this reporting period. The summer 2012 internships are currently underway.

Student Development Plan for the LMRCSC was completed and submitted to NOAA EPP during this reporting period.

**Objective 1.3: Assess the value-added outcomes of degree programs in marine and fisheries sciences at the partner institutions:** Involvement in scientific research, participation in internships at NOAA facilities, and engagement with the “essential curriculum” for marine and fisheries sciences have prepared LMRCSC graduates to enter the scientific and environmental management workforce. Participation in LMRCSC activities adds significant value to students’ educational experiences, and prepares them to make important contributions to the scientific profession.

**Activities and Accomplishments:** Students who did not receive direct student support, but who benefited from Center programs and infrastructure exceed 30 in number. Additionally, the infrastructure that the LMRCSC has provided for the Center MSIs has made a huge difference in the type of research that can be done which has enabled the Center to leverage funds from various agencies including, NSF, NIH, EPA, and other line offices in NOAA. The Center leveraged ~\$1.6 million from external sources during this reporting period.

Monitoring the career paths of LMRCSC students is critical in determining the extent to which the Center is meeting NOAA’s workforce development goals. The LMRCSC provides updates on graduates who have found employment or

graduate opportunities as a result of their work at the Center to the Student Tracker database housed at NOAA EPP three times each year. Since 2001, the LMRCSC has contributed significantly to the research and teaching infrastructure at the partner institutions, which has been detailed in previous reports. More recently, the presence of the LMRCSC has resulted in additional investment by the Universities and leveraged programs, indicative of the importance which the partner universities place on the Center.

**New videoconference facility:** This facility is used as part of the LMRCSC's Virtual Campus for distance learning courses, student committee meetings, seminars and research collaboration.

**Research Fleet:** At the request of LMRCSC, the UMES administration purchased a new 24 foot Carolina Skiff to support field research by the LMRCSC and CREST-CISCEP programs. In addition, an 18 foot John Boat was purchased through a USDA award to Dr. Eric May. This brings the total number of boats at UMES to four, enhancing the Center's research capacity and alleviating pressure on the two older vessels.

**Monitoring student progress:** LMRCSC utilizes the online Student Tracker database as prescribed by NOAA for tracking student progress and outcomes. The Center maintains a series of online evaluation forms for the LMRCSC program overall, which graduating students are requested to submit, and for specific recurring activities such as the LMRCSC research cruise.

**Post Graduate Tracking:** Collection of career information on LMRCSC alumni is a continuing activity at the Center. Leonard Pace (B.S., HU) was employed at NOAA until 2011 and now works for NSF. Adam Tulu was employed on a short term assignment from May to July, 2012 at the APHIS program at USDA following his graduation. Matthew Taylor (B.S., HU), a 2009 REU intern in the lab of P. Chigbu at UMES, was hired in 2011 as Fisheries Observer at the NOAA NMFS Alaska Fisheries Science Center. Current LMRCSC student Jacklyn James is employed as a Survey Technician in NOAA's Office of Marine and Aviation Operations in Atlanta, GA.

**Scholarship:** Jan Vicente (Ph.D, UMCES-IMET) was awarded the Nancy Foster Scholarship in June 2012. Briana Jones (UMES), Brittany Carmon and Camille Gaynus (HU) were accepted into the NOAA Undergraduate Scholarship Program in 2012.

#### **Objective 1.4: Link students to professional networks and employment opportunities in marine and fisheries sciences**

**Activities and Accomplishments:** The following are examples of what the Center did during the current reporting period to link students to professional networks and employment opportunities in marine and fisheries sciences. A list of presentations by Center scientists and students is available in Appendix I.

**American Fisheries Society:** LMRCSC PhD student and NOAA EPP Graduate Sciences Program scholar Lonnie Gonsalves has taken on an active leadership role in AFS, having been nominated as President-Elect for the Equal Opportunity Section, a post he assumed at the 2012 national meeting in August. UMES-PSM student and NOAA contractor Michele Traver continues to serve as Chair for the AFS Equal Opportunity Section's Mentoring for Opportunity Section student travel award.

**Engagement with NOAA:** All LMRCSC graduate students are required to have a NOAA scientist on their research committee and the most appropriate individuals are identified early in the student's academic program.

- LMRCSC students were encouraged to apply for scholarships and fellowships. During this reporting period, 5 students applied for NOAA scholarships or fellowships. Briana Jones (B.S. UMES), Camille Gaynus (B.S. HU), and Brittany Carmon (B.S. HU) were accepted into the NOAA Undergraduate Scholarship Program for 2012.
- SSU M.S. student Sanya Compton began her Knauss fellowship in Washington, DC in February 2012.
- Seven LMRCSC students worked at NOAA labs under the guidance of NOAA scientists.

#### **Education Goal 2: Strengthen collaborations across universities to enhance academic programs in marine and fisheries sciences**

**Activities and Accomplishments:**

**Center Director and Staff:** There were no changes in Center staff during this reporting period.

**Executive Committee (EC):** The EC met via conference call monthly during this reporting period. LMRCSC Strategic Plan, Implementation Plan, and Science Plan were developed and submitted to NOAA EPP during this reporting period.

**Center Core Administration (CCA):** The CCA did not meet during this reporting period.

**LMRCSC Board of Visitors (BOV):** The BOV, consisting of the Presidents of the LMRCSC partner institutions or their designees, last met at RSMAS on Nov. 2, 2011. The next BOV meeting is scheduled for Nov. 1, 2012 and will be hosted by

HU. LMR CSC leadership at UMES along with Dr. Audrey Trotman met with the new UMES President, Dr. Juliette Bell, on August 29 and briefed her on Center goals and accomplishments ahead of the BOV meeting.

**Center Faculty and Staff Positions:** No changes occurred in this reporting period.

**Objective 2.1: Use state-of-the-art, research-based curricula to provide students with the highest quality education in marine and fisheries sciences**

**Activities and Accomplishments: Leveraging significant intellectual capital at partner institutions to advance educational programs and inform curriculum development:** CSC Directors had several conference calls during the reporting period during which potential collaborative research and educational programs were discussed and developed. A major outcome is the development of a proposal to fund and implement a “network of CSCs and high schools to train high school students in geosciences, which was successfully funded and will accept its first cohort in Summer 2013.

- To ensure that students and faculty are informed about current research within LMR CSC, the Center uses Adobe Connect to make its Seminar Series available to students and faculty at all partners via the web.

**Ensuring that curricula delivered at each partner institution are highly coordinated with the “essential curriculum” for marine and fisheries sciences, as identified by NOAA-NMFS:** Curricula at partner institutions are highly aligned with NOAA-NMFS priorities. Each January or February, LMR CSC offers an educational and scientific cruise that introduces students to the use of oceanographic equipment and that trains them in “blue water” fisheries research. The cruise is conducted in collaboration with the NOAA Northeast Fisheries Science Center.

Examples of NOAA scientists collaborating with scientists and students at the LMR CSC are presented in Appendix I.

**Objective 2.2: Use Virtual Campus technology to provide students with the opportunity to learn from some of the nation’s leading scholars in marine and fisheries sciences**

**Activities and Accomplishments:**

**Increased use of the Virtual Campus:** The Virtual Campus was used to provide courses to students, hold student committee meetings, Executive Committee meetings, and thesis and dissertation defenses. The Virtual Campus concept was expanded during this reporting period to include not only courses offered through videoconferencing, but also in an online format (Table 7a).

**Bayesian Statistics:** Dr. Elizabeth Babcock developed an online version of her Bayesian Statistics course and used GoToMeeting to offer this class to all Center students. This class was designated by NOAA NMFS as one of the nine essential courses required for Stock Assessment scientists.

**University of Maryland Interactive Video Network (IVN) courses:** Several University System of Maryland MEES courses were offered in Spring 2012 to LMR CSC students and others at UMES (Table 7b). Courses that were offered online at the Center in Spring 2012 as part of the PSM degree program in quantitative fisheries and resource economics are presented in Table 7a.

**Table 7a. Courses Offered Online at the LMR CSC in Spring Semester 2012 as Part of the PSM Degree Program**

Course number	Course Title	Instructor	Students (online)
MEES688	Bayesian Statistics	Elizabeth Babcock	Dan Cullen (UMES/LMR CSC) Jessica Blaylock (NOAA/UMES/PSM) Evan Lindsay (UMES/PSM) Andrew Turner (UMES/PSM) Leonardo Matthews (UMES/PSM) Jeffrey Kipp (UMES/PSM)
MEES640	Intro to Environmental and Resource Economics	Stephen Tubene, David Tomberlin	Jessica Blaylock (NOAA/UMES/PSM) Cornelius Chilaka (UMES/PSM) Joseph Drummond (UMES/PSM) Evan Lindsay (UMES/PSM) Andrew Turner (UMES/PSM) Leonardo Matthews (UMES/PSM) Jeffrey Kipp (UMES/PSM)
MEES688	Fish Biology and Management	Eric May	Michele Traver (NOAA/UMES/PSM) Jessica Blaylock (NOAA/UMES/PSM) Andrew Turner (NOAA/UMES/PSM)



MEES688	Business & Fisheries Management Ethics	Nicole Buzetto-More	Jessica Blaylock (NOAA/PSM) Cornelius Chilaka (UMES/PSM) Joseph Drummond (UMES/PSM) Evan Lindsay (UMES/PSM) Leonardo Matthews (UMES/PSM) Andrew Turner (UMES/PSM) Jeffrey Kipp (UMES/PSM)
MBF 613	Marine Population Dynamics	David Die	Leonardo Matthews

**Table 7b. Courses offered in Spring 2012 via the USM Interactive Video Network**

Course number	Course Title	Instructor	Students (online)
MEES698G	Zooplankton Ecology	Jamie Pierson	Kristen Lycett (UMES/LMRCSC)
MEES640	Fish Ecology	Dave Secor & Tom Miller	Emily Tewes (UMES/LMRCSC) Whitney Dyson (UMES/LMRCSC)
MEES688	Fisheries Oceanography	Elizabeth North	Emily Tewes (UMES/LMRCSC) Heather Wolfer (UMES/LMRCSC)
MEES 688	Surface Water Quality Modeling	Meng Xia	Dan Cullen (UMES/LMRCSC)

**Seminars:** The LMRCSC Seminar Series continued in this reporting period. The presentations were made available at all LMRCSC partners via the Virtual Campus. Two sessions (Table 8) were held in Spring 2012.

**Table 8. LMRCSC Seminar Series Spring 2012.**

DATE	SPEAKER	TITLE
February 3, 2012	Dr. Elizabeth North (UMCES)	Blue crab larval transport
March 16, 2012	Dr. Edward Houde (UMCES)	Men and menhaden: Declining Recruitment Challenges Management in Chesapeake Bay

**Objective 2.3: Ensure that curricula of degree programs at partner institutions address current challenges and emergent needs within the profession**

**Activities and Accomplishments:**

**Engage undergraduate and graduate students in cutting-edge research experiences in marine and fisheries sciences, including learning experiences at NOAA facilities with NOAA mentors:** One of the defining characteristics of the student academic experience at LMRCSC is extensive participation in scientific research. Undergraduate and graduate students work alongside faculty as collaborators on a range of research projects related to NOAA-NMFS priorities. Many of the projects involve student research at NOAA facilities under the guidance of NOAA mentors. Sixteen (16) students worked at NOAA labs, Center institutions or other agencies in summer 2012 (Table 4).

**Research Goal 3: Develop an exemplary capacity for scientific collaborations among partner institutions in the fields of marine and fisheries sciences -**

The Center's research is grouped into the four key thematic areas, associated with NOAA's research priorities. This research agenda is implemented collaboratively among faculty and students across the seven partnering institutions. LMRCSC research undergoes a rigorous scientific review process. Each year, LMRCSC convenes a Technical Advisory Board (TAB) to guide the Center in its research agenda. The TAB reviews and provides recommendations on the Center's research plan, and ensures that LMRCSC research is of high quality and aligned with NOAA-NMFS research priorities. Each year, LMRCSC issues a Request for Proposal (RFP) within the Center institutions, which seeks proposals for research projects that will be funded by the Center. Proposals are evaluated by the TAB, based on scientific merit, congruence with NOAA-NMFS research priorities, and level of involvement of students in the proposed research. An average of 12 research projects is selected for funding each year.

**Activities and Accomplishments:**

- Twelve proposals submitted to the TAB for review on October 14, 2011 are currently underway (Table 9).

- The LMRCSC Science Meeting was held in conjunction with the NOAA Education and Science Forum on March 25, 2012. Technical Monitor Dr. Kristy Wallmo and Dr. Ned Cyr of NOAA's Office of Science and Technology presented the strategic priorities of the NOAA Fisheries Service. Eighteen proposals were submitted to Dr. Chigbu on June 15, 2012. Review of these proposals occurred on August 15, and 12 projects were selected for funding.

These collaborative projects address various aspects of NOAA's Next Generation Strategic Plan Goal (NGSG): "Healthy Oceans - Marine fisheries, habitats, and biodiversity sustained within healthy and productive ecosystems", and objectives: (1) Improved understanding of ecosystems to inform resource management decisions, (2) Recovered and sustained marine and coastal species, (3) Healthy habitats that sustain resilient and thriving marine resources and communities, and (4) Sustainable fisheries and safe seafood for healthy populations and vibrant communities. They also address some of the goals, objectives and priorities listed in NMFS 2007 Strategic Plan for Fisheries, such as Seafood safety (e.g. Organic contaminants in monkfish, *Lophius americanus*), research on Abundance and Life History of fish stocks (e.g. Development of in-situ assessment and observation methods for black sea bass, *Centropristis striata*), sustainable and environmentally sound aquaculture through the development of alternative feeds such as plant-based proteins (e.g. Taurine – the missing ingredient for development of fish free diets for aquaculture), and impacts of anthropogenic factors and environmental change on species (e.g. Temperature preference of Atlantic Croaker under normoxic and hypoxic conditions). Additional information on how the 2011-2012 projects funded by the LMRCSC address NOAA's NGSG and NMFS priorities are presented below in the section on "TAB Project Summary".

**Table 9. Projects Funded by the LMRCSC for 2011 - 2012**

Principal Investigators	Proposal Title	Amount Approved
1. Andrea K. Johnson (UMES), Ashok Deshpande (NOAA)	Organic contaminants in monkfish, <i>Lophius americanus</i>	\$25,038.00
2. Jessica Miller (OSU), Deidre Gibson (HU), Tom Hurst (NOAA)	Temperature effects on pre- and post-settlement processes in Gulf of Alaska northern rock sole ( <i>Lepidopsetta polyxystra</i> )	\$24,718.00
3. Bradley Stevens (UMES), Beth Babcock (RSMAS), Gary Shepard (NOAA)	Development of in-situ assessment and observation methods for black sea bass, <i>Centropristis striata</i>	\$47,915.00
4. Adam Tulu (UMES-Student), Ali Ishaque (UMES), Rosemary Jagus (IMET), Chris Chambers (NOAA)	Characterization of <i>Microgadus tomcod</i> CYP19A aromatase	\$25,340.00
5. Heather Wolfer (UMES-Student), Andrea K. Johnson (UMES), Andrij Horodysky (HU), Richard Brill (NOAA)	Temperature preferences of Atlantic croaker under hypoxic and normoxic conditions	\$38,580.00
6. Diego Lirman (RSMAS), Andrij Horodysky (HU), Joe Serafy (NOAA)	The role of seascape characteristics of submerged aquatic vegetation as fisheries habitat	\$46,922.00
7. Andrij Horodysky (HU), Andrea Johnson (UMES), Richard Brill (NOAA)	Sensory ecology of Atlantic sturgeon: ecophysiological auditory and visual performance measures	\$18,763.00
8. Al Place (IMET), Tom Rippen (UMES), James Morris (NOAA)	Taurine – the missing ingredient for development of fish free diets for aquaculture	\$36,742.00
9. Deidre Gibson (HU), Andrij Horodysky (HU), David Elliot (IMET), Howard Townsend (NOAA)	Feeding and growth of doliolids as related to food concentration and temperature: Toward a model of doliolid population dynamics	\$28,708.00
10. Joseph Pitula (UMES), Feng Chen (IMET)	Diversity of <i>Hematodinium</i> sp. in the Maryland Coastal Bay ecosystem	\$35,965.00
11. Eric Schott (IMET), Dennis McIntosh (DSU), Gretchen Messick (NOAA)	Monitoring pathogens of blue crabs ( <i>Callinectes sapidus</i> ) along a climatological and latitudinal gradient	\$44,311.00
12. Stacy Smith (DSU), Eric May (UMES)	Using otolith elemental analysis to classify natal grounds of spawning summer flounder, <i>Paralichthys dentatus</i> , and spot, <i>Leiostomus xanthurus</i>	\$16,029.00

### TAB Project Summary

**1. Project Title:** Organic contaminants in monkfish, *Lophius americanus*

**Project Description:** The American monkfish or goosefish, *Lophius americanus* is one of the most important commercial finfish species in the northeastern USA. As bottom dwellers, monkfish are often in direct contact with sediments which may

often contain contaminants such as trace metals, polychlorinated biphenyls (PCBs) and dioxins. Through bioaccumulation, these contaminants may have adverse effects on the organism's reproductive capacity and consumption of this fish could pose a potential health risk to humans. Though a commercially important fish, very little information is available on contaminant concentrations in monkfish tissue from the U.S. The objectives of this study are to: 1) Determine the concentrations of organic contaminants such as PCBs, DDTs, chlordanes and PBDE flame retardants in monkfish muscle, liver and gonads collected from three sites in the northwestern Atlantic Ocean; 2) Correlate concentrations of each contaminant with lipids in each tissue; 3) Correlate concentrations with the age/length data; 4) Determine if there are spatial variation in concentrations of contaminants and lipids, and 5) Examine the utility of selected contaminants as tracers in the delineation of *L. americanus* habitats.

**Thematic Area Addressed:** *Essential Fish Habitat*

**Lead Scientist(s):** Dr. Andrea Johnson (UMES);

**NOAA Collaborator(s):** Dr. Ashok Deshpande, James J. Howard Marine Sciences Laboratory

**LMRCSC Collaborator(s):** None

**LMRCSC Research Student(s):** Bernice Bediako (Ph.D. Student, UMES)

**Planned Start Date:** January 2012

**Planned End Date:** December 2012

**Planned and actual results of project:** Monkfish ( $n=46$ ) were collected by trawl net at depths ranging from 250 to 1,100 m from eight areas during the NOAA-LMRCSC Scientific and Educational Cruise (January 2012). Total length (TL), body weight, and the weights of muscle, liver, and gonads were measured aboard the research vessel and samples of muscle, liver, and gonads were wrapped in aluminum foil and then frozen at  $-20^{\circ}\text{C}$  for organic contaminant analyses. Monkfish samples ( $n=29$ ) were also collected by gillnet by our industry collaborators from February to May, 2012 from the Fingers, Maryland. Fish were stored on ice and transported to UMES for processing. Total length (TL), body weight, and the weights of muscle, liver, and gonads were measured. The samples of muscle, liver, and gonads were wrapped in aluminum foil, and then frozen at  $-20^{\circ}\text{C}$  for organic contaminant analyses. Sampling is still ongoing for the other two sites: Franklin Swell, Massachusetts and Mud Hole, New Jersey.

Monkfish liver, muscle and gonads will be processed during the summer for organic contaminants in Dr. Deshpande's Lab at the J.J. Howard Marine Sciences Laboratory in Sandy Hook by Ms. Bediako. We plan to analyze 34 PCB congeners, 24 organochlorine pesticides, and 27 flame retardant PBDE congeners in monkfish liver, muscle and gonads collected from the three sites by our industry collaborators and during the NOAA-LMRCSC research cruise.

**How will results be incorporated into NOAA Fisheries operations?** This proposal addresses the RFP's targeted area of Essential Fish Habitat. The findings of this study would provide information that will help fisheries biologists in assessing the quality of fish habitat and the potential risk to human consumers.

**How will results be incorporated into LMRCSC research and curriculum?** This research will provide partial fulfillment of the requirements for the Toxicology Ph.D. Program for Ms. Bernice Bediako. Results will be presented at the annual meeting of the American Fisheries Society and at other national/regional science conferences.

## **2. Project Title:** Temperature effects on pre- and post-settlement processes in Gulf of Alaska northern rock sole (*Lepidopsetta polyxystra*): integrating across early life stages

**Project Description:** A critical area of fisheries science is identifying the role of climate in regulating biological productivity. Northern rock sole (NRS) supports a high value fishery for roe in the Gulf of Alaska. However our understanding of the factors regulating recruitment variation of this stock remains limited, as have the potential impacts of climate change. We are examining seasonal and interannual variation in early life history characteristics of northern rock sole in relation to regional climate variability. Otolith structural analysis of 8+ years of archived samples will allow us to determine spawning and hatch date, hatch size, and growth rates during the larval and juvenile stages. We will examine seasonal and interannual variation in these early life history characteristics in relation to climate variation throughout early life. Ultimately, the larger goals of this extended project are to quantify the environmental forcing factors that drive population productivity in pre-recruit stages of NRS and apply our understanding of these mechanisms to evaluate the potential for climate-induced changes in population dynamics and potential fishery yields.

**Thematic Area Addressed:** Quantitative Fisheries and Essential Fish Habitat (climate change)

**Lead Scientist(s):** Jessica Miller, Oregon State University

**NOAA Collaborator(s):** Thomas Hurst, NOAA Alaska Fisheries Science Center

**LMRCSC Collaborator(s):** Deidre Gibson, Hampton University

**LMRCSC Research Student(s):** Ashley Silver (MS Student); Xana Hermillos (Undergraduate Student)

**Start Date:** 1 January, 2012

**End Date:** 31 December, 2012

**Results of project:** Ashley Silver, a MS in Environmental Science at Hampton University, was recruited as an intern during summer 2012. She will be in residence at the Hatfield Marine Science Center from June through August 2012. She has been working with Drs. Miller (OSU) and Hurst (NOAA) on the initial stages of research, which includes extraction and preparation of juvenile northern rock sole otoliths and development of basic mathematical models to examine seasonal and interannual variation in juvenile growth within two Alaskan nursery areas located on Kodiak Island. Initially, we are examining seasonal and interannual variation in size and growth of juveniles during their first summer in two nursery areas in Kodiak Island, Holiday Beach and Pillar Creek Cove. There are persistent size differences between these two nursery areas in early summer; juveniles are 10 to 15% larger at Holiday Beach. However, this size difference increases throughout the season and by August, Holiday Beach juveniles are often >30% larger than those at Pillar Creek Cove. We are developing population growth histories for fish collected from both sites in July and August from 2005 to 2010 to determine how much of the observed variation in size can be accounted for by post-settlement growth variation versus carry-over effects from the larval stage. Future work will focus on determining if there is variation in hatch or settlement dates between these two nursery areas and quantifying the effects of local temperature variation on growth patterns.

**How will results be incorporated into NOAA Fisheries operations?** In the Gulf of Alaska (GOA), northern rock sole are managed as part of the shallow water flatfish complex, with allowable harvest rates based on estimated stock biomass. Recently, an age-structured population model has been developed for northern rock sole. This model uses size, age, and abundance data from the NMFS GOA bottom trawl survey; sex-specific growth and maturity rates; and harvest data to estimate age-specific biomass. Female spawning biomass is converted to reproductive output based on size-dependent fecundity data, which can be used to predict subsequent recruitment rates (to age-2). Improved understanding of the climate effects on growth and mortality in the early life stages will allow managers to improve recruitment estimates through inclusion of surveys of early life stage abundances and climate conditions. We are working with NOAA stock assessment scientist (Teresa A'mar) to incorporate these findings into stock assessment predictions.

**How will results be incorporated into LMRCSC research and curriculum?** Specifically, this project examines how the growth and relative abundance of northern rock sole varies with changes in environmental conditions with the ultimate goal of incorporating environmental data in fishery management strategies. We are also examining the effect of climate variation on nursery habitat quality, which is a component of Essential Fish Habitat. Miller teaches an undergraduate and graduate course on the early life history of fishes. Results of this research will be incorporated in lectures on recruitment and nursery areas of marine fishes.

### **3. Project Title:** Development of in-situ assessment and observation methods for black sea bass, *Centropristis striata*, Year 2

**Project Description:** Black sea bass (*Centropristis striata*) (aka BSB) support an important commercial and recreational fishery in the Mid-Atlantic Bight. Trawl surveys conducted by NOAA are not effective in sampling the heterogeneous inshore habitats, so there is no acceptable index of abundance for adult BSB. We are developing quantitative methods for assessing abundance of BSB in inshore waters using in-situ video technology. The majority of this work is being conducted by Dan Cullen, PhD student at UMES. In year 1 we placed cameras on BSB traps to determine fish abundance, and studied the effect of using baited vs unbaited traps. In year 2 we are testing a stand-alone platform with two different camera types.

**Thematic Area Addressed:** Quantitative Fisheries; Essential Fish Habitat

**Lead Scientist(s):** Bradley G. Stevens (UMES)

**NOAA Collaborator(s):** Gary Shepherd, NMFS, NEFSC, Woods Hole, MA.; Vincent Guida, NEFSC, J.J. Howard Research Laboratory, Sandy Hook, NJ.

**LMRCSC Collaborator(s):** Elizabeth Babcock, University of Miami, RSMAS

**LMRCSC Research Student(s):** Dan Cullen (PhD Student, UMES); Yannick Nkeng (Undergraduate REU student, UMES).

**Start Date:** 1 Jan 2012

**End Date:** 31 December 2012

**Results of project:** In 2012, we tested two versions of a Remote Underwater Fish Assessment System (RUFAS), both of which incorporated a Canon Vixia HF-S30 digital video camera in an Equinox dive housing with artificial lighting. Version 1 was a tower approximately 1.5 m high, and 1 m wide at the base, in which the camera housing was suspended from a rotating support with a vane that allowed it to rotate with the current. Unfortunately, the frame was not strong enough, and launch/recovery of the frame caused it to bend, and the rotating mechanism to jam. Version 2 is a highly reinforced square frame approximately 1 x 0.6 m, to which the camera housing is solidly attached. In addition to the dive housing, three backup GoPro® HD Hero (Woodman Labs, Inc., California) cameras are attached facing outward in different directions.

Sampling began on June 20 2011, and has occurred at least once weekly from the *F/V Andrew G* (chartered vessel) at two sites off the Maryland coast SE of Ocean City, MD, between 25 and 35 m depth. Sampling is conducted predominantly on hard bottom substrates with aggregated natural reef and sand habitat. For each sample, the frame is deployed and allowed to sit for 30 minutes while simultaneous angler assessments of fish CPUE are conducted. Fish CPUE is assessed by three anglers with rod and reel baited with squid and fished while drifting for 3 minutes; this is repeated four times around the frame during each camera deployment. Captured fish are measured and released as soon as possible. Catch data include date, site, depth, hook number (from bottom), number caught, fish length, and trial sequence. After 30 minutes, the frame is lifted and re-set at a distance of at least 50 m from the previous location. Up to 8 deployments are made per day at either site. An undergraduate REU student is assisting with recording and analyses of fish CPUE data. Fish counts from video will be analyzed using the "MeanCount" method: a systematic sample of still frames is taken every 30 seconds from the time when the camera lands on the bottom, and the average number of fish ( $\pm$  95% CI) is determined. Video counts and angler CPUE will be compared to determine if there is a linear (or some other) relationship, and effects of environmental variables such as depth, lighting, temperature, and bottom type on fish counts will be determined using mixed-effect models.

**How will results be incorporated into NOAA Fisheries operations?** We expect to achieve several goals with applicable results: 1) Develop useful indices of fish abundance based on in-situ video observations, and develop a model relating fish abundance to habitat, depth, temperature, trap CPUE and other variables. Such information will be useful for developing better indices of fish population abundance, and will add to the available data base for stock management.

**How will results be incorporated into LMRCSC research and curriculum?** We expect that one PhD dissertation will be based partially on the results of this research. In addition, we will involve one or more undergraduate students in the research project via the NSF-Funded Research Experiences for Undergraduates Program. Data collected during the project will also be used in the class "Survey Sampling" taught by Dr. Stevens for training students to analyze fish stock assessment data.

#### **4. Project Title:** Development of molecular tools and methodologies to evaluate the effects of marine pollutants in the Atlantic tomcod, *Microgadus tomcod*

**Project Description:** Our project is underway to assess the effects of polycyclic aromatic hydrocarbon (PAH) and polychlorinated biphenyl (PCB) contaminants in the estuarine species, *Microgadus tomcod*. As part of this larger body of work, the UMES graduate student, Adam Tulu, has collaborated with Dr. Rosemary Jagus of UMES-IMET to develop molecular tools and methodologies to assess the effects of PAH and PCB on the transcript levels of cytochrome 1A1 (CYP1A1) and cytochrome CYP19A (CYP19A). Mr. Tulu has been successful in purifying RNA from Atlantic tomcod samples generated in Dr. Chambers' laboratory. The purified RNA was used for cloning hepatic CYP1A1cDNA and generating and cloning of a partial cDNA sequence for CYP19A. To finalize his graduate studies, Mr. Tulu proposes to: a) complete the cloning of cDNA for CYP19A; b) generate in vitro transcripts of CYP1A1 and CYP19A for standard curves; and c) evaluate CYP1A1 and CYP19A transcript levels in fish exposed to PAH, PCB, or both, using RT-qPCR. A summer undergraduate intern will be recruited to assist in the processing of the many samples in need of analysis. The data gathered will be analyzed in the context of data already accumulated in this project including histological, biochemical and morphological response to the toxins. The 3'-end of the sequence was completed by 3' rapid amplification of cDNA ends (RACE)-PCR.

**Thematic Area Addressed:** Quantitative Fisheries

**Lead Scientist(s):** Adam Tulu (UMES); Dr. Rosemary Jagus (UMES-IMET), and Dr. Ali Ishaque (UMES)

**NOAA Collaborator(s):** Dr. Chris Chambers (NOAA Fisheries Service, NMFS)  
**LMRCSC Research Student(s):** Adam Tulu (UMES)

**Start Date:** January 2011      **End Date:** December 2012

**Results of project:** 3' rapid amplification of cDNA ends (RACE)-PCR has been successfully applied to construct the full length cDNA sequence of CYP19a aromatase. *In vitro* transcripts of CYP1A1 and CYP19A have been generated for standard curves and conditions for RT-qPCR determination have been optimized. CYP1A1 and CYP19A transcript levels have been determined in fish exposed to PAH, PCB, or both, using RT-qPCR. The study has demonstrated that PCBs alone, but not PAHs, have a significant effect on hepatic CYP1A and ovarian CYP19A. Furthermore, there is a significant interaction between the effects of PAH and PCB on ovarian CYP19A transcript levels, but not on hepatic CYP1A transcript levels. Morphological analysis assays quantify the morphological effects of PAH and PCB on Gonadosomatic Index (GSI), Hepatosomatic index (HSI), and Condition Factor (CF) as a biomarker. The structure and promoter sequences of CYP19A have been characterized in many different fish species and conserved protein domain of aromatase CYP19A, including I helix, heme-binding and oxygen-bindings has identified. The result of morphological assays indicate that adult tomcod of length ( $7.13 \pm 0.77$  cm), and weight ( $7.53 \pm 2.72$  g) did not differ significantly by sex or reproductive condition. When gonadosomatic index (GSI) was analyzed by ANOVA, both high-PCB and high-PAH concentration treatment groups had observed significant ( $P < 0.05$ ) gonadal loss. Hepatosomatic index (HSI) of reproductively mature females indicated that both levels of PCB and both levels of PAH had significant effects on liver average weight compared with the control group. There was no significant PAH-PCB interaction observed in any treatment group.

**How will results be incorporated into NOAA Fisheries operations?** The research will provide unique information on the relatedness of bioindicators, including measures of adult reproductive performance, and it will explicitly analyze the interactions among contaminants. These results extend beyond local species and systems to studies with similar concerns in other marine and estuarine ecosystems. The work has also provided a useful tool to investigate tomcod aromatase, CYP19A.

**How will results be incorporated into LMRCS research and curriculum?** This funding supported the research of Mr. Adam Tulu towards completion of his Ph.D. thesis. The funds were also used to support a summer undergraduate intern, Jordan Gomes.

##### **5. Project Title:** Temperature preferences of Atlantic croaker under hypoxic and normoxic conditions

**Project Description:** Atlantic croaker (*Micropogonias undulatus*), an economically and ecologically important demersal species common in Chesapeake Bay, was used as a model species to assess the mechanistic influence of normoxic and hypoxic conditions on temperature preference and movements using a custom videography behavioral preference system. The results of this study complement currently funded work (NSF-CREST) that assesses croaker movement in Chesapeake Bay via telemetry. Our intent is to provide a model approach which can be applied to other fish species. Coupled with habitat mapping of the Chesapeake Bay, we provide important information on how essential fish habitat is affected by increases in the spatial extent and duration of seasonal hypoxia in Chesapeake Bay.

**Thematic Area Addressed:** Essential Fish Habitat

**Lead Scientist(s):** Dr. Andrea K. Johnson (UMES-LMRCS)

**NOAA Collaborator(s):** Dr. Richard Brill (NMFS-NEFSC)

**LMRCSC Collaborator(s):** Dr. Andrij Z. Horodysky (HU-LMRCS)

**LMRCSC Research Student(s):** Heather Wolfer (UMES graduate student); Cedric Shamley (HU graduate student); Malik Breland (HU undergraduate student)

**Start Date:** 01/12      **End Date:** 12/12

**Planned and actual results of project:** Adult Atlantic croaker were obtained via hook and line and transported to the VIMS Eastern Shore Laboratory. Fish are being maintained in temperature controlled, filtered, sterilized, and oxygenated recirculating 1000 L aquaria maintained at 12 ppt and 25C. Tanks were assayed 1-5 times daily for temperature, salinity, oxygen, and ammonia levels. At the time of a trial, a single croaker is removed from the holding tank and transferred to a ~100 gallon behavioral Shuttlebox tank maintained at normoxia at 22-24 C and 12 ppt salinity that was illuminated from below with infrared light sources. The system consists of two round chambers connected by a short raceway and includes two recirculation pumps, four dosage pumps (for inflow from warm and cold baths), two temperature mixing towers, a CCD video

camera, and two fiber optic oxygen probes and four temperature probes (two for the system and two for the oxygen probes) to monitor temperature continuously. Custom ShuttleSoft software (Loligo Systems) tracks the movements of the animal throughout the Shuttlebox tank sections and controlled temperature accordingly. Changes in temperature are controlled by a DAQ instrument that regulates the activity of sets of pumps, depending on the position of the fish. Passage of the fish into the warmer side of the tank prompts the dosage pumps to increase the temperature in both tanks; the reverse occurs if the fish swims into the low temperature tank. A 2C temperature difference is constantly maintained between the two circular tank sections, regardless of the direction of change. Oxygen saturation is monitored via two fiber optic oxygen electrode which measures the content of water returning from both mixing towers. Custom data acquisition software (DasyLab) controls the addition of nitrogen to the system to attain the desired experimental setpoint. Experiments were conducted for 24 hrs each at normoxia (> 90% O<sub>2</sub> saturation), moderate hypoxia (~50% O<sub>2</sub> saturation), and severe hypoxia (~25% O<sub>2</sub> saturation). Because the probes output oxygen content in uM/mL rather than % saturation, the percentages are approximate and temperature dependent. Full normoxia-hypoxia protocol data have thus far been obtained for two adult croaker; normoxia-only data have been collected for an additional three croaker to establish baseline behavior. In 2011, we obtained normoxia baseline data from three small juvenile croaker and full normoxia-hypoxia protocols from eight small juvenile fish in a shuttlebox ~1/10<sup>th</sup> of the volume of this tank. Experiments also differed from those in this study because of constant illumination required to film the fish in last year's setup. This year's setup allows us to work on larger adult fish, and allows the fish to experience normal diel illumination levels during experiments. At the conclusion of each Shuttlebox experiment, each fish is euthanized and blood, liver, spleen, and gonad tissues are sampled from individuals for histological and biochemical assays.

**a. Determine the temperature preference of Atlantic croaker under normoxic conditions and two levels of hypoxic exposure:** Atlantic croaker used in these experiments were substantially larger than those of last year (by some 25-50mm on average), and all thusfar have been sexually mature. Control croaker (3 days at normoxia) have exhibited fairly broad time-at-temperature distributions favoring warmer waters (> 20C), with similar distributions for each day of the experiment. For the single full protocol hypoxia-normoxia fish, selected temperatures decreased by ~8-10C with decreasing oxygen content. Last year's experiments on juveniles revealed that fish at normoxia, exhibited a broad affinity for temperatures ranging from 19-25C. At 50% oxygen saturation, fish exhibited a bimodal affinity pattern for 19C and 23-24C, which may be indicative of fish moving between the 'warm' and 'cold' sections of the experimental tank sections searching for more optimal oxygen conditions. It is worth-noting that the temperature distribution of croaker at 50% oxygen saturation was constrained relative to normoxia - croaker spent less time at the extremes of the temperature distribution. At 25% saturation, croaker decreased general activity levels in the Shuttlebox tank, strongly preferring cold water (mode: 16C). These results are consistent with general inferences into croaker physiology, as 25% oxygen saturation levels roughly correspond to the inflection point between aerobic metabolism and anaerobic debt. Minimized activity and selection of colder water are common mechanisms fishes use to endure hypoxia (Schurman et al., 1991). We are investigating mechanisms to model the within-individual autocorrelation and covariance in using both frequentist and information theoretic approaches.

**b. Evaluate the effects of temperature and hypoxia treatment on Atlantic croaker general health:** In 2011, based on gonadosomatic index (GSI), and macroscopic assessment of gonad stage, croaker in these experiments were late juveniles and early adults approaching sexual maturity (GSI: 0.29-1.02). Spleno-somatic index (SSI) ranged from 0.05-0.07, and hepatosomatic index (HSI) ranged from 0.4-1.0. Histological analyses of tissues and microscopic analysis of blood cell counts for 2012 adults are ongoing. At the end of the experimental period, fish were removed from the shuttlebox and placed into an anesthesia bath containing an overdose of MS-222 (250 mg/L). Both the length (cm) and weight (g) were taken first. Fish were then bled from the caudal vein with heparinized syringes and the blood placed into prepared tubes on ice. Dissections were performed and the liver, kidney, spleen, gonads, and brain were removed for further analyses. Whole blood was set aside in order to perform hematocrits for packed cell volume. The blood was also spun down in a centrifuge and the plasma was extracted. The plasma was analyzed for both plasma chemistry and electrolytes (Na, K, and Cl). The organs collected were then weighed (g). The indices were calculated using the formula: [Organ weight (g)/Total body weight (g)] x 100%. Hepatosomatic indices (HSI) were found for the liver, gonadosomatic (GSI) for the gonads, and splenosomatic (SSI) for the spleen. These were indicators for general health, reproduction, and immune function, respectively. In 2012, fish held in the shuttlebox under control and treatment conditions as well as fish from the general population are currently being sampled for hematological analysis and organosomatic indices. Plasma chemistry analysis indicated non-specific stress due to elevated glucose levels in hypoxic fish. Heightened levels of certain liver enzymes were possible indicators of damage to this organ as a reaction to an environmental stressor but there was no corresponding anomaly in the HSIs. Calcium and phosphorus measurements in hypoxic fish were signs of renal stress; effects to the kidney were to be expected given the role this organ plays in the fish immune system and stress response.

**c. Integrate observed physiological and behavioral responses determined in laboratory (this project) to telemetered field movements (horizontal and vertical (NSF-CREST-funded research), and to changes in water quality and other environmental variables measured in the field:** On the basis of this initial investigation of croaker behavioral thermoregulation, and to codify laboratory-field integration, we expanded the project in 2012 as part of Dr. Johnson's UMES graduate student's doctoral dissertation (H. Wolfer). The use of a larger Shuttlebox tank has allowed behavioral experiments to be conducted on the larger size class of adult croaker that are being tracked in the NSF-CREST project. Additionally, adjustments to videography via infrared illumination, rather than the white-light illumination we used, allow the assessment of potential diel differences in thermoregulation. These combined modifications would improve mechanistic insights into croaker behavioral thermoregulation and allow stronger integration between laboratory and field inferences.

**How will results be incorporated into NOAA Fisheries operations?** This project provided preliminary insights relevant to the habitat use and resiliency to anthropogenic stressors and habitat degradation of a managed fisheries resource consistent with the missions of LMRCS and NOAA-Fisheries. Such data form baselines to better quantify potential impacts of habitat changes on spatial and temporal use of nursery habitats. This project provides a critical laboratory behavioral link to codify leveraged laboratory and field research (NSF-CREST). The results of this project support an ecosystem-based approach to the ecophysiology of fisheries resources that use coastal mid-Atlantic waters.

**How will results be incorporated into LMRCS research and curriculum?** Data from this project will be included in lectures in Dr. Johnson's Fish Physiology Course and Dr. Horodysky's Ichthyology course. Drs. Horodysky, Johnson, and Brill wish to build a comparative database of ecophysiological function in benthic fisheries resources.

## **6. Project Title:** The role of seascape characteristics of submerged aquatic vegetation as fisheries habitat

**Project Description:** The main objectives of this research are to: (1) assess and document the patch-scale structure of submerged aquatic vegetation (SAV) seascapes in Biscayne Bay, and (2) determine how SAV seascape patterns may have cascading effects on the abundance, distribution, and predator-prey interactions of fish communities. A seascape approach incorporating theories and tools of landscape ecology will be employed to meet these objectives, focusing on the fish responses and interactions with seascape composition and configuration in Biscayne Bay, where nearshore habitats are currently subjected to environmental changes associated with the Comprehensive Everglades Restoration Program's activities. Therefore, this research will provide a direct test of the impacts of biological and human interactions on benthic habitats and fisheries resources at the seascape level.

**Thematic Area Addressed:** Essential Fish Habitat and Quantitative Fisheries

**Lead Scientist(s):** Dr. Diego Lirman (University of Miami, RSMAS)

**NOAA Collaborator(s):** Dr. Simon Pittman (NOAA Center for Coastal Monitoring and Assessment)  
Dr. Joe Serafy (NOAA Southeast Fisheries Science Center)

**LMRCS Collaborator(s):** Dr. Andrij Horodysky (Hampton University)

**LMRCS Research Student(s):** Mr. Rolando Santos (PhD student, University of Miami, RSMAS)

**Start Date:** 1 Jan 2012      **End Date:** 31 December 2012

**Results of project:** Since this project was funded in Jan 2012, we have worked in four major activities: 1) a temporal submerged aquatic vegetation (SAV) seascape analysis of nearshore essential fish habitats in Biscayne Bay (50% completed); 2) the creation of a seascape sampling design (100% completed); 3) the design and testing of different fish sampling techniques (50% completed); and 4) the logistics for a summer internship for two undergraduate students from Hampton University and Savannah State University (75% completed).

The patch-scale spatial and temporal dynamics of SAV seascapes in Biscayne Bay were documented using a combination of historical aerial imagery and satellite images. This seascape analysis was performed by delineating SAV patches and quantifying habitat fragmentation over the past 80 years using techniques in Geographical information systems (GIS) and remote sensing. In this analysis, SAV seascape characteristics of nearshore habitats of Biscayne Bay were quantified and followed every 10 years starting in the 1930's to assess the SAV fragmentation process on a historical time scale. The results suggested that the SAV seascape in Biscayne Bay has been stable across large spatio-temporal scales, and that most of the spatial changes have occurred closer to shore and freshwater canals. The base maps produced by remote



sensing techniques applied to satellite images guided the development of our field sampling design for fish by identifying and classifying sites as either continuous or fragmented SAV seascapes. This is an initial step to accomplish Objective 2 of this research project (to determine how SAV seascape patterns may have cascading effects on the distribution, behavior, and interaction of fish communities found in the bay). A total of 16 sites were identified with either continuous or fragmented SAV seascapes. The SAV seascape classification of each identified site was validated in the field using visual observations and high resolution photographs of the bottom. Sampling of the fish community within the identified sites using seine nets is presently underway. In addition to these seining activities, we have designed and tested baited remote underwater video (BRUV) techniques to be deployed also this summer within the two different types of habitats (fragmented and continuous SAV). BRUVs have been recognized as an efficient method to assess the abundance, diversity, and predatory activities of highly mobile fishes

As part of this program, we identified and recruited two student interns, Matthew Dilly (HU – Junior) and James McCullars (SSU – Senior), who are presently working with Rolando Santos (UM) collecting fish samples in the field, identifying fish and SAV species in the lab, and mapping SAV habitats.

**How will results be incorporated into NOAA Fisheries operations?** The proposed research project results will benefit NOAA Fisheries operation by: (1) providing information on the role of vegetated benthos as essential fish habitats in a heavily exploited region of the US; (2) documenting the impacts of coastal development and water management practices on benthic habitats and associated fisheries resources at relevant spatial scales; (3) providing habitat indicators that relate directly to the abundance and distribution of fish and prey resources; (4) offering new sampling methodologies (BRUV) to assess habitat value, structure of food webs and behavioral patterns of habitat utilization; and (5) developing spatial models that relate the abundance of marine species to habitat structure and changing environmental conditions.

**How will results be incorporated into LMRCS research and curriculum?** The results of this research project will support the mission of the LMRCS by providing research opportunity and material to students from underrepresented communities at the graduate and undergraduate level on fisheries related fields. For example, data obtained in this project will be used by students to learn cutting edge analysis and statistical techniques in marine science and provide a better understanding on how different habitat characteristics influence fish populations at the ecosystem level. In addition, from an ecosystem approach the results will contribute to the management of essential fish habitats by presenting baseline conditions and population models of spatial dynamics of SAV seascapes and their associated fauna in managed coastal areas.

## **7. Project Title:** Sensory ecology of Atlantic sturgeon: ecophysiological auditory and visual performance measures

**Project Description:** The ecophysiological abilities of coastal fishes to cope with environmental variability and anthropogenic stressors have received little attention. We therefore seek mechanistic insights into the influence of biotic and abiotic processes on the auditory and visual systems of Atlantic sturgeon. We will evaluate these ecophysiological performance measures as assays of essential fish habitat, predator-prey interactions, and anthropogenic stressors. This proposal responds directly to research priorities delineated in the LMRCS RFP, and directly supports the mission of NOAA-Fisheries, and provides research experience for undergraduate students.

**Thematic Area Addressed:** Essential Fish Habitat

**Lead Scientist(s):** Dr. Andrij Z. Horodysky (HU-LMRCS)

**NOAA Collaborator(s):** Dr. Richard Brill (NMFS-NEFSC)

**LMRCS Collaborator(s):**

**Research Student(s):** Cedric Shamley (HU graduate student); Malik Breland (HU undergraduate)

**Start Date:** 01/12

**End Date:** 12/12

**Planned and actual results of project:** Atlantic sturgeon were obtained from hatchery sources in Maryland; fish are of Canadian stock. Fish were transported by Drs. Brill and Horodysky to the VIMS campus and maintained in temperature controlled, filtered, sterilized, and oxygenated recirculating 1000 L aquaria at the VIMS Eastern Shore Seawater Lab, where they were maintained at 0 ppt and 25C. Tanks were assayed 1-5 times daily for temperature, oxygen, and ammonia levels.

A) AUDITORY ECOPHYSIOLOGY: 1) Characterize the frequency sensitivity and pressure and particle motion thresholds of Atlantic sturgeon, and 2) Using auditory thresholds, calculate theoretical auditory ranges as a function of depth: Auditory brainstem response experiments will be conducted for five sturgeon in mid-July-August 2012. Given the recent listing of the species under the Endangered Species Act, we are redesigning the delivery of anesthesia to subjects to increase the likelihood that fish will recover and be returned to the captive populations. Further, we have been using longnose gar as a freshwater fish proxy to identify mechanisms to overcome issues with recording electric potentials from brainstem of freshwater fishes (simple for marine fishes, difficult for freshwater fishes). Experiments have been conducted on five gar to this point, with two successful datasets. For each fish, experiments on anesthetized fish will involve stimuli from (i) a speaker that will present both pressure and particle motion components of sound (range: 100-2000 Hz), and (ii) a vibration mini-shaker that presents predominantly particle motion (range: 100-1000 Hz). The skull and extremely tough skin of sturgeon present issues for proper placement of fine wire electrodes, making the recording of auditory evoked potentials fairly very challenging. We are investigating the use of nonimplanted electrodes to minimize recovery of the species after experiments. The duration of stimulus presentation and the number of recorded signal averages will be adjusted to optimize the recording of auditory brainstem responses. Based on our previous work, at all frequencies, tautog and black sea bass exhibited fairly high thresholds to speaker stimuli, demonstrating relatively poor auditory performance relative to other coastal fishes surveyed with the same technique. These results suggest that these two reef fishes survey the auditory scene of the temperate reef environment at low frequencies, and that sensitivity to faint sounds and to higher frequencies (e.g., high frequency invertebrate stridulation noises) may not provide a selective advantage to the species. On the basis of morphology (lack of connection between the swim bladder and inner ear), we predict that sturgeon will likewise have fairly poor auditory abilities compared to other soniferous species.

B) VISUAL ECOPHYSIOLOGY: *Characterize the luminous (intensity) sensitivity, flicker fusion frequency (speed of vision), and chromatic (color) sensitivity of Atlantic sturgeon:* We will use whole-animal corneal electroretinography (ERG) to examine potential circadian changes in the response of Atlantic sturgeon visual systems to light stimuli varying in wavelength (spectral sensitivity), intensity (luminous sensitivity), and temporal properties (flicker fusion frequency, FFF). We have been using longnose gar as a freshwater fish proxy to identify mechanisms to overcome issues with recording electric potentials from intact corneas of freshwater fishes. Experiments have been conducted on three gar to this point, with two successful datasets. Previous work suggests that other sturgeon species have multiple cone mechanisms and are fairly sensitive to dim light. Similar outcomes were observed in our previous work on tautog, which demonstrated fairly high and diel-invariant sensitivity to dim light (dynamic range of  $2.2 \log \text{cd m}^{-2}$ ) and moderate speeds of vision ( $\text{FFF}_{\text{day}}$  38 Hz;  $\text{FFF}_{\text{night}}$  34 Hz), consistent with patterns observed in other deeper-dwelling and temperate reef-associated fishes with which they co-occur. The eyes of tautog are comparatively more sensitive and slower than those of most shallow-dwelling coastal sciaenids and epipelagic coastal piscivores. Tautog exhibited broad spectral sensitivities from 400-560 nm, with peak sensitivity circa 490 nm (blue-green wavelengths). Rhodopsin templates fitted to the photopic spectral sensitivity data via maximum likelihood suggest the presence of two cone pigments: one centered in short blue wavelengths (464 nm) and another at longer green wavelengths (525 nm). These results are consistent with seasonal migration patterns from the shallow green-yellow coastal waters in cooler months to the deeper blue-green coastal waters during spawning in warmer months, and correlate well to results from other coastal fishes. Collectively the visual systems of tautog and other temperate reef fishes thus correlate well with the photoclimate and light niches they inhabit.

**How will results be incorporated into NOAA Fisheries operations?** The overall goals of this project are to provide sensory data relevant to the habitat use and resiliency to anthropogenic stressors and habitat degradation of a managed fisheries resource consistent with the missions of LMRCS and NOAA-Fisheries. Such data form baselines to better quantify potential impacts of habitat changes on spatial and temporal use of nursery habitats. The results of this study will be reported to local, state, and federal constituents as well as at national scientific meetings.

**How will results be incorporated into LMRCS research and curriculum?** Data from this project will be included in lectures in Dr. Horodysky's Ichthyology course. Drs. Horodysky and Brill are building a comparative database of sensory function in mid-Atlantic fauna that remain highly susceptible to overfishing due to their typically slow growth, complex life-history and reproductive habits, and high exploitation rates due to the ease of location of reef habitats where these species aggregate. Other threats to these fauna include marine construction and development of oil-drilling and wind farm operations proposed along the Mid-Atlantic seaboard.

### **8. Project Title:** Taurine – the missing ingredient for development of fish free diets for aquaculture?

**Project Description:** Develop and evaluate commercially viable husbandry technologies for new candidate species in both near-shore, offshore, and land-based aquaculture systems. (NMFS Objective 4.5) and b.) Develop alternative feeds for aquaculture (NMFS Objective 4.4).

**Thematic Area Addressed:** Aquaculture

**Lead Scientist(s):** Dr. Allen R. Place (UMCES-IMET)

**NOAA Collaborator(s):** Ronald B. Johnson (NOAA NWFSC, Seattle, WA)

**LMRCSC Collaborator(s):** Thomas E. Rippen (Seafood Technology Specialist, UMES)

**LMRCSC Research Student(s):** Aaron Watson (Ph.D. student, IMET)

**Start Date:** 1 Jan 2012

**End Date:** 31 December 2012

**Results of project:** So far in this project we have assayed the taurine concentrations in fish feeds, livers and fillet muscle tissues from Sablefish being utilized in fishmeal reduction studies by NOAA/NWFSC in Seattle, WA. In both muscle and liver, taurine concentrations mimic the pattern of the diets, with the plant protein diet with taurine supplementation having lower concentrations than control fish being reared on a standard, commercial trout feed. We have begun the primer design and verification steps to be able to measure transcript levels of the genes involved in the biosynthesis of taurine when NOAA conducts a broader grow out of sablefish on diets containing a graded level of taurine.

**How will results be incorporated into NOAA Fisheries operations?** Results of this work are helping to establish the minimum taurine requirement and its effects at different inclusion levels for several commercially important species in aquaculture. We believe that taurine plays a major role in allowing the reduction and elimination of fishmeal as the aquaculture industry seeks fishmeal replacements from more sustainable, plant protein based sources. Aiding the ability to reduce fishmeal and possibly fish oil through taurine inclusion and the use of sustainable products will greatly enhance the ability of the aquaculture industry to increase global production to meet the ever increasing global demand for high quality, safe seafood.

**How will results be incorporated into LMRCSC research and curriculum?** This project is providing 25 % support for graduate training of Aaron Watson (Ph.D. student, IMET) and has provided training to a summer undergraduate intern. Travonya Kenly, the LMRCSC summer intern on this project for the summer of 2012 has gained experience in many molecular methods including RNA extraction, reverse transcription, PCR, quantitative PCR as well as primer design and testing. This experience will help her in her undergraduate progress toward a degree in biology at Cheney University.

### **9. Project Title:** Feeding and Growth of Doliolids as Related to Food Concentration and Temperature: Toward a Model of Doliolid Population Dynamics

**Project Description:** Episodic blooms of filter-feeding pelagic doliolids have the potential to restructure marine food webs and biogeochemistry, influencing the dynamics of phytoplankton and copepod populations that are prey for planktivorous fish. We will assess and model the influence of temperature and prey dynamics on doliolid feeding ecology and population dynamics. This study complements Gibson's current NSF-OCE funded research investigating variables driving doliolid bloom formation, and directly involves LMRCSC student interns. This study focuses on obtaining the necessary data to build a preliminary working model of doliolid population dynamics.

**Thematic Area Addressed:** Essential Fish Habitat, Quantitative Fisheries

**Lead Scientist(s):** Dr. Deidre Gibson (HU-LMRCSC)

**NOAA Collaborator(s):** Dr. Robert Wood (NOAA-NCCOS, Cooperative Oxford Lab), Dr. Xinsheng Zhang (NOAA-NCCOS, Cooperative Oxford Lab)

**LMRCSC Collaborator(s):** Dr. David Elliott (UMCES-HPL), Dr. James Pierson (UMCES-HPL), Dr. Andrij Z. Horodysky (HU)

**LMRCSC Research Student(s):** Shadaesha Green (HU undergraduate)

**Start Date:** 01/12

**End Date:** 12/12

#### **Planned and actual results of project:**

(A) **Doliolid collection and culturing:** Seawater for doliolid culture maintenance was obtained from the Georgia continental shelf on a research cruise aboard the R/V Savannah from Skidaway Institute of Oceanography. Doliolids for culture were

generously provided from the laboratory of G. A. Paffenhofer at Skidaway, and algal food cultures generously provided from the J. Nejstgaard lab at Skidaway. Water was transported by Dr. Elliott and doliolids by Dr. Gibson and S. Green from Georgia to the UMCES Horn Point Laboratory in Maryland and the culture was maintained in a temperature controlled incubation chamber. From the three phorozoids obtained to initialize the culture, we were able to acquire approximately 50 gonozoids, on which S. Green performed pilot feeding experiments under the supervision of Dr. Gibson and Dr. Elliott. Most of the acquired gonozoids failed to produce eggs and subsequent larvae, with only one known larva produced after approximately three weeks of keeping the gonozoids in culture. We were able to rear this larva for approximately one week before it, as well as the surviving gonozoids succumbed to a suspected bacterial contamination of the culture seawater.

**(B) Feeding and growth experiments:** Given the amount of time remaining this summer (2012) we will abandon efforts to culture doliolids for further feeding and growth experiments. Instead, we are focusing on the requirements for model development.

**(C) Individual based model (IBM) construction:** The structure for the model is already developed as a MatLab code, and the proper parameters for doliolids are in the process of being identified and incorporated into the model. Required terms include stage specific growth rates, feeding rates as necessary to predict growth rates, and mortality rates, as well as factors for converting doliolid size (length) to carbon content. Our culturing experience during the first half of the 2012 grant year indicated that the phorozoid and gonozoid stages are quite similar apart from their reproductive behaviors. This suggests the possibility of applying published rates and conversion factors for gonozoids to phorozoids. Our comparative analysis of feeding and growth rates of phoro- and gono-zoids will help to justify such an approach. Similarly, we plan to explore the possibility of parameterizing the feeding and growth rates and carbon contents of nurse-colonies as the sum of these terms for all individuals contained within each colony. We will be able to evaluate this approach by comparing the resulting feeding rate estimates with available feeding rates reported for nurse-colonies (Paffenhofer and Koster, 2011). The feeding and growth rates and carbon contents of larvae and oozoids will still be unknown. Therefore, we will need to use age at metamorphosis and cadophore formation as the parameters determining the rate at which larvae grow into nurse-colonies. This approach requires the assumption that larval and oozoid stages are not food limited. Given the small size of these stages, this assumption seems reasonable under conditions where enough food exists to support a bloom nurse-colonies, phorozoids, and gonozoids. Thus, sufficient data are available to develop a preliminary working model of doliolid population dynamics, and to support the necessary assumptions in this model. The second half of the 2012 grant year will be dedicated to the final development of said model.

**How will results be incorporated into NOAA Fisheries operations?** Our work will help to improve predictions for doliolid bloom occurrence. The abundance of doliolids in oceanic regions is relevant to the NOAA mission in several ways. Doliolid blooms may alter the trophic structure and food resources available to different continental shelf fish species. It has been suggested that future climate change and variability will affect plankton and planktivorous fish food web structure and function. We are working to describe potential impacts of the projected increase in temperature on doliolid population dynamics in the US South Atlantic Bight. Findings from the proposed research will improve our understanding of the impacts of a projected temperature increase on doliolids, and its implications for plankton and fish food web structure and function. In addition, the results of this study provide information that is needed for ecosystem-based management planning.

**How will results be incorporated into LMRCS research, training and curriculum?** Dr. Gibson is in the process of setting up a lab at HU to rear zooplankton under controlled environments in the efforts to work with Dr. Elliott to submit an NSF proposal to continue this project. Shadaesha Green will continue to analyze data from this project through the end of the funding period of this project. She will also be trained by Dr. Elliott on the construction of the IBM. Data from this project will also be included in lectures in Dr. Gibson's Intro to Marine Science and Zoology courses.

**10. Project Title:** Diversity of *Hematodinium* sp. in the Maryland Coastal Bay Ecosystem

**Project Description:** The blue crab (*Callinectes sapidus*) fishery is of critical importance to the economics of the Chesapeake Bay region. Stressing these populations is infection by the dinoflagellate parasite *Hematodinium* sp. Detection of free-living *Hematodinium* sp. from environmental samples will be important to understand how crabs may acquire infection, and what stages in the parasite life cycle influence infectivity. Using the most specific molecular technology available, this collaboration between UMES, IMET, NOAA, and the National Park Service (NPS) will investigate potential reservoirs of blue crab disease in the Maryland Coastal Bays. Our goal will be to develop an understanding of the community population structure among the various dinoflagellates within this ecosystem.

**Thematic Area Addressed :** Essential Fish Habitats

**Lead Scientist(s):** Dr. Joseph Pitula (UMES)

**NOAA Collaborator(s):**

**LMRCSC Collaborator(s):** Dr. Feng Chen (IMET)

**LMRCSC Research Student(s):**

**Planned Start Date:** January 1, 2012

**Planned End Date:** December 31, 2012

**Planned and actual results of project:** The long-term goal of this study is to investigate potential environmental reservoirs and associated biotic factors of blue crab disease in the MCB. We will be exploring the spatial and temporal dynamics of *Hematodinium sp.*, along with other dinoflagellate species, through PCR-based assays. We will also explore the community structure of the putative free-living dinospore life cycle stage. The study area will include bays with different levels of anthropogenic and agricultural impacts and a historical presence of *Hematodinium sp.* This will give us greater insight into how disease transmission may occur, and what the possible biotic reservoirs for disease may be.

**How will results be incorporated into NOAA Fisheries operations?** The mode of infection of blue crabs, particularly in its natural environment, remains unknown. These studies are designed to contribute information relative to these potential modes. By correlating these observations with seasonal cycles in oxygen concentrations and potential algal blooms, we will have a more complete picture of those factors that contribute to this disease of crabs.

**How will results be incorporated into LMRCSC research and curriculum?** The techniques learned will be essential in expanding the capabilities of UMES and will provide skills in molecular analysis. Students trained under this project will thus have increased competency in additional techniques that involve biotechnology. The use of genetic analysis will also provide a means for performing Cluster analysis which will enable students to generate and analyze phylogenetic comparisons among dinoflagellate species. In the coming semester (Fall 2012) Dr. Pitula will be team teaching a graduate course in Environmental Microbiology, in which he will be incorporating this work into his unit on algal phytoplankton species. In addition, this project has resulted in the training of two MS students in the LMRCSC, one MEES student, and generated a publication with two of these graduate students plus one undergraduate intern.

**11. Project Title:** Monitoring pathogens of blue crabs (*Callinectes sapidus*) along a climatological and latitudinal gradient

**Project Description:** Using sensitive quantitative molecular methods, we are assessing the prevalence of two fatal pathogens of blue crab, a reovirus and a protozoan parasite, from DE Bay to the south shore of MA. This project, which involves both graduate and undergraduate students, can serve as a template for long-term studies of the effects of climate change and latitude on blue crab disease prevalence in the Northeast.

**Thematic Area Addressed:** Essential Fish Habitat\_

**Lead Scientist(s):** Eric J Schott (UMES-IMET)

**NOAA Collaborator(s):** Ron Goldberg (NOAA-NMFS, Milford Lab)

**LMRCSC Collaborator(s):** Dennis McIntosh (DSU)

**LMRCSC Research Student(s):** Ammar Hanif (Graduate student, IMET)

**Planned Start Date:** Jan. 1, 2012

**Planned End Date:** Dec. 31, 2012

**Planned and actual results of project:**

**Specific objectives of the project:**

1. Determine the early and late season *Hematodinium sp.* and reovirus (RLV) prevalence in blue crabs within the DE NERR.
2. Measure *Hematodinium sp.* and RLV prevalence in blue crabs of mixed age/size classes along a climatic and latitude gradient from DE Bay to southern Massachusetts.
3. Establish and enhance a network to conduct long term crab disease monitoring in the region, to enable correlations between disease, crab abundance, and climate change.

**Activities addressing the specific objectives:**

- \* A summer intern (Erica Igwacho) from Morgan State University is being trained in molecular detection of crab pathogens, crab health, and field sampling methods. Graduate student Ammar Hanif is completing his master's

dissertation. Summer intern Igwacho has completed the virus analysis of 2011 crabs from Barnegat Bay, NJ. She extracted RNA, conducted quantifications, and followed that with quantitative PCR to detect the blue crab reovirus. Her qPCR data show that RLV is indeed present at low prevalence in NJ waters.

Master's student Ammar Hanif is planning to defend his MS dissertation in August of this year. He has plans to continue with PhD studies with another faculty member (A. Place) at IMET.

- \* Collaborations with state managers in DE, MA, and NJ: These relationships are established, and will be used to obtain crabs from waters of respective states late in summer 2012. Collaborators will send crabs to us in September and October. Pathogen analyses will be conducted throughout the winter.
- \* The collaboration with DE NERR managers is particularly helpful. Summer intern Erica Igwacho, master's student Ammar Hanif, and PI Eric Schott accompanied DE NERR staff (Mike Mensinger) and his intern on a sampling trip on July 19. Crabs were trawled from the upper, middle and lower St Jones River as well as the nearshore DE Bay. The communications with the Sound School (Tim Visel) have also been good, and we are discussing possible sources of non-fishing mortality, including pesticide residue related to mosquito control in the NE.
- \* Development of a map of the distribution of blue crab RLV and *Hematodinium* in the Northeast: Thus far, analysis of 2011 samples from NJ (Barnegat Bay) have shown *Hematodinium* and reovirus. This is the farthest north we have observed *Hematodinium*. Even farther north, near the west end of Long Island, we have detected the most northerly presence of RLV.

**How will results be incorporated into NOAA Fisheries operations?** Blue crabs are not a federally managed species. However, interactions with state and federal scientists in MD, DE, CT, and MA demonstrate how relevant this research is to the management of blue crabs, which support a \$160 million fishery in the US. It is reasonable to expect that in the Northeast, with the growing recreational and commercial harvest of blue crabs, supply and disease issues will arise. In the spring of 2011 we were contacted to help investigate the cause of a blue crab die-off in CT. This underscores the relevance of the proposed survey to multi-state crab health monitoring.

**How will results be incorporated into LMRCSC research and curriculum?** Findings will be incorporated into Dr. Schott's seminar course, offered this fall to MEES students in the University of MD system (including LMRCSC students at UMES or IMET): Diseases in the Chesapeake Bay" MEES 608C. Dr. Schott was recently invited to present a lecture to the Biology Department at University of Notre Dame. March 17, 2012. "Chesapeake Bay health from the blue crab perspective".

**12. Project Title:** Using otolith elemental analysis to classify natal grounds of spawning summer flounder, *Paralichthys dentatus*, and spot, *Leiostomus xanthurus*

**Project Description:** This project aims to collect juvenile flounder and spot along the Delaware and Chesapeake bays, and extract their otoliths for ageing and for elemental analysis. Adult flounder and spot will also be collected, aged and otoliths will be analyzed for elemental ratios. Connectivity between fish groups (Delaware Bay vs. Chesapeake Bay) will be determined using the elemental fingerprints.

**Thematic Area Addressed:** *Essential Fish Habitat*    *Quantitative Fisheries*

**Lead Scientist(s):** Stacy Smith (DSU)

**NOAA Collaborator(s):**

**LMRCSC Collaborator(s):** Eric May (UMES)

**LMRCSC Research Student(s):** Aicha Toure (DSU)

**Planned Start Date:** 1 January 2012

**Planned End Date:** 31 December 2012

**Results of project:** The overarching goals of this project are to assess the stock structures of summer flounder, *Paralichthys dentatus*, and spot, *Leiostomus xanthurus*, in the Delaware and Chesapeake bays. Of the five objectives originally proposed, we are currently working on two: 1) collecting and ageing juvenile fish by counting right sagittal otolith rings; and 2) training and engaging LMRCSC undergraduate and graduate students in fisheries research that is aligned with and relevant to NOAA's mission. To date, LMRCSC-funded undergraduate student, Aicha Toure, and graduate student Hillary Dean have collected juvenile flounder and juvenile spot from Woodland Beach, Smyrna, DE, Ted Harvey Conservation Area, Kitts Hummock, DE, and Cape Henlopen State Park, DE. They will continue to collect juvenile flounder

and spot through the end of October. We will add more Delaware Bay sites and several Chesapeake Bay sites also. The students will also collect adult summer flounder and adult spot from August through October. The students are currently extracting and preparing otoliths for ageing. Once all samples are collected, the second sagittal otoliths from each fish will be sent to partnering institutions to be examined for their elemental constituents (Ba:Ca, Mg:Ca, Sr:Ca and Mn:Ca).

**How will results be incorporated into NOAA Fisheries operations?** The objectives support the NOAA/NMFS priorities to increase understanding and knowledge of fisheries resources. Summer flounder is an important recreational and commercial fish along the Atlantic coast and are not currently overfished but have been in the past. According to the most recent stock assessment, the spawning stock biomass target has nearly been achieved; however, discovering information about species connectivity between bays can be valuable information to managers. No stock assessment has been done on spot, which is an important forage fish. Information about its patterns and whether or not it returns to its natal grounds is relevant to NOAA fisheries.

**How will results be incorporated into LMRCS research and curriculum?** The results will be used in Fish Ecology courses as examples of interconnections between fish groups in adjacent bays.

### **Objective 3.2: Foster collaborative research programs to strengthen the research capacities of partner institutions by leveraging the significant strengths and resources of research universities as infrastructure for capacity building**

#### **Activities and Accomplishments:**

- Monthly meetings and discussions were held by the LMRCS Research Committee that resulted in the development of a Science Plan and CSC-CSC joint research project that was submitted to NOAA EPP
- Several collaborative research projects between scientists at LMRCS MSIs and scientists at Research Intensive institutions (RSMAS, IMET, OSU) are on-going.

#### ***Leverage multiple sources of funding to support the Center's research agenda:***

##### **Activities and Accomplishments:**

- Leveraged funds during this reporting period totaled ~\$1.6 million (Appendices II and III)

**Provide supportive networks and mentoring for early-career faculty, including faculty from underrepresented groups:** LMRCS provides a strong intellectual community for scholars in the marine and fisheries sciences.

- Among the early-career faculty who received funding from the LMRCS for 2011-2012 to conduct research are: Eric Schott (UMCES-IMET), Joseph Pitula (UMES), Andrij Horodysky (HU), Andrea Johnson (UMES), Jessica Miller (OSU), and Stacy Smith (DSU).

**Provide faculty development opportunities that enhance the quality of the academic work environment for faculty at the partner institutions:**

- Andrea Johnson (UMES) made several short visits to NOAA NMFS Woods Hole Lab to conduct research. She also spent two months (May and June, 2012) conducting research at NOAA NOS, Charleston, SC. She has also been provided opportunities to gain administrative experience by being appointed as Associate Director and Education Coordinator of the LMRCS leveraged Center, CREST-CISCEP funded by NSF.

#### **NOAA LMRCS Scientific and Educational cruise aboard the NOAA Ship Delaware II**

**LMRCS Cruise Planning for 2012:** The purpose of this cruise was to provide at-sea experience to scientific personnel, graduate and undergraduate students of the LMRCS. The plan was to conduct three to four deepwater trawl hauls at depths ranging from 250 to 1,100 m in each of eight areas on the continental slope following a brief sonar survey to assess trawlability. In addition, twenty-three (23) stations, primarily on the continental shelf, were surveyed using a 2 m beam trawl (single wire). Three studies were conducted during the cruise: 1) Climate Change: use of trawl sampling off Virginia and Maryland to investigate northward progress of southern species previously encountered during LMRCS winter cruises, 2) Ocean Acidification (OA) through the collection of deep sea fauna in known locations in Hudson Canyon for laboratory culture in support of the NEFSC OA and Habitats programs, and 3) Deep water stock assessment: to collect monkfish and deep sea red crabs on the mid-Atlantic shelf and slope from Southern New England and the mid-Atlantic sub-regions. Catches of the latter will include genetic sampling to define stock structure of monkfish and systematic collection of stock metrics and reproductive data for rarely-assessed deep sea red crab. Six LMRCS graduate students participated in the cruise from UMES and DSU.

## **SCHOLARLY PRODUCTIVITY**

In the current reporting period, LMRCSC students and faculty made 81 presentations (42 oral and 39 poster) at scientific meetings, published 12 articles in refereed journals with another 3 in press or accepted (Appendix V).

**Grantsmanship:** A total of ~\$1.6 million (Appendix II and III) was collectively awarded to the LMRCSC partner institutions during the current reporting period which directly or indirectly impacted Center activities. Of the total amount of funds awarded to LMRCSC, ~\$40,000.00 came from NOAA, whereas \$1.55 million was obtained from other agencies. The funds provided by these agencies were used to support faculty and students and develop/enhance infrastructure. Four proposals that total \$1.7 million (Appendix IV) were submitted to various agencies during this reporting period.

## **SECTION II – EDUCATION AND OUTREACH ACTIVITIES**

### **1. How many students and faculty were recruited to participate in academic programs, training, workshops, conferences or seminars?**

More than 73 students (Tables 1-6) participated in academic programs, training, workshops, conferences or seminars during this reporting period. Dr. Shari Wiley, an Applied Mathematician hired in fall 2011 by HU in the Department of Mathematics, has begun collaborations with LMRCSC faculty, particularly at HU

**2. What are the new education programs (degree certificate programs, etc.)?** A consortium of NOAA Cooperative Science Centers has formed a partnership to offer a six week summer program for 20 high school seniors interested in pursuing degrees in the Geosciences. Students receive training in geology, physical oceanography and atmospheric science, marine biology, marine chemistry/biogeochemistry, and remote sensing/GIS through hands-on laboratory and field exercises, lectures and field trips. Students will also enroll in a college-level Algebra or Calculus I course and a freshman seminar designed to introduce them to college life.

**3. Students receiving direct and indirect support from the LMRCSC.** Seventy two students received direct support, whereas more than 30 students received indirect support from the LMRCSC during this reporting period.

### **4. What outreach activities (e.g. workshops, conferences, seminars) have the Cooperative Science Center coordinated as part of the project?**

**K-12 Education and Outreach Programs:** The Center conducts several initiatives aimed at exposing students in grades K-12 to the marine sciences.

- **SSU Coast Camp for Youth:** During this reporting period, LMRCSC offered its month-long summer marine science camp to ~100 youth at SSU for the 6<sup>th</sup> consecutive year. The SSU Coast Camp, coordinated by Dr. Dionne Hoskins, is designed to teach students how to be better stewards of the marine environment using NOAA's 7 ocean literacy principles. Students are divided into 4 classes: lower elementary (7-8 years), higher elementary (9-10 years), middle school (11-13 years), and high school (14-18 years). Each class is taught by 3-4 counselors. By serving a broad age group and being affordable, the SSU Coast Camp offers strong, accessible science instruction and long term exposure to marine science for a diverse audience of youth. A new component was the inclusion of 'junior counselors', high school students who had participated in the program the previous year. Askia Muhammad, Bonnie O'Donnell, and Bill Gardner are all 5 year camp veterans who taught this year.
- **CREST CISCEP Student Enrichment and Experiential Learning (SEEL):** LMRCSC faculty hosted and mentored 7 high school students from Worcester, Wicomico and Somerset county public schools in Maryland for 7 weeks during summer of 2012. Students conducted research along-side their mentors, LMRCSC graduate students and REU undergraduates and produced posters and Powerpoint presentations of their results. These were presented at a symposium that was held at UMES on August 3, 2012.
- **Teacher Development Workshop:** UMES offered a workshop for K-12 science teachers from July 16-27, 2012, designed to provide hands on lessons in lab and field research in marine and environmental science which can be infused into existing K-12 science curricula. Approximately forty (40) applications were received for the 2012 program from teachers nationwide with eight initially accepted, however five ultimately participated. Teachers conducted research projects under the guidance of Drs. Paulinus Chigbu, Andrea Johnson and other UMES faculty and produced a lesson plan for use in the classroom.
- The Living Marine Summer interns at UMCES-IMET participated in the **Coastal Environmental Adventure** provided by SciTech for over 100 students from two middle schools from Pennsylvania. During the ~ 6 hours the middle school students were at IMET, they rotated through 8 different activity stations in groups of about 13 students. The 8 activities were: 1) a tour of ARC; 2) an overview of the Chesapeake Bay watershed; 3) a "Chesapeake Bay Critter Investigation"



activity, where students checked out some of the cool critters that live in the Bay; 4) a water collecting/water quality testing activity; 5) a “Who Polluted the Inner Harbor?” talk/demo, where students find out about the effects of pollution on the Bay; 6) a “History of the Chesapeake Bay” talk; 7) a talk/activity about Pierce’s Park; and 8) a “detox” station, where the kids can just hang out.

- LMRCSO graduate students and summer interns have participated in the **Healthy Harbor Scientist Program** organized by the Waterfront Partnership as part of Baltimore’s Healthy Harbors Initiative, <http://healthyharborbaltimore.org>. The students have been educating the public on the health of the Baltimore Harbor, problems with stormwater runoff, life in the Harbor, summer changes in water quality: Weekends at Inner Harbor June-August, 2012.
- Dr. Dionne Hoskins and Mr. Greg Hunter are co-regional coordinators for the National Ocean Science Bowl at Savannah State and hosted the 2012 NOSB with a \$25,000 subsidy from the Consortium for Ocean Leadership. An NOSB webpage with student videos was created to recruit high school teams ([www.southernstingraybowl.wordpress.com](http://www.southernstingraybowl.wordpress.com)).
- **Website:** A major redesign of LMRCSO web site ([www.umes.edu/lmrsc](http://www.umes.edu/lmrsc)) intended to make the site more comprehensive and centralized was launched during this reporting period. The new site highlights linkage with NOAA and Center accomplishments and make them more accessible to the user. The site includes biographic information for faculty and graduate students at each Center partner. Each of the LMRCSO partner institutions also has its own website that is directly linked to the LMRCSO main web page.
- **Facebook:** LMRCSO Technical Monitor Jeanine Cody created an LMRCSO page on Facebook which went live on July 20, 2009. It provides students and others a forum to network and discuss marine and fisheries issues, job and funding opportunities, current events in marine science, etc. Two hundred forty-eight (248) individuals, including many students, have signed up as ‘fans’ of the site.

### SECTION III – SUCCESS STORIES (SCIENTIFIC AND STUDENT ACCOMPLISHMENTS)

- The Center established the Network of NOAA Cooperative Science Centers and High schools for training High School Students in the Geosciences. This collaboration of LMRCSO, ECSC, NCAS and CUNY-CREST will train approximately 20 graduating high school seniors in marine geology, physical oceanography and atmospheric science, marine biology, marine chemistry/biogeochemistry, and remote sensing/GIS through an intensive 6-week residential program. Many of these students will enter CSC undergraduate programs following their participation.
- Jan Vicente (PhD, UMCS-IMET) was awarded the Nancy Foster Scholarship in June 2012.
- Five new PhD students were added to the Center during this reporting period: Michline Brice and Hector Malagon (UMES), Chante Davis, Melissa Litz and Smith Vasquez Caballero (OSU).
- Two students from the initial cohort of four accepted into the PSM program at UMES, Jeffrey Kipp and Andrew Turner, graduated in May 2012. Jeffrey has secured a position as a Stock Assessment Scientist with the Atlantic States Marine Fisheries Commission. Andrew is working as a Fishery Biologist at the NOAA Chesapeake Bay Office.

#### 1. What specific contributions have the projects made to the Center, NOAA and partners?

- The LMRCSO educational, research and outreach activities have resulted in several contributions during this reporting period. Seventy two (72) students from B.S. to doctoral levels were supported and trained in NOAA core sciences. Four (4) MS students graduated. Twelve (12) projects funded through the TAB are underway for 2011-12; \$1.6 million in external funding is supporting Center-related activities.
- The Center’s doctoral graduates, Larry Alade, Ayeisha Brinson and Jose Reyes-Tomassini, all NMFS employees, are continuing to collaborate with the Center particularly in teaching courses in support of its mission.
- Noelle Hawthorne’s (M.S., SSU) work is helping to refine how GRNMS estimates utilization of Gray’s Reef by commercially important migratory species. Tiffany Ward’s (B.S., SSU) (with Eric Ransom) work on natural and artificial oyster reefs is allowing us to provide important data to the restoration center on the comparative value of restored oyster reefs.

**2. How many students participated in Center projects or activities?** Seventy two (72) students participated in the Center projects. The names of some of the students, their research projects and presentations they made during this

reporting period are presented in Appendix V. More than 200 K-12 students participated in the Center educational and outreach activities.

**3. What specific benefits were accrued to students, faculty members and the institution(s) by participating in the program?** Students benefited from their participation in the projects through hands-on research experience, completion of theses in partial fulfillment of their degree requirements, stipend, and travel awards to conferences. Besides, some students secured employment after completion of their degree programs, or received scholarships for graduate studies.

**Student Awards:**

- Jan Vicente (Ph.D., UMCES-IMET) was awarded the prestigious Nancy Foster Scholarship to study the impact of ocean acidification on the ability of sponges to build their skeleton and to investigate how the bacterial symbionts of the sponge *Mycale laxissima* vary in accordance to acidifying ocean conditions. The purpose of this study is to look for microbial communities that could serve as biological indicators of climate. See: <http://www.umces.edu/imet/project/noaa-scholarship-awarded-jan-vicente-study-impact-ocean-acidification-marine-sponges>. Jan was also awarded the Lerner Grey Fellowship from the American Museum of Natural History to study the symbiotic relationship between *Plakortis* sp. and *X. deweerdtiae*, \$2000 for one year.
- Smith Vasquez Caballero (Ph.D, OSU) was awarded with an “Honorable Mention for Outstanding Published MS Thesis” at the Western Agricultural Economic Association annual meeting in June 2012. Smit was also awarded the Eric Englund Post-Graduate Memorial Scholarship for the 2012-2013 academic year.
- Noelle Hawthorne won a travel grant to the Southeastern Estuarine Research Society Meeting in NC (April 11-13).
- Nine LMRCSC students were recognized for their research at the 6<sup>th</sup> NOAA Education and Science Forum in Tallahassee, FL in March 2012
  - Jeanette Davis (Ph.D, UMCES-IMET) – First Place Oral Presentation (Graduate)
  - Monet Murphy (B.S., SSU) – First Place Oral Presentation (Undergraduate)
  - Eric Evans (Ph.D., UMES) – First Place Poster (Graduate, Weather Ready Nation)
  - Crystal Smith (M.S., SSU) – First Place Poster (Graduate, Healthy Oceans)
  - Symone Johnson (B.S., HU) – First Place Poster (Undergraduate, Healthy Oceans)
  - Keya Jackson (B.S., HU) – Honorable Mention (Undergraduate, Healthy Oceans)
  - Whitney Dyson (M.S., UMES) – First Place Poster (Graduate, Resilient Coastal Communities)
  - Amy Cannon (B.S., UMES) – Honorable Mention (Undergraduate, Resilient Coastal Communities)

**Students who Received Employment as a Result of their Work at the Center:** Jeff Kipp is now employed as a stock assessment scientist at the Atlantic States Marine Fisheries Commission. Andrew Turner is working as a fishery biologist at NOAA Chesapeake Bay Office.

**Students who Received Scholarships for Graduate Degree Programs as a Result of their Work at the Center:**

Xaymara Serrano and Rolando Santos (RSMAS) continued to receive support during this period from the McKnight Fellowship to support their PhD work.

Kendall Crawford (HU) received a two year Marshall Scholarship for graduate studies at University College, London.

**Students who received Training at NOAA Laboratories or at Center Institutions**

a) William Gardner has been conducting research in collaboration with Dr. Ashok Deshpande at the NOAA J.J. Howard Marine Science Lab at Sandy Hook continuously from April, 2009 to the present. William is analyzing the PCB content of Atlantic coast and Chesapeake Bay striped bass. He is expected to graduate in December 2012.

**4. To what extent have the projects or activities enhanced and improved outreach, education, training and NOAA related research at the institutions?** Students supported under the LMRCSC have access to tools and training they would not have were it not for the LMRCSC. Several students at the Center institutions who are not directly funded by the LMRCSC are benefiting from the infrastructure and equipment made available to the institutions by the LMRCSC. The LMRCSC has secured leveraged funding that has enabled the Center institutions to recruit and support more students than they would otherwise be able to support.

**5. Did students participate in experiential research at, site visits to, or seminars at/with NOAA laboratories and/or facilities?** Yes. Names of the student participants are listed in Tables 4 and 5.

**6. In what specific NOAA science, service or stewardship activities (e.g. NOAA research cruises; weather forecast modeling, etc.) were students involved?** NOAA LMRCSC research cruise.

**7. What significant impact(s) does the LMRCSC research, education and outreach, and administrative functions have university-wide, for the local community, and at the local, state, regional or national level?**

- The Center is having a significant positive impact nationally on the number of students trained in NOAA-related STEM disciplines.
- SSU's marine sciences program was noted by state Senator Buddy Carter, chairman of the state Senate Higher Education Committee, (<http://m.savannahnow.com/news/2012-01-06/savannah-state-armstrong-atlantic-not-consolidation>) and Georgia Board of Regent's Chancellor Hank Huckaby as being respected for its degree offerings. This opinion significantly deterred discussions of merging SSU with Armstrong Atlantic State Univ. in Sept. 2011.
- LMRCSO supported graduate students participated in teaching STEM lab courses to more than 100 students enrolled each year in the Department of Natural Sciences at UMES.

**SECTION IV – REVISIONS TO TASKS AS DESCRIBED IN GRANT AWARD AMENDMENTS AND THE IMPACT TO THE AWARD:** There were no amendments to the award.

**APPENDICES**

**Appendix I: Partial List of NOAA NMFS Scientists Collaborating with LMRCSO Scientists and Students**

<b>NOAA Scientists</b>	<b>NOAA Lab</b>	<b>Role at the LMRCSO</b>
Larry Alade	NOAA NEFSC Woods Hole Lab, MA	UMES Adjunct Faculty. Participates in teaching the Fish Stock Assessment course at UMES
Ayeisha Brinson	NOAA NEFSC Woods Hole Lab, MA	Participated in teaching Intro. to Environmental and Resource Economics course at UMES
Ambrose Jearld	NOAA NEFSC Woods Hole Lab, MA	UMES Adjunct Faculty. Participated in teaching the Fish Stock Assessment course at UMES
Mike Fogarty	NOAA NEFSC Woods Hole Lab, MA	Participated in teaching the Fish Stock Assessment course at UMES. Member of LMRCSO External Advisory Committee
Dvora Hart	NOAA NEFSC Woods Hole Lab, MA	UMES Adjunct Faculty. Participated in teaching the Fish Stock Assessment course at UMES; Served on graduate student committee
Rich McBride	NOAA NEFSC Woods Hole Lab, MA	Collaborates with Andrea Johnson (UMES); Serves on graduate student committee; Works with Evan Lindsay (PSM graduate student during summer internship)
Ashok Deshpande	NOAA NEFSC, Sandy Hook Lab	Collaborates with Eric May; Will Gardner (UMES Ph.D. student) works in his lab at NOAA
Chris Chambers	NOAA NEFSC, Sandy Hook Lab	Collaborates with Ali Ishaque (UMES), Rose Jagus (IMET); Adam Tulu (UMES Ph.D. student) works in his lab at NOAA
Vince Guida	NOAA NEFSC, Sandy Hook Lab	Jacklyn James (UMES graduate student) worked in his lab at NOAA
Beth Phelan	NOAA NEFSC, Sandy Hook Lab	Collaborates with Brad Stevens; Courtney McGeachy (UMES M.S. student) worked with her at NOAA
Anne Richards	NOAA NEFSC Woods Hole Lab, MA	Collaborates with Andrea Johnson (UMES); Serves on graduate student committee; Worked with Dan Cullen (UMES graduate student) and Belita Nguluwe (UMES graduate student)
Elizabeth Brooks	NOAA NEFSC Woods Hole Lab, MA	Served as mentor of Jessica Blaylock (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Kate Andrews	NOAA NEFSC Beaufort, NC	Served as mentor of Jeff Kipp (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Richard Brill	NOAA NEFSC/VIMS	Collaborates with Andrea Johnson (UMES) & Andrij Horodysky (HU); Serves on graduate student committees
Bruce Vogt	NOAA Chesapeake Bay Office, MD	Served as mentor of Andrew Turner (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Howard Townsend	NOAA Chesapeake Bay Office, MD	UMES Adjunct Faculty. Collaborates with P. Chigbu; Served as mentor of Andrew Turner (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Doug Wilson	NOAA NEFSC Chesapeake Bay Office, MD	Serves as a member of External Advisory Committee of LMRCSO

Gary Wikfors	NOAA NEFSC Milford Lab	Collaborates with Eric Schott (IMET); Gulnihal Ozbay (DSU); Serves on Graduate Student committee
Gary Shepherd	NOAA NEFSC Woods Hole Lab, MA	Works with Brad Stevens (UMES) and Dan Cullen (UMES graduate student)
Kristy Wallmo	NOAA Headquarters, Silver Spring, MD	LMRCSC Technical Monitor; UMES Adjunct faculty. Participates in teaching Intro. to Environmental and Resource Economics course
David Tomberlin	NOAA Headquarters, Silver Spring, MD	UMES Adjunct Faculty. Participates in teaching Intro. to Environmental and Resource Economics course
Mark Brady	NOAA Northeast Regional Office, Gloucester, MA	Served as mentor of Leonardo Matthews (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Kevin Chu	NOAA Southwest Regional Office	Member Employer Advisory Board of the Professional Science Masters degree Program that was leveraged with the LMRCSC.
Jim Nance	NOAA SEFSC Galveston, TX	Member, External Advisory Committee of the LMRCSC
Gretchen Messick,	NOAA NCCOS Cooperative Oxford Lab, MD	Collaborates with Eric Schott (IMET)
Bob Wood	NOAA NCCOS Cooperative Oxford Lab, MD	Serves as a member of Employer Advisory Board of the Professional Science Masters degree Program that was leveraged with the LMRCSC.
John Jacobs	NOAA NCCOS Cooperative Oxford Lab, MD	UMES Adjunct Faculty. Collaborates with Eric May (UMES), Serves on graduate thesis committee of UMES students (Lonnie Gonsalves and Candace Rodgers)
Frank Morado	NOAA NWFSC, Seattle, WA	Collaborates with Joseph Pitula (UMES)
Margaret Miller	NOAA SEFSC, Miami, FL	Collaborates with Daniel Benetti (RSMAS) and RSMAS graduate student (Dwight Ebanks)
Joe Serafy	NOAA SEFSC	Collaborates with Diego Lirman (RSMAS) and Rolando Santos (Graduate student, RSMAS)
Tom Hurst	NOAA AFSC	Collaborates with Jessica Miller (OSU)
Ed Farley	NOAA AFSC	Serves on graduate committee of Shari Mullen (UMES graduate student)
Jamal Moss	NOAA AFSC	Serves on graduate committee of Shari Mullen (UMES graduate student); Shari conducts her research at AFSC.

#### Appendix II. Current leveraged funding from NOAA to LMRCSC institutions

Author	Funding Agency	Title of Project	Start/End Date	Amount	Current 6 month period
Johnson, A.K (UMES) and R.A. Richards (NOAA)	NOAA NMFS-Monkfish Set Aside Program	Influence of temperature on the distribution and catch rates of monkfish, <i>Lophius americanus</i> .	5/1/11-4/30/12	\$ 79,899	\$39,949.50
<b>TOTAL</b>					<b>\$39,949.50</b>

#### Appendix III. Current leveraged funding to LMRCSC institutions from sources and agencies other than NOAA (\*Students)

Author	Funding Agency	Title of Project	Start/End Date	Amount	Current 6 month period
*Serrano, X. (RSMAS-Student)	Mote Marine Lab	Coral connectivity between deep and shallow sites in the tropical western Atlantic:	10/2009-10/2012	\$18,000	\$3,000.00
*Santos, R. (RSMAS-Student)	McKnight Fellowship	Multi-scale spatial variation of nearshore submerged aquatic vegetation seascapes at Biscayne National Park	8/2009-7/2012	\$30,000	\$5,000.00
Die, D.J. (RSMAS)	NTVI (*)	Center for independent experts	9/2007-9/2012	\$343,610	\$34,361.00

Die, D.J. (RSMAS)	NTVI (*)	Development of survey inventory fishery independent survey	8/2011-8/2012	\$152,827	\$76,413.00
Die, D.J. (RSMAS)	ISSF	Evaluation of management strategies for tropical tuna fisheries	7/2010-7/2012	\$132,906	\$33,226.00
Frischer, M. (SKIO), Gibson, D.(HU) G. Paffenhöfer	NSF	Doliolid Blooms: What are the Driving Variables? Investigations of Trophic Interactions	1/1/09-12/21/12	\$75,688	\$12,614.67
Halverson, C., Gibson, D.(HU) and C. Witherspoon	NSF OCE ISE	Communicating Ocean Sciences to Informal Education Network (COSIEN)	10/1/10 – 9/1/12	\$32,281	\$8,070.25
Smith, S. (DSU), Ozbay, G. (DSU)	USDA-NRCS	The efficacy of heavy use area protection (HUAP) pads to decrease runoff of nonpoint source pollution into the Chesapeake Bay watershed.	8/1/2011-8/1/2012	\$99,435.92	\$49717.96
Ozbay, G. (DSU)	USDA-CBG	“Enhancing Geographic Information System Education and Delivery through Collaboration: Curricula Design, Faculty, Staff, and Student Training and Development, and Extension Services.	9/1/2010-8/30/2013	\$299,996	\$49,999.33
Ozbay, G. (DSU)	USDA-AFRI	Inactivation of enteric foodborne viruses in high risk foods by non-thermal Processing technologies.	2/1/2011-1/31/2016	\$2,000,000	\$200,000
Ozbay, G. (DSU)	USDA Evans-Allen program	Monitoring aquatic health and habitat value of oyster ( <i>Crassostrea virginica</i> ) gardening and restoration through community-based oyster enhancement efforts.	9/1/2010-8/31/2012	\$209,750	\$52,437.50
Ozbay, G. (DSU)	NSF	Research Experience for Undergraduates Site: Undergraduate Research in Molecular Genetics & Genomics at DSU	5/2010-9/2012	\$250,000	\$62,500
Ozbay, G. (DSU)	EPA	Mid-Atlantic Drinking Water Program: Drinking Water and Human Health. National Integrated Water Quality Program (NIWQP)	12/1/2009-11/30/2012	\$48,000	\$8,000
Hoskins, D.(SSU)	Ocean Leadership	National Ocean Science Bowl (GA-SC) competition	2011-12	\$15,000	\$7,500.00
Hoskins, D. (SSU)	Ocean Leadership	Diversity Initiative	2011-12	\$10,000	\$5,000.00
Curran, C.(SSU)	US Dept of Edu	THBCU Graduate Program	2009-15	\$3,000,000	\$250,000.00
Gilligan, M.(SSU)	NSF	Research Experience for Undergraduates	2009-14	\$291,434	\$48,739.00
Pride, C.(SSU), C. Curran, (SSU), P. Verity	NSF	New GK12: Building Ocean Literacy in a Coastal Community Through Science	2009-14	\$2,214,884	\$221,488.40
P. Chigbu & J. Love (UMES)	NSF	University of Maryland Eastern Shore REU in Marine and Estuarine Science	6/1/09 – 5/31/12	\$231,521	\$38,586.83
P. Chigbu, J. Pitula, E. May, M. Mitra, & A. Johnson (UMES)	NSF	CREST Center for the Integrated Study of Coastal Ecosystem Processes and Dynamics	8/1/10 – 7/31/15	~\$5,000,000	~\$500,000
P. Chigbu, K. Wallmo (NOAA),	NSF	Professional Science Master’s degree in Quantitative Fisheries and Resource	5/1/10 – 4/30/13	~\$700,000	\$116,666

J. Okoh, J. Keane-Dawes, S. Tubene (UMES)		Economics			
E. May, A. Allen (UMES)	USDA Capacity Bldg Grant	Capacity Building Grants Program, Watershed Level Examination of Urea Use as Fertilizer and the Production of the Biotxin Domoic Acid	10/1/10 – 9/30/13	\$499,950	\$83,325.00
A. Allen, E. May (UMES)	USDA Capacity Bldg Grant	Development of A Subsurface Application Technology for Dry Poultry Litter to Protect Air and Water Quality	10/1/10 – 9/30/13	\$599,000	\$99,833.33
Gibson, D., Horodysky, A., Cuker, B.	NSF (HRD-HBCU-UP)	Targeted Infusion Project: Educational Partnership in Climate Change and Sustainability (EPiCCS)	9/1/11 – 8/31/14	\$300,000	\$50,000.00
Gibson, D.	NSF	Doliolid Blooms: What are the Driving Variables? Investigations of Trophic Interactions	January 2009 - December 2012	\$75,688	
<b>TOTAL</b>					<b>\$1,516,478</b>

#### Appendix IV. Grants submitted by LMRCS during this reporting period (Jan. 1 to Jun. 30, 2012)

Author	Funding Agency	Title of Project	Amount
Die, D. (RSMAS)	GOM GRI2	Spatial modeling of impacts of oil spills on GOM fish stocks	\$737,080
Chigbu, P. (UMES), Gibson, D. (HU), Pierson, J. (UMCES)	NSF	CREST-CISCEP Supplement	\$100,000
Chigbu, P. (UMES), Ishaque, A. (UMES), Khanbilvardi, R. (CUNY)	NSF	A network of Cooperative Science Centers for training high school students in geosciences	\$500,000
May, E.B. (UMES), Allen, A.L. (UMES), Chigbu, P. (UMES), Hashem, F.M. (UMES), Ruby, D.E. (UMES)	NSF	Collaborative Research: Climate change and land use impacts of spatial-temporal nutrient dynamic interactions across the mid-Atlantic and Gulf Coast Regions of the United States	\$373,397
<b>TOTAL</b>			<b>\$1,710,477</b>

#### Appendix V: Presentations and Publications

##### Oral Presentations (\*Students, Presenter in bold)

- Bratcher, M.\*, Maurer, L., Pitula, J., and J. S. Chung. Determination of the ontogenetic variation in salinity tolerance of the blue crab, *Callinectes sapidus*. University of Maryland Eastern Shore 2012 Regional Research Symposium. April 19, 2012
- Chen, F. "Marine Microalgae and their Viruses" The South China Sea Institute of Oceanography. Chinese Academy of Science. Guangzhou, China, May 3, 2012
- Chen, F. "Molecular Tools and Microbial Oceanography" State Key Laboratory of Marine Environmental Sciences, Xiamen University, Xiamen, China, April 27, 2012.
- Chen, F. "Marine Viruses and their Ecological Significance" State Key Laboratory of Marine Environmental Sciences, Xiamen University, Xiamen, China, April 23, 2012.
- Chung, J. S. CHH neuropeptide family: pleiotrophic effects on molting and reproduction. Host, Mike Roman, UMES-HPL. January 2012.
- Crawford, K.C.\*, S. Harper, D. Zeller. Reconstruction of Marine Fisheries Catches for Tuvalu (1950-2009), 2012 Ocean Sciences Meeting, Salt Lake City, UT
- Curran, M.C: Adapting Fisheries Science for K-12 Classrooms. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012.
- Davis, J.\* Hill, R. T.: Bacterial symbionts of a marine invertebrate as sources of anticancer compounds. Sixth NOAA-EPP Education and Science Forum, FAMU, March, 2012. *First prize oral presentation, NOAA Healthy Oceans category for graduate students.*

- Flowers, E.M., Whitaker, B. R., Arnold, J., Jenkins, E., Torres\*, L.A., Droppa, D. & Schott, E. "How does a fatal reovirus of the blue crab, *Callinectes sapidus*, move from crab to crab? Eastern Fish Health Workshop. Lake Placid, NY. 23 - 27 April 2012. (Torres was a 2011 LMRCSC summer intern)
- Gaynus, C.\* Isolation and Characterization of Bacteria Samples from Assateague Island, 2012 Ocean Sciences Meeting, Salt Lake City, UT
- Gaynus, C.\* Isolation and Characterization of Bacteria Samples from Assateague Island. 6<sup>th</sup> NOAA Education and Science Forum. March 26-28, 2012. Tallahassee, FL.
- Gonsalves, L.; Jacobs, J.; May, E.; Matsche, M.; Uphoff, J.: Prey Availability and Striped Bass Condition in the Chesapeake Bay. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012.
- Hawthorne, N. C.; Ogburn, M. B.: Separating Behavior from Environmental Interference: Controls in a Marine Acoustic Telemetry Study. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012.
- Hill, R.: Marine biotechnology: Opportunities for South Africa. Host: Michael Davies-Coleman, University of the Western Cape. South Africa. June, 2012.
- Hill, R.: Symbionts in marine sponges: Signaling and other interactions. Host: Michael Davies-Coleman, University of the Western Cape. South Africa. June, 2012.
- Hill, R. Bacterial symbionts in marine sponges: Signaling and other interactions". Host: Mair Churchill, University of Colorado, Denver, Anschutz Medical Campus. April, 2012.
- Horodysky, A. Z.; Crawford, K.; Seagroves, E.; Johnson, A. K.; Brill, R.W.: Sensory ecophysiology of temperate reef fishes in coastal Mid-Atlantic waters: form-function environment syntheses. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Jackson, K. \*Scales, a Nonlethal Alternative to Muscle Tissue for Observing  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  Stable Isotopes of Atlantic Croaker, 2012 Ocean Sciences Meeting, Salt Lake City, UT
- Janiak, C.\* and McIntosh, D. 2012. Mummichogs as a model species for aquaculture education. Aquaculture America, Las Vegas, NV.
- Janiak, C.\* and McIntosh, D. 2012. Alternative Spawning Substrate for the Mummichog, *Fundulus heteroclitus*. Aquaculture America, Las Vegas, NV.
- Johnson, S.\* and R. Brill. Investigation of the Hypoxia Tolerance of Blue Crab (*Callinectes sapidus*), 2012 Ocean Sciences Meeting, Salt Lake City, UT
- Johnson, S.\* and R. Brill. Investigation of the Hypoxia Tolerance of Blue Crab (*Callinectes sapidus*), 2012 Ocean Sciences Meeting, Salt Lake City, UT
- Lopez, L.M.\*, Johnson, A.K., and H. M. Wolfer. Blood chemistry values for Atlantic croaker (*Micropogonias undulatus*) under normoxic and hypoxic conditions. 2012 Ocean Sciences Meeting, Salt Lake City, UT
- McGeachy, C.T.\*, Cullen, D.\*, and B.G. Stevens. Evaluation of black sea bass (*Centropristis striata*) behavioral interactions in and around traps using in situ video. 2012 Ocean Sciences Meeting, Salt Lake City, UT
- McGeachy, C.; Stevens, B. G.: Behavior of Black Sea Bass (*Centropristis striata* L.) around fish traps. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012.
- Mullen, S.; Moss, J.; Shotwell, K.; Ormseth, O.; Zimmerman, M.: The Gulf of Alaska Integrated Ecosystem Research Program: Preliminary Findings from the First Two Field Seasons. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012.
- Murphy, M.; Hoskins, D.: NOAA'S Preserve America Initiative: Unlocking the History of African Americans in Georgia's Coastal Fisheries. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012.
- Nguluwe, B. S.; Johnson, A. K.; Richards, A.; Carlin, J.; Place, A. R.: Stock identification of American monkfish in the Northwest Atlantic Ocean using Mitochondrial DNA. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012.
- Pegus, C.; Ogburn, M. B.; Hoskins, D.L.: The missing link: Do Postlarval White Shrimp *Litopenaeus setiferus* Use Pressure and Salinity as Cues for Estuarine Immigration? 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012.
- Santos\*, R. O.; Lirman, D.: Temporal and Spatial Dynamics of Submerged Aquatic Vegetation Seascapes in Biscayne Bay, Florida, USA. NOAA EPP 6<sup>th</sup> Forum 2012 Tallahassee, FL
- Schott, E. "Chesapeake Bay health from the blue crab perspective". Host, Biology Department, Notre Dame University of Maryland. March 17, 2012.
- Schott, E. "Assembling a program to monitor the prevalence of pathogens of the blue crab (*Callinectes sapidus*) in the Northern limit of its range". National Shellfisheries Association 104<sup>th</sup> meeting. Seattle, WA. March 25-29, 2012.

- Schott, E. "How does a fatal reovirus of the blue crab, *Callinectes sapidus*, move from crab to crab?" Eastern Fish Health Workshop. Lake Placid, NY. 23 - 27 April 2012.
- Seagroves, E. \*, A.Z. Horodysky, RW. Brill, & A.K. Johnson. Visual ecophysiology of tautog (*Tautoga onitis*). 2012 Ocean Sciences Meeting, Salt Lake City, UT.
- Serrano\*, X.; Baker, A: Vertical connectivity in the Caribbean broadcast spawning coral *Montastraea cavernosa* NOAA EPP 6<sup>th</sup> Forum 2012 Tallahassee, FL
- Serrano, X.\*; Baker, A: Vertical connectivity in the Caribbean broadcast spawning coral *Montastraea cavernosa*. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012.
- Sherman, M., B\*.; Curran, M., C.: The Influence of Temperature on the Starvation Rate of Daggerblade Grass Shrimp *Palaemonetes pugio* Infected with the Bopyrid *Probopyrus pandalicola*. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Smith, D.T.\*; Ogburn, M.; Curran, M.C.: Using Acoustic Telemetry to Track the Bonnethead *Sphyrna tiburo* in Romerly Marsh Creek, Georgia, USA. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Stevens, B. G.: Growth, Molting, and Feeding of Juvenile Red King Crabs, *Paralithodes camtschaticus*, in the Laboratory: Effects of Temperature, Size, Molting, and Feeding Frequency. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Watson, A.\*; Barrows, R., Place, A.. Molecular and morphometric approaches to understanding the taurine biosynthesis pathway in the marine carnivore cobia, *Rachycentron canadum*. 20 minute oral presentation. Aquaculture America 2012. Las Vegas, Nevada.
- Watson, A.\*; Rippen, T., Chaudhuri, A., Place, A. Organoleptic differences in fillets from gilthead sea bream, *Sparus aurata*, and striped bass, *Morone saxatilis*, raised on fishmeal and plant protein based diets. 15 minute oral presentation. Aquaculture America 2012. Las Vegas, Nevada.
- Wiley, S.; Yakubu, A.: Harvesting and predator-prey interaction in a Georges Bank food chain. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012

#### **Poster Presentations** (\*Students, Presenter in **bold**)

- Booker, T.\*; May, E.: Evaluate the Potential for Estrogen Steroid Hormones to Affect Larval, Juvenile and Sub-Adult Striped Bass (*Morone saxatilis*) in the Chesapeake Bay. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Cannon, A., \* Ozbay, G., Smith, S. 2012. Wastewater Discharge in Delaware Inland Bays Tidal Canal: A Case Study on Heavy Metal Contaminants. NOAA EPP Sixth Education and Science Forum, Tallahassee, FL. (*Honorable Mention*)
- Cinelli, M\*.; McIntosh, D.: Thermal Tolerance of the Weakfish *Cynoscion regalis*. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Crawford, K.\*; Harper, S.; Zeller, D.: Reconstruction of Marine Fisheries Catches for Tuvalu (1950-2009). 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Cullen, D.W.\*; Stevens, B.: Comparing Baited and Unbaited Video to Assess Black Sea Bass (*Centropristis striata* L.) Abundance. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Dasi, E.\*; Choi, E., & Jagus, R.: Optimization of the expression of zebrafish PKR. UMBC Undergraduate Research and Creative Achievement Day, April, 2012.
- Dasi, E\*.; Eunseok, C.; Jagus, R.: Optimization of the Expression of Zebrafish PKR. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Denson, L. S.\*; Shertzer, K. W.: Spawning Potential Ratio of Red Snapper: Effects of Discard Mortality. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Evans, E.\* and P. Chigbu. The effects of El Nino Southern Oscillation on the abundance, distribution, and recruitment of bay anchovy (*Anchoa mitchilli*) in the Maryland Coastal Bays. University of Maryland Eastern Shore 2012 Regional Research Symposium. April 19, 2012.
- Elfadul, R\*.; Chen, N.; May, E.; Ishaque, A.: *Determination of Contaminants of Emerging Concern (CECs) in Maryland Coastal Bay (MCB)*. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Evans, E. \*; Chigbu, P.: The Effects of *El Nino* Southern Oscillation Events on the Abundance, Distribution and Recruitment of Bay Anchovy (*Anchoamitchilli*) in the Maryland Coastal Bays. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012



- Dyson, W. E.\*; Schott, E.; Hanif, A.; Pitula, J. S.: A PCR-Based Assay for Detection of *Hematodinium* Sp. in Sediment and Water from the Maryland and Virginia Coastal Bays. Sixth NOAA-EPP Education and Science Forum, FAMU, March, 2012. *First prize poster in Resilient Coastal Communities category for graduate students.*
- Gardner, W. G\*.; May, E. B.; Deshpande, A.: Spatial and Age-related Dynamics in Bioaccumulation of Polychlorinated Biphenyls in Chesapeake Bay Striped Bass (*Morone saxatilis*). 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Gaynus, C\*.; Okulate, D.: Isolation and Characterization of Bacterial Samples from Assateague Island Maryland. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Gillespie, K.\*; Eunseok, C.; Currie, A. E.; Jagus, R.: Elucidating cDNA Sequences of eIF4E Family Members -2A and -2B from Zebrafish. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Hanif, A\*.; Mesinger, M.; McIntosh, D.; Estrella, B.; Goldberg, R.; Schott, E.: Assembling a Program to Monitor the Prevalence of Pathogens of the Blue Crab (*Callinectes sapidus*) in the Northern Limit of its Range. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Hanif, A.\*; Mensinger, M., McIntosh, D., Estrella, B., Goldberg, R., & Schott, E. Assembling a program to monitor the prevalence of pathogens of the blue crab (*Callinectes sapidus*) in the Northern limit of its range. National Shellfisheries Association 104th meeting. Seattle, WA. March 25-29, 2012.
- Hernández, W. J.; Armstrong, R. A.: Benthic Habitat Mapping for La Parguera Marine Reserve, Southwest Puerto Rico, using Passive and Active Remote Sensing Data. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Jackson, K. J.; Walther, B. D.: Scales, a Nonlethal Alternative to Muscle Tissue for Observing  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  Stable Isotopes of Atlantic Croaker. 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Johnson, S\*.; Brill, R.: Hypoxia Tolerance of the Blue Crab (*Callinectes sapidus*). 6<sup>th</sup> NOAA EPP Education and Science Forum. Tallahassee, FL. March 26-28, 2012
- Janiak, C\*., Blank, G. McIntosh, D. 2012. Feasibility of decreasing salinity during incubation and hatching on growth and survival of the marine baitfish, *Fundulus heteroclitus*, Aquaculture America, Las Vegas, NV.
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### **Appendix VI. Acronym and LMRCS Links**

1. **Link to the LMRCS Performance Reports** - <http://www.umes.edu/LMRCS/Default.aspx?id=16024>
2. **Link to LMRCS Leveraged CREST-CISCEP** - <http://www.umes.edu/crest/Default.aspx?id=31676>
3. **Link to the LMRCS Leveraged PSM Program** - <http://www.umes.edu/psm/Default.aspx?id=30892>

### **Appendix VII**

10 April 2012

#### **CRUISE RESULTS NOAA Ship Delaware II DE-12-01 NOAA LMRCS SCIENTIFIC AND EDUCATIONAL CRUISE**

##### ***Executive Summary and Highlights***

A ten day cruise was conducted during January, 2012 for the purposes of training students in the NOAA Living Marine Resources Cooperative Science Center (LMRCS) in fisheries science, including learning field sampling procedures, and in support of projects being conducted by faculty and graduate students in the LMRCS program. Scientific objectives included:

- 1) An examination of latitudinal variation in habitat and fish assemblages with a particular eye toward detecting Carolinian fauna making inroads into the Virginian faunal province as an indicate for climate change,
- 2) Investigating spatio-temporal patterns in demersal-megabenthic habitats on the shelf and slope around Hudson Canyon, and
- 3) Exploration on the continental slope to define depth limits of monkfish distribution and the biological condition of the deep sea red crab stock throughout the mid-Atlantic region, with an additional mission to collect live deep sea corals for culture in the laboratory with possible use in ocean acidification work at Sandy Hook.

In pursuit of the latitudinal variations projects, 11 fixed stations off Maryland and Virginia were sampled with CTD and beam trawl. Eleven fixed stations were sampled with CTD and beam trawl for the Hudson Canyon study. These objectives were covered satisfactorily. Due to overoptimistic planning, weather, and equipment loss, only about half of the deep trawl

stations originally planned were sampled. Twelve successful deepwater trawls were made at depths between 235 and 986 m: largely beyond depths sampled by the NEFSC groundfish survey.

Among the highlights of the cruise were the following:

#### **Training and Research Support:**

- One NOAA/NMFS scientist, one LMRCSC faculty member, one NOS technician, and six students participated in the cruise, and one additional faculty who were not actually aboard will be utilizing data and samples obtained on this cruise.

#### **Habitat Observations:**

- **Water temperatures were the highest seen since these cruises began in 2005** throughout the water column shelf-wide and in the upper water column over the slope at all latitudes.
- A pattern continues to emerge on the shelf and slope in which a background of resident species appear consistently in particular habitats year-to-year while others, largely seasonal migrants, do not appear to make use of those habitats in a consistent manner, even in the same season. Data of all types from this and other cruises is being assembled into a **habitat model** to try to understand factors governing the distribution of resource stocks around this canyon.
- **An association between overwintering black sea bass, sponges, and sea scallops** was suggested by the distribution of catches of those species off Maryland and Virginia.
- Dense patches of **deepwater corals** (the solitary cup coral *Dasmosmilia lymani*) and **sponges** continue to persist around the rim of Hudson Canyon. These data are currently being incorporated into **habitat suitability models** for these structural species and **habitat maps** for the canyon.
- Persistence of *D. lymani* has made it possible to collect specimens reliably in a blind beam trawl at Hudson Canyon and keep them alive until they could be transferred to a rearing facility at the Long Island (Atlantis) Aquarium in Riverhead, Long Island, New York. Our collaborators at the Aquarium have thus far been **successful in feeding *D. lymani* specimens and maintaining them in good condition** for the 2 months since the cruise. These and their progeny may be used for biological studies of this species. This is one of only two known successes in the U.S. in rearing deep sea corals.

#### **Ecosystem Assessment:**

- A dataset continues to be developed by which **to assess year-to-year changes in biota shelf-wide** based on a combination of sampling methods taken on a grid of fixed, geographically widespread sites on the mid-Atlantic shelf (the Latitudinal Transects). This includes a **near-synoptic assessment of hydrological climate** that drives migratory patterns in large part. Subject to further development and critical review, this could serve as the basis for a direct biological indicator of fisheries ecosystem state.
- For the fourth year (2008, 2009, 2011, 2012), substantial numbers of juvenile **southern white shrimp** were taken on the shelf off Virginia; their progression northward should be monitored both as a possible indicator of climate change and for its potential commercial importance. Other rare Carolinian species caught in smaller numbers include the **horned whiff** (small flatfish) and a macrurid (grenadier) known primarily from Florida waters. The long-spined sea urchin caught in two previous years was not seen.

#### **Resource Stocks:**

- **Monkfish** (140 count) were caught at depths ranging from 100 to 868 m. Samples were taken for genomic analysis at the University of Maryland Eastern Shore. They occurred in deepwater otter trawls from all four deepwater slope and canyon areas and in some shelf samples taken by beam trawl in the Hudson Canyon vicinity. None were taken on the Maryland-Virginia shelf, as they had been in January, 2011.
- High densities of **deep sea red crab** (exceeding  $10^5$  individuals/km<sup>2</sup>) and **witch flounder** (approaching  $10^4$ /km<sup>2</sup>) were estimated from deepwater trawls. Both species were present at all four slope/canyon areas; deep sea red crabs were dominant in all cases.